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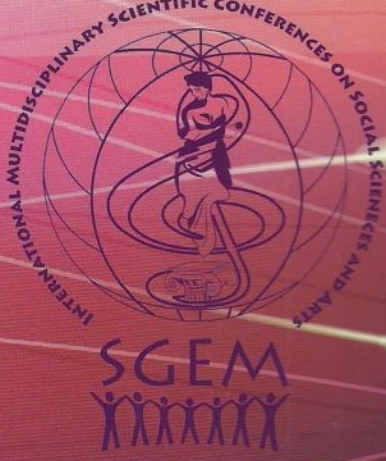

FINANCE
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POLITICAL SCIENCES, LAW, FINANCE, ECONOMICS AND TOURISM

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ECONOMICS AND TOURISM

SECTION FINANCE

ECONOMIC EVALUATION OF FIRE PROTECTION MEASURES

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ABSTRACT

Worldwide there is a big pressure to resources efficiency usage in every process. This pressure is also in safety protection measures. Article presents main result of the project FIREFF. The main goal of research project was to simplify and improve the quality of economic efficiency evaluation of fire protection measures. In the article we are focused on application of economic efficiency evaluation method. Dataset in the article come from project research, mainly from Slovak state institutions. We applied Cost benefit analysis with risk investment allowance. The results can be applicable in several fields related to economic efficiency resource usage.

Keywords: fire protection measures, economic efficiency, cost benefit analysis

INTRODUCTION

The term economic efficiency is popular nowadays. Every project, program and other financial activity have to be effective. Efficiency accent the economic justification. Economic justification can be understand as the project which benefits are bigger than costs. The economic justification of the fire safety design alternative may be a relatively complicated task which depends on an array of input parameters, some of them are not easily available. In our article we will be focusing on fire protection measures. In this case economy justness is application of only these fire protection measures which have relation to main risks. In the case of expected effects and costs of fire prevention measures to the economic dimension investment decision also adds the aspect of life, health and environmental protection. Many of these factors are difficult to quantify.

Part of the planning and execution of each construction project is budget, which depends mainly on the size, type of building and the required on building equipment. Amount of the budget is usually limited primarily to financial possibilities of investor, who obviously has an interest for money saving. However, not all parts and construction equipment are for investors and project managers as attractive, because they are unprofitably "unpopular" and investor tends to question their legitimacy. The manifestation is to minimize the cost on safety measures as are fire safety measures.

In the process of fire safety design of a building a number of fire protection options may arise. Although the minimum required level is usually set in legislation and standards, there may be various approaches in addressing them or stakeholder(s) place an additional performance objective. This often includes property protection, business continuity and heritage protection. The fire safety engineer is then faced with a task of finding such a combination of fire protection systems which minimise potential loss by

fire and threat to life. The second selection criterion in the process is the cost of such combination.

Each building should contain elements of fire safety systems. These are generally required by legal and technical standards. Their primary purpose is to protect the health and lives of people in case of fire. In the Slovak Republic it is through Act no. 314/2001 on fire protection [1] Decree of the Ministry of Interior no. 94/2004 [2]. It is laying down technical requirements for fire safety during the construction and use of buildings and a set of technical standards are also stated in STN 92 0201 about Fire safety of buildings [3] sector and related government regulations and technical standards. The inclusion of fire protection systems into building design is usually driven by two aspects – legal requirements and economic feasibility.

The main goal of project FIREFF was to create practical model, which could be used during building design [4]. Practical model is able to make an analysis of safety level and economic efficiency of the cost. Article presents this model and one case (study) of its application.

FIREFF MODEL DESCRIPTION

The basic purpose of the model is to compare different variants of building fire safety from perspective of potential impacts of fire on the building. Different variants of the fire safety are understood the specific combination of active and passive fire prevention measures. Every combination is characterized by certain expected impacts. Therefore, it can be expressed effectiveness of fire prevention measures such things as the reduction of death probability or assumed damages in the building caused by fire. Its efficiency can be calculated by using cost-benefit analysis as economic interpretation of these fire prevention measures.

