

## RM/RA CRAMM – QUANTITATIVE RISK ASSESSMENT METHOD FOR PREVENTION OF CRIMINALITY

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### ABSTRACT

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RM/RA CRAMM is a comprehensive risk assessment methodology for crisis management, which consists of identifying, analysing and assessing risks. Quantitative outputs serve as a basis for identifying risk management priorities, preparing preventive measures and responding to identified facts. The methodology is applicable to a wide range of risk types, natural risks, including fire risks, technology risks, criminal risks and other risks of a social nature. The RM/RA CRAMM methodology provides the basis for determining the real state of a given territory, allowing it to sort individual risks according to priorities. Risk assessment is the starting point for the reaction phase. By reacting, we mean preventive measures, including the allocation of Police units, Integrated rescue system units, their training, technical equipment and population awareness. The RM/RA CRAMM methodology provides the basis for determining the real situation in the given territory, allowing the individual risks to be sorted according to the priorities. Risk assessment is the starting point for the reaction phase.

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## INTRODUCTION

RM/RA CRAMM is designed for flood, fire, other natural disasters, industrial accidents, chemical matter leaks, mass traffic accidents and social riots, criminal or other risks in the monitored area.

The main purpose of the original CRAMM<sup>1</sup> was to support the risk analysis process within the information systems. CRAMM was first developed by CCTA in 1985 in response to the growing need for information systems security. CRAMM method was originally based on interviews with risk owners was changed by prof. Mullerova<sup>2</sup> and her team during the scientific task solving in Academy of Police Force in Bratislava in order to absorb all the relevant information sources<sup>3</sup>.

The new method of RM/RA CRAMM uses also long-term statistics in order to find the trend of risk treated. Personal interviews are time-consuming e.g. for initial phase of analysis where the real value is needed to estimate the maximal damage. The dwelling value can be estimated based on Real-estate web information with high accuracy. There are following useful information sources available online:

- Population census,
- Maps of criminality,
- Real-estate pages,
- Emergency event official statistics,
- Maps of ecology threats,
- Technology maps.

In case we treat the city centre we need to estimate real number of people, not just number of inhabitants living in the area. For many areas are multiplied during evenings, especially city centres or shopping centres, factories etc. There is a strong need for quantification of inputs.

RM/RA CRAMM unlike CRAMM calculates the risk based on quantified inputs taking in account the differences among each object or group of objects.

The main progress involved in RM/RA CRAMM includes:

- Quantified inputs based on real values, statistics and trends,
- People, material values incl. environment are included,

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<sup>1</sup> CRAMM = CCTA Risk Analysis and Management Method.

<sup>2</sup> J. Müllerová, *Final report VVÚ 216: Model of RM/RA CRAMM methodology and its use to prevent disaster*, Academy of Police Forces, Slovakia 2014, p. 18.

<sup>3</sup> RAC: CRAMM 5 Case study, 2013, online.

- Relative value distinction among treated objects,
- Quantitative outputs easily comparable,
- Flexibility in automatic calculation when the input values are changed.

The following procedure represents the RM/RA CRAMM methodology schematically shown below. The fundamental question of each procedure is: “What is the objective?” The answer can be:

- To assess the risks for people in selected territory, area, objects or community.
- To assess a certain risk type in some area e.g. flood risk, wild fire risk, dwelling fire risk, criminality risks etc.

### RISK MANAGEMENT PROCESS

Risk management (RM) process involves Risk assessment process<sup>4</sup> (RA), monitoring, consulting, initial phase and reaction phase. Identification, analysis and evaluation are fundamental phases of Risk assessment (Fig. 1)<sup>5</sup>.

In the process of preparation definition of the field of investigation, team building, identification of information sources. Creating a basic working document Assessment Score board. All the necessary information. Criminal risk assessment of certain region is a complex task of many components, and various risks.

