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USE OF OPERATIONAL ANALYSIS PERT ON THE EVALUATION OF THE CROSS- BORDER COOPERATION DURING DISASTERS

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Abstract: *The aim of the paper is to inform the specialists' public about the partial research results of the managing processes in the Integrated Rescue System (IRS) and the authorities of crisis management at all levels of public administration of the Slovak Republic during natural disasters and catastrophes in border regions of EU Member States within Schengen area. The papers shows some evidence how important it is to use the scientific method of analysis and evaluation of managing processes PERT to protect human lives, health, property and environment in border regions, where the cross-border cooperation of rescue teams is essential.*
Key words: *cross-border cooperation, Schengen area, crisis, PERT.*

INTRODUCTION

The cross-border cooperation to solve the crisis that affect the border regions and are caused by natural disasters and civil catastrophes is part of the foreign policy of the Slovak Republic and it is very well communicated with all neighbouring countries. [1]. A lot of subjects are taking part at the cooperation – constitutional authorities, central bodies of the state administration, authorities of local state administration and self-governments as well as other organisations.

The accession of the Slovak Republic and its neighbouring EU Member States into the common Schengen area has inspired politician, crisis managers and researcher to evaluate the present status of the rescue teams' cross-border cooperation in neighbouring countries during the natural disasters and manmade catastrophes in border regions.

In spite of high effort of the representatives of the EU, European Council and national authorities to accelerate and to simplify the cross-border cooperation of neighbouring regions it is still not possible to cross the internal Schengen border by professional and voluntary rescue teams without complications according to the current legal status. To enable the border crossing of these teams it is necessary to meet a lot of activities by the Integrated Rescue System and regional and ministerial crisis management bodies. The PERT method is one of the operational research methods and it enables to analyse and to evaluate the efficiency of the managing processes in instable – stochastic environment, as the processes of crisis management are.

This paper informs about the author's research results evaluating the effectiveness of the managing processes of IRS and the crisis management authorities of the Slovak Republic and Hungary in the border regions – Novgorod. The research has revealed a range of problem fields in the cooperation - from the mutual notification of emergency situation up to providing help to rescue lives and health of the population, property and environment. These results also confirm the rightness and the validity of method PERT to look for more effective ways of cross-border cooperation

during catastrophes taking into account the Schengen area possibilities.

1. The aims and methods of the research

The main aim of the author's thesis was to evaluate the efficiency of the managing processes of the crisis management bodies and the rescue teams of the IRS of the Slovak Republic and Hungary to solve the crisis situation in the border regions and to suggest a new and more effective management model. A partial task to achieve this given goal was to carry out the analysis of managing processes, to evaluate their continuity and to take into account the time difficulty after the emergency situation has been reported in the border region of Novgorod until the required permission for providing assistance was granted from the neighbouring country [2].

The following scientific methods were used for research: scientific abstraction and description, scientific problem analysis and synthesis, mathematical-statistical methods, graph theory and at least deduction and induction. The main research method to evaluate the efficiency of managing processes and their operations was the scientific method of evaluation and control techniques - PERT (Program Evaluation and Review Technique). The graph theory and the theory of probability were used here as a common basis.

2. Research tasks

The rescue of human lives, health, property and environment during natural and other catastrophes depends on the fact if the emergency teams of the Integrated Rescue System react fast and effective on the situation. The precondition to activate the managing processes of the regional coordination centre of the Integrated Rescue System is to receive a call about the emergency situation on the international phone number 112. In case the emergency situation occurs in the border region it is very often more convenient to call also for the emergency teams from the neighbouring country. In some cases they could be situated much nearer to the place of emergency than the own emergency teams.

The current legal status of the cross-border cooperation is based on the bilateral governmental agreements and specific treaties of competent regional bodies of the public administration in Slovak Republic and neighbouring EU Member States. In accordance with these agreements it is very complicated to require assistance from neighbouring country because a lot of operations taken by competent bodies must be met and they slow the process of providing real help.

