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Summaries

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Efektywność – rozważania nad istotą i pomiarem

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Dorota Kuchta, Anna Ślusarczyk
Wrocław University of Technology
e-mails: dorota.kuchta@pwr.edu.pl; anna.slusarczyk@pwr.edu.pl

APPLICATION OF PROACTIVE AND REACTIVE PROJECT SCHEDULING – CASE STUDY

Summary: The paper presents the description of a real-world project in which a combination of proactive and reactive scheduling was applied with success. The aim of the case study is to prove the usefulness of such an approach. A deep analysis of the case is provided, where the reader can follow how the project evolved, what kind of problems were encountered and how the proposed method helped to prevent or solve them. The way the project manager collected the necessary information and cooperated with the project stakeholders is described. A presentation of reactive and proactive scheduling based on a literature review is also provided. The conclusion is that the approach seems to be a necessity in the practice of project management and it is only the lack of openness of organisations and project managers and teams which may prevent it from being widely used in practice.

Keywords: proactive scheduling, reactive scheduling, time buffer.

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1. Introduction

Projects are often delayed – this statement is considered to be true byprobably everybody, as everybody notices many delayed projects in everyday life (e.g. big construction or modernization projects in cities). This statement is also confirmed by serious studies on huge representative samples of projects. For example according to the Chaos Report in the years 2002-2012 [Standish Group 2013] around 80% of IT projects were late. The report of KPMG (a global network of professional firms providing Audit, Tax and Advisory services) says that about 2/3 of projects in their area are late [KPMG 2013]. A delayed project means lost money (often public money), lost opportunities, disturbances in the organizations functioning etc. Thus, an effective project time management is a still unsolved, but very important issue.

As a solution, the literature on project management [Brcic, Kalpic, Katic 2014; Janczura, Kuchta 2012; Demeulemeester, Herroelen, Leus 2010; Ghezail, Pierreval,

Hajri-Gabouj 2010; Van de Vonder, Demeulemeester, Herroelen 2008; Deblaere, Demeulemeester, Herroelen 2011; Van de Vonder et al. 2007] suggests to use in project scheduling a combined approach, composed of proactive and reactive component. The former one is to be applied before the project starts and "aims at constructing a protected initial schedule that anticipates possible future disruptions by exploiting (…) knowledge of uncertainties that have been detected and analysed in the project planning phase" [Van de Vonder et al. 2007]. It has to be taken into account that one has to find a compromise between the protection degree and the planned project completion time [Herroelen, Leus 2004] – a high protection degree is usually not advisable, because it is rare so that all the probable events will actually take place and the planned project completion time cannot be too far away in time, as the customer would not accept it. Thus, the initial schedule is never fully protected, even with respect to knowledge available at the beginning of a project. Apart from that later, after the project starts, new information will be available, as the future is never fully predicable. For these reasons later on, during the project execution, the initial schedule may turn out to be infeasible. Reactive scheduling [Van de Vonder et al. 2007] is then needed, "to repair the schedule in such a way that it reflects the objective and constraints of the evolved environment while minimizing the negative impact of the disruption".

Proactive scheduling can be put into practice in many ways [Ghezail, Pierreval, Hajri-Gabouj 2010]. One of them is the slack based technique, where "additional slacks are inserted into the initial schedule which expand the planned processing time of certain project tasks, providing extra time in order to minimize the effect of disruptions". This extra time may be isolated from the basic planned execution time of project tasks, in which case it is called "buffer" [Van de Vonder et al. 2005]. Buffers are used among others in the Critical Chain method [Goldratt 1997], where they are placed at the end of tasks sequences. This way of using buffers is adequate in case the project completion moment is the most important moment and should be strongly protected, but individual project tasks may move (within certain limits) with respect to the initial schedule. In case the completion times of individual activities are important too, the buffers may be placed even after each activity [Van de Vonder, Demeulemeester, Herroelen 2008; Van de Vonder et al. 2005; Kuchta 2014; Kobylański, Kuchta 2007]. In many approaches the buffers size, or even the buffers existence, is unknown to task executors. Only the project manager knows about them, and the buffers have a psychological role to play: the project team members know they should be ready at a certain date, which disregards the buffers, and it makes them work harder than in case when they knew they had in fact more time (because of the so called student syndrome [Goldratt 1997]).

