Received: 11.11.2023.
Accepted: 08.12.2023.

e-ZBORNIK 26/2023

*Professional paper*

Electronic collection of papers of the Faculty of Civil Engineering

https://doi.org/10.47960/2232-9080.2023.26.13.64

ISSN 2232-9080

# Time deviation analysis of the baseline plan on the case study: Implementation of reinforced concrete works on a school construction project in the Republic of Croatia

**Ksenija Tijanić Štrok**
University of Rijeka, Faculty of Civil Engineering, Ph.D, ksenija.tijanic@uniri.hr
**Diana Car-Pušić**
University of Rijeka, Faculty of Civil Engineering, Ph.D, diana.car.pusic@uniri.hr
**Filip Marfan**
Studio Marić d.o.o., filip.marfan@hotmail.com

**Abstract**: In the paper, an analysis of the time aspect of the baseline plan for the execution of reinforced concrete works was carried out on a case study. The case study covers the construction of a public school in the Republic of Croatia, which was completed in 2023. By analyzing the baseline plan, it was determined that it has shortcomings and that the duration of the activities does not correlate with those actually achieved. Compared to the initial 86 working days, the baseline plan actually lasted 272 working days, which is an overrun of 216.28%. The leading causes of overruns in individual activities were identified, and lack of communication between project participants proved to be one of the particularly frequent ones. Recommendations were given for better time planning and for reducing deviations from planned durations, which can improve the processes of time management and project management in general.

**Key words**: school, reinforced concrete works, baseline plan, exceeding the deadline, recommendations

# Analiza vremenskog odstupanja početnog plana građenja na studiji slučaja: Izvođenje armiranobetonskih radova na projektu izgradnje škole u Republici Hrvatskoj

**Sažetak**: U radu je na studiji slučaja provedena analiza vremenskog aspekta početnog plana građenja za izvođenje armiranobetonskih radova. Studija slučaja obuhvaća gradnju javne škole na području Republike Hrvatske koja je završena 2023. godine. Analizom početnog plana građenja utvrđeno je da ima nedostatke te da trajanja aktivnosti nisu u korelaciji s onim stvarno ostvarenima. Plan je u odnosu na početnih 86 radnih dana u stvarnosti trajao 272 radna dana što je prekoračenje od 216.28%. Prepoznati su glavni uzroci prekoračenja po pojedinim aktivnostima, a kao jedan od posebno učestalih pokazao se manjak komunikacije između projektnih sudionika. Dale su se preporuke za kvalitetnije vremensko planiranje te za smanjivanje odstupanja od planiranih trajanja, a koje mogu poboljšati procese upravljanja vremenom i projektom općenito.

**Ključne riječi**: škola, armiranobetonski radovi, početni plan, prekoračenje roka, preporuke

## 1. INTRODUCTION

A construction project is a complex undertaking for the construction of a building of given characteristics and purpose with separate time, financial and technical implementation goals [1], [2]. Project management techniques are applied in order to fulfill these goals and in order for the project to succeed. Project management is defined as the application of knowledge, skills, tools and techniques to project activities in order to achieve project requirements/goals [3]. An important criterion for the success of a construction project is completion within the planned construction period [1], [4], however, it is precisely in the time aspect that large deviations occur [5]. The reason for this often lies in the fact that the deadlines in the early stages of planning are set presumptively [6], not taking into account the real needs and capabilities of the contractor and ignoring numerous uncertainties, limitations and risks [7]. The execution time limit is an integral part of the construction contract [8] and is an important parameter for making decisions in the early stages of construction [9], so its planning should be approached with particular care. The bases that are developed as a result of planning are necessary tools of project management, therefore it is exceptionally important to have the most realistic time plan possible [4], [10]. It has been shown that experience and knowledge from completed construction projects can help prevent mistakes and increase the chances of success of future projects [11]. More realistic time planning of future projects requires the collection of information on completed projects [12] and in-depth processing and analysis of such data in order to identify trends and problems, with the purpose of providing recommendations and measures for planning and greater time efficiency.

The objective of this paper is to analyze and determine time overruns in the construction phase, using the example of a completed construction project that is complex in nature, with many stakeholders and requirements. The project covers the construction of a public school in the Republic of Croatia. The main goals of this paper include the analysis of the initial construction plan, identification of the causes of time overruns, and the proposal of possible ways to eliminate or minimize them in future projects of similar characteristics. Due to the complexity and share of reinforced concrete works in the plan, as well as the availability of data, only aspects of these works will be treated in the subject school construction project. The research was conducted using the case study method.

