METHODS FOR EVALUATION OF BUSINESS CONTINUITY MANAGEMENT SYSTEM IN TRANSPORT

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Abstract: The proactive approach is necessary to reach the essential goals in the area of transport resilience. One option to improve the plan during crisis is the implementation of the Business Continuity Management System. This can improve planning of transport services during the crisis situation in the affected area. The level of efficiency depends predominantly on which evaluation method is used. During the selection of the method for business continuity is important to take into account the fact that this method must cover all the aspects of activities, must be easy to understand to evaluators and last but not least this method must provide the required outputs for evaluation. It is advisable that this method allows to use outputs for further use and further evaluation.

Keywords: resilience, transport, BCMS (Bussiness Continuity Management system), evaluation

1 Introduction

This paper follows up the paper "Bussiness Continuity Management in the Transport". The previous paper introduced analysis describing and synthesizing realization of the Continuity System in the Transport Branch. In this paper we concluded that BCMS can be characterized at a certain time by its CCB capacity. It determines BCMS ability to absorb inactivity in demanded activities and the size of which can be affected by individual activities. Individual activity can be evaluated by the determined criteria.

2 Multicriterial evaluation of Activities Continuity

Business Continuity Assessment is a typical task of multi-critera assessment. The evaluation uses expert-level input data. It is therefore important that the method itself is in the most comprehensible form understandable to the evaluator. The aim of the expert assessment of the continuity evaluation is to maximize the consensus of the experts, but also to get as many original expert opinions as possible. Although expert methods can also be used to work with groups of experts (so-called group methods), expert methods for working with individual experts (so-called individual methods) seem more appropriate in assessing the continuity of activities.
It is advisable to obtain the expert opinions of the evaluation of the continuity of activities in several stages. In the first stage, the steering group will be assembled and the head of the group will be appointed. The rights and obligations of individual group members will be defined. In the second stage, the scope for the preparation for the survey itself will be proposed. In the third stage, specific experts will be identified. In the fourth stage the respective expert estimates will be proposed. Here, the experts will learn about the subject and purpose of the expertise, they will receive the information about the problem, the basic approaches to its solution and the planned course of expertise. It is then possible to obtain their assessments for processing. We can assume that the individuals (experts) are influenced by different motives, needs and interests and will be therefore subjective in their testimonies, while keeping the overall objectivity of evaluation during the survey, there is no direct communication between experts allowed.
From the analysis we can see that the input values of BCMS are vague and therefore we have to use to solve this problem the theory of fuzzy sets and fuzzy logic. In contrast to common quantification procedures, the fuzzy logic and its sets are variable and capable of working with variable intermediate values. Unlike sharp sets that have clearly defined ranges of values, fuzzy sets have these ranges variable. Since fuzzy theory is attempting to cover the reality in its inaccuracy and uncertainty (2) and furthermore, given the nature and complexity of BCMS, BCMS assessment using fuzzy logic evaluation system is a possible solution.

3 Evaluation criteria

The choice of criteria relevant to the evaluation haveaffects the outcome. Individual activities can be evaluated according to the monitored parameters. Partial values can be used for the overall evaluation of the department, section or enterprise.
Creating a purposeful set of criteria for the continuity assessment of activities is an important step that can significantly influence the final results. The specified set of evaluation criteria should therefore meet certain

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requirements. The set of criteria should be such as to allow assessment of all significant long-term and short-term, both positive and negative, direct and indirect impacts. Each criterion must be clearly and conclusively defined. Furthermore it must be also defined the way it is going to be measured. Each aspect should only come into the evaluation once, the criteria should not overlap. It is most important to choose the correct number of criteria (properties). Too many features can make it difficult or even impossible to find solutions. If there is too few of them, there is a risk of omitting some important aspects vital for valid evaluation. It is therefore essential to find a sufficient number of characteristics with sufficient information and discernment. The rationality of creating assessment criteria depends on the thorough knowledge of the assessed object, on the structural as well as functional system of understanding..