The buffers size has to reflect the properties of the project tasks they protect and the relevant information about the project and its environment [Van de Vonder, Demeulemeester, Herroelen 2008; Ślusarczyk, Kuchta 2013]. If these properties and this information change, the reactive scheduling has to adjust the buffers size for the remaining schedule part [Kuchta, Ślusarczyk 2014].

In practice the proactive and reactive scheduling are rarely used. It may be one of the reasons why the time effectiveness of projects is so bad. A combination of the two approaches may be very helpful in an effective project time scheduling. At least this is the hypothesis the authors of this paper think is true.

The aim of the paper is to provide an argument in favour of this hypothesis using the case study method. We adopted the case study methodology from [Eisenhardt, Graebner 2007; Yin 1994] We present a single case study – it concerns only one project, a terminated project in which one of the authors of the present paper was the project manager. Of course, it would be desirable to have more cases at our disposal, but there are situations [Yin 1994] when a single case study is justified. One of these situations is when the investigated object is revelatory [Yin 1994], i.e. a researcher can carry out observations and analyses which have not been able to be subject to previous academic scrutiny. The analysis we have been able to carry out here is based on sincere and rather objective observations of the project manager, who was an external person to the organisation – she came to the organisation around the start of the project execution (for a temporary internship) and left after it. She had no affective relation to the organisation and to its members. On the other hand, the organisation was unusually open and ready to accept totally new approaches, which it proved by naming an external trainee the project manager and letting her try out a completely new method without setting any limits. These two factors make this case study a special one, in which we can observe and analyse phenomena normally hidden and impossible to observe.

The outline of the paper is as follows: in the first section we present the context of the case study, in the second section the situation one of the authors of the paper found when she started her internship. In the third section we describe the proactive procedure she used and in the fourth section the reactive procedure and the final result. The paper finishes with conclusions.

2. Context of the case study

One of the authors of this paper was offered an internship at a large international company, hereinafter referred to as the contractor. Thanks to this proposal she had the chance to become part of the team responsible for the project realized for a very significant public sector organization. She was even named the project manager of one of the subprojects. Due to the conditions set by the client, hereinafter referred to as investor, the author was obliged to sign a confidentiality agreement, therefore the presented description of the project will be largely latent, limited to the most necessary information.

The contractor and the investor signed a framework agreement, which provided that the project would be divided into several projects, which together would create a portfolio of projects, understood as a set of projects grouped together in order to enable their efficient management.

As part of the attended internship, the author of this paper presented to the organization management the idea of proactive and reactive scheduling based on the use of buffers, whose size was to be determined on the basis of [Van de Vonder, Demeulemeester, Herroelen 2008; Ślusarczyk, Kuchta 2013], thus taking into account the features of the protected tasks and the available information about theproject and its environment. The proposal aroused great enthusiasm, and the author was offered the possibility of a practical application of the method.

In the method in question both tasks specific features and the global information pieces about the project and its environment should be listed with the help of possibly all the project participants and then evaluated (in terms of consequences for thetasks duration and the probability of being a cause of delay). On the basis ofthe numbers obtained the buffer size is determined. The important thing is that in this process the features which influence more than one task are identified as being such. Thus, if a task is executed and we learn that one of its features was evaluated in a wrong or no more valid way, we can take this into account in the reactive scheduling, correcting the respective buffer sizes in the remaining part of the schedule. We can do the same whenever we get any new piece of information concerning any feature connected to any yet unexecuted task and generally the project future.

The author was appointed the manager of one of the projects included in the portfolio, hereinafter referred to as Project D1.

3. Situation of the project the moment the author became its manager

At the time when the author of this paper took on the role of the manager of Project D1, in theory (thus according to the planned schedule, which had been prepared purely intuitively, without using even the basic, traditional project scheduling methods [Wysocki 2011], not talking about the more advanced ones), its implementation had lasted already for three weeks. Nevertheless, because of limited resources, a low priority of the project in the portfolio and the reluctance of people to take responsibility for the kind of tasks that were to accomplishin the project, the progress of the project was in fact zero. Moreover, the former manager responsible for Project D1 believed that the situation concerning the implementation of the project was under control. As he told the author of this paper, the contractor had received from the investor much more time than it was necessary for the implementation of this project. Thus, it was obvious that such attitude of the project manager in conjunction with the reluctance of team members to perform this kind of tasks very easily could have led to delay caused by the attitude of the team members, which is described in the scientific literature by Parkinson's law and student's syndrome [Goldratt 1997]. Therefore the need of conducting a proactive planning procedure in order to verify whether the previous project manager actually was right claiming that the project had been provided much more time than it was actually needed was indisputable.

