Crisis management in the railway transport and their additions

Dana Rozová[1], Martin Šustr[2], Radovan Soušek[3], Petr Šohajek[4]

[1] *Jan Perner Transport Faculty Studentská 95, 532 10 Pardubice 2, Czech Republic, E-mail: rozovad@szdc.cz*
[2] *Jan Perner Transport Faculty Studentská 95, 532 10 Pardubice 2, Czech Republic, E-mail: martin.sustr@student.upce.cz*
[3] *Jan Perner Transport Faculty Studentská 95, 532 10 Pardubice 2, Czech Republic, E-mail: radovan.sousek@szdc.cz*
[4] *Jan Perner Transport Faculty Studentská 95, 532 10 Pardubice 2, Czech Republic, E-mail: petr.sohajek@student.upce.cz*

Abstract

Directive 2004/49/EC of the European Parliament and of the Council about on safety on the Community's railways so-called Railway safety directive on the basement of the directive and national Czech laws in is used in the Czech Republic the System for security (SESY). Every train operating company (TOC) must create the plan for the crisis situation in accordance with the SESY. Every plan creates by the TOC's must by regularly checked and updated by the possible threat. The SESY brings indicators, methods, goals and the ability to proactive approach to the risks elimination and protection. From the crisis management point of view the SESY brush with intervention plans, warning branch and information plans for the event of an emergency. These plans are agreed between authority and TOC. The regular plan check is necessary for the crisis situations and for the searching of weak points of planning. The plan check is realized like training with other subjects, too. For the plan sustain plans actual is necessary the proactive indicators and checking mechanism in the railway transport system.

In the railway transport system is necessary to use the reactive and proactive approach in the SESY. The using of proactive methods, guides and monitoring systems, control and communication mechanisms can be improved thank to the crisis management additions.
KEYWORDS: Crisis management, proactive approach, business continuity management system

1 Introduction

Crisis management in the railway transport was characteristic with a reactive approach. A reactive approach means, that if the crisis situation occurred, the SESY guidelines was very effective for impact reduction. The specific of reactive approach is solves problems when they happen and the main attention in regard to the removal of impacts. On the other hand, currently the crisis management in the railway transport take into account the prevention of crisis and it is the proactive approach. The proactive approach in the long-time horizon offers a wide flow of specialized expertise that respects broad contexts and views. Thanks to the focusing on risks and vulnerability, and through the multi-risk scenarios in a dynamic design, crisis management can be more effective. By the 7(1) proactive approach in the crisis management is based on the prevention and on the early detection of the initial signs of the problem. This approach in the crisis management is based on the prevention and early detection of the initial signs of the problem. Last but not least the problem solution during the crisis is an initial part, too. The proactive approach generally reduces the time to identify the problem and significantly increases the practical effectiveness of crisis management.

In the current crisis management are various tools (additions) for better opportunities for improvement SESY. Very useful addition for railway undertakings is the business continuity management system (BCMS). BCMS is a mean for applying the proactive approach, too. BCMS increases the company resilience against disruption, interruption, or loss of ability to meet its strategic goals. In the proactive approach is applicable predictive diagnostic. The predictive diagnostic is another addition to the process of crisis management in the railway transport. If BCMS and predictive diagnostic merge, new tool for the diagnostic of railway transport resilience will be created.

7(1), 7(2),7(3)

2 Crisis management in the railway transport

Rail transport is a coherent system of activities. The principal role of the performer in rail transport activities is represented by infrastructure managers; TOC's and rail administrative authorities (RAA). In the paper, these subject will be called like railway entities. Individual activities in the railway transport seem to be outlying. However, the opposite is true. The activities fulfilled by railway entities are linked, moreover, the activities are blend together. This is also related to the co-operation of the individual railway entities in the activities. Infrastructure manager tries to improve railway infrastructure. Usually (in the Czech Republic and in

another European Countries) the infrastructure manager create the timetables and control the railway traffic. TOC provides services related to train running (provide transport services to passengers and freight transport customers). RAA is national supervision in the field of railways and building regulations. RAA also assess the extraordinary events and investigate the extraordinary events. Last but not least RAA approve the type of technical device and approve the personal competence.