The system analysis shows that the partial value of the continuity *h* activity depends on the questions:

- how much it can be done in extraordinary event (e. g. crisis events),
- how long the activity being evaluated does not have to be carried out without the consequent problems
- how many activities are interconnected with the disturbing activities
- it is possible to replace the activity, if this activity can be performed by another worker or at another workplace
- how much is required the specialization of resources for activity
- there are effective measures, steps or practices addressing risk reduction

To assess the continuity of activities, 6 basic criteria are proposed, which are relevant to the previous concerns. Table 1 lists the individual criteria for with their label.

Table 1

Criteria for evaluation of activities continuity

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

Source: Authors

Fulfilment 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 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 amount 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. Second part in the formula v_0 is 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 influenced 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.

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.

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 Activity *p* and the continuity of activity *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. 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 no 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 activity *z* is defined like a resulting effect of the threat elimination procedures, is quite obvious that the performance of the activity *p* is fully independent on it.

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 link between Achievements of Activity *d* and Continuity of Activities *k* is quite obvious. The more the activity is substitutable, the less interruptible it becomes. There is a direct relationship here. On the other hand, no direct relationship has been found between the parameters of the Fulfillment activity *v* and the Difficulty activity *n*, between Interconnectivity activity *v* and Reachability activity *d*, Interconnectivity activity *v* and the Vulnerability activity *z*. If the activity is limited or stopped as a result of the negative impact, then it will disturb or fully stop the follow-up activities, respectively, their number will be limited according to their priority.

The Difficulty activity *n* has no direct relation to the Reachability activity *d*. If is possible to replace the empoyees with the full required number, the difficulty of the activity must ramain on the same level.

The vulnerability activity *z* does not have direct effect on the Difficutly 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.

4 Description of the evaluation procedure

Each activity is evaluated based on six criteria. Both criteria and their relationships are considerably complicated in terms of evaluation. The evaluation itself has two basic segments. The first are the measuring instruments (prepared scales), which are presented to the experts. The second segment is the experts themselves. The evaluation procedure is devoted to the creation of a measuring instrument. This was implemented in Microsoft Excel using a language-oriented fuzzy expert model.

In order to evaluate the continuity of activities, criteria are the input variables. At the beginning, these parameters must be measured. Here is the display of the measured quantities on the appropriate scale. Then the input values are converted to data. Each criterion related to a particular activity can be worded with the verbal characteristic. For this purpose we can use a 10-parts language scale complemented by language descriptions. This section is called fuzzy inference.

In Table 3, as an example, we can see an assessment of the range of Continuity of Activity *k*, which characterizes smooth performance of the activity. The maximum tolerable disruption of the activity is chosen up to one month when the crisis situation is resolved. Table 3 is the rating range for the maximum tolerable interruption of the activity.

From the logical realities, it is possible to consider and to infer further interconnections of how to deal with individual parameters. A relevant function of connectives must be assigned to partial valuation of the characteristics. The result of fuzzy inference is the fuzzy value of an individual activity criterion.

The defuzzification transforms the result of the previous fuzzy inference operation using the language assessment of the continuity of activities to the real values. The goal is to convert the fuzzy value of the output variable so as to best represent the result of the fuzzy calculation verbally. It is necessary to set the relevant terms. In defuzzification, there are language variables of the continuity of activity values defined by five terms. After assigning of evaluation terms follows the assignment of minimum and maximum values to individual terms. Table 5 lists the maximum and minimum values for each valuation of the single language terms.