Preparing the project for implementation left much to be desired. The only available documentation was poor with respect to what is required even in basic project management [Wysocki 2011]. It followed from contractual provisions that the project should have been divided into two phases − the first phase was to be completed within three months or thirteen weeks from the date of commencement of the project, while the second stage should be completed within nine months from the date of the start of the project. Important information from the point of view of the proposed method was that the second stage had virtually the same scope of work as the first stage, therefore, the features of the activities and of the environment in both cases were very similar. It was therefore obvious that the execution of the first stage would constitute an initial verification of the proposed solution.On the other hand, the reactive scheduling procedure in the first stage would provide valuable information in terms of the preparation of the schedule (proactive procedure) of the second phase of the project.

Before proceeding to describe the course of the project planning procedures, it should be noted that due to the fact that this was a project implemented for a public sector organization, its implementation had to be consistent with the provisions of the law on public procurement. For this reason, final products of both phases of the project subjected to assessment under the so-called cycle of evaluation. Cycle evaluation of the final product of the project was divided into four steps in which the following terms were determined and had to be respected by both parties.

1. The transfer to the assessment (TA) – its deadline may be exceeded by, in case of Project D1, ten days.
2. Comments from the investor of the project (CIP) − within 5 working days from TA.
3. The position of the contractor towards CIP − within 5 working days from CIP. This step is repeated until a common position between the investor and the contractor is achieved.
4. Forward for approval (FA) – its deadline may be exceeded by, in case of Project D1, ten days. This stage is followedby the investor's payment obligation with respect to the contractor for the completed project.

Originally, contrary to the fundamental theory of project planning [Wysocki 2011], the project scope had not been broken into tasks which would have allowed to construct a project network and a Gantt chart. Thus, although according to the schedule the project was advanced, almost everything had to start from the beginning.

4. Proactive scheduling

As mentioned above, the work had to be started from almost zero: project tasks, their basic planned duration (i.e. the planned duration given to theproject team, for the non-risky situation, not containing the extra protection time) and the basic dependencies between them (of the type end-start) had to be identified, before which a Work

Breakdown Structure [Wysocki 2011] had to be worked out. In such a way a project network came into being. During these preparations, it turned out that the scope of the project had not been properly defined. It was necessary to implement additional tasks that were not included in the contract signed with the investor of the project. An annex to the contract concerning a change in the scope of the project andits price had to be signed. Both parties were complicit in this situation, that is why the negotiations proceeded without major difficulties and completed successfully, with mutual consent. It was also agreed that the planned deadline of the project did not change, but if necessary, depending on the circumstances, the contractor of the project could ask for a possible delay. It should be noted that thanks to such a thorough analysis arguments that could be used in negotiations with the investor in case of difficulties in completing the project on time were identified.

As already announced, the author decided to use the method of buffers. In order to be able to determine the places in the project schedule where they should be located and their size, using the method described in [Van de Vonder, Demeulemeester, Herroelen 2008; Ślusarczyk, Kuchta 2013], which requires identifying features and characteristics of the whole project, tasks groups and individual tasks and to evaluate them, she had to search for the adequate information sources. She used:

- experience of people who were involved in D1 or similar projects;
- discussion with the stakeholders of Project D1– e.g. team members, sub-contractors, suppliers;
- own observations – the author had monitored the team members responsible for Project D1 long before she became its manager. Her observations helped to specify potential risk factors;
- computer software (own product of the contractor for internal use only) that enabled the identification of risk factors on the basis of historical data about previous projects;
- literature analysis – the author analysedseveral reports and papers about implementing similar projects;
- brain storming − this method was employed by the author during the preliminary meeting of Project D1 team members.

One part of the work was to identify features of individual tasks which might cause their prolongation with respect to their basic duration. The author proposed to evaluate for each task the degree of influence and the probabilityof occurrence of the following aspects: task novelty, task complexity, newness of resources (newness with respect to the task type or methods/technology used), resources availability, resources reliability. But the project team suggested to add one more aspect to this list. In Project D1 team members from three different European countries were required. For that reason, the range of tasksfeatures to be evaluated was enriched by "Necessity of distance team work". For each task all these aspects were evaluated as to their possible impact on the task duration and the probability of such an impact occurrence.

Then features common for the whole project or task groups were identified, in order to be able to catch things which influenced more places in the project schedule and where a global view and constant updating on the base of the current knowledge should be used. The author together with the project team identified six types of global risk factors (see table 1).