Function of important processes in the railway transport system is necessary. These processes are linked and blend together. Every change in the system is transferred further.

Due to interdependence was creating the Commission Implementing Regulation (EU) no. 402/2013 on the common safety method for risk evaluation and assessment. The regulation no. 402/2013 solved procedures for the occurrence of incidents on the railways and the assessment of changes in the railway system in terms of safety risks.

For solving the different types of crisis situations and extraordinary events, the TOC's in the Czech Republic are created and permanently updated the crisis plans. These crisis plans are created for readiness on the crisis situation, too. Current crisis management in the railway transport branch is part of management and it is responsible for the tasks:

- In the normal situations (normal train operations and standard traffic situation) ensures through the Security Council actions in for prevention of crisis situations,
- During the crisis situation monitored the situation through the security council and assesses the situation in its field of competence, cooperates with crisis management units of local authorities in the implementation of emergency measures, manage the elimination of the consequences of the crisis situation and restore traffic and the operability of the railway infrastructure
- After crisis situation ensures inspections of objects and equipment that manages and evaluates damage on their property.

3 BCMS like an addition in the crisis management

The integral part of proactive crisis management must be continuity management process. The continuity management process represents readiness for the unexpected events with the negative impact on the railway transport branch. BCMS systematic approach is a one way to start the continuity management process. In this case, BCMS is a set of organizational, personal, material, technical, financial and other measures to provide the necessary resources for the implementation and strengthening processes during extraordinary and crisis situations.

For ensuring the continuity is necessary various resources (technical equipment, humans, etc.) and measures (systematic planning documents, procedure plans, etc.). The BCMS elements are a set of measures, steps, procedures or resources which secure resources and faces to the higher resilience of activities.

BCMS solve the human activity, as well. The BCMS is a soft system (human activities) with elements related to hard systems.

Soft systems are more compatible with fuzzy structure systems and with systems of uncertainty and risk. The important aspect is system development over time (dynamic system). Dynamic system can be very difficult defined. In the BCMS for railway system are the coexistence of values inaccuracy, the uncertainty of attributes ability and the unpredictability of processes.

The problematic situation in the railway transport system can be shown on the Rich Picture. The rich picture is a complex situation capture with main tasks and problematic situation. The rich picture is figured on the Fig. 1*: BCMS Rich Picture*.

The problem in the continuity of activities ensuring on the railways is the interruption of the train operation. The interruption of train operation can be caused by several caused. The reason may be to stop the activity which is directly before the investigated activity or resources do not provide what is required for the activity. Figuration *Fig. 1* illustrates the problem of interruption of activity. Some sources of activity are in the object, some of them are in the neighbor of the object. Figuration*Fig. 1* also shows links. Links to sources from the neighbor are one-way because the system is not set to transform resources which are out of the system.

Links in the system are two-way due to mutually interaction. Main sources for continuity of activities are "means" (hardware, buildings, workplaces, energy, etc.). On the figuration, these means are marked with a light and dark green color. Humans out of the systems are marked with blue color and processes are marked with yellow and brown. The figure shows the senior manager and person who proceed documents because it is a system with desirable behavior. The system is controlled by a senior manager.