The paper begins with an introductory part that presents the observed issues and the objective of the research. The second section summarizes the studies of similar issues from the Republic of Croatia and Bosnia and Herzegovina in the last 30 years or so. Section three shows how the research was conducted and which methods were used. In the fourth section, the treated case study is described and the analysis, processing and discussion of the obtained results are carried out. The fifth section provides recommendations for better management of the time component during construction projects. The last section includes conclusions.

## 2. OVERVIEW OF PREVIOUS RESEARCH ON TIME OVERRUN IN CONSTRUCTION PROJECTS FROM CROATIA AND BOSNIA AND HERZEGOVINA

Planning is the process of predicting events and activities of future projects, where execution plans are developed based on known data and bases [1]. The baseline plan is the first accepted project execution plan with a defined sequence of events, allocated resources and acceptable dates for key milestones, of which the construction completion date is particularly important. The baseline plan is the basis for planning cash flow, managing resources, measuring progress, identifying trends and changes in terms of costs and time, predicting future values, and reporting on project progress [13]. Baseline plans are of exceptional

importance in time management in construction projects [14]. Managing time primarily means ensuring the maintenance of the planned deadlines for the execution of works, i.e. ensuring the completion of the project within the planned time limit. The construction industry generally has a bad reputation in terms of exceeding the initially planned deadlines (time) in the project [4]. Time overrun is a situation in which projects fail to be completed within the stipulated period [15]. It can be caused by any party to the contract and can be a direct consequence of one or more circumstances [16]. Time overrun often brings with it other problems such as cost overruns, disputes, delays and sometimes complete abandonment of the project [17-19]. In practice, overruns occur in almost every construction project, and the magnitude of these overruns varies considerably from project to project and from country to country [20]. Some of the significant studies on the topic of time overruns in construction projects from the Republic of Croatia and Bosnia and Herzegovina will be presented in the following.

Radujković [5] conducted a broad study on the subject of time and cost overruns in Croatia. The study included 333 projects, and the results showed an overrun of construction time in 78% of them. It was established that time overruns are present in almost all projects with a longer construction period. The following aspects were identified as the most important causes of overruns: changes in technical documentation, climate conditions, financing conditions, obtaining permits and approvals. A similar study was conducted by Car-Pušić [21], who, based on 107 projects, concluded that the most common causes of construction time overruns are inadequate management and failures in the organization of works. On the basis of a study of several cases, Tijanić and Car-Pušić [4] processed 12 different construction projects and found that they all had overruns of the stipulated time frames, and the average overrun was 28.16%. The most common causes of overruns in the subject projects are weather conditions and unforeseen works.

In Bosnia and Herzegovina, Žujo [22] dealt with the observed issue, and in her doctoral dissertation she analyzed 177 projects. The results showed that the contracted deadline was not met in 51.40% of them. From the same database, 29 new construction projects and 24 reconstruction projects were selected. It was shown that time overruns in new constructions are 12.80%, and in reconstructions 22.51%. An overrun of the contracted deadline is mostly influenced by risk factors related to incomplete and inaccurate technical documentation, bad climate, permits and approvals, and an unrealistically set contract deadline [6]. Based on a study where 75 projects were studied, Petruseva et al. [23] recorded that there was an overrun of the construction period in 55 (73%) of them. The maximum overrun of the contracted deadline was 100%, while the average overrun of the contracted deadline was 11.55%. Five different reasons for which inconsistencies occur were specified, namely: approvals and permits, climate, incomplete and imprecise technical documentation, delivery of materials and financing conditions. Žujo et al. [24] reported failure to observe the contracted deadline in 28 (70%) of 40 water supply system projects. The maximum overrun of the contracted deadline is 150%, while the average overrun of the contracted deadline is 27.93%.

It is evident that in both countries, the issue of exceeding the planned construction deadlines was the subject of research studies, but in their construction practice, the occurrence of said overruns is still common, which was also shown in this paper. The knowledge and experience gained on completed projects are valuable input data for the success of some future projects [11], so research into this issue should not be ignored, because from each project something new can be learned that can potentially improve the processes of time management and project management in general.

## 3. WORK METHODOLOGY

The methodology of the work is shown in the flowchart in Figure 1.

