Assessment of losses when risks realization at an economic object

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Abstract. In this paper, based on the systematic approach the methods of estimating the impact of various risks on the economic and social facilities. A method for using the intensity estimated numbers for constructing matrices indices risk and risk of impact on the object. Practical examples show the use of the proposed model for creating security systems of various objects.

1. Introduction

In today's reality, human life is filled with all sorts of threats. There are risks and the military, and social and human–induced, and financial, economic and environmental, and technology, and information, and many others. security concept implies the implementation of the security of all permissible risks (threats), the probability of recognizing the non–zero.

Creating a security concept of the object – a complex, painstaking work of experts of various specialties, issuing recommendations on the construction of the whole system of technical, organizational and human resources, aimed at creating a protected object around the entire sphere of guaranteeing recognition of the risks, to classify them, to prevent their occurrence or their reflection.

And one of the main issues is the objective assessment of the damage to the object in the case of the implementation of a risk.

2.Determination of the estimated parameters of the damage and the probability of realization

Assess losses from the risks taken in the currency. However, here there is one problem. Estimated models tied to the national currency, will give different figures in different countries. In some countries the goods imported, expensive, in other the same goods – locally produced, cheap, and third countries, it exists duties, fourth – not. Domestic prices are heavily dependent on labor payment, etc.

The use of the dollar and exchange rate not solve the problem, everyone knows about the difference in the exchange rate and the exchange rate the Big Mac. Hundred dollars in Western Europe and in African countries – a different one hundred dollars. As well as damages of $ 1 million for companies with a turnover of 50 million and 10 billion – is very different losses.

In this regard, we propose to take as a basis for the company's turnover. We understand that this is not a universal method, but it allows you to evaluate the costs and losses in relative terms understandable. After all, the company's turnover generates the salaries of employees, management and operational capabilities of the profit to the owners. If you take an annual turnover of 100% (for example, in US dollars –. $ 100 million) while losses associated with damage caused by the
implementation of risk assessment and, on the scale discussed above can be represented in table 1 where D (from the English – damage) – the expected loss in the evaluation of intensity numbers [1-5].

**Table 1.** Values of the damage caused by the implementation of risk and their evaluation.

| №   | Percentage of turnover | Losses                | Qualification, D |
|-----|------------------------|-----------------------|------------------|
| 1   | 0.1%                   | Minor ($ 100 thousand).| 2                |
| 2   | 1%                     | Notable ($ 1 million). | 4                |
| 3   | 10%                    | Significant ($ 10 million). | 6            |
| 4   | 25%                    | Serious ($ 25 million). | 8                |
| 5   | 50%                    | Disastrous ($ 50 million). | 10            |

The very nature of the risks involved determines their probabilistic nature. It involves the use of the apparatus of probability theory, stochastic models in particular.

**Table 2.** Probabilities of risks and their evaluation.

| number | The probability of occurrence | Description likelihood | The emergence of risk | evaluation P |
|--------|-------------------------------|------------------------|-----------------------|--------------|
| 1      | 0,0 <P ≤ 0,1                 | The event may occur in exceptional cases. | Almostimpossible      | 2            |
| 2      | 0,1 <P ≤ 0,4                 | A rare event, but it has already taken place. | unlikely              | 4            |
| 3      | 0,4 <P ≤ 0,6                 | The event may occur cannot occur | Probably              | 6            |
| 4      | 0,6 <P ≤ 0,9                 | The event may occur. | Very likely           | 8            |
| 5      | 0,9 <P <1,0                  | Event should occur.    | almost certainly      | 10           |

3. **Development of risk index matrix**

In the simplest case, the loss for the risk assessment risk index is used, which is calculated as $R = P \times D$, where $P$ is the probability of risk and $D$ – the estimated loss in the evaluation of intensity numbers. Risk index allows you to analyze the likelihood of damage from a particular risk.

After describing all of us are interested in the risks necessary to determine the effect of each on our object, its place in the hierarchy of threats. To do this, use the estimates in tables 1 and 2 and form the matrix influences. Just note that the figures in tables 1 and 2 are not a dogma, and for different organizations, different objects and different risks will be different, for example, one organization losing 1% of turnover – significant damage to the other – a significant, for the third – a minor. Then the vertical matrix postpones the likelihood of risk realization. Across – the size of the damage. And fill the matrix R. risk indices obtain risk index of from 4 to 100 (table 3).