In the process of identifying the risks, it is necessary to take into account the various organizational factors, but especially the individuality of humanity, which is manifested especially in social risks. Therefore, the universal support techniques brainstorming or the Delphi method are often applied in the risk identification phase or in previous initiative phase<sup>6</sup>. These two methods can take into account the individual views of team members or several stakeholders.

In practice of RM/RA CRAMM we need to find out the value of the objects in order to compare the risk level. However, the value is a part of analysis, during the identification phase we need to clear out what is going to be done to get the realistic numbers. We need to collect

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<sup>4</sup> International Organization for Standardization. *ISO/IEC Guide 73:2009 (2009). Risk management — Vocabulary.*

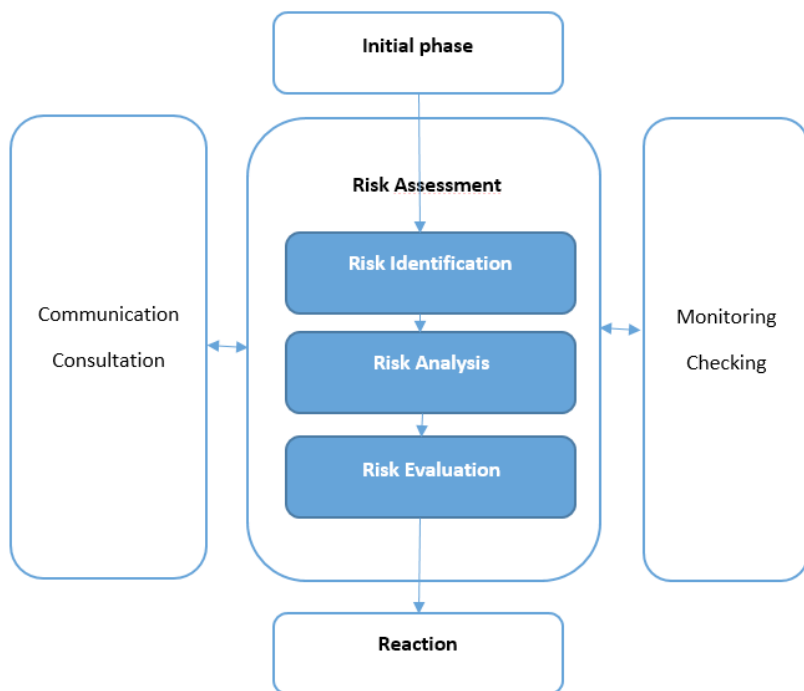
<sup>5</sup> International Organization for Standardization, *ISO 31010 (2012). Risk management — Principles and Guidelines on implementation*, p. 22.

<sup>6</sup> J. Buzalka, J. Müllerová, *RM/RA CRAMM – New methodology for crisis management*, Security forum, UMB Banská Bystrica 2015, p. 213.

fundamental information about the area. During the identification phase we can ask following questions:

- What is the demographic structure?
- Are there some socially high risk potential points – ghettos, no-go zones or others?
- What is the character of area – rural or urban?
- How many objects are located in area?
- How many people live in the locality?
- How many people are in productive age, how many children, how many seniors?
- Are there some important companies with higher number of employees?
- Is there some specific or unique object in sense of historic value?
- Are there some shops, markets, business centres?
- Are there some tourist sites?
- When and what times is location most populated?
- Are there some objects of critical infrastructure?
- Are there tunnels, important bridges, highways, airports, ports, power plants, railway station, bus terminals, energy supply centres or water dam?

FIG. 1. RISK MANAGEMENT PROCESS ACCORDING ISO 31010



There are more questions of that type that can help to characterize the area assessed by the method. The aim is to find out as more as we can for this phase is crucial for the next phase of analysis where exact numbers are needed.

**RISK MANAGEMENT/RISK ASSESSMENT CRAMM**

**INITIATIVE PHASE – PREPARATION PHASE**

Definition of the field of investigation, team building, identification of information sources. Creating a basic working document Assessment Score board. All the necessary information. There are two basic approaches how to deal with the complex risk assessment. In the initial phases all the relevant information about the region, demographic characteristics, social and industrial characteristics, religion impact etc. For each type of risk the risk assessment scoreboard need to be done.

