ISBN 978-86-80593-52-4

Modeling of Internal Control of Occupational Safety in Corporate Systems by Using Multiple Criteria Decision Making Methods

Ivan Mance*, Vesna Nikolić**, Vladimir Huzak***
*HP - Croatian Post / Department of Occupational Safety, Fire Protection and Ecology, Zagreb, Republic of Croatia
**University of Nis / Faculty of Occupational Safety, Nis, Serbia
***HP - Croatian Post / Department of Occupational Safety, Fire Protection and Ecology, Zagreb, Republic of Croatia
*ivan.mance@posta.hr; **vesna.nikolic@znrfak.ni.ac.rs; ***vladimir.huzak@posta.hr

Abstract **- It is possible to use methods of information science to research and resolve many problems in the occupational safety system. Starting from the known theoretical facts and principles, the paper discusses the problems of internal supervision of occupational safety in major corporate systems by using the multiple criteria decision making (MDCM). As the research sample, it was taken a major corporate system HP - Croatian Post. Firstly, the elements (procedures) of internal supervision that are used by occupational safety professionals in everyday practice, are determined and they constitute the criteria of the methodology of MDCM. By taking in consideration that the most biased part of the methodology of MDCM is assigning weights to the criteria, in this paper that step has been accomplished by using AHP methods through the Expert Choice 11® tool. The team of sevenoccupatonal safety professionals, individually compares criteria each "with each other" in sens of how much is one of the criteria more or less significant compared to the other. In that way each criterion receives seven different weights, which are further brought down to a geometric middle, which then represents the actual weight assigned to each criterion. Furthermore, the paper defines several approaches to internal control, which represent alternatives of the methodology of MDCM. Defining the initial decision matrix and applying appropriate Electre I method (Elimination and Choice Expressing the Reality), the paper ultimately defines those alternatives that are the most important, and in the end they make the basis of a proposed model of internal control in big corporate systems.**

Keywords: occupational safety, internal supervision, MDCM, AHP method, Electre I method.

I. INTRODUCTION

Internal control of occupational safety represents the legal commitment related to occupational safety [18], but it is also an indispensable factor for correct implementation of occupational safety systems in business organizations, and operational performance of occupational safety. The purpose of internal control is reflected in regular and professional monitoring of occupational safety processes in the organization. It is conducted by experts of occupational safety and the other factors of integral safety in the organization (trustees of the employer, the workers' trustees etc.) and they suggest correction of the organizational, technical and other perceived shortcomings in the field of occupational safety. Certainly the most important work of internal control is carried out and must be carried out precisely by occupational safety professionals [5], because its conduction by other factors is highly questionable given their expertise, motivation and business workload. Some authors [2] observe internal control as an essential part of the security process which is involved in work and work-related activities, but it also affects the forms of behavior of the organization.

Especially interesting are researches of the attitudes of occupational safety experts on problems of internal control in this area. Results of the researches that took place in Croatia show that the most respondents / experts of occupational safety (41.12%) rate internal supervision over the implementation of safety rules as very good, while a negative score is present in 0.59% of respondents [3]. Experts of occuaptional safety evaluate similarly their own work in the area of internal control [4]. If we take in consideration Kacian's cyber security model according to which the implementation of internal control reflects the "patterns of behavior" in the field of occupational safety in the organization, it is to be expected that the efficiency of the internal control of occupational safety affects the consciousness of workers and employers as well as of operating by the rules of secure working. A challenge would be to conduct a study that would prove or disprove the thesis.

Trupčević also recognizes the importance of internal control by the employers. [6] The author gives a proposed

ISBN 978-86-80593-52-4

model by forming checklist / forms for some smaller organizational units, he proposes the internal control elements (elements are very widely proposed and they are related to the specific areas which occupational safety covers such as examination of work resources, protection of non-smokers, hazard assessment, etc. .) and proposes rating of each area by analyzing the lower organizational units. Total occupational safety condition according to internal control would be administered by summing and giving the average score of all organizational units of the employer. However, the proposed model is not based on a specific research and it belongs to a professional proposal of the author, nor it has been applied in practice, which would have given us an insight into the advantages and disadvantages of that kind of approach.

Norwegian authors [7] display internal control as a concept of proven and systematic strategy for improving health and occupational safety. The results of research in Norway show that the internal occupational safety control in this country is at the level of deviations from prescribed and that it needs to be undertaken multi-disciplinary investigation. The results of this and similar studies encouraged the authors of this paper to the application of methods from the field of information sciences in the research and the projection of the internal occupational safety models in corporate systems.

II. METHODOLOGY

The topic of the research is modeling of internal supervision of occupational safety in a large corporate system. The research was conducted in the corporate system of Croatian Post Inc. which belongs to a public limited company formed by separation of public company Croatian Post and Telecommunications into two companies (HP Inc. and HT). Croatian Post Inc. has a registered capital of HRK 952,636,100.00 divided into 9,526,361 shares with a nominal value of HRK 100 and 9650 employees which makes it a national giant corporation. The objectives of the survey are based on:

- Defining the most important elements in implementation of internal supervision of occupational safety in the corporation Croatian Post
- Selection of 7 experts of occupational safety which will independently and individually compare the importance of the defined elements "with each other"
- Defining multiple access of internal supervision of occupational safety by applying the already set of elements
- Selection of the most important internal control accesses by using MCDM methodology of Electre I
- Proposition of modeling of internal supervision of occupational safety in the corporate system of Croatian Post

From the objectives derive hypotheses:

H1 - It is possible to set different approaches of internal control of occupational safety by taking in consideration the total activity which it contains, and to define through them the most important one.