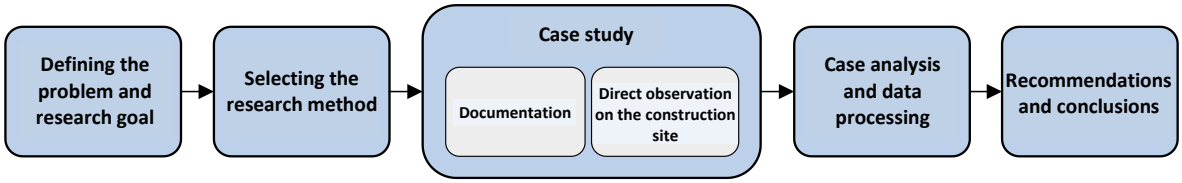


Figure 1. Work flowchart

The work begins by identifying the defined problem and research goal, followed by the selection of the method by which the research will be carried out, in this case it is a case study that was conducted on the basis of data from two sources, namely the project documentation and the direct observation of one of the construction participants at the construction site. The processing and analysis of the data of the subject case study resulted in conclusions and recommendations for reducing time overruns in future similar construction projects.

The case study method is a qualitative research method that seeks to record comprehensive information about the case of a certain group or category of phenomena, and based on them, conclusions are drawn about other cases of the same category [4]. According to Creswell [25], a case study is applied when exploring a real life, contemporary bounded system (a case) or multiple bounded systems (cases) over time, through detailed, in-depth data collection involving multiple sources of information. When conducting a case study, it is therefore recommended to use multiple data sources, including two or more of: direct detailed observations, interviews, and documents [26]. In this research, project documentation and direct observation of the subcontractor for reinforced concrete works at the construction site were used as data sources. When conducting a case study, after selecting a representative case and collecting data, the data is analyzed and processed with the purpose of drawing conclusions and modifications, or improving the existing system in the form of guidelines, recommendations or measures.

The case study is assessed as a suitable method for conducting this work due to the complexity of the studied case, whose characteristics and problems are very often shared by other construction projects, and the conclusions and recommendations obtained on the basis of this study will be applicable to projects outside of this case, which will potentially lead to a reduction in time overruns in future projects.

## 4. CASE STUDY – REINFORCED CONCRETE WORKS ON A SCHOOL IN THE REPUBLIC OF CROATIA

### 4.1 Characteristics of the case study

The selected case study is the construction of a public school building in the Republic of Croatia.

The subject school institution is a public project of social importance financed by the public administration. The tender for the contractor was conducted through public procurement. The construction of the school was completed in 2023, and lasted about four years. The construction of the building itself is estimated at around 4,000,000 euros.

The building covers an area of over 2900 $m^2$, on several floors with a flat impassable roof. Floors include ground floor, 1$^{st}$ floor and 2$^{nd}$ floor. Communication between floors is provided by staircases and one elevator. The entire load-bearing structure is made of reinforced concrete, and consists of foundations, upper foundations, slabs, walls, columns, beams and staircases. Concrete steel B500B was used to reinforce the elements. Delivery of concrete was provided from the nearby concrete plant by truck mixers, and concrete was placed by

mobile concrete pumps. The basic load-bearing structure of the building consists of reinforced concrete walls, which were made in smooth, wide-surface formwork, reinforced in two zones with reinforcing mesh and concreted with concrete of compressive strength class C25/30. Installation of formwork was performed with tower cranes [27].

Reinforced concrete works were selected as an area of interest in the subject school construction project due to their importance for the entire building, the complexity of these works, as well as their quantity and the estimated construction duration and costs, which make up a significant portion on the observed building. Also, problems that caused large time deviations were observed within them.

Reinforced concrete works on the building were performed by a subcontractor engaged by the main contractor. According to findings of the authors of this paper, no project manager was engaged within the project.

More detailed information about the project itself is not given in this paper in order to protect data and not disclose the identity of the legal entities involved in the execution. More detailed information can be obtained upon request and approval from the authors of this paper.

## 4.2 Analysis of the plan and reasons for deviations

The baseline construction plan was prepared by the main contractor. In this particular case, the reinforced concrete works were performed by a subcontractor.

The subject reinforced concrete works include the activities of installing formwork, reinforcing and concreting individual structural elements. The total (approximate) quantities of individual works according to the cost estimate are as follows: formwork 12,500 $m^2$, reinforcement 270 t, concrete 2,000 $m^3$. Each of these works has its own performance and quality requirements. The importance of reinforced concrete works for this project is unquestionable, since the entire load-bearing structure is made of reinforced concrete elements, therefore there must be no failures in the execution. All elements must be performed according to the structural design, according to the drawings, according to the concrete design, and must meet the basic requirements for the structure, which are defined in the Republic of Croatia by the Law on Construction [28].

Before starting the works, it was necessary to develop a baseline construction plan that defines the necessary resources, necessary activities, their time schedule and sequence, as well as interrelations, in order to have a realistic construction deadline. Adequate planning enables better project control, reduces delays, improves quality and rationalizes costs.

An inspection of the baseline construction plan for reinforced concrete works revealed certain deficiencies that affected the successful execution of the plan.