Table 1. Features of the D1 Project potentially influencing the duration of several tasks

Absence of some specialists (limited number of highly qualified and fully certified specialists) caused by the fact that Project D1started during holiday season.
One of the most important specialists suffered from health problems. His condition was classified as stable at the beginning of the project, but such an affliction could easily develop into a serious disease.
Delayed or no reaction from company (M) employed as sub-contractor contributed to many difficulties in implementing other projects (such a situation was observed by the author and confirmed by opinions of other Project D1members) and may be a problem also in case of project D1.
Paternity leave of a key team member. The expected childbirth and finalization of project D1 overlapped in time.
Difficulty in getting a feedback about the first part of project D1within a set deadline, which might result in a delay of the second project part.
An unreliable supplier – according to the contract, the company could not change the supplier.

Source: own elaboration.

Also here the parameters weight and probability were evaluated for each task in order to use the formula fromthe literature referred to above. Then everything was ready for the determination of the buffers' size.

The next step was to create a project schedule, together with buffers (Fig. 1). As it was already said before, from the beginning of her work as the project manager, the author of this study was under the pressure of the fact that the project was delayed. After a conversation with the manager of the entire portfolio of projects, it was established that in the case of Project D1, it was very important that its execution would be completed on time, but the individual tasks could be a bit delayed, respecting, however,a few important in between deadlines, following from the cycle evaluation scheme quoted above. Thus, the buffers did not have to be placed after each task. Given the management guidelines, an analysis of different variants of buffers distribution led to the conclusion that the most suitable solution was to place the buffers only in a few selected areas − where an important in between deadline had to be kept. Buffers were thus placed at the end of the path of the tasks 6 and 7 and 12 and 13. The reason was the fact that due to the limited availability of resources needed for the implementation of certain tasks, more precisely tasks 6 and 7 and tasks 12 and 13, it was decided that the implementation of these tasks would not start exactly right after their predecessors, but would be deferred in time, which was possible exactly because there was extra time in these paths. However, in order to avoid the delay of

Figure 1 shows the planned schedule for Project D1:

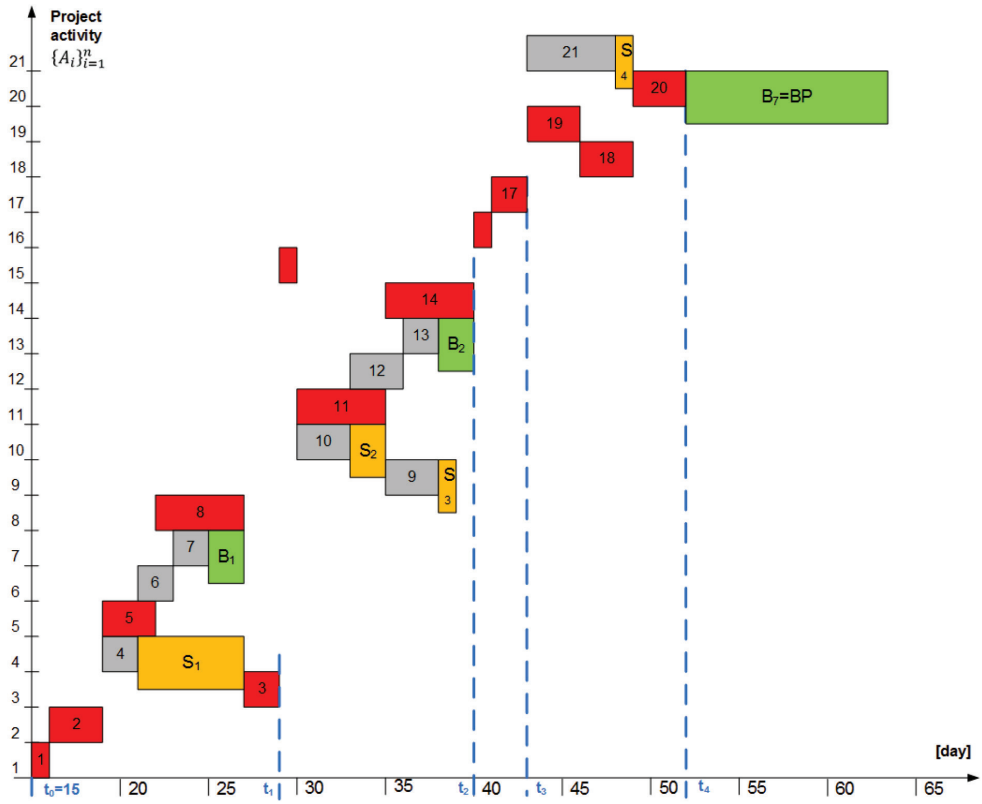

Figure 1. Base project schedule for Project D1 (BP – Project Buffer, B_x – the other buffers, S_x – slacks, constituting an additional information for the project manager)

Source: own elaboration.

the project due to an additional delay in those tasks, at the end of the paths of the tasks 6 and 7 and 12 and 13 buffers were placed. However,the most important role from the point of view of exceeding the deadlineof the whole project was played by theproject buffer.