This problem became the main hypothesis of the research. We suggest that the current legal status is a disincentive to the bilateral requirements for assistance as well as for assistance provided during catastrophes. With the objective to verify or to disprove the mentioned hypothesis we have chosen three basic tasks of our research:

1. *to find out the critical way* - to adapt all necessary legal and on international agreements based managing processes to submit the request of Slovak national authority (Department of Civil Protection at the Section of Crisis Management and Civil Protection Ministry of Interior) to the Hungarian national authority (National Headquarters for Protection against Catastrophes) *for assistance* during catastrophes in border region,
2. to determine the *shortest time limit* needed to submit the request for assistance from Slovak authority to the competent Hungarian national authority,
3. to determine *the shortest time period* needed to inform the Hungarian authority that the emergency situation has occurred in the border region and the citizens and property of the neighbouring country could be affected by it, too.

3. Research procedure

To achieve the fulfilment of conditions for correct procedure of using the method of operational analysis we have determined the subjects responsible for the managing processes at the territory/side where the emergency situation was caused in the first phase of the research. After that we have worked out a list of activities and a network graph and using specialized software we have carried out an analysis of activities and knots.

The determination of subjects responsible for managing and progressing activities after being notified about the emergency situation by calling the European Emergency Number 112:

a) Responsible institution in the Slovak Republic:

- regional coordinating centre of Integrated Rescue System,
- operational centres of the basic and other units of the Integrated Rescue System,

- regional operational centre of the Fire Brigade and Rescue Corps,
- crisis management department of the district authority in the seat of the regional administration,
- operational centre of the Civil Protection Department at the Section of the Crisis Management and Civil Protection of the Ministry of Interior Slovak Republic,
- operational centre of the Presidium of the Fire Brigade and Rescue Corps,
- other related central authorities of the state administration.

b) Responsible persons in the Slovak Republic:
- participant at/ witness of the emergency situation,
- operator of the coordination centre,
- commander on duty of the Integrated Rescue System,
- chief of the crisis management department of the district authority in the seat of the regional administration,
- chief of the Civil Protection Department of the Section of the Crisis Management and Civil Protection of the Ministry of Interior Slovak Republic.

c) Competent institutions of the crisis management in Hungary that will overtake the information from the Slovak Republic where the emergency situation has occurred:

- Regional Directorate for the Protection against Catastrophes,
- National Headquarters for the Protection against Catastrophes.

The list of necessary activities to be executed to fulfil the needed task

The key task of the operational analysis PERT was preparing the list of activities. The examined processes are typical in the stochastic environment characterised by the fact that the lasting period of each activity is understood as a random quantity with a specific segment of probability. This has enabled to express the level of uncertainty using the probability assessment about the termination of the process or its important phases. There were no statistical data available to estimate the examined quantities. The PERT method has enabled to use the qualified expert estimates on the activities of the coordination centres and emergency teams of the Integrated Rescue System and other competent authorities of the crisis management at all management level of the public administration.

The identified operations were put in order as they follow. The start and the end of the operation was restricted by the start and end knot. The distance between the knots did not expressed the estimated period of operation. Each activity was estimated as optimistic „a“, or as pessimistic „b“ or as the most probable lasting period of the activity „m“. All data were recorded in the auxiliary table. The table was later used as the basis for the calculation of the estimation of the process lasting mean value and to draw up the network graph to determine the critical way. (Table 1)

Table 1 Auxiliary table of activities and estimations of the lasting period expressed in minutes – preliminary part

No.	Start knot	End knot	Activity	Optimistic estimation “a”	Pessimistic estimation “b”	Assumed lasting period “m”	To be carry out by
			notifying the emergency situation on phone No. 112 – coordination centre of IRS				participant/ witness
1	0	1	notifying the operational centre of OS HaZZ, OS ZZS, OS PZ by conference call	0.25	2	1.25	IRS coordination centre operator
2	0	4	notifying OS BZS, and other teams of IRS	1	4	2	IRS coordination centre operator
3	0	6	requesting KCHL through OCO KMCOMV SR	0.5	1.25	0.75	IRS coordination centre operator