FIG. 2. RISK MANAGEMENT CYCLE ACCORDING ISO 31000

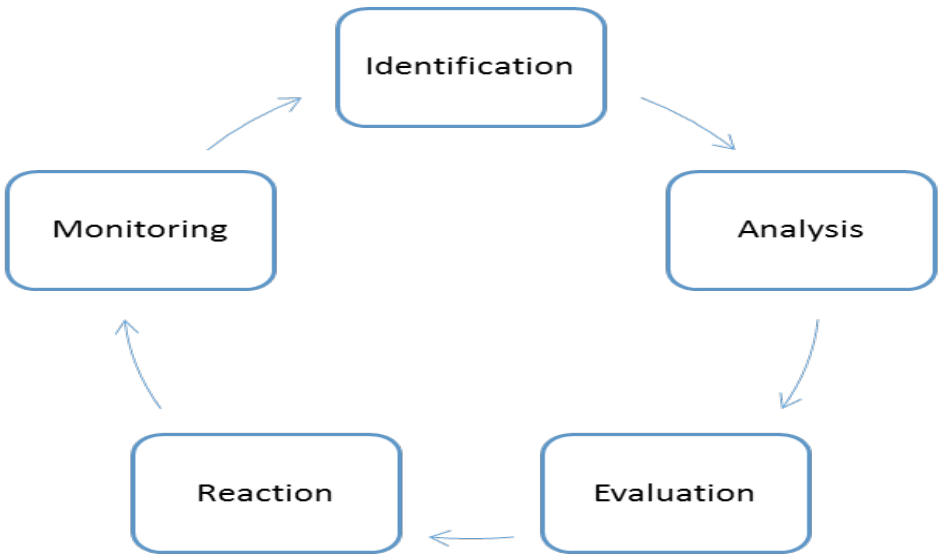
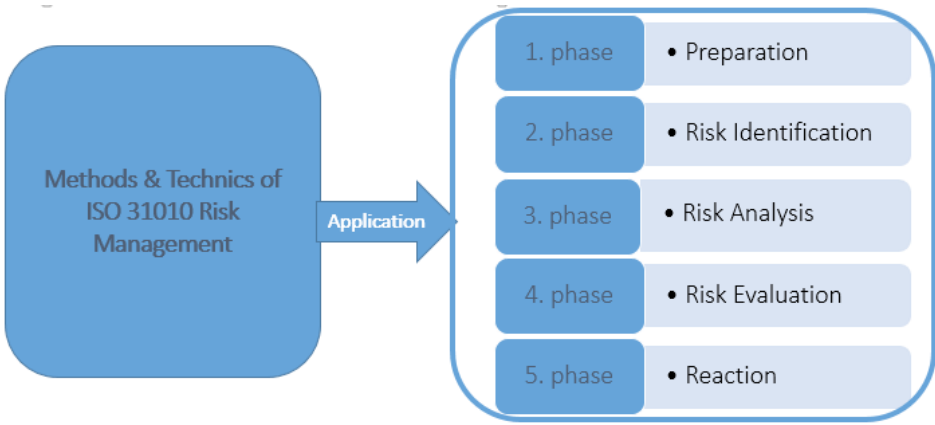


FIG. 3. PHASES OF RM/RA CRAMM



The process of Risk assessment consists of Risk identification, Risk analysis and Risk evaluation. In the following case study we are going to demonstrate the RM/RA CRAMM applied on Criminal risk of Burglary, Vandalism and Robbery in the Shopping centres, car shop, tyre shop and one supermarket in the city of Žilina, Slovakia.