**Table 3.** Matrix of risk indices.

| the probability of | 10 | 8  | 6  | 4  |
|--------------------|----|----|----|----|
| the probability of  | 20 | 16 | 12 | 8  |
|                      | 40 | 32 | 24 | 16 |
|                      | 60 | 48 | 36 | 24 |
|                      | 80 | 64 | 48 | 32 |
|                      | 100| 80 | 60 | 40 |
Now divide the matrix into five zones, described in detail in table 4.

**Table 4.** The effect of the risk allocation matrix

| №  | Colour | Riskindex, R | The probability of the risk, P | Loss in % of turnover, D | Relationship with risk |
|----|--------|--------------|-------------------------------|-------------------------|------------------------|
| 1  |        | 1 - 10       | 0.0 ≤ P ≤ 0.4                 | 0.1% ≤ P ≤ 1%           | Acceptable, and unlikely risks with small losses. It is necessary to carefully evaluate the costs of the opposition, not to exceed the limit of possible losses. Minor risks. High probability risks with small losses or a very low probability risks of large losses. It is necessary to counteract the optimized low-cost techniques. Manage risk. It is necessary to evaluate all possible options for response. Each risk must be countered by a strategy to counter. |
| 2  |        | 11 - 25      | 0.1 ≤ P ≤ 1.0                 | 1% ≤ P ≤ 50%            | Intolerable risks. It is necessary to evaluate all possible options for the opposition, to create a single optimized Sat. Each risk must be countered by a detailed counter strategy. |
| 3  |        | 26 - 50      | 0.4 ≤ P ≤ 1.0                 | 10% ≤ P ≤ 50%           | Catastrophic risks. It is necessary to evaluate all possible options for the opposition, to create a single optimized Sat, provide reserve funds to counter and alternative courses of action. Each risk must be countered by a layered strategy to counter. Consider the possibility of restructuring the object. |
| 4  |        | 51 - 75      | 0.4 ≤ P ≤ 1.0                 | 10% ≤ P ≤ 50%           |                                                              |
| 5  |        | 76 - 100     | 0.6 ≤ P ≤ 1.0                 | 25% ≤ P ≤ 50%           |                                                              |

Undoubtedly, for each object, and the risk (and to consider, as a rule, accepted a bunch of "object–risk") that the above list of activities, models and methods can be adjusted for simple implementations significantly reduced. To assess the risks for a studio apartment cannot so expensive way. But for important sites with large potential damage with high probability of risk realization, the work of risk analysis is better to entrust the organization with appropriate qualifications.
4. Assessment of the damage caused by the risk during implementation

Now, using a systematic approach, we will try to assess at what costs us the realization of a risk. We evaluate all possible losses and form following function $Df(i)$

$$Df(i) = L(i) + Hl(i) + Fa(i) + Ca(i) + Ek(i) + Pl(i) +$$
$$Ol(i) + Sc(i) + Co(i) + Rr(i) + Db(i) + Nh(i)$$

(1)

Where:
- $Df(i)$ – the total losses in the implementation of the $i$-th risk;
- $L(i)$ – the costs associated with the loss of human life;
- $Hl(i)$ – the costs associated with the restoration of victims' health;
- $Fa(i)$ – the costs associated with the restoration of fixed assets;
- $Ca(i)$ – the costs associated with the restoration of circulating means;
- $Ek(i)$ – the costs associated with the restoration of the ecology in the territory of implementation of risk;
- $Pl(i)$ – the lost profit for the liquidation of the consequences of the implementation of the risk;
- $Ol(i)$ – the costs associated with lost opportunities for the liquidation of the consequences of the implementation of the risk;
- $Sc(i)$ – the costs of sanctions on torn contracts;
- $Co(i)$ – the costs associated with the transfer of credit obligations;
- $Rr(i)$ – the costs associated with the restoration of the banking market and reputation;
- $Db(i)$ – the costs associated with the restoration of databases;
- $Nh(i)$ – the costs associated with the recovery of lost technology and development.

Then we get all $N$ risks for object $k$:

$$Df(k) = (2) \sum_{i=1}^{N} Df(i)$$

(2)

If we have custody gets some objects becomes two amounts:

$$Df = (3) \sum_{k=1}^{K} \sum_{i=1}^{N} Df(i,k)$$

(3)

The method is applicable to simplify the assessment ALARP (as low as reasonably practicable – as low as reasonably possible) [6], is widely used in optimization models. It allows you to share all the risks into three groups (figure 1.)

- Unacceptable risk;
- ALARP – Risk;
- Acceptable (as agreed) risk.

The first group fall risks, the implementation of which leads to unacceptable results, which must oppose, regardless of cost and complexity of events (risks entailing loss of human life or catastrophic loss of Tab. 3, 4). For example, a fire in crowded places, a fire in a warehouse of fuel, terrorism, etc.

