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Organisation of Territory Restoration Activities Following a Natural Disaster

Barbora Helešicová, Jana Nováková, Petr Marvan, Vít Hromádka*

Brno University of Technology, Faculty of Civil Engineering, Veveří 331/95, Brno 602 00, Czech Republic

Abstract

Natural disasters are unfrequent, but inevitable parts of life. This article addresses this topic and at the same time proposes a methodology for managing the restoration of the territory affected by natural disasters. The application of this methodology is presented using a case study dealing with the restoration of a municipally owned building in the Czech Republic damaged by a tornado. This is the first recorded natural disaster of this kind in the area under study, which resulted in the necessity to pay attention to new approaches to the restoration of the affected territory. The project management tools were chosen in accordance with common construction practice, the originality lies mainly in the incorporation of the methods used into the actual process of the affected territory restoration which places special demand on its course in terms of organization, time, financial and decision-making processes. The outputs presented in this paper are designed to help municipal authorities manage the restoration of damaged buildings quickly and efficiently.

Keywords: project management, work breakdown structure (WBS), organigram, responsibility assignment matrix, natural disaster, time schedule.

* Corresponding author. Tel.: +420541148641.
E-mail address: hromadka.v@fce.vutbr.cz

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1. Introduction, state of art and objectives

The paper focuses on the management and organization of partial activities following a natural disaster in order to address the immediate needs of local residents and the subsequent recovery of the area as quickly as possible. The aim of the research presented in the paper is to propose a methodological procedure for the organization of activities leading to the recovery of the territory after a natural disaster and subsequent verification of its functionality on a case study from an affected region in the southeastern part of the Czech Republic. The issue of management of activities aimed at the restoration of the territory after a natural disaster is quite complex and often addressed in the scientific literature. In general, the basic procedures of activity management can be taken from the literature dealing with project management. Article [1] deals with a general definition of the issue and the identification of key project management tools. An important global player in the field of project management is the International Project Management Association (IPMA). The essential project management tips proposed by this association are summarized in the material [2]. Practical aspects of project management with regard to sub-activities, time frame, organisation and responsibility are introduced in the article [3]. An effective tool for managers dedicated to the organisation of activities leading to territory restoration can be the Handbook for Post-Disaster Reconstruction [4], which focuses on structuring decisions leading to the long-term sustainability of territory after restoration. Methods, procedures and training systems in the field of project management of activities implemented after a natural disaster are the subject of texts [5] and [6], which also presents a tool for managing sub-activities after a natural disaster based on the Ballance Scorecard approach commonly known from the business community.. The responsible approach in the form of solutions leading to higher resilience of the territory after the disaster is subsequently addressed by the material [7]. The results of an audit monitoring the effectiveness of post-disaster activities pointing to the frequent waste of resources on unnecessary acquisitions are presented in the article [8]. The critical factors of project management of activities after a natural disaster are the subject of the paper [6]. Due to the significant degree of difference from conventional construction projects, a conceptual framework for managing post-disaster restoration projects is designed in the paper [9]. A separate chapter of project management of post-disaster activities is risk management. Paper [10] focuses on the very causes of a natural disaster and the potential risk of its recurrence, while the general issue of risk mitigation of natural disasters is addressed by paper [11]. The issue of predicting the risks of natural disasters within the "Foresight" philosophy in relation to long-term planning is subsequently dealt with in the article [12], similar topic is solved by authors of paper [13] in he for of Bayesian predictive abalysis. The key issues that generally need to be addressed after a natural disaster are summarized and analysed in the text [14] in an illustrative way. The ways, how to asses environmental losses are described in paper [15]. The research gap generally consists in the absence of specific recommendations on how to proceed in the case of managing activities after a natural disaster. The aim of the contribution is to present the possibilities of using project management methods in the optimization of procedures ensuring the most efficient way to restore the territory.

2. Methods

Restoration of territory after a natural disaster is a quite complex project as a rule, so the application of project management is appropriate. Due to the construction nature of the project, it is advisable to choose project management tools that are more commonly used in the current construction industry and thus more easily applied by the project team during the actual restoration. Each of the outputs should therefore be developed into the required detail and in a descriptive way suitable for use in construction practice. Such project management tools include work breakdown structure -WBS, organigram, responsibility assignment matrix time schedule. The individual tools used build on each other, see the publications [1-3] for more details. The methodology used is shown schematically in Figure 1.