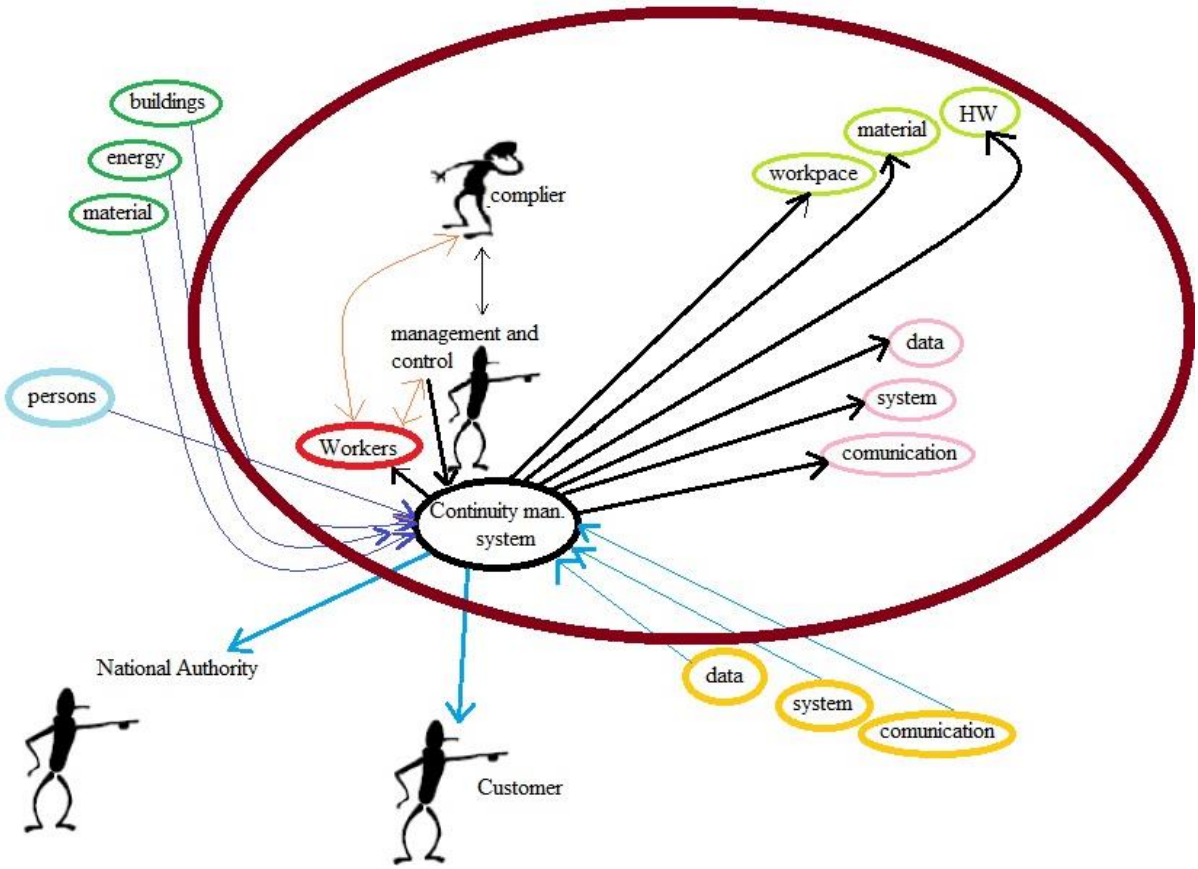

Fig. 1: BCMS Rich Picture

Source: Authors

For creating BCMS are important 4 basic processes. The results from these processes are transformed outputs meeting the BCMS requirements and expectations from the surrounding area. It is PDCA (plan do check act). In the first step is determined politics, goals, tasks, measures, process and procedures of continuity. In the next step, every point which arises in the first step is implemented by the strategic business goals. The system is monitored and tested in the third step. In the third step are provided outputs. The last step, based on the results of the third process, can accept any change, update, or confirm the processes in the first document process as a correct. The system structure is on the Figuration 2.