Table 3
Evaluation of the Activities continuity k

The scope Verbal characteristic in the Continuity of Activity *k*	Point rating of the Continuity of Activity *k* (1–10)	Maximum tolerable time of the activity disruption
Critical Activity	10	up to 1 hour
Semi-critical Activity	9	up to 2 hours
Hight Importance Activity	8	up to 3 hours
Semi-hight Importance Activity	7	up to 6 hours
Important Activity	6	up to 9 hours
Semi-important Activity	5	up to 12 hours
Medium Importance activity	4	up to 1 day
Low Important Activity	3	up to 3 days
Unimportant Activity	2	up to 1 week
Insignificant Activity	1	more than 1 week (up to 1 month)

Source: Authors

In the next step, language terms are defined using truth functions. The rating "inadequate" is defined by L functions. For truthful functions of terms, sufficient, good, and very good, a function having a triangular form is used.. The term excellent have the Γ truthful function.

Table 4
Deadlines of evaluation in the cointinuity of activity with their evaluation

Language valuation of continuity of activities	min	max
insufficient	0	0,3
sufficient	0,1	0,5
good	0,3	0,7
very good	0,5	0,9
excelent	0,7	1

Source: Authors

Because the partial rating of the characteristics is expressed by fuzzy numbers, the fuzzy weighted average is used to calculate the continuity activity evaluation. The resulting fuzzy number, which expresses the value of the criterion of the activity under investigation from the point of view of continuity, is assigned the appropriate weight of the criterion. The normalized weight of each criterion was calculated by modifying the Fuller method. The resulting scales then express the meaning of the criteria. The more important is perceived the criterion, the higher its weight.

5 Calculation of Continuity evaluation

It is advisable to use the computing tool to evaluate the continuity of activities themselves. The computational tool was created in the Microsoft Excel for creation of the method. The user interface of the calculation tool has been subordinated to the Microsoft Excel environment with the need for interaction and combination of elements. For the entire evaluation, the computing tool works only through one Excel workbook, by inserting data into the unlocked cells of the respective worksheets. It is advisable to include contextual help in the calculation tool. In addition, the cells on the computational algorithm sheets that are needed for computation were hidden and locked when using the tool. Each activity evaluated is processed on one sheet of the workbook. The structure of sheets for sub-evaluations of individual activities must be the same. Criteria are evaluated in the tool using group frames and switches inserted in them for each word expression that characterizes the activity level. With the switch stored in the frame, you can always specify only one size for each awarded criterion. The data entered here is transmitted as a point in the graph, which here represents the basic features of the relevant function. Depending on the properties of the individual attributes, the appearance of the graph here uses the

linear function as either increasing or decreasing. Using the point position in the graph, the fuzzy value of the criterion is determined. This is illustrated by Figure 1.