The second group of risks that lead to significant losses, but the opposition of (financially sustainable), these losses can be minimized and the risks themselves to move into the third group. For example, fire, theft in the supermarket, etc.
The third group consists of risks, counter which is more expensive than the damage from their realization. For example, small shoplifting, etc. In this case, the losses from these risks are written off losses. You only need to constantly monitor their appearance, to predict the time of the transition to the second group.

For every risk you must have a special risk map, which bring all the data, calculations, estimates and uncertainty derived parameters. This would allow an expert focus group on risk assessment, including a visual ranking.

When deciding on a place in the hierarchy of risk and the extent to counteract it, you must make sure that all possible information is gathered and methods available to reduce the degree of uncertainty exists.

5. Here are some practical examples (on the basis of existing facilities)
The first example:
Calculation of damages and assessment of risks arising in the commodity stock of the federal network of retail stores.

The initial and boundary conditions:
Location – outskirts million regional center in Central Russia, to a total protected area (concrete fence, barbed wire, video surveillance, security) next to the objects of other owners. The two–story building, 700 m² of concrete and foam concrete, finishing with a service life of 2 years. Cost of inventories (TMC), simultaneously held in stock – 20 million rubles, the annual turnover –. 80 million rubles. Group – 7 people.

Compile a table of evaluation of the probability of the risk of loss of their implementation and risk index (using tables 1, 2, 3, 4):

![Figure 1. Risk sharing by the method ALARP.](image-url)
### Table 5. Risk Assessment, Example 1.

| № | Risks                                           | The probability of the risk | Assessment of the probability of P | The amount of damage assessment D | Risk index R | Comments                                                                                                                                 |
|---|-------------------------------------------------|----------------------------|-----------------------------------|-----------------------------------|--------------|------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Flood                                           | 0.001                      | 2                                 | 5                                 | 5            | 10 The river is far away, the sea – very far.                                                                                              |
| 2 | Fire                                            | 0.7                        | 8                                 | 20                                | 8            | 64 Heating water, electric wiring is new, corresponds to GOST and SNIP. Smoking - open fire is forbidden to breed in designated locations far from the premises. But the human factor cannot be excluded, fires in warehouses – a regular event. |
| 3 | Earthquake                                      | 0.01                       | 2                                 | 2                                 | 2            | 4 According to calculations – to 2 points.                                                                                                                                                          |
| 4 | Hurricane                                       | 0.05                       | 2                                 | 1                                 | 2            | 4 in theory only.                                                                                                                                                                                  |
| 5 | Eruption                                        | 0.001                      | 2                                 | 5                                 | 5            | 10 Probability is not available.                                                                                                                                                                   |
| 6 | Sill                                            | 0.001                      | 2                                 | 2                                 | 4            | 8 Probability is not available.                                                                                                                                                                   |
| 7 | The explosion (spontaneous or terrorist)        | 0.001                      | 2                                 | 10                                | 7            | 14 The probability of no, no hazardous goods and materials.                                                                                                                                         |
| 8 | Violation of designs                            | 0.001                      | 2                                 | 5                                 | 5            | 10 Probability is not a new building.                                                                                                                                                              |
| 9 | Electricshocks                                  | 0.01                       | 2                                 | 0.05                              | 1            | 2 As on any object with the power supply. Probability is not available.                                                                                                                              |
| 10| Biological contamination                        | 0.001                      | 2                                 | 0.05                              | 1            | 2 Probability is not available.                                                                                                                                                                   |
| 11| Chemical contamination                          | 0.001                      | 2                                 | 0.05                              | 1            | 2 Probability is not available, a chemical plant more than 10 km.                                                                                                                                 |
| 12| Radioactive contamination                       | 0.01                       | 2                                 | 20                                | 8            | 16 There are nuclear power plants in the region.                                                                                                                                                   |
| 13| Damage to persons                               | 0.2                        | 2                                 | 0.1                               | 1            | 2 The territory has a fleet of heavy-duty trucks, heavy trucks bring goods and materials.                                                                                                          |
| 14| The destruction of human                        | 0.001                      | 2                                 | 0.1                               | 1            | 2 Probability is not available.                                                                                                                                                                   |
| 15| The alienation of man (theft)                   | 0.6                        | 7                                 | 10                                | 7            | 49 Is always present                                                                                                                                                                             |

For the primary risk ranking, we have not used the formula (1), taking into account only the loss of working capital. From the analysis table shows that most of the risk fall within acceptable profile or minor risk of table 4. Only the risk of theft enters the section controlled risks (R = 49) and falls into
the fire section intolerable risks ($R = 64$). Risks of explosion and radioactive contamination fall into minor risks. Apply to these four risks formula (1) and arrange it in a table.