7(5), (6)

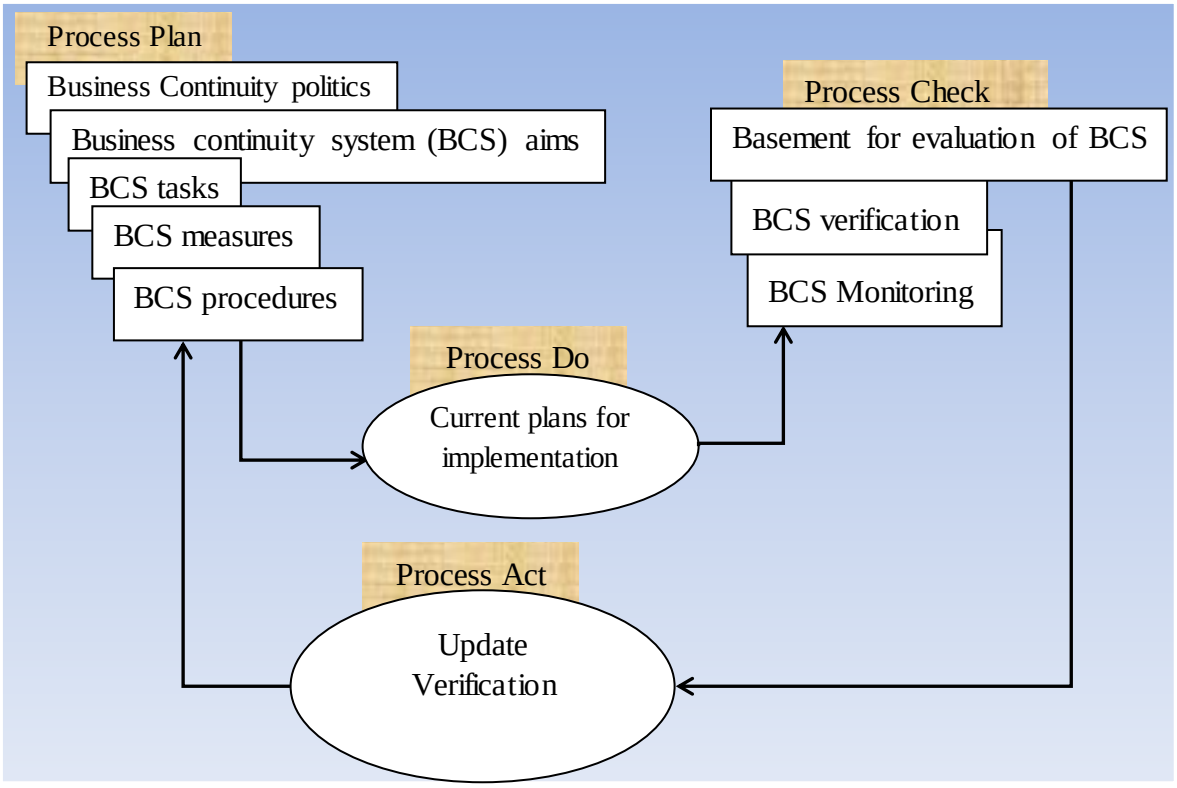

Fig. 2: Continuity of activity system - structure

Source: Authors

In the process of the BCMS goal must be constantly monitored. Continuity of object is characterized by the transition from one state to another when there is no significant conflict in the change. That continuity of object is a BCMS goal. The BCMS must help ensure the level of criticality in the operations at an acceptable level. This level of criticality should not be exceeded in the normal situation and in the crisis situations, too.

(1), 7(6), (7), (8)

4 Prediction diagnostic

Prediction diagnostic is a tool, which finds its application especially in reliability and the life cycle of complex systems. Thanks to the prediction diagnostic are possible to estimate crisis or extraordinary situation and do timely warning.

Despite the fast, that prediction diagnostic is a very efficient tool, it has a disadvantage, too. In many real systems, it is not possible to determine the exact values for all incoming parameters and their uncertainty must be taken into account. In the railway transport cannot be possible to determine the all incoming values parameters exactly. If the imputing values have an indefinite character, it is handle to use the theory of fuzzy sets to solve multi-criteria evaluation of such tasks.

4.1 Theory of fuzzy sets in the evaluation

Logic works only with two options: *Yes* or *No*. In the real world is another option. Tool for closer capturing of reality which makes the solution more precious for the evaluation can be found in fuzzy logic.