H2 - By defining significance (importance) of individual accesses of the internal supervision it is possible to propose a model of internal supervision of occuptional safety in the corporate system.

The study used the following apparatus in scientific research:

- Descriptive method to describe the elements and accesses of the internal supervision of occupational safety in the corporation Croatian Post
- Statistical methods (descriptive statistics, arithmetic mean, geometric mean) which will be used to describe expert analysis of individual elements and to define the value of each of them in the initial decision-making table of multicriterial analysis
- Methods of MCDM (AHP and ELECTRE I) that will prove or disprove H1.
- Method of MCDM Electre III, which will be used to rank by the importance individual approaches of the internal control and modeling method that will prove or disprove the H2.

III. RESULTS

Internal supervision of occupational safety in corporations that make the largest business systems stems from the fact of a large number of employees, a big dislocation and the number of locations and series of business processes that occure on a daily basis in such systems. To monitor physically any process in such circumstances, and having in mind the limited resources of the maximum number of people in the supervision departement, limitation of working hours, the vast territorial coverage and the other represents a huge challenge in the organizational, priority and professional sense. Internal supervision of occupational safety can and must be exclusively conducted on the field, analyzing the safe conduct of work and work-related activities, the excesses of the set system of security as well as possible sources of danger, hazard and effort. The most effective internal supervision of occupational safety, as already mentioned, implement occupational safety specialists according to references [8], [5], [6] and based on this knowledge the professionals are selected among occupational safety experts[1],who will analyze the main elements of the internal control in the corporate system of Croatian Post.

There are selected 21 elements of internal supervision of occupational safety (see Table 1), which got abbreviations for easier analysis and modeling. In the first phase of the research the weight values are assigned to the defined elements in a way that the expert team enters the individual estimate values of the elements comparing elements "each with each other," applying "Analytic

[1]The expert team consisted of seven (7) occupational safety specialist in the Croatian Post Inc. (alphabetically):

- Joško Cikojević, BSc, Split areamanager
- Vladimir Huzak, Msc, Coordinator of the Occupational safety department
- Zdravko Jelenić, bacc., Gospić areamanager
- Ivan Mance, MSc., Head of the Occupational safety department
- Jadran Matić, bacc, Rijeka area manager
- Ratko Peček, BSc, Zagreb area manager
- Damir Vidović, BSc, Čakovec area manager

ISBN 978-86-80593-52-4

TABLE I.
REVIEW OF THE ELEMENTS OD INTERNAL CONTROL OF OS

No	Nameofthe element	Abb.
1.	Availability and use of personal protective equipment	OZS
2.	Safe and proper use of work equipent	PSR
3.	Analysis of practical training in the area of training for work safetly	OSP
4.	correctlightning rod installation	GROM
5.	Condition of the heating system	KOTL
6.	Availability of evacuation routes	PE
7.	Availability and condition of fireextinguishers	DVA
8.	Availability and condition of hydrants	DHM
9.	Availability and state of resources for first aid providing	PP
10.	Availability and condition of toilets	WC
11.	Damage of theload-bearing parts of the building structures	NG
12.	Leakag e of water on electrical installations and / or devices	VEL
13.	Electric installation correctness	ELIN
14.	Coloration and cleanliness of the walls	ČZID
15.	Analysis of free space per worker	SPACE
16.	Microclimate conditions	KLIMA
17.	Daily mode of working (work inshifts)	SMJ
18.	work under the influence of alcohol and other addictive substances	ALKO
19.	Safety and maintenance of work resources	ISR
20.	Teamwork when performing demanding work processes	TIM
21.	Availability and condition of fire alarm systems	ZOP

Hierarchy Process (AHP)" method [10] and Expert Choice11® tool. "The basic steps in constructing and examining an AHP model are: (1) decompose the problem into a hierarhical structure, (2) perform judgments to establish priorities for the elements of the hierarchy, (3) synthesis of the model (4) perform a sensitivity analysis."[11]

Given that the weight assignment criteria is the most subjective part of the methodology of multiple criteria decision making [9], it went on trough seven passes of AHP method (seven experts), which minimized subjectivity in assigning weight criteria. After analysing the elements "each with each other" from the part of the expert team and calculation of geometric and arithmetic mean [32] of each element it was noticed a slight difference in their values (the difference in the third decimal place). This is significant because geometric mean implies a measure of the average spread of some changes [12], or the average of the most frequently repeated values in a row and is not, in contrast to the arithmetic mean subjected to large changes due to the change of a single value in the series. We come to the conclusion that the geometric mean is the only suitable for weight criteria assigning [1], and a small difference between the calculated geometric and arithmetic means show that the expert team had similar thinking regarding the importance (weight) of each element of the internal supervision of occupational safety. The biggest difference between the geometric and arithmetic mean (see Figure 1) was determined by the element ZOP (availability and status of thefirealarm system), to which Ivan Mance gave much greater significance than the other experts and in that way increased the value of the arithmetic mean, which would then increasedsignifically (for exactly