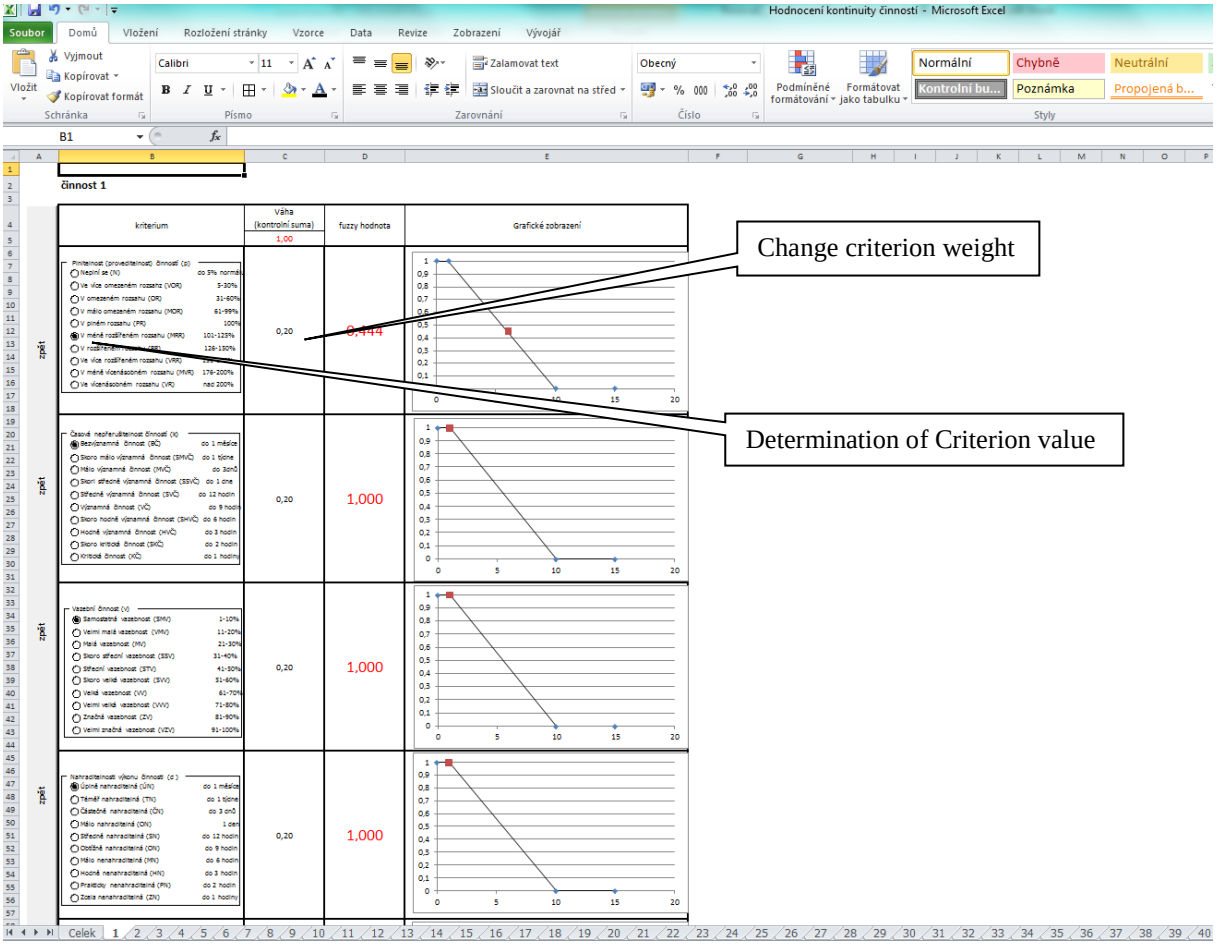

Fig. 1: Sheet with the valued activity
Source: Authors

The evaluation tool itself was applied to the newly created "fuzzy" feature that extended the commonly-offered Microsoft Excel options. This is a subprogram that performs an action and returns a value. It is written to the module using formatted source code. The basic idea of function is the similarity of triangles. The two triangles are similar when they coincide at two angles. If the two triangles are similar, then the ratios of all the corresponding sides of the triangle are the same. For illustration, Figure 2 shows a graph with similarity. The fuzzy value is expressed by the y-axis, the criteria being evaluated on the x-axis.