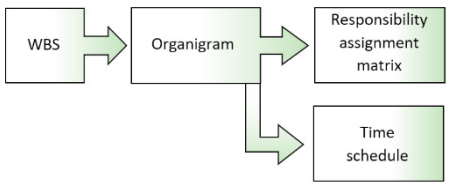

Fig. 1. Graphical representation of the methodology used (authors' own source).

3. Results

The above-stated methods were applied to a case study of the restoration of a part of a municipality located in the southeastern part of the Czech Republic after a natural disaster in the form of a tornado that occurred in June 2021.

3.1. Description of the natural disaster

The described methodology was applied to the territory of the Czech Republic after a tornado stuck a territory to the southeast of Brno. The tornado damaged over 1,200 buildings in five neighbouring municipalities (Hrušky, Moravská Nová Ves, Mikulčice, Lužice, Hodonín). The tornado advanced through the territory 26 km long and stripe up to 700 m wide belt. In addition to the damage to property, vegetation and infrastructure, estimated at CZK 15 billion, the natural disaster resulted in 6 deaths and approximately 200 injured. The case study focused on the restoration of the property of the Hrušky municipality. This municipality was the most affected by the natural disaster and proper organisation was essential for the proper management of the repairs. Other important factors in the selection of a suitable site for the use of the methodology were the helpful and proactive approach of the municipality representatives and good access to the necessary data. The case study dealt only with the municipally owned property.

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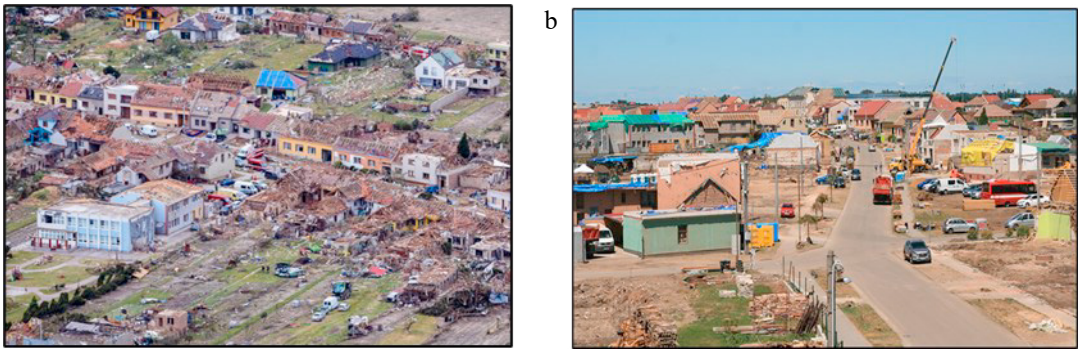

Fig. 2. (a) Hrušky municipality after the tornado, source [20]; (b) The beginning of the restoration of Hrušky municipality, source [22].

The proposed methodological procedure is illustratively applied to the reconstruction of a kindergarten building that was extensively damaged by a tornado. The kindergarten building (built-up area: 266.1 m^2; built-up space: 2,133 m^3) was built in 1977. It was a solid brick building. In 2014 the building underwent extensive modernization when an extension of another floor was added in order to expand the capacity. The kindergarten building consisted of three buildings:

- A – Main building
- B – Technical facilities + classrooms
- C – Connecting passage between buildings A and B

a b

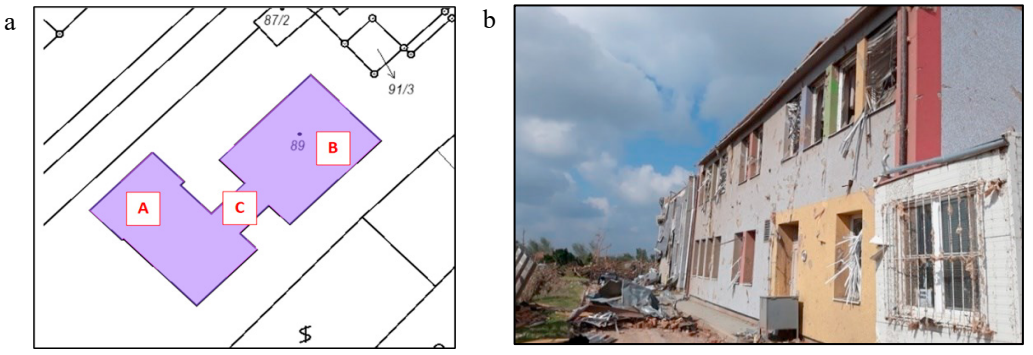

Fig. 3. (a) Division of the kindergarten, source [24]; (b) Hrušky kindergarten after the tornado, source [31].