Locality	Main Object	Object detail	Property damage (€)	People under threat
Žilina	OC AUPARK	Jewelery	7900	0
Žilina	OC MIRAGE	Watchmakers	1350	0
Žilina	OC DUBEŇ	Sport shop	3600	0
Žilina	AC GALIMEX	Car dealer	13500	1
Žilina	PNEUCENTRUM MRÁZIK	Tyre dealer	2400	1
Žilina	LIDL	Supermarket	900	0

### RISK IDENTIFICATION

Table 2 identifies the risks of the crisis over the period. These data are very important for determining the likelihood of occurrence of an emergency event. If the probability of occurrence of an emergency event relates

to a one-year period, then the probability value for two-year occurrences will be 50% (table value 5), we will assign a 5-year event to a table value of 2, events occurring once every four years We will assign a value of 2.5. For events occurring more than once a year, we will automatically assign a 10 t.j. 100%. Risks of  $R_i < 0,10$  are referred to as very low risks,  $< 0,35$  low,  $< 35,65$  medium,  $< 65,85$  high,  $< 85,100$  extremely high.

TABLE 2. RISK ASSESSMENT SCOREBOARD WITH ANALYTIC PHASE DONE

Identification		Analysis				Evaluation	
ID of Area/ Object $i$	Danger/ Crisis	Value/ Damage $H_i$ (1-10)	Integrity $I_i$ (1-10)	Indispensableness $N_i$ (1-10)	Probability $P_i$ (1-10)	Risk $R_i$ (1-100) very low-very high	
OC AUPARK	Robbery	6	4	4			
OC MIRAGE	Robbery	8	6	6			
OC DUBEŇ	Robbery	6	4	4			
AC GALIMEX	Robbery	6	4	4			
PNEU- CENTRUM MRÁZIK	Robbery	6,2	4	4			
LIDL	Robbery	6	4	4			

TABLE 3. MATRIX OF VALUE  $H_i$  FOR RISK ANALYSIS

Value $H_i$	Number of people under risk									
Overall object est. value (1000 €)	0	1 – 10	11 – 100	101 – 500	501 – 1k	1001 – 5k	5001 – 10k	10001 – 50k	50001 – 100k	over 100k
0 – 5	1	2	3	4	5	5	6	6	7	7
5 – 10	2	3	4	5	5	6	6	7	7	8
10 – 30	2	3	5	5	6	6	7	7	8	8
30 – 60	3	4	5	6	6	7	7	8	8	9
60 – 100	4	5	5	6	7	7	8	8	9	9
100 – 250	5	5	6	7	7	8	8	9	9	10
250 – 500	5	6	6	7	8	8	9	9	10	10
500 – 1 000	6	6	7	7	8	8	9	9	10	10
1 000 – 3 000	6	7	7	8	8	9	9	10	10	10
Over 3 000	7	7	8	8	9	9	10	10	10	10



## RISK ANALYSIS

The phase of risk analysis is the most important in the sense of final results. We need to analyse the risk from more points of view. The first value to be expressed is the relative value of the object or group of objects.

**Value/Damage  $H_i$**  expresses max. loss or damage resulting from emergency situation. Instead of nominal value we use qualified estimate in the scale 0 – 10, according the value matrix which respects both human life and material aspect of the value. This is the property expressing how much can we lose in relation to the other objects. Is it more or less?

Table above is an example of expressing the value of the threat, damage to property and life. Scaling can be varied depending on the nature of the risk assessment. We should put more emphasis on the value of human life as the value of the property. According to Müllerová<sup>7</sup>, it is not necessary to know the exact value of the object under consideration, tens, hundreds, thousands of euro.

The table above lists integer values of  $H_i$ . For a more detailed distinction of the individual objects under consideration, it is possible to enter real numbers close to the recommended data from the matrix of values in the evaluation table.