In comparison with usual procedures, the fuzzy logic is their sets are variable. The fuzzy logic is able to work with variable intermediate values. The specific of fuzzy logic is a variable set of values.

Although the concepts of Fuzzy logic and Fuzzy set first appeared in 1965, its use in crisis management is not a common issue. The fuzzy means also matte, hazy, vague or undefined. It also corresponds with a problem which is solved in fuzzy theory. It is trying to cover the reality of its inaccuracy and uncertainty.

(7), (8)

The fuzzy set is a set that, in addition to *yes* or *no*, allows partial option. It means that the element belongs to a set with a certain degree of belonging (level of affiliation). Its mean, that element belongs to the set with defined level of affiliation. The strict description leads to the reality description only by means of a two-element set {0, 1}. If the problem is not possible to define by this two-element set, it splits into smaller sub solutions. Thanks to the dividing problem to the subsolution there is a deviation from reality, which can be called a mistake. With frequent dividing, deviations increase. The phrase above is a principle of incompatibility.

Creating a fuzzy logic system involves three basic steps. The first is a fuzzification. In the fuzzification are real variables converted to a fuzzy value. The second step (fuzzy interference) defines the behavior of the system on the linguistic level. The resolution in the fuzzy interference is a linguistic variable. Defuzzification is the third step. Defuzzification changes the fuzzy interference to the real value.

(8), (10), (11)

4.2 Choice of Criteria

The criteria choices are the most important step for prediction diagnostic. The criteria evaluation could have a different nature. In the crisis management is necessary, distinguish between criteria, whether the parameters exist independently of the evaluator's will. Parameters exist independently on the evaluators will are characteristics, the properties that are created are attributes. The specified set of evaluation criteria should meet certain requirements. Assessment of the set of criteria should allow regard all important (long-term and short-term, positive and negative) impacts. Each criterion must be clearly defined and the way it is measured must be defined, too. Each aspect should enter into the evaluation once, the criteria should not overlap each other.

For evaluation is most important choose the right number of characteristics. Too high number can complicate finding the solution. If there is too little number of characteristic, there is a risk that some important feature will be neglected. It is proper to find a sufficient number of characteristics with sufficient information. The rationality of creating evaluation criteria depends on the knowledge of the assessment object and on the knowledge of their structure and functions. Expert evaluation calculates with a low number of criteria. The low number of criteria is desirable, otherwise, the outcome of the variants is complicated. However, some of the above requirements are contradictory and cannot be met at the same time. Sometimes a compromise is needed.

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5 BCMS and prediction diagnostic

Continuity of activities aims to minimize the reconstruction time in order to avoid the development of a crisis situation. The seriousness of the crisis situation usually exponentially increasing. The seriousness of the crisis situation depends on the interruption time. The continuity of activities can improve the resilience of the railway transport system and effectively overcome potential traffic disruption.

For the effective management of the continuity of processes on the railways, it is necessary to pay attention to the evaluation of the activities in terms of continuity and continuity monitoring. Combining these two additions, it is possible to estimate when and how the crisis situations can occur and to carry out the early warning and the necessary action. In the specific situations, the activity setting can be changed. Thanks to the changes, the problem will be completely or partially eliminated.

Therefore, the combination of predictive diagnostics with BCMS appears to be an extremely effective tool for dealing with crisis situations in the railway transport.

The evaluation of the continuity of activities is a typical task of multicriterial evaluation. The input system values of the continuity of activities are indefinite. For the following solution can be used the theory of fuzzy sets. The first, in evaluating, must be specifying the basic system problem. The basic problem of continuity is a specific event. It is such an extraordinary event with a limitation of resources or other activities. Such an episode can be called an event of discontinuity. In the continuity of activities in crisis situations is necessary to find a way of buffer of activities otherwise boost activities that will allow the continuation of transport and can solve the crisis situation. The core of the problem is finding the point for sustain the original activities in the railway transport on the necessary level.