The division of the kindergarten is shown in Figure 3a, the condition after the tornado is shown in Figure 3b.

3.2. WBS and responsibility assignment matrix

The kindergarten restoration project was divided into three main parts: pre-investment, investment and operational. The investment part was further divided into planning and implementation parts. The following Figures 4, 5 and 6 list individual activities whose fulfilment lead to the completion of the project objective, i.e. the re-commissioning of the building.

According to the structuring principles, the restoration of the kindergarten was divided into several parts for the purpose of a clearer flow of planning and management. The first part of the restoration was a part of the building that was planned to be newly used as a kindergarten canteen. The canteen was under construction before the tornado struck and a separate building permit was previously issued for this part. The second part of the restoration was the air-conditioning system newly installed in the kindergarten building, so it could not be included directly in the restoration of the building as a whole. The implementation of the air-conditioning system was covered by a public contract on the change of construction and design, concluded between the building authority of Břeclav and the municipal authority of Hrušky. The largest part of the restoration was the renovation of the kindergarten building itself. The completion of restoration finish by a final inspection. All the works required for the restoration of the kindergarten are listed in the structural plan in Figure 4, Figure 5 and Figure 6.

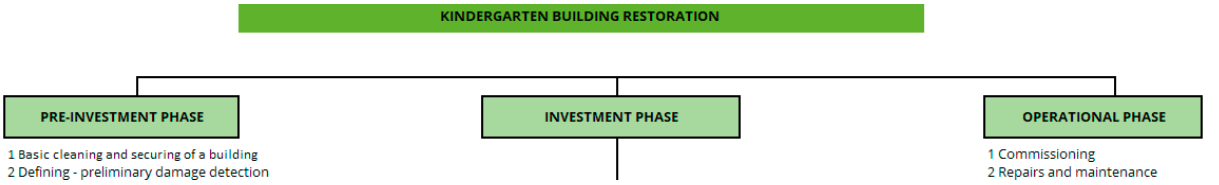

Fig. 4. WBS of the kindergarten restoration, part 1, own work.

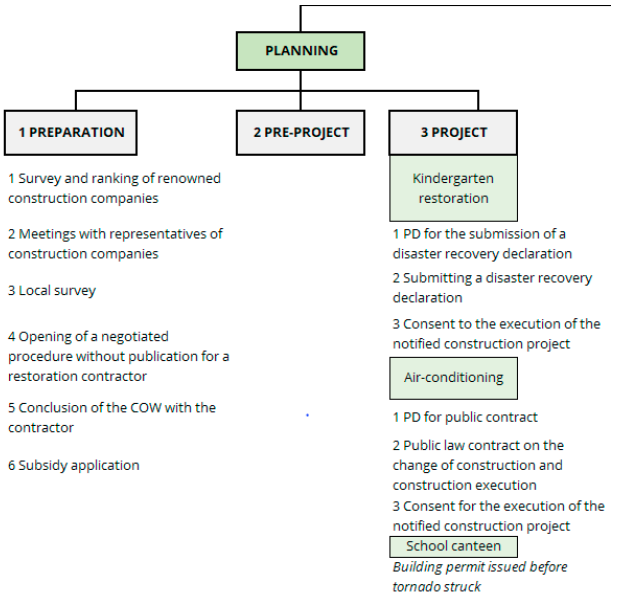

Fig. 5. WBS of the kindergarten restoration, part 2, own work.

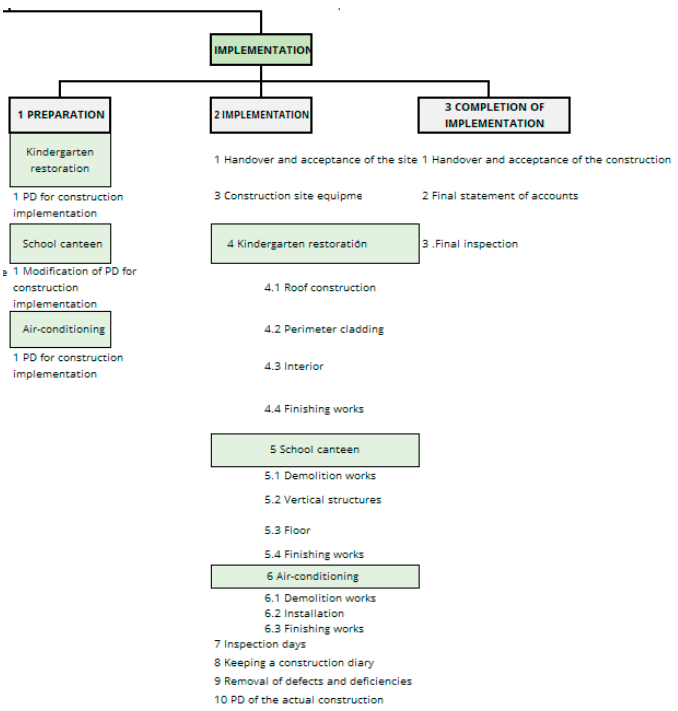

Fig. 6. WBS of the kindergarten restoration, part 3, own work.