The initial construction plan prepared according to information from the main contractor is shown in Figure 2.

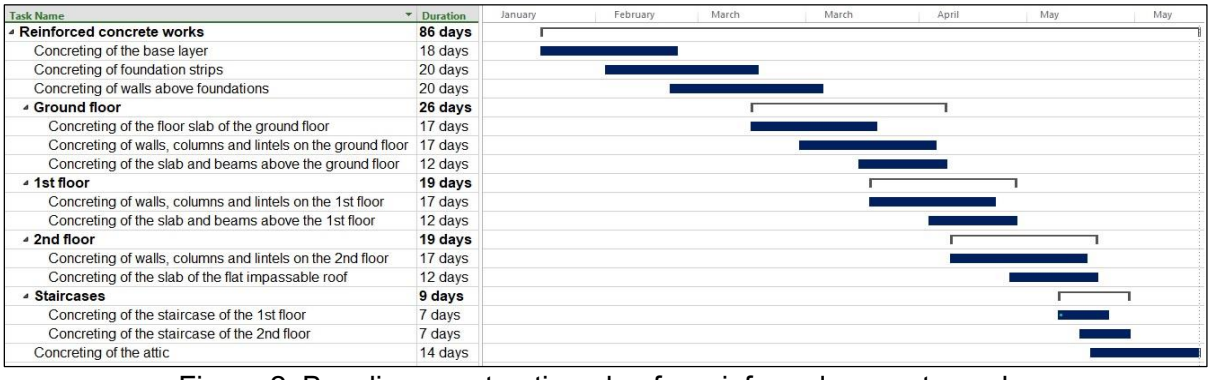


Figure 2. Baseline construction plan for reinforced concrete works

According to the plan from Figure 2, the total duration of the works is 86 working days, where the beginning of the works is specified at the beginning of 2020, and the completion date is in the middle of the same year. The plan consists of 13 activities.

The plan does not adequately and in detail work out the hierarchical structure of activities, which in construction projects is usually done through the work breakdown structure of the project or WBS. When preparing the plan, it is important to understand well the project content and to present that content in the plan using the structure. Structure is essential in order to facilitate and improve the process of planning, monitoring and control [1]. The task of the WBS is to coherently define and break down the project into elements that can be executed individually in an organized manner, i.e. in this case to plan and calculate in order to prepare the project plan. Such a structure must include the entire scope or the work that needs to be done in order for this part of the project to be completed. Within the presented plan, there are no numerical markings of the WBS levels, the observed part of the project could have been worked out in more detail and divided into several sub-projects (e.g. foundations and upper foundations, roof added to the existing ones), certain activities are combined into one group activity, which complicates the management of such activities (e.g. concreting of walls, columns and lintels), also, the activity of concrete work on the flat roof, which was specified in the project, was left out of the plan.

The relations between the activities that indicate their interdependence are not marked within the plan. In this way, it is difficult to verify the accuracy of the plan as well as its use. It is difficult to understand the logic behind the determination of the work schedule and the total duration of the plan. It is not clear from the plan which activities are critical or what are the amounts of time reserves for individual activities [1]. A consideration of the time reserves makes it clear how much certain activities can be rescheduled or prolonged, without affecting the final project deadline.

A deeper insight into the problems of the plan established that the duration of the works was determined approximately without taking into account the standards for the works. Standards indicate the consumption quantities of materials, time, driving energy and manpower, which are used as the basis to develop plans and calculate the duration of individual activities. Public and generally accessible standards for construction works are often applied [29, 30]. Construction companies can also use their own internal standards, specific to them with regard to the method of operation and available resources. Since no standards were used in the subject case study, the durations of most works were underestimated.

According to everything presented, it can be concluded that the plan presented here was developed using unfounded and superficial methods without following the theoretical and professional rules for its preparation.

In addition to the stated initial issues of the prepared plan, additional aggravating external circumstances also appeared. Namely, during the planned period of execution of the subject works, the world was faced with the epidemic of the COVID 19 disease, which disrupted the smooth flow of construction works, primarily in the timely delivery of the necessary materials. One of the problems was also the location of the construction site itself, which is in the zone of densely populated areas with additionally increased traffic during the summer months, and the traffic to the construction site was difficult due to these reasons. Although very important, these two circumstances were not the main source of the time overruns, nor could they be easily influenced.

In reality, the works were carried out for a total of 272 working days, as compared to the initial planned 86 days, which is a total overrun of the plan of 216.28%. The main reasons for the deviation of individual works are shown in Table 1.