## EVALUATION

This phase must give a definitive response to the nature and value of the risk under consideration. Output can be quantitative or qualitative or semi-quantitative. The quantitative output can be represented by a table of quantifying potential damage and costs for prevention and removal of an emergency event, as well as the likelihood that the emergency event occurs. The qualitative output will be worded to approximate the course and nature of the risks associated with the particular event. Semi-quantitative output is the numerical expression of the verbal evaluation, ie. That predetermined numerical values from a determined rating scale are assigned to individual descriptions and scenarios, e.g., 0 – negligible risk, 10 – very high risk. Typically, a combination of semiquantitative and qualitative outputs is used, with quantitative outputs being ideal. However, their quantity is limited by the quantity and availability of quantitative data at the input of the risk assessment process. Step by step we need

<sup>7</sup> J. Müllerová, *RM/RA CRAMM as a new risk management method for the prevention of ecological disasters*. SGEM 2016, p. 609.

to fill the RA Scoreboard in order to get the final risk values. The calculation itself is made in Table editor with automatic function. Whenever the change in input is needed the function enables the automatic re-calculation. The table shows that OC Duben is the biggest risk of loss and loss of property. The overall risk of robbery overflows in the city is generally low. However, far from too low or zero (Table 3).

The quantitative risk statement is performed based on the values from the risk table that are added to the relationship (1). The greatest difficulty in computing is the determination of the key values of  $H_i$ ,  $I_i$  and  $N_i$  as well as the coefficients  $a$ ,  $b$ ,  $c$ , which represent the weights or importance of these variables.

With growing interest in the RM/RA CRAMM method and the questions about the accuracy and accuracy of the calculation we have found very important to explain the logic of the variables, coefficients and qualitative estimates themselves that are critical to the resulting risk value. The relationship to the risk calculation (1) results from the assumption that risk is a function of potential damage and the probability that the undesirable event occurs.

$$R_i = Q_i \times p_i \quad (1)$$

$R_i$  – risk value for i-th object (maximum value is 100)

$Q_i$  – the relative value of the total damage expressed by the weighted arithmetic mean of the three characteristics (max. 10)

$P_i$  – The degree of probability indicates the probability of damage to the object being investigated by an emergency event,  $<0.10> \sim <0\%, 100\%>$ .

The basic relationship for the calculation of risk (1) shows equal importance, respectively. The same weight of the total damage value  $Q_i$  and the probability of the damage occurring. Equivalence is obvious due to the absence of coefficients in a given relationship that would assign a weight to one or the other variable. The coefficients  $a, b, c$  are found in the below mentioned relationship (2) for calculating the variable  $Q_i$ , which is a function of three variables,  $a$  – a relative value of  $H_i$ ,  $b$  – a relative degree of integrity  $I_i$  and  $c$  – a relative degree of Indispensableness  $N_i$ .

$$Q_i = \frac{a \cdot H_i + b \cdot I_i + c \cdot N_i}{3} \quad (2)$$

By completing the basic relationship, we will get instructions for the total risk calculation  $R_i$  for the  $i$ -object (3).

$$R_i = \frac{a \cdot H_i + b \cdot I_i + c \cdot N_i}{3} \times p_i \quad (3)$$

$H_i$  – relative value of  $i$  – th object or. Possible damage to the object, life or property being considered. At the simultaneous threat to life and property, it is expressed using a matrix of values,  $\langle 0,10 \rangle$ .

$I_i$  – the relative degree of integrity of the  $i$ -th object reflects the degree of its importance for the functioning of other elements or systems. The highest degree of integrity will be associated with an element of critical infrastructure at the state level, most of the objects will have a very low integrity value, higher will have centers of varying importance, Bridges, tunnels, general office buildings, fire brigades, energy facilities, etc.,  $\langle 0,10 \rangle$ .

$N_i$  – the relative degree of irreplaceability of the object is the relative rate of its recovery or resp. Compensation for damage caused by an emergency event,  $\langle 0,10 \rangle$ . Value 10 represents absolute irreparable, irreparable damage.

$a, b, c$  – weights expressing the importance of parameters  $H, I$  and  $N$ .

The coefficients  $a, b, c$  get real values  $\langle 0,3 \rangle$  with  $a + b + c = 3$ . The selected scales are valid for all risk assessment objects! They can not be changed in one table.