3.3. Organigram

All the persons involved in the restoration of the kindergarten are shown in the organigram, see Figure 7. Metrostav a.s. was chosen as the contractor on the basis of a tender procedure. The tornado struck at a time when the reconstruction of the kindergarten canteen was already under progress, which was carried out by the construction company PLUS, s.r.o. Metrostav a.s. was chosen as the main contractor for the subsequent reconstruction following a tender procedure. In order to simplify the management of the construction works, an agreement was made between the construction companies, on the basis of which the construction company PLUS s.r.o. was still listed as the contractor of the canteen, with Metrostav becoming its main sub-contractor.

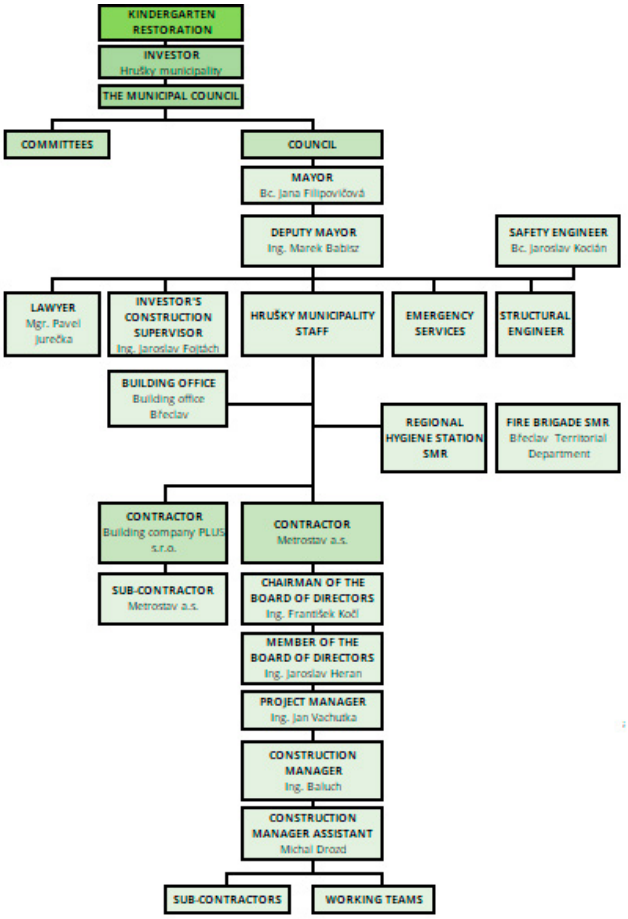

Fig. 7. Kindergarten organigram, own work.

3.4. Responsibility assignment matrix

The work breakdown structure plan and organigram are followed by the responsibility assignment matrix. This is a very clear way to allocate responsibility for all the activities listed in the structure plan. The matrix usually lists people in the rows and the individual work packages identified in the structure plan in the columns. The intersection of the specific person and work is used to record the person's responsibility for completing the activity. The abbreviations stand for:

- M – Manages and controls the activities

- C – Cooperates in the accomplishment of the activity
- P – Processes the activity

The investment phase of the project, specifically the planning - preparation part was chosen for the presentation of the case study results, see Table 1.

Table 1. Kindergarten responsibility assignment matrix.

Activities	Mayor	Staff of the Hrušky municipality	Construction manager	Lawyer	Structural engineer	Contractor
INVESTMENT PHASE						
Planning						
1 Preparation						
Survey and ranking of renowned construction companies	P	C				C
Meetings with representatives of construction companies	M, P	C	C			P
Local survey	C	C	P		M	P
Opening of a negotiated procedure without publication for a restoration contractor	M	C		P		C
Conclusion of the COW with the contractor	M	C		P		P
Subsidy application	M	P		C		C

3.5. Time schedule

The time schedule was processed using the Gantt chart. This was developed in two versions - the originally planned schedule and the actual implementation schedule. The kindergarten restoration was planned to take approximately 6 months. The time schedule was continuously updated throughout the duration of the project and the position of the critical path was relocated. Thanks to that, the overall delay of the kindergarten restoration was only one month, although the individual parts were delayed by more than three times more in total. The investment phase of the project, the planning-preparation part, was chosen for the presentation of the results. The original planned time schedule can be seen in Table 2, the updated time schedule can be seen in Table 3.