Table 1. Deviations of the planned duration of activities and reasons for deviations

| No. | Activity | Plan (days) | Execution (days, approx.) | Reasons for deviation |
|---|---|---|---|---|
| 1 | Concreting of the base layer | 18 | 3 | Miscalculated input quantities for estimating the duration of work |
| 2 | Concreting of foundation strips | 20 | 30 | Lack of coordination and communication between the contractor and the subcontractor, installation of reinforcement was more demanding than expected (use of reinforcement bars with larger diameters, RA ∅20-25) |
| 3 | Concreting of walls above foundations | 20 | 30 | Lack of coordination and communication between the contractor and the subcontractor, installation of reinforcement was more demanding than expected (use of reinforcement bars with larger diameters, RA ∅20-25) |
| 4 | Concreting of the floor slab of the ground floor | 17 | 12 | Installation of the formwork was simpler than expected |
| 5 | Concreting of walls, columns and lintels on the ground floor | 17 | 55 | Lack of coordination and communication between the contractor and the subcontractor, the subcontractor's workers did not have previous experience in working with large-surface formwork |
| 6 | Concreting of the slab and beams above the ground floor | 12 | 31 | Lack of coordination and communication between the contractor and the subcontractor, installation of reinforcement was more demanding than expected (use of reinforcement bars with larger diameters, RA ∅20-25) |
| 7 | Concreting of walls, columns and lintels on the 1st floor | 17 | 55 | Lack of coordination and communication between the contractor and the subcontractor, the subcontractor's workers did not have previous experience in working with large-surface formwork |
| 8 | Concreting of the slab and beams above the 1st floor | 12 | 31 | Lack of coordination and communication between the contractor and the subcontractor, installation of reinforcement was more demanding than expected (use of reinforcement bars with larger diameters, RA ∅20-25) |
| 9 | Concreting of walls, columns and lintels on the 2nd floor | 17 | 55 | Lack of coordination and communication between the contractor and the subcontractor, the subcontractor's workers did not have previous experience in working with large-surface formwork |
| 10 | Concreting of the slab of the flat impassable roof | 12 | 31 | Lack of coordination and communication between the contractor and the subcontractor, installation of reinforcement was more demanding than expected (use of reinforcement bars with larger diameters, RA ∅20-25) |
| 11 | Concreting of the staircase of the 1st floor | 7 | 4 | Change in staircase design |
| 12 | Concreting of the staircase of the 2nd floor | 7 | 4 | Change in staircase design |
| 13 | Concreting of the attic | 14 | 10 | Reduced planned attic height |
| 14 | Making the concrete for the slope of the flat impassable roof | 0 | 23 | The item is not specified in the initial plan |

The time deviation values of individual activities are presented graphically in Figure 3.

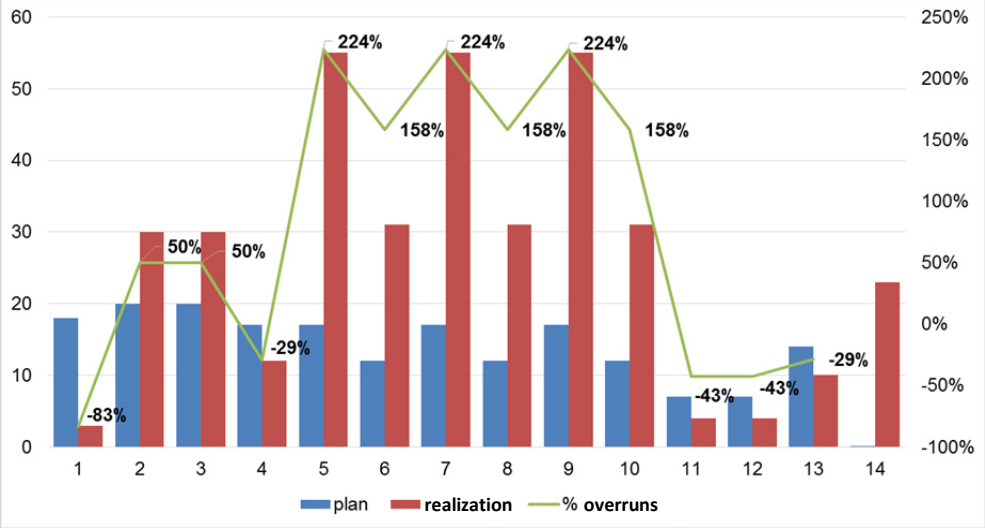


Figure 3. The values of time deviations of individual activities from the planned

The average difference between the planned and actual duration of individual activities is about 113%.

In addition to the planned 13 activities during the actual realization of the works, there was an additional activity that includes making concrete for the slope of the flat impassable roof, which was not specified at all in the initial construction plan. Four activities were completed faster than planned, while all others lasted longer.