A	B	C	D
Ime i prezime	ISR	TIM	ZOP
Ivan Mance	0,104	0,024	0,123
Vladimir Huzak	0,088	0,088	0,091
Joško Cikojević	0,055	0,016	0,051
Zdravko Jelenić	0,05	0,006	0,021
Ratko Peček	0,085	0,007	0,013
Damir Vidović	0,048	0,019	0,097
Jadran Matić	0,053	0,027	0,075
Aritmetička sredina	0,06900	0,02671	0,06729
Geometrijska sredina	0,06598	0,01845	0,05273
Razlika Art-Geo	0,00302	0,00826	**0,01455**

Figure 1. The biggest difference in arithmetic and geometric mean

0.01455) importance of the element of the ZOP. As this was not the attitude of the other experts, and by taking in consideration that geometric mean is used in the weight criteria assigning, the weight of the element ZOP has remained within the limits of the most frequently repeated values.

By defining the weights of all the criteria (see Figure 2) they are arranged by the importance obtained, and it is clearly visible that the first four criteria (VEL, ALKO, NG and ELIN) bear exactly 50.14% (from 100%) of the weight or importance. So for the team of internal supervision of occupational safety far the most important (most important) is to supervise the "leakage of water on the electrical installations and devices" and "work under the influence of alcohol and other addictive substances," which can certainly be interpreted as an experiential analysis of the situation on the ground, or it can be said that the experts most frequently encountered above two mentioned problems, and they make them stand out as the most important ones in the conduction of internal supervision of occupational safety.

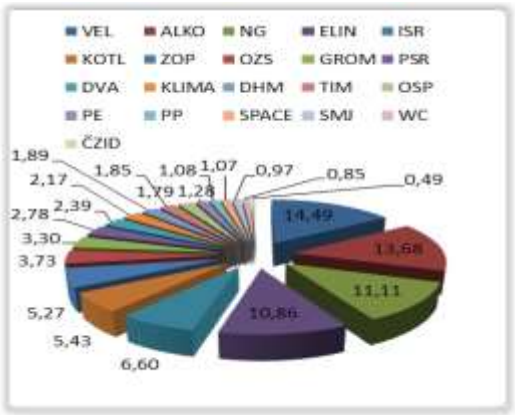


Figure 2. Layout of the weight assigned to the elements of internal control

ISBN 978-86-80593-52-4

By the textbook sample, the alternatives for needs of the initial decision matrix are made from all the elements of internal supervision of occupational safety. Alternatives (types of supervision) contain six elements of

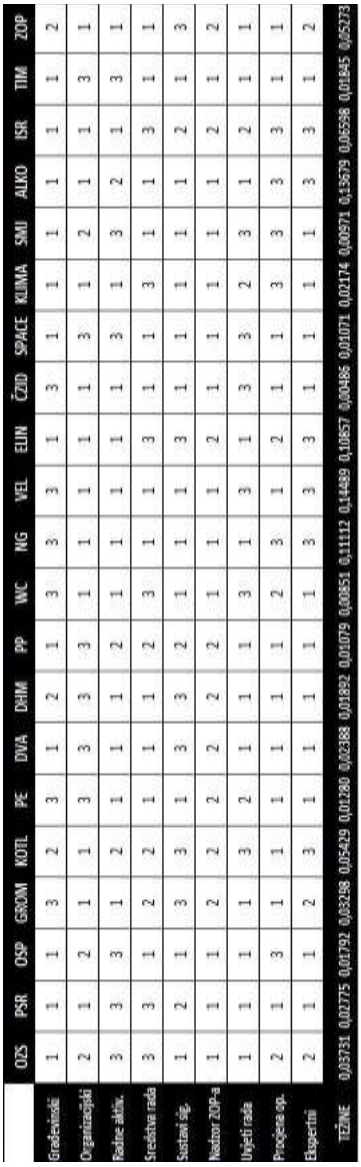
TABLE II.
TYPES OF INTERNAL CONTROL OF OCCUPATIONAL SAFETY

Types of internal control (alternative)	Ordinal number of elements from Table 1.
Construction supervision	4. 6. 10. 11. 12. 14.
Organisational supervision	6. 7. 8. 9. 15. 20.
Supervision of activities at work	1. 2. 3. 15. 17. 20.
Supervision of work resources	1. 2. 10. 13. 16. 19.
Supervision of security systems	4. 5. 7. 8. 13. 21.
Supervision of fire protection	4. 6. 7. 8. 9. 21.
Supervision of working conditions	5. 10. 12. 14. 15. 17.
Supervision according to risk assessment	3. 11. 16. 17. 18. 19.
Expert supervision	5. 11. 12. 13. 18. 19.