Table 2. Kindergarten planned time schedule.

Activity name	Duration (days)	Start (days)	Finish (days)
KINDERGARTEN RESTORATION	168	24/06/2021	14/03/2022
INVESTMENT PHASE	165	29/06/2021	14/03/2022
Planning	52	29/06/2021	16/09/2021
1 Preparation	52	29/06/2021	16/09/2021
Survey and ranking of renowned construction companies	5	29/06/2021	06/07/2021
Meetings with representatives of construction companies	3	07/07/2021	12/07/2021
Local survey	4	12/07/2021	16/07/2021
Opening of a negotiated procedure without publication for a restoration contractor	2	16/07/2021	16/07/2021

Conclusion of the COW with the contractor	3	21/07/2021	26/07/2021
Subsidy application	30	03/08/2021	16/09/2021

Table 3. Kindergarten actual time schedule.

Activity name	Duration (days)	Start (days)	Finish (days)
KINDERGARTEN RESTORATION	189.5	24/06/2021	18/04/2022
INVESTMENT PHASE	186.5	29/06/2021	18/04/2022
Planning	47	29/06/2021	09/09/2021
1Preparation	47	29/06/2021	09/09/2021
Survey and ranking of renowned construction companies	4	29/06/2021	05/07/2021
Meetings with representatives of construction companies	5	05/07/2021	13/07/2021
Local survey	2	13/07/2021	15/07/2021
Opening of a negotiated procedure without publication for a restoration contractor	1	16/07/2021	22/07/2021
Conclusion of the COW with the contractor	3	16/07/2021	22/07/2021
Subsidy application	27	29/07/2021	09/09/2021

4. Discussion

The methods used are best applicable to the restoration of single-owner properties. For such a large-scale project, the single-owner factor proved to be essential for several important reasons, namely the way of financing, the unchanging core of the project team, the unified vision and the legislative way of carrying out the repairs. The presented approach could be further applied to the restoration of company-owned properties. Similarly, the important factor of a single owner is present and the methodology remains unchanged.

In the case of the procedure applied for the restoration of privately owned property, the procedures have to be accordingly adapted. The collection of the data on which the structure plan was based would be much more complicated. Based on practical experience, it can be concluded that the private owner does not keep proper construction documentation (unlike the state or company owner, where this obligation is enforced by law) describing the original condition of damaged buildings. This makes the conditions for a local survey much more complicated. Furthermore, there is a problem in the financing of restoration, where several private owners have different financing options and it is not possible to develop a single financing plan. The so-called self-construction factor would also interfere with such a modified project, where the property owner repairs most of the damaged building on his own, usually at a lower cost than if he had used a construction company for the same work. However, there is a risk of unprofessional execution of the work.

The organisation of activities in the restoration of territory after a natural disaster is accompanied by a number of specific conditions that affect project management in both the preparatory and the implementation phases of the project. For public contracting authorities, these include in particular the way in which public contracts for services, supplies and works are awarded in an exceptional way in a state of emergency. In terms of project management and organisation of activities, problems may arise from the fact that locally responsible persons such as the mayor, the area manager or their deputies are often also the victims and have to divide their efforts between saving and securing both municipal and their own assets. The management and implementation of the works are also affected by the traffic logistics in the affected area, which is usually closed for a longer period by security forces in order to protect public and private property from theft or looting. The conditions for the actual construction work are also specific, with a high demand for skilled labour at the same time. In the case of the tornado, this included carpenters, roofers and plumbers, as hundreds of damaged roofs had to be secured and repaired.

5. Conclusion

The article deals with a plan for the organization of the restoration of a territory affected by a natural disaster. The text proposes a methodology for the process of organizing the restoration of the territory affected by a natural disaster. The procedures were subsequently applied in a case study. It dealt with the restoration of the property of Hrušky municipality, located in the Czech Republic to the southeast of Brno after a tornado struck it. This is a very rare type of natural disaster in the area under research, yet the tornado left behind a devastated landscape and billions of crowns worth of a destroyed real estate. The outputs of the case study are a developed work breakdown structure plan, an organigram of the responsibility assignment matrix, a planned time schedule and an actual time schedule of the actual construction. These documents were used in the restoration of the damaged building, helping municipal officials to organise repairs more quickly and to manage them efficiently and transparently.

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