In current model variant, we are calculating with these fire protective measures: compartment, fire alarm system, fire extinguishers and sprinkler protection. Table 1 shows all 16 possibilities of their use in building [5].

Table 1. Fire protection alternatives considered

No.	Fire alarm	Fire exting.	Sprinklers	Compartment
1	N	N	N	N
2	Y	N	N	N
3	N	Y	N	N
4	N	N	Y	N
5	N	N	N	Y
6	N	Y	N	Y
7	Y	N	Y	N
8	N	Y	Y	N
9	Y	Y	N	N
10	Y	N	N	Y
11	N	N	Y	Y
12	Y	Y	Y	N
13	Y	Y	N	Y
14	Y	N	Y	Y
15	N	Y	Y	Y
16	Y	Y	Y	Y

Obviously, the minimum fire protection measures requirements for each building type would be set in legislation or standards. This would lead to rejection of certain combinations from table 1.

According to the complexity of the building design and the specific impact in various conditions [6] in the model currently isn't included smoke and heat exhaust ventilators. In the model is calculated fire development and its future extent of damages calculated by event trees analysis (ETA) [7,8]. Each node in ETA represent the stages of development of fire and the influence of fire prevention measures on it in the relevant probability level. Impact of the fire prevention measures for the protection of life is expressed through the correction coefficients resulted from statistic reports. To clarify the effects could be used for comparison times ASET and RSET, which requires the involvement of a relatively complex modelling methods [9]. The model includes technical and economical part. As it is stated in figure 1.

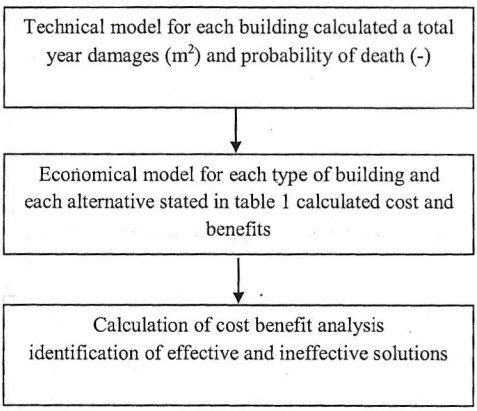

Figure 1: Logical framework of FIREFF model

However, calculations are difficult for normal user of model, it's not necessary to work with them. Normal user, which should be designers of building, just has to put inputs which are stated in table 2 into model. Inputs can be categorized to quantitate and qualitative. In technical part of model qualitative are building type, speed of fire development, fire load, building construction and category of firefighting units. All these inputs can be selected from list. Other inputs are quantitative and it is users decision which numbers are put into model.

Table 2: Inputs interface form FIREFF model

According to: [10]

Inputs					
Technical part			**Economical part**		
Building specification			**Specification of fire protection measures**		
Building type	Flat house		**Fire protection tools**	**Investment Costs (€)**	**Operational Costs (€/year)**
The speed of fire development	Ultra-fast		**Fire alarm**	10000	500
Fire load	High		**Fire extinguishers**	2000	200
Building construction	Light		**Sprinklers**	30000	1000
Category of firefighting units	P3		**Compartment**	6000	300
Fire compartment size	900	m^2			
The total area of the building	3600	m^2			
The average value of the building	500	€/m^2			
Lifetime of the building	20	Years			

APPLICATION OF COST BENEFIT ANALYSIS

Further approach, for an input data and for the drafting alternative stated in table 1, is calculated benefit and cost. The calculation of this indicator is as follows: for a given combination of applied fire protection tools are summarized costs. Costs are the sum of investment, operational fire protection tools and expected losses due to damage to the building analysed and estimated losses of human lives.