internal control that are fully implemented in that specific internal control (see Table 2). For example. "Construction supervision" contains elements under numbers 4, 6, 10, 11, 12 and 14 from Table 1, while "expert supervision" contains six major elements assessed by an expert team, those are the elements under numbers 5, 11,12, 13, 18 and 19 in Table 1. This means that the subjective internal supervisions are carried out in the context of those constitutive elements. Each alternative has elements that are important for its implementation, and all the elements are relatively evenly spaced in the way that 12 elements are represented 3 times, while the other 9 elements are represented two times by the proposed distribution and the content of the internal occupational safety.In the initial decision matrix, criteria will be evaluated on a scale from 1 to 3, where 1 concernes the value of "not implemented", 2 concernes the value of "partially implemented" and 3 implies the value of "fully implemented". The elements defined by the type of internal control (see Table 2) will be evaluated by the grade 3 while there will be chosen 3 more elements for every type of internal control of occupational safety that can make a part of this particular inspection and will be evaluated by grade 2 - that means partially implemented - and in the end the rest of the elements, which are not implemented in the individual supervision, will be evaluated by the grade 1. To the expert supervision that is considered special supervision selected by an expert team, to the six of the most important elements will be awarded additional three elements by rank of the importance that the expert team has determined (see Figure 2) and which will be evaluated by grade 2. Aftrewords the weight values of each element are getting entered in the initial decision matrix and the same gets structured as described above (see Figure 3).

There are a lot of researches which are using Electre methodology or other methodology of MCDMas the basis for the analysis of alternatives, the ranking possibilities etc. The Universities [22] in the UK are ranked with the help of Electre III methodology. Various variants of Electre methods were used in the analysis of the banking sector [23], environmental analysis of solid waste management system [24] and other environmental activities [28], in selection of an optimum irrigation [25], and even to defense scientific theses [26] and PhD thesis [27].

By setting the initial decision matrix, workflow of the



	OZS	PSR	OSP	GROM	KOTL	IPE	DVA	DHM	IPP	WC	NG	VEL	ELIN	ČZID	SPACE	KUMA	SMU	ALKO	KSR	TIM	ZOP
Gradevinski	1	1	1	3	2	3	1	2	1	3	3	3	1	3	1	1	1	1	1	1	2
Organizacijski	2	1	2	1	1	3	3	3	3	1	1	1	1	1	3	1	2	1	1	3	1
Radne aktiv.	3	3	3	1	2	1	1	1	2	1	1	1	1	1	3	1	3	2	1	3	1
Sredstva rada	3	3	1	2	2	1	1	1	2	3	1	1	3	1	1	3	1	1	3	1	1
Sustavi sig.	1	2	1	3	3	1	3	3	2	1	1	1	3	1	1	1	1	1	2	1	3
Nadzor ZOP-a	1	1	1	2	2	2	2	2	2	1	1	1	2	1	1	1	1	1	2	1	2
Ugjeti rada	1	1	1	1	3	2	1	1	1	3	1	3	1	3	3	2	3	1	2	1	1
Procjena op.	2	1	3	1	1	1	1	1	1	2	3	1	2	1	1	3	3	3	3	1	1
Ekspertini	2	1	1	2	3	1	1	1	1	1	3	3	3	1	1	1	1	3	3	1	2
TEŽINE	0,03731	0,02775	0,01792	0,03258	0,05429	0,01280	0,02388	0,01892	0,01079	0,00851	0,11112	0,14489	0,10857	0,00486	0,01071	0,02174	0,00971	0,13679	0,06598	0,01845	0,05273

Figure 3. Inital matrixof decision making

problem-solving methods by using Electre I method implies: calculation of normalized decision matrix; calculation of the weighted normalized decision matrix; determination of set of approvals and disapprovals; calculation of matrix of approvals; calculation of matrix of disapprovals; calculation of the matrix of domination by approval; calculation of the matrix of domination by the disapprovals; calculation of the aggregate matrix of domination and elimination of the weakest alternatives. We obtain normalized decision matrix by reference [11], [14], [15] through several different methods such as Euclidean normalization, the percentage normalization, normalization summing etc. The weighted normalized decision matrix V is calculated from the normalized decision matrix R by multipying matrix R columns with weights of appropriate criteria w_i. This is followed by determination of sets of approvals and disapprovals in a way that each pair of alternatives (a_k, a_l), $k, l \in$ (1,2,

...,n), $k \neq l$ the index set of criteria J = {1, 2, ..., *m*} is divided into two subsets:

- A set of approvals

$$C_{kl} = \{j / f_j(a_k) \geq f_j(a_l)\} \quad (1)$$

- And a set of disapprovals

$$D_{kl} = \{j / f_j(a_k) < f_j(a_l)\} \quad (2)$$

The set C_{kl} consists of the criteria by which alternative a_k is not weaker than the alternative a_l, and set D_{kl} is made of criteria by which the alternative a_k is weaker than the alternative a_l. Below is necessary to calculate the matrix of approval, and its elements are the indices of compliance (with the dominance of an alternative a_k compared to a_l) and is calculated by using the following formula:

$$c_{kl} = \sum_{j \in C_{kl}} \frac{w_j}{\sum_{j=1}^{m} w_j} \quad (3)$$

Then it follows the implementation of the count of dissaproval matrix. Index of disapproval d_{kl} that is forming this matrix reflects the resistance of the alternative a_l to the domination of alternative a_k :

$$d_{kl} = \frac{\max_{j \in D_{kl}} |v_{kj} - v_{lj}|}{\max_{j \in J} |v_{kj} - v_{lj}|} \quad (4)$$