Lack of coordination and communication between the main contractor and the subcontractor was found to be one of the major problems at the construction site. The contractor defined very short deadlines, ignored the demanding nature of the work and planned certain work delivery methods that the subcontractor could not meet in a timely manner due to the available resources and experience, and the works were prolonged due to difficulties in performing the works. The identified participants should have and could have improved mutual communication, got into line and formulated the necessary time for performing individual works and thus had a more realistic construction plan. This could be achieved by using the internal standards of the subcontractor, who, given its capabilities and experience, could more accurately determine the techniques and methods for carrying out the works, or the duration and sequence of individual activities, which would result in a more precise assessment of deadlines. Developing a high-quality baseline plan would provide an adequate basis for further planning and forecasting of construction. Then, it is necessary to continuously monitor, control and update the baseline construction plan in order to have timely and adequate information about completions and the future plan. This would provide valid information for resource management and work organization. Other subcontractors on the particular construction site would be given adequate information about the completion of the subject works, that is, it would be possible to reserve in time the start date of other works that follow the reinforced concrete works, as well as reserve, engage, acquire and deliver the necessary resources. Also, in this case, the investor would get a more accurate insight into the completion date, which is the most important information for it, along with the costs.

## 5. RECOMMENDATIONS FOR REDUCING TIME OVERRUNS IN CONSTRUCTION PROJECTS

According to the treated case study and the obtained results, the following measures that can potentially help reduce time overruns in the project construction phase are recommended.

- Before starting work planning, it is important to analyze in detail the project documentation, the conditions on the construction site and identify all the project requirements, scopes and goals in order to take into account all circumstances with the plan and to reduce the occurrence of unplanned works or unnecessary changes to the project.
- The development of the plan should be approached seriously, adhering to all theoretical and professional knowledge. The plan should be based on proper technological processes, performance conditions, technical instructions, relevant provisions of legal regulations, with the application of safety at work measures, use of best practices and standards and rules of the profession. It is recommended to calculate the duration of the works using the relevant construction standards or the internal standards of the legal entity involved in the construction. The plan should be clear, precise, realistic and unambiguous. It should be clearly structured, with defined necessary resources and responsible persons, and there should be a clear relationship between individual activities. The plan should be developed with sophisticated computer tools.
- The plan should include the factor of uncertainty, or activation of risk factors, so that the baseline construction plan adequately assigns a sufficient amount of time reserves that serve to absorb the negative impact of uncertain actions, such as unavailability of materials, delays due to external circumstances, breakdowns of construction machinery, unfavorable weather conditions, etc.
- After the planning of work is carried out, it is important to monitor the progress of the project and regularly review the plan to identify potential problems and make adjustments if necessary. Continuous monitoring and revision of the plan will allow flexibility and adequate response to changes that may occur during the execution of the project. When delays are detected, it is necessary to define and analyze their causes and determine adequate methods to get closer to the original deadlines. This may include reallocating resources, speeding up the performance of activities by engaging additional resources, or rescheduling activities, all in order to minimize the impact of delays on the overall project time limit.
- It is recommended to use a project status monitoring and reporting system. The above will ensure transparency in project time management. The system will facilitate and speed up the process of making decisions that will be based on actual data and will provide timely information on the progress and status of the project to all project participants. For these purposes, modern monitoring and control tools can be used, such as the Earned Value Analysis method, which, in addition to time, also monitors realized costs. The proposal of measures includes the monitoring of available resources, identification of their availability and alignment with the project needs.
- Managing the time component of the project requires high-quality and timely communication and cooperation within the project with all its participants. The main participants of the project are: investor, designer, construction supervision and contractor. In addition to them, project managers, subcontractors and suppliers often participate in projects. Continuous communication allows monitoring of project progress, early detection of problematic aspects and timely response to difficulties related to deadlines and time. Cooperation with project participants is crucial for

meeting deadlines, since it enables aligned and coordinated performance of activities. It should be an obligation to hold meetings with all project participants at least once a week, at which all problematic issues will be addressed. In case of need, meetings should be held more often. For high-quality and efficient communication on the project, it is also recommended to use computer communication platforms. Today, there are specialized platforms on the market for communication and management of construction projects that allow easy and fast information exchange, data security, time saving, risk and cost reduction throughout the life cycle of the building (e.g. PlanRadar, VOLUM3). In this way, deadlines, tasks and responsibilities of individual project participants are managed transparently.