Formulae from [Ślusarczyk, Kuchta 2013] were used in order to calculate the buffers sizes and thus the planned project deadline, including buffers. This deadline turned out to be acceptable in view of other project constraints. It should be mentioned that project D1 still had an additional provision of ten days.

Because of the psychological significance of the buffers, the team members were not informed of their existence and size, thus of theextra time in the schedule. They were only informed of the intermediate deadlines following from the cycle evaluation. The base project schedule was never disclosed. Keeping the secret was fairly

easy. The team performed at the same time a portfolio of about twenty projects, thus the majority of its members were forced to multitasking. This phenomenon is usually classified as negative [Goldratt 1997], but in this case it contributed to the success of the implementation of the buffer technique − most of the team members were too much concerned with the performance of their duties to even think to recreate the schedule prepared by the author. Not without significance was the fact that the team responsible for the project was deployed in three European countries, which obviously hampered communication between its members.

Table 2. The size of the buffers in project D1

Name of buffer	Buffersize [days]
B_1	1
B_2	1,5
B_3 = BP	10

Source: own elaboration.

Table 2 shows the size of the individual buffers. The project buffer size was ten working days, thus two weeks.

5. Reactive scheduling

In order to apply the reactive scheduling, it is necessary to decide when the project is controlled and its schedule updated. Too many control points create extra work, too little may not allow the project manager to be informed about an important approaching delay early enough. In the case analysed here the author together with the project team identified the moments when they thought it would be useful to have a critical look on the project schedule and redefine it if necessary. All these moments occurred shortly, but not too shortly (so that a reaction would still be possible) before an important intermediate deadline following from the milestones described in Section 2. The following moments (marked in Fig. 1) were chosen (t_0 is the actual start of the project, 15 working days after the theoretical planned start. i.e. the moment when the author of this paper became the project manager):

- t_1 – after completion of task 3,
- t_2 – after completion of task 14,
- t_3 – after completion of task 17,
- t_4 – after completion of task 20.

The reactive scheduling in each of the control points is presented below:

Control point t_1 – after the completion of task no. 3

The following actual state of individual tasks was identified: completed execution of tasks no. 1,2,3,4,5,6,7 and 8.

The completion time of task 3, as planned at point t_0, was to take place on the fourth day of the sixth week of the project. In fact, this phase of the project was completed on the second day of the seventh week, which meant that in relation to the base schedule, the project was delayed by three days. Due to difficulties with the availability of resources (the holiday season), the author of this work was expecting a much longer delay. However, thanks to the right decision to postpone the implementation of tasks 6 and 7, she managed to partially solve the problem with the availability of resources and significantly reduce the size of the delay. The realisation of task no. 4 was significantly extended, which eventually did not result in any difficulty, thanks to the extra time provided. It was found that the reason for this delay was the reluctance of a team member to perform such tasks. The same person had a significant share in task No. 11, which was part of the critical path and its possible delay could of course have an impact on the actual completion time of the project. That is why for task No. 11 the evaluation of the risk factor "Reliability of resources" was redefined. As for the health of the key resource, it was stable − the definition of features of the other tasks of the project remained unchanged. As a result the estimation of the planned project completion time did not change, but it became clear that it was necessary to supervise the work of the team member responsible for the delay of task no. 4 during the realization of task no. 11.