In the next few steps the calculation of the matrix of domination by consent is performed, and the process ends

	Gradevin.	Organiz.	Radne aktivnosti	Sredstva rada	Sustavi sigurnosti	Nadzor ZOP-a	Uvjeti rada	Procjena opasnosti	Ekspertni	EFFECT
Građevinski	0	1	1	1	0	0	1	0	0	
Organizacijski	0	0	0	0	0	0	0	0	0	
Radne aktiv.	0	1	0	1	0	0	0	0	0	
Sredstva rada	0	1	1	0	1	1	1	1	0	
Sustavi sig.	0	1	1	1	0	1	1	0	0	
Nadzor ZOP-a	1	1	1	1	1	0	1	0	0	
Uvjeti rada	1	1	1	0	1	1	0	0	0	
Procjena op.	0	1	1	0	0	1	1	0	0	
Ekspertni	1	1	1	1	1	1	1	1	0	

Figure 4. Aggregate matrixof domination

with the calculation of the aggregate matrix of domination (incidence matrix), which is usually identified with the letter E [16].This matrix involves the final calculation step and in it bySanna[2]tool by tag EFFECT is defined the dominant alternative / s.Traversing the whole Electre I procedure (see Figure 4) it is shown that in the aggregate matrix of domination is designated alternative "Expert supervision" as the one that dominates over all the other alternatives. With this methodology of MCDMElectre I, a good quality selection of elements of internal supervision of occupational safety by an expert team is confirmed. Electre I is a method that extracts the dominant alternatives (ie by reference [16] effective against inefficient), and therefore we can conclude that the "expert supervision" the form of / access to internal supervision of occupational safety is the one that needs to be used the most. With everything said we managed to prove H1, because we were able to extract from the different approaches of the internal control of occupational safety the most important one.

With Electre I developed five types of ElectresMDCM methodologies, namely: Electre II, Electre III, IV Electre, Electre and Electre A TRI [14]. Due to the development of the method of Electre I which separates, as already mentioned, the most dominant alternatives, the need of complete ranking of all alternatives from the best to the worst option arose, it was necessary to develop a methodology of MDCM, which made it possible. "This led to the birth of ELECTRE II (Electronic two): a method for dealing with the problem of ranking actions from the best option to the worst. Just a few years later a new method for actions ranking was devised: ELECTRE III (Electronic three). The main new ideas introduced by this method were the use of pseudo-criteria and fuzzy binary outranking relations". [14]

Indif. Class	Alternative
1.	Ekspertni
2.	Procjena op.
3.	Građevinski
4.	Sustavi sig.
5.	Sredstva rada
6.	Nadzor ZOP-a
7.	Uvjeti rada
8.	Radne aktiv.
9.	Organizacijski

Figure 5. Electre III, ranking of the alternatives

To be able to fully rank all the alternatives of internal supervision of occupational safety in the present study, we used the Electre III method [13], through which we got (see Figure 5) fully ranking. The alternative of "Expert supervision" turns out the most valuable, same as in the method Electre I. Furthermore the display of Electre III ranking, the approaches of internal control can be divided into three groups, where the first and the most important group make the alternatives 1-3, another relatively significant group make alternatives 4-6 and the least significant group make alternatives 7-9. This ranking and analyzing of the first and the most important group shows very interesting if we take a look at the alternatives that we have got as the most important. So in addition to the "Expert supervision" which through different methodologies of MCDM sets as the most significant one and confirms the thesis that the expert team recognized the significance and value of the individual elements of internal control, the next in importance comes supervision by risk assessment. As the hazard assessment is the fundamental document in the field of of occupational safety, or to the references [21, 255]it makes an important step in the protection of workers and the interests of the organization, through which "... The employer is obliged, taking into consideration the tasks and their nature, assess risks to life and health of the workers and people at work, particularly in relation to the work equipment, work environment, technology, physical hazards, chemicals, etc. ". [18]. It is very interesting that the methodology of MDCM upheld professional and legal significance in hazard assessment

[2]SANNA (System for ANalysis of Alternatives), http://www.fhi.sk/files/katedry/kove/ssov/VKOX/Jablonsky.pdf, 11.08.2014.

ISBN 978-86-80593-52-4

as, according to references [31], the basic document in the field of safety and health at work, which must be respected by the employer and all employees. In this internal supervision by risk assessment it is intended to monitor those elements which, among other things, reflect as deficiencies listed in the "Plan of measures to reduce the risk," which is an integral part of each document of hazard assessments in the field of occupational safety. The third alternative involves construction supervision, which is also very interesting, because the construction sector in Republic of Croatia is the area of activity with the most deadly accidents at work per year for a good two decades. Thus the year 2005. was the most disturbing with even 27 deaths injuries in the construction industry in the Republic of Croatia [19], while the situation in the Republic of Slovenia is slightly better because the construction sector is the fourth activity with the most injuries at work, and it's after agriculture, hunting and forestry [20]. In this alternative of internal control it is imagined to supervise the "structural elements", ie those elements of internal control that in a greater or lesser extent, constitute integral parts of the building constructions or systems installed in the buildings itself.