The level of continuity of activity depends on:

- how much can be realized in extraordinary events or crisis situations,
- how long the desired activity mustn't be realized without another impact,
- how many activities are linked with the activity
- it is possible activity replaced by another worker or on another workplace

The six basic criteria for assessing the continuity of activities corresponding to the previous questions. In the table *Table 2* are individual criteria for evaluation.

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Table 1

Criteria for evaluation of activities continuity

Criterion name	**label**
Fulfillment of Activity	*p*
Continuity of Activity	*k*
Interconnectivity of Activity	*v*
Reachability of Activity	*d*
Difficulty of Activity	*n*
Vulnerability of Activity	*z*

Source: Authors

5.1 Interpretation of individual parameters

Fulfillment of an activity *p* is the parameter that evaluates the overall use of the activity in any situation, both in the normal state and in crisis situations. The value of the Fulfilment of an Activity *p* can indicate that the activity is suitable only for a normal situation, a normal day-to-day regime without the possibility of its use in emergency situations or crisis situations. Under normal circumstances, all activities are valued equally because they meet the essential requirements for the outcome of the activity resulting from the expected benefit of performing the activity. In crisis situations, this standard expected performance requires more effort which is positively related to increasing intensity of the crisis. The value of this criterion of given activity is directly linked to individual crisis situations. For the actual evaluation of the value of the continuity of activities, a direct link to non-military crisis situations has been used.

The continuity of activity *k* is the very essence of continuity of activity, the basic observed parameter. It is assessed by the time lag between the termination of the activity and the renewal of the performance without any subsequent problems.

The interconnectedness of the activity *v* indicates a number of previous and subsequent activities in general. For this evaluation, only a two-member causal chain was used in the sense of the cause (the activity under consideration) and the consequence (the number of follow-up activities per activity evaluated). The resulting value v can then be determined by the relationship:

$$v = v_p + v_0$$

In the formula, v_p stands for Interconnectivity, which tells about intra-company synergies, and it is the number of links of individual activities to other activities in the department, in the unit or in the enterprise. The second part in the formula v_0 stands for External Link, which is the number the activity is connected to the surroundings outside of the enterprise.

The reachability of activity *d* is understood here as the representation of a worker who normally carries out the work by a worker from another, from another department, section, enterprise or outside the enterprise. In other words, it is about the substitution or substitutability for the worker who performs the activity and which, in the event of an emergency, would not be able to perform the activity himself. The term "reachability" was chosen from the point of view of its letter *d* because letters *z* and *n* are already used for following parameters. In the short term, the job performed by one worker can be divided among other workers who perform the same work in parallel workplaces. In the long-term absence, workers cannot be overloaded, as their fatigue would negatively influence their job performance. Therefore, it is also possible to consider the possibility of substitution of a worker who has been absent for a long time with a worker from a different workplace who would be able to perform the activity after a short period of training. In the partial evaluation of Reachability of Activity *d*, the required quality of representation can be expressed by the weight of the criterion, depending on whether a worker from the workplace is required (by increasing the weight of the criterion) or whether the worker can work from external sources (by reducing the weight of the criterion).

Criterion the Difficulty of activity *n* is characterized for this purpose as the number of workers involved for achieving this activity. If the number of people performing the activity is dropped consequently the performance is reduced and the desired result is not achieved. The value of this parameter can be extended by the financial cost, possibly space requirements for its implementation.

Due to the difficulty in obtaining the financial cost data and the space requirement for its implementation, the third feature was used – the number of workers who carry out the activity.

The Vulnerability parameter is *z* is reduced by rules, steps, or procedures. Measures to eliminate risks can only be partial or complex, depending on the degree of practice and their form.

5.2 Relation between criteria

The relationship between the criteria is also important for evaluation. It is also important to find the possible interdependencies or similarities between the various aspects of the assessment.