Control point t_2 – after implementation of task no. 14

Tasks no. 9,10,11,12,13,14 and 15 were completed. The completion time of task no. 14, as planned at the t_1– checkpoint, was to happen on the third day of the ninth week of the project. However, the work had been completed more quickly than expected, two days ahead of time. This situation seemed quite strange. The analysis conducted by the author of this paper indicated that the tasks carried out in the time interval (t_1, t_2) were rather complex and time-consuming. So a fast termination of these tasks raised doubts about the quality of the work done. Internal verification of the effects of the work was to take place later, however, the author decided to add and evaluate at this stage risk factors associated to the possible need to improve the work done and redefine the corresponding buffers. After this re-estimation the planned project completion time became equal to 16 weeks, surpassing the final deadline for completion required by the external constraints from the investor. Therefore renegotiations with the investor on the date of completion of the project were necessary. In these negotiations the arguments determined before were used (the investor was guilty of an error in the specification of requirements). The accepted deadline for completion of the project accepted by the investor was set at 17 weeks, which was about a week more than requested by the contractor. Therefore also the deadline of the TA changed.

Control point t_3– after the implementation of task no. 17

Tasks no 16 and 17 were completed. However, it was necessary (and thanks to the reactive scheduling, there was time for it) to verify project manager's earlier

concerns about the quality of the final product delivered. Unfortunately they were confirmed. Immediately after identifying the deficiencies, the team proceeded to their correction. This task was completed a week before the newly agreed date of TA.

Control point t_4 – project end

Finally the project was completed before the agreed deadline and the quality of the work was satisfactory. The project manager, the project team and the organization agreed that this was possible to a high extent thanks to the method applied. The reactive and proactive scheduling was acknowledged as being valuable and useful and the extra time that had to be spent on identifying and evaluating the risk factors decisively was notlost time.

6. Conclusions

The case study is a deep analysis of a real world project, where one of the authors of the present paper had the opportunity to apply a combination of proactive and reactive scheduling based on buffers. The case study shows how important and useful it may be to use a combination of proactive and reactive scheduling, based on the usage of buffers whose size is determined at the beginning on the basis of features of the project, its environment and its tasks, and later systematically updated using current information and taking into account links exiting between the tasks, e.g. such a link that the same resource takes part in the execution of both tasks.

Thanks to a systematic application of proactive and reactive scheduling which required at the project beginning and in selected control points to evaluate (for each task and for the whole project) such factors as duration increase due to the nature of task and the resource specificity, it was possible to foresee early enough and provide the adequate protection in the schedule for problems linked to the fact e.g. that the resources were reluctant to do the kind of tasks which were part of the analysed project. Also it was possible to notice and take formally into account factors that were already known at a certain moment and might have impact for the future, like e.g. the similarity between the first and the second part of the project, the health problems of one of the team members, an incomplete definition of the project scope. The interactive procedure of proactive and reactive scheduling made the project team reflect on other risk factors than the ones proposed by the project manager and generally made them reflect on the project, its actual situation and its future and cooperate in this respect with the project manager. This allowed to notice even the fact that a seemingly terminated task was in fact unterminated, because the quality of the work was bad. And thanks to the reactive scheduling there was time to correct the work.

Certainly, the practical application of the proactive and reactive scheduling has to be verified in many more projects. But the authors of the paper are convinced that it is the right approach. However, there is one problem which might constitute an obstacle to the practical application of the method: the lack of openness of organisa-

tions and project managers, as well as of project teams. So a lot of effort should be put in finding the possibility to work out more case studies like the one presented in this paper, which in the opinion of the authors would be the best method to convince project stakeholders that proactive and reactive scheduling are not a useless theory, but a necessity.

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ZASTOSOWANIE PROAKTYWNEGO I REAKTYWNEGO HARMONOGRAMOWANIA PROJEKTÓW – STUDIUM PRZYPADKU

Streszczenie: Artykuł prezentuje studium przypadku rzeczywistego projektu, w którym jeden ze współautorów, jako stażysta i jednocześnie kierownik projektu, miał okazję zastosować w praktyce kombinację harmonogramowania proaktywnego i reaktywnego. W przekonaniu autorów projekt zakończył się sukcesem, w dużej mierze dzięki zastosowaniu takiego podejścia. Czytelnik może krok po kroku prześledzić przebieg projektu, napotykane problemy i sposób, w jaki, dzięki zastosowanemu podejściu, udawało się im zapobiec lub je rozwiązać. W artykule przedstawiono również ideę harmonogramowania reaktywnego i proaktywnego z wykorzystaniem przeglądu literatury. W przekonaniu autorów kombinacja podejścia proaktywnego i reaktywnego do zarządzania projektami powinna się stać standardem w zarządzaniu projektami. Wymaga to jednak zmiany mentalności i większego otwarcia ze strony organizacji, kierowników i wykonawców projektów.

Słowa kluczowe: harmonogramowanie proaktywne, harmonogramowanie reaktywne, bufor czasowy.