Analyzing the second group (Alternatives 4-6) and the third and least significant one (Alternatives 7-9) one may notice that certain consistency in multicriterial analysis of analytics. It is certainly in the context of the potential harmful events (fire, accident, etc..) and possible injuries at work due to the malfunctioning of work equipment and / or safety devices, significant and important to monitor alternatives of "Safety System", "work equipment" and "Supervision FP from" organizational supervision "and the other the least significant alternatives. And this is in a way confirmed by the methodology Electre III.

Class	Alternative
1.	Ekspertni
2.	Procjena op.
3.	Sustavi sig.
4.	Gradevinski
5.	Sredstva rada
6.	Uvjeti rada
7.	Nadzor ZOP-a
8.	Radne aktiv.
9.	Organizacijski
MAPPACC	

Figure 6. MAPPACC, ranking of the alternatives

To confirm further the complete ranking of all alternatives the samehas been performed through MAPPACC [17] methodology of MDCM, where the ranking is almost identical (see Figure 6). Only the "construction supervision" and "supervision FP system" are dropped by one place in the ranking of significance.

IV. MODELING OF THE INTERNAL CONTROL OF OCCUPATIONAL SAFETY

In the study, the MCDMwanted to point out the most significant alternative of internal control of occupational safety by ranking all the proposed alternatives. The research sample was a corporate system of Croatian Post Inc. and the study proposes a model of internal supervision of occupational safety in this business system. It could have been clearly suggested a completely simplified model, in which in a reference period, by taking in consideration Electres I dominant alternative of "Expert supervision" and the Electres III complete ranking, the most of the internal supervisions would have been undertaken in the context of expert supervision, then slightly less in the context of supervision by risk assessment and so on until it would reach a minimum of supervision according to the alternative of organizational control. But such a model would be difficult to put in a timeframe and it would be also extremely difficult to monitor its implementation. Therefore, the authors of this study, given the fact that the proposed models will try to be implemented in the real system of the Croatian Post, firstly propose a frame that model must meet in order to be able to exist in practice:

- The corporate system of the Croatian Post Inc. has 1,040 locations which in internal supervision of occupational safety realisticly visit 16 occupational safety experts, according to that it turns out one expert on average 65 locations. The practice shows that since the locations are quite dislocated, it turns out that occupational safety expert is able to do internal supervision once every quarter or four times a year. In addition to other activities that occupational safety professionals perform, with reaction time of the other services in order to remove the identified shortcomings and the need of verification of work done, internal supervision of occupational safety at the Croatian Post works on the principle of Deming cycle (PDCA: Plan-Do-Check-Act) [31], and because of all that quarterly (four times a year) tours of the internal control are considered optimal which suggested model must take into concideration.
- The model must take into account the dominance of "Expert supervision" and the ranking of alternatives according to Electre III method.
- Given that the alternatives are composed of the very elements of internal control, the model must take into account all the alternatives, and all the elements of internal control (see Table 1). All the elements that make up the internal control of occupational safety in the corporate system must be reviewed and analzyed in some periode of time.
- The model must take into account, like mentioned above, the implementation in the real system, but more importantly it must be possible to control the efficiency of its application in practice, and what goes in the direction of further investigation which will be discussed in conclusion.
- The model must, as far as possible, take into account the possible overload of occupational safety experts in its implementation.

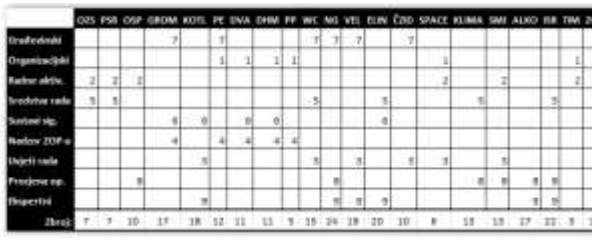


Figure 7. Scoring of the elements of internal control

Given all the above it is going to be used the initial decision matrix (see Figure 3) in the way to leave only scale 3, which means "full use of the element" or one

ISBN 978-86-80593-52-4

element of which the individual alternative is made (see Table 2) . Then the "threes" are replaced by the points on the principle of "more is better" in a way that each of the nine alternatives ranks through maximum of nine and a minimum of 1 point. Thus elements (triplets), predominant alternatives of "expert supervision" receive

TABLE III.
MATRIX OF THE INTERNAL MODEL OF SUPERVISION

Abbreviation	Points	Periodics of internal supervision	Ranking	Number of elemenats		Ordinal number of supervision	Type of control	Annual nuber of elements
NG	24	EVERY TIME (22-24)	A	2		1.	A	18
ISR	22					2.	AB	
ELIN	20	EVERY 2nd (19-21)	B	2		3.	AC	
VEL	19					4.	ABD	
KOTL	18	EVERY 3rd (16-18)	C	3		1.	AE	29
GROM	17					2.	ABCF	
ALKO	17					3.	AG	
WC	15	EVERY 4th (13-15)	D	3		4.	ABDH	
KLIMA	13					1.	AC	29
SMJ	13					2.	ABE	
PE	12	EVERY 5th (10-12)	E	6		3.	A	
DVA	11					4.	ABCDF	
DHM	11					1.	A	27
OSP	10					2.	ABG	
ČZID	10					3.	ACE	
ZOP	10					4.	ABDH	
OZS	7	EVERY 6th(7-9)	F	2		1.	A	26
PSR	7					2.	ABCF	
SPACE	6	EVERY 7th(4-6)	G	2		3.	A	
PP	5					4.	ABDE	
TIM	3	EVERY 8th(1-3)	H	1		Annual average of the elements:		25, 80

each 9 points, followed by elements of "hazard assessment" each 8 points and so on until the elements of "organizational control" each 1 point, and all of according to the ranking of alternatives of the Electre I and the Electre III (see Figure 4).