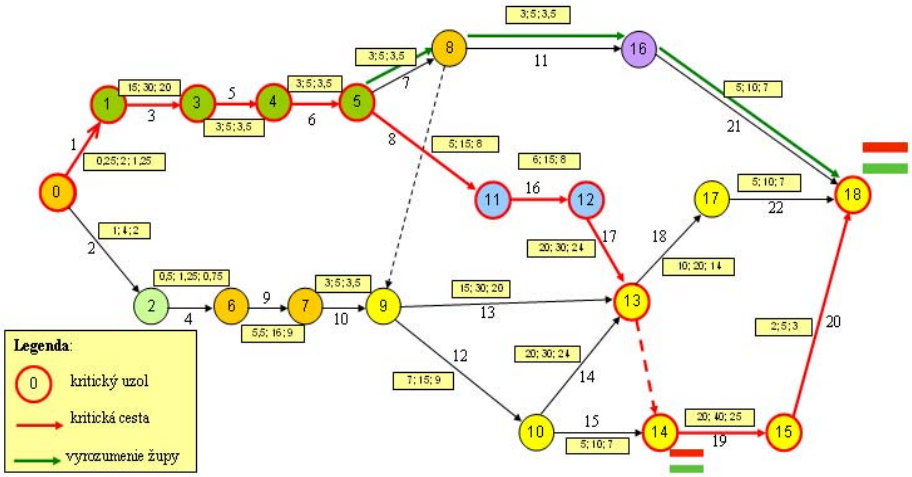
Source: own compilation

Legend:
IRS – Integrated Rescue System
OS ZZS – operational centre of the Emergency Medical Service
OS PZ – operational centre of the Police Force
OS BZS – operational centre of the Mining Rescue Service
OS HaZZ- operational centre of the Fire Brigade and Rescue Corps
KCHL – chemical laboratory check
OCO KMCO MV SR – Civil Protection Department at the Crisis Management and Civil Protection section of the Ministry of Interior Slovak Republic

Network graph
A detailed network graph was elaborated based on the information from the auxiliary table: edge oriented network graph with the limited set of knots U and edges (activities) H. We can label the graph mathematically as **G = (U,H)**. The edges between two knots marked with bold lines respond to a specific real activity and dashed line is used to mark an imaginary activity (no time needed, no cost), just to mark the relations and connection between some activities. Our edge oriented graph consisted of 18 knots and 22 edges. (see Graph 1)

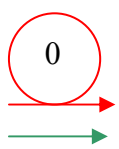
There are particular operations of managing authorities and executive teams and estimations of lasting periods recorded in the graph. The start and the end of the activities of particular institutions or responsible persons are marked as coloured knots.

Graph 1 The network graph of the crisis management authorities and the rescue teams activities after the arising of the emergency situation with cross-border effects that requiring assistance from the neighbouring country



.Source: Own compilation based on the established information about the managing processes

Legend:



- critical knot
- critical way
- notification of the neighbouring Hungarian district

5; 10;7 - optimistic estimation, pessimistic estimation, the most probable lasting period of the activity

Activities and knots analysis

The activities and knots analysis was carried out using computers and software MS doss 02 prg – network analysis. The results were transferred in two tables: table 2 – the results of activities analysis and table 3 – the results of knots analysis.

4 Research results

Based on the ascertained data we present the following **conclusions**:

1. There were totally identified 22 activities of the project. It is necessary that **ten connected and two parallel activities of them will be realized on the critical way** to fulfil the aim – the request on assistance during an emergency situation send by the competent Slovak authority to the competent Hungarian authority on the agreed way (viva voce or in writing). Critical activities are recorded in the last column in the table 2 with the value 1 and are red coloured. The critical way is marked as red in the network graph. From the total number of 18 knots we have determined the critical knots for start and end of particular activities. We have also determined the start and end knot of the project. We have found out that the possible and the admissible time limit are the same - 101,04 minutes and there is no time reserve. The results from the knots analysis are recorded in network graph as well as marked red in the table 3 and they correspondent to 50 % of the probability.