- In the initial stages of the project, it is justified to conduct and confirm the time estimation using databases of completed projects with similar characteristics. On the basis of such databases, it is possible to develop scientifically based mathematical estimation models that can additionally improve the precision of initial time plans. Future research should go in this direction.
- In implementation of projects of public interest, it is important to include a project manager who will be involved in it from the earliest stages all the way to the end of the project and will enable and implement all the above-mentioned measures. In the Republic of Croatia, the obligation to appoint a project manager for the construction of public buildings applies only to investments over EUR 4,645,300.00 excluding VAT [31]. The project manager is a professional who will direct, supervise and lead projects and teams. He/she is the one who coordinates the other participants and establishes high-quality communication between all parties. A high-quality project manager must have technical and professional knowledge in construction, specialist knowledge in project management theory, a set of basic interdisciplinary knowledge in organization, law and economics, as well as general knowledge of human behavior, sociology and psychology [32]. As an operational manager, the project manager is responsible for the achievement of project goals, is responsible for planning and organizing work on the project, communication with senior management and other project participants, managing activities and delivering the construction project to the investor/client within the framework of the expected quality, costs and time [33].

The project treated in this paper is a complex project of social interest that involves the public authorities, a large number of stakeholders such as the local community, parents, students, project participants, etc. Schools are one of the most important institutions in the social community due to their educational role. Any extension of the deadline for construction of a school delays the start of the provision of public service and increases the spending of public money.

The problems specified in this paper can occur in all construction projects, therefore the measures presented here are broad and useful for all projects.

## 6. CONCLUSION

Completion of the project within the specified time is one of the main indicators of its successful realization. A delay involves a number of other problems, of which the increase in costs is especially critical, so it is important to address time planning very carefully. During the execution of works itself, it is important to monitor, supervise and control the realization and to take all necessary measures to control overruns.

On the example of a public school construction project, this paper analyzes the time aspect of the execution of reinforced concrete works. First, it analyzes the baseline construction plan, which was found to have been prepared presumptively, without using

structure, standards, there are no time reserves, nor is the relationship between individual activities known. In addition to these shortcomings of the baseline plan, there were also performance problems that additionally pushed the time limits. The biggest problem was observed in the lack of communication between project participants, which is the basis for successful project management. The main recommendation for addressing the problem of lack of communication goes in the direction of improving collaborative relationships through mandatory regular meetings and the use of computer platforms for project management.

One of the identified measures includes the involvement of a project manager in the construction process, whose engagement in all public projects in the Republic of Croatia is still not mandatory. Considering the numerous inadequacies during the development of the plan and the actual execution of the works on the subject project, and observing the specified tasks, roles and importance of the project manager, it was recognized that his/her engagement would contribute to the success of future projects in terms of completion within the planned time.

Based on the presented data from the subject project, other possible measures were also proposed to prevent the occurrence of and minimize deviations from the planned durations in future projects, which can improve the processes of time management and project management in general.

## REFERENCES

1. Radujković, M., Car-Pušić, D., Ostojić Škomrlj, N., Vukomanović, M., Burcar Dunović, I., Delić, D., Meštrović, H.: Planiranje i kontrola projekata, University of Zagreb, Zagreb, 2012
2. Car-Pušić, D., Marović, I., Gudac, I.: Važnost projekta organizacije u pripremi izvođenja građevinskih radova, Zbornik radova (Faculty of Civil Engineering, University of Rijeka), 2010, 13(1), pp. 225-244
3. Project Management Institute: A Guide to the Project Management Body of Knowledge (PMBOK Guide), PMI, Newtown Square, USA, 2021
4. Tijanić, K., Car-Pušić, D.: Prekoračenja rokova i proračuna građevinskih projekata – studija slučajeva, Zbornik radova (Faculty of Civil Engineering, University of Rijeka), 2018, 21(1), pp. 87-101
5. Radujković, M.: Izvor prekoračenja rokova i proračuna građevinskih projekata, Građevinar, 1999, 51(2), pp. 159-165
6. Žujo, V., Car-Pušić, D.: Prekoračenje ugovorenog roka građenja kao funkcija rizičnih faktora, Građevinar, 2009, 61(8), pp. 721-729
7. Car-Pušić, D., Tijanić Štrok, K., Petruseva, S., Zileska-Pancovska, V.: Comparative Analysis of Linear Regression and Soft Computing Methods for Estimating Highways Construction Time and Cost in the Republic of Croatia, Proceedings of 15th International Conference Organization, Technology and Management in Construction, 2022, pp. 169-178
8. Zhang, Y., Thomas Ng, S.: An ant colony system based decision support system for construction time-cost optimization, Journal of Civil Engineering and Management, 2012, 18(4), pp. 580-589
9. Ambrule, V. R., Bhirud, A. N.: Use of artificial neural network for pre design cost estimation of building projects, International Journal on Recent and Innovation Trends in Computing and Communication, 2017, 5(2), pp. 173-176
10. Petruseva, S., Zileska-Pancovska, V., Žujo, V., Brkan-Vejzović, A.: Construction costs forecasting: comparison of the accuracy of linear regression and support vector machine models, Tehnički vjesnik, 2017, 24(5), pp. 1431-1438
11. Tijanić, K., Car-Pušić, D., Šperac, M.: Cost estimation in road construction using artificial neural network, Neural Computing and Applications, 2020, 32, pp. 9343-9355.