The resulting points are calculated for each element separately (see Figure 7), and ultimately we get the power matrix of each element. Thus, for example element NG - damage bearing parts of building structures (see Table 1) gets the highest score, while the element of TIM - teamwork when performing demanding workflows gets the lowest score.

According to the obtained rank of the elements, matrix model of internal control is arranged (see Table 3). The matrix shows a model for use in a five-year cycle, and is defined as followed:

- The abbreviation means the acronym of the element of internal control (see Table 1), which are arranged from the point most important to the least important element (column points).
- The periodicity of internal control involves a proposed model after which, by considering the number of points, we define in which period individualy elements of internal supervision of occupational safety will be carried out. Since there is the maximum of 24 points, and periodicals are divided into eight steps, so each period will be in the range of three points. Ex.: from 1 to 3 points - elements are used in internal supervision every eighth time; 13 to 15 points - elements are used in internal supervision every fourth time or 22 to 24 points - elements are used in internal supervision every time.
- Ranking simply replaces periodical scoring with ranks from A (elements used in internal control every time) to H (elements used in internal control every eighth time)
- Ordinal control number means to meet the demand by which an internal control is performed once every quarter or four times a year.
- Type of control defines which rank of the internal supervision of the occupational safety we use in the inspection tour by taking in consideration the periodicity of internal supervision and
- Number of yearly elements tells us how overloaded are the occupational safety professionals with the amount of the elements that must be accepted in the whole year activities of internal supervision of occupational safety. Clearly, in the first year that the workload is a bit smaller, but in the following years, that burden gets almost equal.

All the requirements mentioned above are accepted by the suggested model of the internal occupational safety, and especially the ranking obtained by Electre methods. The biggest number of points are related to the elements of the most dominant alternatives, it is easy to conclude that they are the most appearing ones in the periodical of the internal control. This proves also the H2 because it suggests a model of the internal supervision of occupational safety in corporate system through the most important single approaches of the internal control of occupational safety.

V. CONCLUSION

The authors of this study managed to find only two studies that apply the methodology of MCDMin the field of occupational safety. These were the studies [16], in which Electre method was used for ranking versions of system of customer relationship management in the occupational safety companies, or, the AHP method was used for the evaluation of security measures in laboratories of dental restoration production [30]. Similar or same situation exists in the other branches of the security: „Maritime safety is a critical issue and attracts the interest of academics, professionals and policy-makers. There are many approaches and many references available in the literature; however, most of them do not use the MCDM methodological and decision-making tools used and tested in other fields“[29]. According to reference[14] the Electre methods of MCDM, can be used in all of the situations when:

- The decision-maker wants to include in the model at least three criteria; - Actions are evaluated (for at least one criterion) on an ordinal scale or on a weakly interval

scale; - A strong heterogeneity related with the nature of evaluations exists among criteria (e.g., duration, noise, distance, security, cultural sites, monuments, ...); - Compensation of the loss on a given criterion by a gain on another one may not be acceptable for the decision-maker and; - For at least one criterion the following holds true: small differences of evaluations are not significant in terms of preferences, while the accumulation of several small differences may become significant.

In accordance with things mentioned above, it is evident that there are a number of problems in the field of occupational safety, and that could or even have to use MCDMmethodology, but unfortunately that is not the practice in the world of scientific research. Therefore, multidisciplinary researches are more than necessary in the field of occupational safety, especially in the aspects of the information science research and methodology.In this study, the model of internal supervision of occupational safety is proposed, and it accepts the ranking obtained through the methodology of MCDMand the reality of implementation into big business systems. The authors plan to implement the proposed model and start with its realisationand monitoring the latest in early, 2015. According to this it is proposed to continue the research in the way to document all measurable activities of the proposed model in practice at work, so a new study that will analyze the adequacy of the proposed model could be done in detirmeneted timeframe. In this analysis, it is suggested to pay attention to the good and bad features of the model and the possible correlation between the proposed model and improval of some elements of occupational safety in the corporate system, for eg.: injuries, raising awareness among workers about the importance of occupational safety, safer working of employees, technicaly correct work equipment, etc.

Acknowledgment

This work was supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia under Grant III 42006 and Grant III 44006.

VI. REFERENCES

[1] J. Aczel and T. L. Saaty, *Procedures for synthesizing ratio judgment*, Journal of Mathematical Psychology, vol. 27, 1983., pp. 93 – 102.

[2] N. Kacian, Security basics. IPROZ, Zagreb, 2000.

[3] I. Božaić et al., *Occupational safety expert*. Croatian society of occupational safety engineers, Zagreb, 2010.