Table 2 – Results of activities analysis

i	j	Optimistic estimation	Pessimistic estimation	The most probable lasting period	Mean lasting period	Possible start	Possible end	Admissible start	Admissible end	Dispersion	Critical activity
0	1	0,25	2	1,25	1,21	0	1,21	0	1,21	0,09	1
0	2	1	4	2	2,17	0	2,17	21	23,17	0,25	0
1	3	15	30	20	20,83	1,21	22,04	1,21	22,04	6,25	1
2	6	0,50	1,25	0,75	0,79	2,17	2,96	23,17	23,96	0,02	0
3	4	3	5	3,50	3,67	22,04	25,71	22,04	25,71	0,11	**1**
4	5	3	5	3,50	3,67	25,71	29,38	25,71	29,38	0,11	1
5	8	3	5	3,50	3,67	29,38	33,04	33,54	37,21	0,11	0
5	11	5	15	8	8,67	29,38	38,04	29,38	38,04	2,78	1
6	7	5,50	16	9	9,58	2,96	12,54	23,96	33,54	3,06	0
7	9	3	5	3,50	3,67	12,54	16,21	33,54	37,21	0,11	0
8	9	0	0	0	0	33,04	33,04	37,21	37,21	0	0
8	16	3	5	3,50	3,67	33,04	36,71	90,21	93,88	0,11	0
9	10	7	15	9	9,67	33,04	42,71	37,21	46,88	1,78	0
9	13	15	30	20	20,83	33,04	53,88	50,38	71,21	6,25	0
10	13	20	30	24	24,33	42,71	67,04	46,88	71,21	2,78	0
10	14	5	10	7	7,17	42,71	49,88	64,04	71,21	0,69	0
11	12	6	15	8	8,83	38,04	46,88	38,04	46,88	2,25	1
12	13	20	30	24	24,33	46,88	71,21	46,88	71,21	2,78	1
13	14	0	0	0	0	71,21	71,21	71,21	71,21	0	1
13	17	10	20	14	14,33	71,21	85,54	79,54	93,88	2,78	0
14	15	20	40	25	26,67	71,21	97,88	71,21	97,88	11,11	1
15	18	2	5	3	3,17	97,88	101,04	97,88	101,04	0,25	1
16	18	5	10	7	7,17	36,71	43,88	93,88	101,04	0,69	0
17	18	5	10	7	7,17	85,54	92,71	93,88	101,04	0,69	0

Source: Own compilation of the research results

Table 3 – Results of knots analysis

Knot	Possible time limit	Admissible time limit	Critical reserve	Dispersion possible	Dispersion allowed	Dispersion critical	Probability of critical knot
0	0	0	0	0	25,72	25,72	0,50
1	1,21	1,21	0	0,09	25,64	25,72	0,50
2	2,17	23,17	21	0,25	19,11	19,36	0
3	22,04	22,04	0	6,34	19,39	25,72	0,50
4	25,71	25,71	0	6,45	19,28	25,72	0,50
5	29,38	29,38	0	6,56	19,17	25,72	0,50
6	2,96	23,96	21	0,27	19,09	19,36	0
7	12,54	33,54	21	3,33	16,03	19,36	0
8	33,04	37,21	4,17	6,67	15,92	22,59	0,19
9	33,04	37,21	4,17	6,67	15,92	22,59	0,19
10	42,71	46,88	4,17	8,45	14,14	22,59	0,19
11	38,04	38,04	0	9,34	16,39	25,72	0,50
12	46,88	46,88	0	11,59	14,14	25,72	0,50
13	71,21	71,21	0	14,36	11,36	25,72	0,50
14	71,21	71,21	0	14,36	11,36	25,72	0,50
15	97,88	97,88	0	25,47	0,25	25,72	0,50
16	36,71	43,88	57,17	6,78	0,69	7,47	0
17	85,54	93,88	8,33	17,14	0,69	17,84	0,02
18	101,04	101,04	0	25,72	0	25,72	0,50

Source: Own compilation of the research results

2. **The shortest period** needed to submit the request for assistance to the national Hungarian authority since the emergency situation was notified on phone No. 112 is between **85,54 minutes** (start) and 92,71 minutes (end). Under some unfavourable circumstances it is possible to accept the start from the 93,88 minutes do 101,04 minutes. The data are recorded in the table 2 and are marked yellow.
3. **The shortest possible time limit needed to notify the Hungarian authority** about the emergency situation on the Slovak territory possible to affect the health or lives or property in the neighbouring region of Novgorod in Hungary is:
   - **on regional level** (the activities between the knots 16 and 18, chief of the Crisis Management and Civil Protection Department of the district authority in the seat of the regional administration in Banská Bystrica informs by phone the District Directorate for the Protection against Catastrophes in Salgótarjáne) it starts in **36,71 minutes** and its possible end is in 43,88 minutes,
   - **on national level** (the activities between the knots 10 and 14, operator of the coordination centre of the Civil Protection Department at the Crisis Management and Civil Protection section at the Ministry of Interior Slovak Republic informs per phone the operator of the National Headquarters for Protection against Catastrophes in Hungary) with the possible start in **42,71 minutes** and possible end in 46,88 minutes.