The basic concept for examining the relationship between two characters is their independence. The two criteria are independent if the assessment of the first one does not depend on the value achieved by the latter.

There is interconnection between the Activity *p* and the Continuity of activities *k*. It has its justification both in its normal state in terms of meeting its expected benefit and speed and the need for its use. If the activity is fulfilled even in crisis situations when the time demands for the activity are usually increased, then the period of possible interruption of the given activity should be one day at the most, in order to avoid the risk of delay.

Therefore, if the p performance of the p activity is highly valued, there should not be too long interruptions, so the value of Continuity of activities k should be also high. Otherwise, there is a logical disproportion.

Indirectly there is also relation between the parameters of the activity Interconnectivity *v* the Fulfillment activity p. The low value of the activity *p* leads to the assumption of the low connectivity to the surrounding activities, in other words, the greater the demand for performing the activity, the more other activities require such an activity and the more requirements for the results of given activity. It is not a direct link with any exceptions, however, the general trend the connection is significant. Therefore, it can be generally assumed that the higher the value of the Fulfillment activity p higher the Interconnectivity activity *v*.

The Reachability activity d has a direct link to the Fulfillment Activity p, therefore, the activity p can be maintained in the long-term even in crisis situations. There is also another parameter for the need for the performance of the activity. If the activity is not sustained and continuously claimed, the activity is less necessary and for this reason, it is not necessary to provide substitution.

There was no immediate link between the Fulfillment Activity *p* and the Difficulty Activity *n*. Both parameters are independent of each other. However, if the number of workers carrying out the activity in normal condition is reduced to a smaller number of workers in a crisis situation, the difficulty in performing the activity will consequently increase.

If the Vulnerability of the activity *z* is defined as the resulting effect of the threat elimination procedures, it is quite obvious that there is no bond or relationship to the *P* performance of the activity.

The continuity of activity k influences the relevance of activity v and vice versa. An activity that has several previous and sequential activities is clearly more required and has a higher requirement for continuity of activities *k*. The more people participate in the performance, the more difficult is to achieve the imperceptibility of such activity. Changes in the performance of the original activity can happen if the conditions change. The severity of activity n is therefore indirectly dependent on Continuity of activity *k*.

Indirect dependence is also between the Vulnerability of Activities z and the Continuity of Activities *k*, because the more the risk is eliminated, the less the activity is interrupted. It is an indirect dependence.

The vulnerability activity *z* does not have direct effect on the Difficulty activity *n*. In the case that the substitution is full within required scope, it will fulfill given activity and thus there is no direct link between the parameters of Reachability activity d and the Vulnerability activity z. Table 2 shows the relationships between the criteria.

Table 2

Relation between criteria

	p	*k*	*v*	*d*	*n*	*z*
p	-	Direct	Direct	Direct	-	-
k	Direct	-	Direct	Direct	Indirect	Indirect
v	Direct	Direct	-	-	-	-
d	Direct	Direct	-	-	-	
n	-	Indirect	-	-	-	-
z	-	Indirect	-		-	-

Source: Authors

The partial value of the continuity activity can be noted as *h* and its magnitude is determined by the dependency of the observed continuity criteria.

For expert evaluation of continuity of activity is proper to create own calculation tool. The calculation tool can be created in the Microsoft Excel.

(12)

6 Conclusion

In the continuity of activities is necessary to find way to boost activities which allow maintaining the train running, on the other hand, reduce activities that make the crisis situation more serious. The necessary is allowing the continuity of transport and solving the crisis situation. The core of the problem is finding the point for sustain the original activities in the railway transport on the necessary level. BCMS should be monitored regularly.

Finally, authors must note that important additions for better use of all possibilities of crisis management in the railway transport are blending of the traditional reactive and new proactive approach. Despite the fact, that unlike reactive approaches, the proactive can be applied even before an accident occurs. Experiences of reactive approaches are necessary to ensure the continuity of crisis management in the railway transport.

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