Cost = $\sum$ costs of Fire protection tools + $\sum$ damages at all [€] (1)

Cost of Fire protection tool = cost of fire protection tool investment + cost of fire protection tool operational * lifetime of the building [€] (2)

Damage at all = damages on building + economic losses due to human deaths [€] (3)

Cost-Benefit analysis is calculated for each investing alternative as share between benefits and costs. Benefits are calculated as variance between damages with and without realisation of fire protection measures. Economic justified are just these fire protection measures which have results bigger than one. Application of model is wide for presentation of outputs in article. In spite of, we choose one application according to data stated in table 2 and all variant stated in table 1. Results are stated in table 3.

Table 3: Outputs form from FIREFF model

According to: [10]

No.	Yearly damages on building caused by fire (m2)	Probability of death	Effective/Ineffective	Benefit/Cost share
1	11.85	6.49E-05	Ineffective	0
2	9.27	3.25E-05	Ineffective	0.25
3	9.48	4.87E-05	Ineffective	0.24
4	1.21	3.25E-05	Effective	1.66
5	3.72	6.49E-05	Effective	1.40
6	5.92	2.43E-05	Ineffective	0.73
7	0.95	1.62E-05	Effective	1.41
8	3.29	3.25E-05	Effective	1.29
9	0.97	2.43E-05	Effective	1.65
10	2.98	4.87E-05	Effective	1.67
11	0.40	3.25E-05	Effective	1.68
12	0.6	1.22E-05	Effective	1.42
13	2.09	2.43E-05	Effective	1.65
14	0.36	1.62E-05	Effective	1.38
15	0.32	2.43E-05	Effective	1.62
16	0.23	1.22E-05	Effective	1.34

Proposed alternative 1 corresponds to state that none of the potential investment to the fire prevention measures are realised. In spite of the logical calculation of the ratio B / C shows that the value has to be 0. Proposed alternative 16 corresponds to the state that it is implemented all possible invest to the fire prevention measures. In these case is value of the ratio B / C equal to 1.34. It follows that the investment is justified and therefore for the analysed building is an investment in fire prevention measures the most effective, when is value ratio B / C highest. On bases of this case it is alternative 11, where are used sprinklers and compartment (degree of B / C = 1.68).

Economic efficiency of investment to the fire protection measures can be calculated by using these methods:

- Cost Benefit analysis associated with investment risks allowance,
- Cost Benefit analysis associated with investment risks allowance and other factors,
- Cost Benefit analysis, which reflects the change in value of money during the time,
- DEA (Data envelopment analysis),
- ALARP (As low as reasonably practicable).

However, these methods are all used for economic evaluation of investment. The difference is in required various input data. In fact, the construction of the presented model was limited by the available data. This is the foundation of other factors determining model (only address the issue of - economic part of model):

- Any consideration about the time value of money,
- Any consideration of inflation
- Damages are connected only to the building (construction part) and due to loss of lives,
- In evaluation of the economic impacts is taken into account depreciation and evaluation of buildings (building part and the inside of the building).

Perspective development model (with an emphasis on the economic statement consequences) can be finalized in the following tasks:

- Quantification of the value of the equipment building (by category),
- Quantifying costs and damages, which are important from the standpoint of economic efficiency of fire protection measures (environmental damage, costs of firefighter solution of fire and costs associated with damage of interior fittings of the building),
- Benefits to quantify the problem of the tax shield.

CONCLUSION

In the article is presented the main result of the project FIREFF and software model for economic efficiency evaluation of fire protection measures. Model use a lot different calculation based on statistical fire data, which are very important during building design. Purpose of this model is to simplify the work for building designer, whose honestly cannot fully understand of these statistical calculation. Model in current state can calculate 16 various fire protection variants (stated in table 1) in the building. Model has two basic parts: economical and technical. However, it is hard to connect these parts (it is caused by various datasets) we make easy solution, which is user friendly and its show in table 2. Results of these calculation are stated in table 3 (only for one actual type of building). Model is free to use, which is also important for future users. Results can be used in different countries, but building designers have to consider also legal acts and standards in their country, which can lead to reject of some alternatives (from table 1).

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