[4] D. Cmrečnjak et al., *Occupational safety service*. Croatian society of occupational safety engineers, Zagreb, 2009.

[5] I. Mance and E. Žiger, *Design of the model and management of occupational safety*, 2nd Scientific conference with international participation Management and safety, Croatian society of occupational safety engineers, 2007., pp. 125 – 139.

[6] Z. Trupčević, *Occupational safety evaluation at the employers*, Safety, vol. 48, 2006., pp. 57 – 62.

[7] J. Hovdenand R. K. Tinmannsvik, *Internal control - a strategy for occupational-safety and health. Experiences from Norway*, Journal of occupational accidents, vol. 12, 1990., pp. 21 – 30.

[8] J. Taradi and N. Grošanić, *Process model of occupational safety in business system* 4th Scientific conference with international participation Management and Safety, Croatian society of occupational safety engineers, 2011., pp. 330 – 341.

[9] M. Nikolić, *A possibility of assigning weight citeria in multiple criteria decision making method*, IMK 14 – Reasearch and development, vol 8, 2002., pp. 43. – 48.

[10] T. L. Saaty, *The Analytic Hierarchy Process*, McGraw-Hill, 1980.

[11] T. Hunjak, *Mathematical foundations of the methods for multicriterial decision making*, Mathematical Communications, vol. 2, 1997., pp. 161 – 169.

[12] B. Petz, *Basic statistical methods for non-mathematicians*. Publisher Slap, Jastrebarsko, 2007.

[13] J. Jablonský, *Software support for multiple criteria decision making problems*, Management Information Systems, vol. 4., 2009., pp. 29 – 34.

[14] J. Figueira, V. Mousseau and B. Roy, *Electre methods*, International Series in Operations Research & Management Science, vol. 78., 2005., pp. 133 – 153.

[15] J. Figueira, V. Mousseau and B. Roy, *Multiple Criteria Decision Analysis: State of the Art Surveys, ELECTRE methods*, Springer Verlag, Boston, Dordrecht, London, 2005., pp. 133. – 162.

[16] I. Mance and R. Fabac, *Application of the ELECTRE method for determination of dominant version of CRM system in the field of occupational safety***,** Safety, vol. 55, 2014., pp. 319 – 332.

[17] B. Matarazzo, *Multicriterion analysis of preferences by means of pairwise actions and criterion comparisons (MAPPACC)*, Applied mathematics and computation, vol. 18, 1986, pp. 119 – 141.

[18] … Law on Occupational safety, National newspapers, number 71./2014., Zagreb

[19] Đ. Pap, *Occupational safety in 2010*, Safety, vol. 53, 2011., pp. 203 – 216.

[20] M. Pavlič and M. Markič, *Injuries at work in the Republic of Slovenia from 1906. to 2008.*, Safety, vol. 52, 2010., pp. 1 – 17.

[21] Z. Ćosić, M. Boban and M. Ivković, *Integrated approach to risk assessment – Inseparable part of business organization*, Safety, vol. 53, 2011., pp. 255 – 260.

[22] C. Giannoulis and A. Ishizaka, *A Web-based decision support system with ELECTRE III for a personalized ranking of British universities*, Decision Support Systems, vol. 48, 2010., pp. 488 – 497.

[23] X. Damaskos and G. Kalfakakou, *Application of ELECTRE III and DEA methods in the BPR of a bank branch network*, Yugoslav Journal of Operations Research, vol. 15, 2005., pp. 259 – 276.

[24] A. Özkan et al., *Application of the ELECTRE III method for a solid waste management system*, Anadolu University Journal Of Science And Technology, vol. 12, 2011., pp. 11 – 23.

[25] B. Karleuša, B. Beraković and N. Ožanić, *Application of ELECTRE III method on the selection of optimum irrigation*, Builder, vol. 57, 2005., pp. 21 – 28.

[26] B. Kovačić, *Multicriteria decision making in traffic–master's thesis*,University in Zagrebu, Zagreb, 2004.

[27] Z. Dragašević, *Model of multiciteria analysis to rank the banks – PH. D. thesis*, University of Montenegro, Podgorica, 2010.

[28] A. Hatami-Marbini et al., *A fuzzy group ELECTRE method for safety and health assessment in hazardous waste recycling facilities*, Safety Science, vol. 51, 2013., pp. 414 – 426.

[29] O. Schinas, *Examining the use and application of Multi-Criteria Decision Making Techniques in Safety Assessment*, International Symposium On Maritime Safety, Security And Environmental Protection, Athens, Greece, 2007.

[30] B. Agarski et al., *Multi-criteria assessment of environmental and occupational safety measures in dental prosthetics laboratories*, Journal of Production Engineering, vol. 15, 2012., pp. 53 –56.

[31] D. Gavanski, M. Sokola and S. Krnjetin, *Adoption of the Act on the Risk Assessment-expiriences in the Republic of Serbia*, 5th Scientific conference with international participation Management and Safety, Croatian society of occupational safety engineers, 2010., pp. 247 – 260.

[32] M. Biljan-August, S. Pivac and A. Štambuk, *Sttistical analysi in economics. Faculty of Economics of University in Rijeka*, Rijeka, 2009.