12. Car-Pušić, D., Mlađen, M.: Early stage construction cost prediction in function of project sustainability, Proceedings of 15th International Conference on Durability of Building Materials and Components, 2020, pp. 631-638
13. Han, S., Choi, J. O., O'Connor, J. T.: Quality of baseline schedules: Lessons from higher education capital facility projects, Journal of Professional Issues in Engineering Education and Practice, 2017, 143(1), pp. 04016017.
14. Milat, M.: Višeciljni optimizacijski model za izradu rezistentnih vremenskih planova izvođenja građevinskih projekata u uvjetima nesigurnosti, University of Split, Faculty of Civil Engineering, Architecture and Geodesy, Split, 2022.
15. Negesa, A. B.: Assessing the causes of time overrun in building and road construction projects: the Case of Addis Ababa City, Ethiopia, Journal of Engineering, 2022
16. Gupta, C., Kumar, C.: Study of factors causing cost and time overrun in construction projects, International Journal of Engineering Research and Technology, 2020, 9(10), pp. 202-206
17. Salunkhe, A. A., Patil, R. S.: Effect of construction delays on project time overrun: Indian scenario, International Journal of Engineering Research and Technology, 2014, 3(1), p. 543-547
18. Ullah, K., Abdullah, A. H., Nagapan, S., Suhoo, S., Khan, M. S.: Theoretical framework of the causes of construction time and cost overruns, IOP Conference Series: Materials Science and Engineering, 2017, 271(1), pp. 012032
19. Gashahun, A. D.: Causes and effects of delay on African construction projects: A state of the art review, Civil and Environmental Research, 2020, 12, pp. 41-53.
20. Alaghbari, W. E., Kadir, M. R. A., Salim, A.: The significant factors causing delay of building construction projects in Malaysia, Engineering, construction and architectural management, 2007, 14(2), pp. 192-206
21. Car-Pušić, D.: Metodologija planiranja održivog vremena građenja (Sustainable construction time planning methodology), Doctoral thesis, University of Zagreb, Faculty of Civil Engineering, Zagreb, 2004
22. Žujo, V: Doprinos upravljanju građevinskim projektima kroz planiranje vremena građenja (Contribution to construction project management through construction time planning), Doctoral thesis, "Džemal Bijedić" University in Mostar, Faculty of Civil Engineering, 2008
23. Petruseva, S., Zileska-Pancovska, V., Žujo, V.: Predicting construction project duration with support vector machine, International Journal of Research in Engineering and Technology, 2013, 11(2), pp. 12-24.
24. Žujo, V., Car-Pušić, D., Zileska-Pancovska, V., Ćećez, M.: Time and cost interdependence in water supply system construction projects, Technological and Economic Development of Economy, 2017, 23(6), pp. 895-914.
25. Creswell, J. W.: Qualitative Inquiry & Research Design: Choosing Among Five Approaches, Third Edition, Sage Publications, Thousand Oaks, USA, 2013
26. Rowley, J.: Using Case Studies in Research, Management Research News, 2002, 25(1), pp. 16-27
27. Marfan, F.: Usporedna analiza uzroka odstupanja ostvarene realizacije i početnog dinamičkog plana i mjere prevencije (Comparative analysis of the causes of deviations between the actual realization and the initial dynamic plan and prevention measures), Graduation thesis, University of Rijeka, Faculty of Civil Engineering, 2023
28. Law on Construction, Official Gazette No. 153/13, 20/17, 39/19 and 125/19 (in Croatian)
29. Bučar, G.: Normativi i cijene u graditeljstvu, ICG d.o.o., Omišalj, 2003
30. GK; Normativi i standardi rada u građevinarstvu, od knjiga 1 do knjiga 7, Građevinska knjiga d.o.o., Beograd, 2008
31. Law on Spatial Planning and Construction Jobs and Activities, Official Gazette No. 78/15, 118/18, 110/19 (in Croatian)
32. Radujković, M.: Voditelj projekta, Građevinar, 2000, 52(03), pp. 143-151
33. Omazić, M., Baljkas S.: Projektni menadžment, Sinergija nakladništvo, Zagreb, 2005