### Table 6. Assessment of the damage caused by the most dangerous risks (mln. Rubles), Example 1.

| № | Losstype | Theft | Fire | Explosion | Radioactive contamination |
|---|----------|-------|------|-----------|-------------------------|
| 1 | L (i) – the costs associated with loss of life, my dear. rub; | 0 | 5 | 2 | 0 |
| 2 | Hl (i) – the costs associated with the restoration of the health of victims, mil. rub; | 0 | 1 | 1 | 0.5 |
| 3 | Fa (i) – the costs associated with the restoration of fixed assets mil. rub; | 0 | 0.5 | 1 | 5 |
| 4 | Ca (i) – the costs associated with the restoration of circulating means mils. rub; | 10 | 20 | 10 | 10 |
| 5 | Ek (i) – the costs associated with the restoration of the ecology in the territory of implementation of risk mil. rub; | 0 | 0.01 | 0.01 | 0 |
| 6 | Pi (i) – the lost profit for the liquidation of consequences of risk realization, mil. rub; | 3 | 3 | 1 | 3 |
| 7 | Ol (i) – the costs associated with lost opportunities for the liquidation of consequences of risk realization, mil. rub; | 1 | 1 | 0.5 | 1 |
| 8 | Sc (i) – the costs of sanctions on torn contracts mil. rub; | 1 | 1 | 0 | 1 |
| 9 | Co (i) – the costs associated with the transfer of credit obligations, mil. rub; | 1 | 1 | 0 | 1 |
| 10 | Rr (i) – the costs associated with the restoration of banking and market reputation, my dear. rub; | 0.5 | 0.5 | 0 | 0 |
| 11 | Db (i) – the costs associated with the restoration of databases mil. rub; | 0 | 0 | 0 | 0 |
| 12 | Nh (i) – the costs associated with the recovery of lost technology and development, mil. rub; | 0 | 0 | 0 | 0 |
| 13 | Df (i) – the total losses in the implementation of risk mil. rub | 16.5 | 33.01 | 15.51 | 21.5 |
| 14 | Preliminary damage estimates from Table. 3.8. | 10 | 20 | 10 | 20 |
| 15 | Preliminary estimates of the risk index of the table. 5. | 49 | 64 | 14 | 16 |
| 16 | Refined risk index values | 49 | 72 | 14 | 16 |

Data to populate the table 6 can be obtained in a financial or economic department of the organization. Analysis of the table shows that, despite the fact that the preliminary assessment of the risk of the index changed only in one of the four cases and not one of the risks has not changed the partition table 4, refined calculations necessary to carry out. In many cases, there is substantial implicit damage.
A second example: Calculation of damages and assessment of risks arising from large-scale non-food supermarket federal retail network.

The initial and boundary conditions: Location – one of the areas million regional center in Central Russia, the three–storey mall (shopping center), next to the objects of other owners, organized by CCTV, security. Located on the third floor of the building, made of concrete and foam concrete, decoration, service life of 10 years. 1200 m2. Cost of goods and materials, which are simultaneously in the store – 40 million rubles, the annual turnover –150 million rubles. The team – 20 people per shift.

Create a table similar to Example 1.

| №  | Risks                                      | The probability of the risk | The assessment of the probability of P | The amount of damage mln. Rub. | Damage assessment D | Risk index x R | Comments                                                                 |
|----|--------------------------------------------|-----------------------------|----------------------------------------|---------------------------------|---------------------|----------------|--------------------------------------------------------------------------|
| 1  | Flood                                      | 0.001                       | 2                                      | 0                               | 0                   | 0              | The river is far away, the sea – very far.                              |
| 2  | Fire                                       | 0.9                         | 9                                      | 40                              | 8                   | 72             | Heating water, electric wiring is new, corresponds to GOST and SNIP. Smoking – open fire is forbidden to breed in designated locations far from the premises. But the human factor can not be excluded, fire in the shopping center – a regular event.               |
| 3  | Earthquake                                 | 0.01                        | 2                                      | 2                               | 2                   | 4              | According to calculations – to 2 points.                                |
| 4  | Hurricane                                  | 0.05                        | 2                                      | 1                               | 2                   | 4              | In theory only. Probability is not available.                           |
| 5  | Eruption                                   | 0.001                       | 2                                      | 1                               | 2                   | 4              | Probability is not available.                                          |
| 6  | Sill                                       | 0.001                       | 2                                      | 1                               | 2                   | 4              | Probability is not available.                                          |
| 7  | The explosion (spontaneous or terrorist)   | 0.1                         | 2                                      | 10                              | 5                   | 10             | The probability exists, explosive goods and materials can be .. Probability is not available. The probability exists, although building a new, operated correctly. As on any object with the power supply.                           |
| 8  | Violationofdesign ns                       | 0.1                         | 2                                      | 10                              | 5                   | 10             | Probability is not available.                                          |
| 9  | Electricshocks                             | 0.01                        | 2                                      | 0.05                            | 1                   | 2              | Probability is not available.                                          |
| 10 | Biologicalcontamination                    | 0.001                       | 2                                      | 0.05                            | 1                   | 2              | Probability is not available.                                          |
Table 8. Assessment of the damage caused by the most dangerous risks (mln. Rubles), Example 2.