Based on the results of the activities and knots analysis it can be stated that the current model of cross-border cooperation is a set of difficult, dynamic, parallel and connected activities of competent institution and authorities.

We consider the established shortest time limit to notify the Hungarian authority on the regional or national level for extremely long. There is a doubt if the Hungarian authorities for the protection against catastrophes will have enough time to warn their citizens and to undergo the necessary measures for rescuing or evacuation. We are convinced that this task will be faster accomplished by border towns/villages with connected warn and notifying systems.

Our next evaluation is that the possible shortest time limit to submit the request for assistance to the Hungarian authority in 85,54

minutes is also too long. We believe that the time to get the permission from the neighbouring country to assist in these catastrophes is too long to be fast enough and effective.

An example: Fire at the petrol station in Slovenské Ďarmoty. This village is situated on the border to Hungary. The rescue teams of the Slovak Integrated Rescue System based in Veľký Krtíš or Šahy are more far away that the rescue teams in neighbouring town Balreassagyarmat. Unfortunately the village is not competent to ask for assistance directly the neighbouring Hungarian town and has to wait until the Slovak rescue teams arrive and it takes them to come much longer than if they would come from behind the border. The high number of necessary managing activities to be done to get the permission from the Hungarian authority is a proof of non- flexibility and inefficiency of cross-border cooperation during catastrophes.

We think it is necessary to change this cooperation model especially after the Slovak Republic as well as Hungary is at Schengen area and both countries are EU Member States. EU citizens can cross the internal border without any restrictions but there are unfortunately other rules for border crossing of the rescue teams.

The cross-border cooperation of the EU Member State can improve by applying the *Article 25 and 26 of Prüm Treaty* [3]. According to this treaty it will be possible to provide mutual assistance by rescue teams in emergency cases as catastrophes and accidents by crossing the border without the previous permission and when needed. During natural catastrophes and fires near the state border the rescue and fire brigade teams can cross the internal EU border without requesting the other party but having the permission of the border mandatory.

Conclusions and recommendations

In the research has been confirmed that using the scientific method of operational analysis PERT is a right way to evaluate the efficiency and validity of the managing processes of the competent authorities of the Integrated Rescue System and crisis management bodies at all level of public administration. Through the PERT operational analysis the time reserves, duplicity and other negatives can be revealed in the managing processes. It can be used to form difficult processes, to prepare their optimisation and to adapt to the internal and external condition with the aim to achieve the determined goals in good time limit [4] not only in public sector but also in private sector (small and medium enterprises, too) [6].

The research results have confirmed the main hypothesis that the current status of the managing processes of the cross-border cooperation during catastrophes does not enable effective and fast cooperation to rescue human lives and protect their health and environment. According to the gained results and based on the theory [5] and best practice on this topic we suggest following measures:

- **in legislation:** to change the legislation to strengthen the competency of the towns and villages in border region to be authorised to sign agreements on cross-border cooperation and local assistance during the catastrophes,
- **organisational matters:** to determine villages with more competences on the field of crisis management, to employ professional crisis managers, to better the crisis planning in towns and villages and to evaluate the current system of emergency situations risk management in the border regions,
- **human resources:** to provide special training for the elected representatives in towns and villages, to support common alarm drill exercises of the crisis management authorities and rescue teams at local level,
- **technical matters:** to set up a mutual connection of public warn system and notifications system of the competent authorities in neighbouring border towns and villages, modernisation of the infrastructure as well as modernisation of the rescue teams equipments.

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СЪТРУДНИЧЕСТВО ПРИ БЕДСТВИЯ

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***Ключови думи**: международно сътрудничество, Шенгенско пространство, криза, PERT.*

***Анотация**: Целта на статията е да информира специалистите за частичните резултати от изследването на управлението на процесите в Интегрираната система за спасяване (IRS) и властите на всички равнища на публичната администрация на Словакия за управлението на кризите при природни бедствия и катастрофи в граничните райони на страните членки на ЕС в рамките на Шенгенското пространство. Показани са доказателства за важността на приложението на научния метод за анализ и оценка на управляването на процесите PERT за защита на човешкия живот, здраве, собственост в граничните райони, където международното сътрудничество на спасителните екипи е особено важно.*