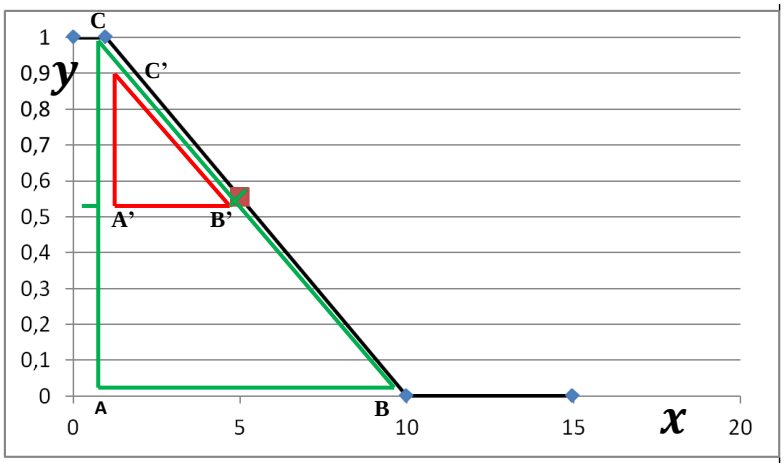

Fig. 1 Graph of the Fuzzy value with the triangular similarity
Source: Authors

The fuzzy weighted-average is used to express the overall fuzzy value of activitybecause the sub-criteria corresponding with the individual criteria constitute a disjoint decomposition of the overall evaluation and the partial fuzzy evaluation of the criteria expresses the fuzzy degree of fulfillment of the evaluation.
For the overall activity continuity assessment, the enumeration tool applies two newly created functions. The new "defuzzification" function combines the resulting fuzzy number of the activity being evaluated with the second table, with the language values. The function determines the percentage expression of the language value. Another new feature here used is called "rating." The function works with language valuation and the result of defuzzation. It projects a verbal and visual expression of the continuity of activities in its value form.
Experts were presented with a calculation tool that is only one workbook in a Microsoft Excel spreadsheet application. On sheet 1 "The whole" of the set, a pre-arranged list was added to complete all the titles of the evaluated activities and the overall evaluation of the whole enterprise. The first sheet of the file provides aggregate results for the entire rated area. There are four tables. In the first are the cells for the names of the entire rated object, the individual names of the activities in the object, the weight of the activities and the specific fuzzy values of the activities. For textual evaluation of the overall continuity of activities, the same calculation terms were used for both the minimum and maximum valuations as in the evaluation of individual activities. Using the resulting fuzzy value, the entire field under investigation can be evaluated and the result can be plotted graphically. Figure 3 shows the evaluation tool sheet 1.

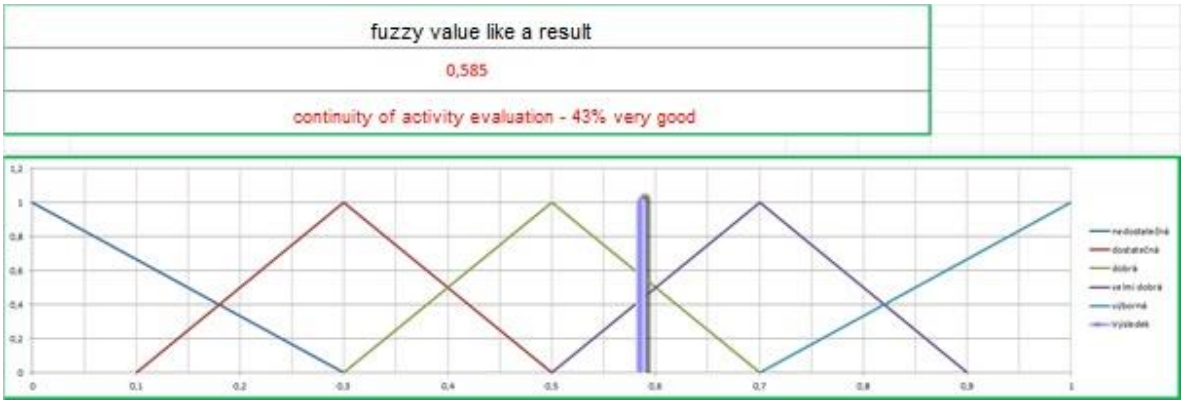

Fig. 3: Calculation tool – final evaluation
Source: Author

If the calculation determines that the activity does not affect the continuity of activities, the weight "0" is added on sheet 1, and this does not count towards the total result. Additional sheets of the file are for each activity evaluation. The visual form of the evaluation of individual activities was presented in Figure 1. Other data are not required. The calculation tool determines the value of the individual activity as well as the rated entity (enterprise).

6 Conclusinon

The properly configured BCMS of the transport company or infrastructure manager copies the optimal limits that BCMS has to reach. From the assessment of the BCMS activities we will see which ones need to be addressed.
By assessing BCMS, it is possible to optimize the continuity of individual activities and thus reduce the possibility of interruption of traffic and transport services of the area.

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