| №  | Loss type                                           | Theft | Fire | Explosion | Radioactive contamination | Violation of designs |
|----|----------------------------------------------------|-------|------|-----------|---------------------------|----------------------|
| 1  | L (i) – the costs associated with the loss of human life; | 0     | 10   | 5         | 0                         | 5                    |
| 2  | HI (i) – the costs associated with the restoration of victims' health; | 0     | 5    | 2         | 0.5                       | 2                    |
| 3  | Fa (i) – the costs associated with the restoration of fixed assets; | 0     | 0    | 0         | 0                         | 0                    |
| 4  | Ca (i) – the costs associated with the restoration of circulating means; | 5     | 40   | 20        | 20                        | 20                   |
| 5  | Ek (i) – the costs associated with the restoration of the ecology in the territory of implementation of risk; | 0     | 0    | 0         | 0                         | 0                    |
| 6  | Pl (i) – the lost profit for the liquidation of the consequences of the implementation of the risk; | 1     | thirty | 20        | thirty                    | 20                   |
| 7  | Ol (i) – the costs associated with lost opportunities for the liquidation of the consequences of the implementation of the risk; | 1     | 10   | 5         | 10                        | 5                    |
| 8  | Sc (i) – the costs of sanctions on torn contracts; | 0     | 1    | 1         | 1                         | 1                    |
| 9  | Co (i) – the costs associated with the transfer of credit obligations; | 1     | 3    | 1         | 3                         | 1                    |
| 10 | Rr (i) – the costs associated with the restoration of the banking market and reputation; | 0     | 1    | 1         | 1                         | 1                    |
| 11 | Db (i) – the costs associated with the restoration of databases; | 0     | 0.5  | 0.5       | 0                         | 0.5                  |
| 12 | Nh (i) – the costs associated with the recovery of lost technology and | 0     | 0    | 0         | 0                         | 0                    |
Analysis of the table shows that the proximate calculation, four out of five examined risk index value changed, a fire risk of catastrophic joined section.

### 6. Conclusions

Example 1 to the following conclusions:

- According to the risk of theft is necessary to organize access control, video surveillance inside the building and the adjacent territory, to ensure the liability of employees, the protection system during off–hours with an alarm to the control of the service to call the rapid response team (RRT).
- According to the risk of fire – all the measures provided for documents of the Government of the Russian Federation and the Ministry of Emergency Situations, it regulated all with a good margin of safety.
- According to the risk of explosion (a terrorist act) – the event for the first two risks allow to counteract the risk of explosion with sufficient guarantee.
- On the risk of radioactive contamination. Prevent the accident at the NPP Security forces impossible. It is necessary to monitor background radiation (portable dosimeters) and to consider the plan of evacuation of personnel and goods and materials.

According to Example 2, the following conclusions:

- On the risk of theft is necessary to organize access control, video surveillance inside the building, to ensure liability of employees, the protection system during off–hours, and careful control of employees and visitors at the time of entry / exit (in compliance with the legislation of the Russian Federation).
- According to the risk of fire – all the activities encompassed the documents and the Government of the Russian Federation Ministry of Emergency Situations, regular inspection of fire protection systems and public address systems, strict adherence to all points of fire regulations.
- According to the risk of explosion (a terrorist act) – the event for the first two risks allow to counteract the risk of explosion with sufficient guarantee.
- On the risk of radioactive contamination. Prevent the accident at the NPP Security forces impossible. It is necessary to monitor background radiation (portable dosimeter) and consider evacuation plan visitors, staff and the TMC.
- By fracture risk structures – regular inspection specialists bearing structures using specialized equipment to determine their integrity.

In this paper, based on the systematic approach the methods of estimating the impact of various risks on the economic and social facilities. A method for using the intensity estimated numbers for constructing matrices indices risk and risk of impact on the object. Practical examples show the use of the proposed model for creating security systems of various objects.

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