## RISK REACTION

After the risk assessment we need to focus on unacceptable risks. The competent offices should set up the tolerance margins. The line of acceptability. We have picked up 6 highest values reached by all the three criminal threats assessed (Table 5). These should be focused on. Risk assessment is fundamental part of risk management.

However, the budget is always limited, the manager need to prioritize the risks, at first. Then he needs to come with effective preventive reaction. Very often, each team member brings his own solution, there are plenty of possibilities what to do. It can bring conflicts into the risk management team. Therefore, sophisticated multi-criteria decision making is recommended in order to find the effective solution based on rational calculation<sup>8</sup>.

<sup>8</sup> A. Nejedlý, *Selected Problems of the Implementation and Strategic Development of the Integrated Rescue System of the Slovak Republic*, Dissertation, Academy of Police Forces, Bratislava 2016.

TABLE 4. RISK ASSESSMENT SCOREBOARD WITH EVALUATION PHASE DONE

Identification		Analysis				Evaluation	
Object $i$	Danger/ Crisis	Value/ Damage $H_i$ (1–10)	Integrity $I_i$ (1–10)	Indispensableness $N_i$ (1–10)	Probability $P_i$ (1–10)	Risk $R_i$ (1–100) very low – very high	
OC AUPARK	Robbery	6	4	4	4.5	24	Medium risk
OC MIRAGE	Robbery	8	6	6	3	22	Medium risk
OC DUBEŇ	Robbery	6	4	4	3.5	18.7	Low risk
AC GALIMEX	Robbery	6	4	4	3	16	Low risk
PNEUCENTRUM MRÁZIK	Robbery	6.2	4	4	2	10.9	Low risk
LIDL	Robbery	6	4	4	4.5	24	Medium risk

TABLE 5. RESULTS OF RISK ASSESSMENT FOR EACH OF CRIMINAL RISK TYPE

Locality	Main Object	Criminal Threat	Risk Ri (0–100)	
Žilina	OC DUBEŇ	Robbery	35,8	Medium
Žilina	AC GALIMEX	Robbery	27,5	Medium
Žilina	AC GALIMEX	Burglary	27,5	Medium
Žilina	PNEUCENTRUM MRÁZIK	Burglary	22,9	Low
Žilina	AC GALIMEX	Vandalism	22	Low
Žilina	PNEUCENTRUM MRÁZIK	Vandalism	18,7	Low

Initial phase is the most important due to simple fact: The quality of Outputs depends on quality of inputs. Once improper data are put in, the calculation results will be wrong and the reaction ineffective. Before the RM/RA CRAMM method is applied, we need to do initial preparation, to collect fundamental data related to the regional characteristic. However, the budget is always limited, the manager need to prioritize the risks, at first.

Then he needs to come with effective preventive reaction. Very often, each team member brings his own solution, there are plenty of possibilities what to do. It can bring conflicts into the risk management team. Therefore, sophisticated multi-criteria decision making is recommended in order to find the effective solution based on rational calculation.

## CONCLUSION

Criminal risks are the most important social hazards, incl. violent crimes, organized crimes, robbery, theft etc. Quantification of these criminal risks is essential for planning the forces and means of Police and other responsible offices.

The RM/RA CRAMM application should not be automatic. Each step and each value input has to be based on real information and professional

estimation. Careful consideration of analytical values based on the nature of the risk has to be done. At the risk of assets, we have the choice either to use the same coefficient for all variables and to use very low figures for the values of integrity and irreversibility, or to highlight the importance of the value of the asset by a higher coefficient value and lower coefficients *b* and *c*, respecting the conditions given in the calculation relation. Throughout the process, the key phase of risk identification is where the investigator has to know the context and the interrelationships of the objects under consideration based on facts. Only then will it be possible to make qualified estimates of the values themselves, and especially the likelihood that the event will occur. Each value affects the overall result and ranking of the investigated objects by risk.

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