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Multicriteria analysis of safety climate measurements at workplaces in production industries in Serbia

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ABSTRACT

This paper presents the results of measuring certain safety climate indicators in Serbian production companies. As a result of these investigations, which have already been conducted by this group of authors, a 21-item questionnaire was developed in 2010. In this research, we developed a methodological framework to measure the safety climate in Serbian companies. The investigation was carried out in companies that were engaged in different industrial sectors. The aim was to determine the initial degree of developing the safety climate in every industrial sector, i.e. to compare and rank them. The following demographic factors were used for this purpose: types of industry, the number of employees in the company, the position in the organizational structure of the firm, age groups, employees with a different length of work experience, employees' gender, those who have or have not been involved in an occupational accident and the level of employees' education. Our analysis defined the significance of every demographic subgroup based on the results obtained by measuring the safety climate in all organizations. However, taking into consideration a large number of subgroups, the starting hypotheses were proposed only for the two most important ones: the type of organization does have an influence on safety climate indicators – hypothesis H_1 and the position of the employee in the firm does have important influence on safety climate indicators – hypothesis H_2. Both hypotheses were confirmed on the base of the results of further analyses.

Relevance to industry: The questionnaire used in this paper provides the evaluation of safety climate in production companies, and the applied multicriteria methodology provides the comparative analysis of safety climate among the companies and different industries. It is suitable for research purposes as well as for practical use.

1. Introduction to the safety climate paradigm

In papers published recently, there have been numerous discussions concerning the importance of safety issues on the overall work performance of the companies (Silva et al., 2004; Lin et al., 2008; Snyder et al., 2008; Shannon and Norman, 2009; Kines et al., 2011; Radosavljević and Radosavljević, 2011). Most of these papers were dealing with the relationship (and differences) between safety climate and safety culture (Shannon and Norman, 2009). According to the mentioned investigations, safety culture is part of the organizational culture and it tends to focus on the deeper and less accessible core values and assumptions of the organization regarding safety and human resources. On the other hand, the review of the literature, conducted by Wiegmann et al. (2001) indicated that the term was first highlighted by Zohar (1980), so that the literature has never presented a generally accepted definition of safety climate. In fact, some definitions of safety climate are almost identical to the definitions of safety culture, while some are completely different.

One of the definitions of safety climate which is likely to be the most adequate for the investigations presented in this paper, is: "Safety climate is viewed as an individual attribute, which consists of two factors: management's commitment to safety and workers' involvement in safety" (Dedobbeleer and Beland, 1991). On the other hand, safety culture refers to the term used to describe a way in which safety is managed at the workplace, and often reflects "the attitudes, beliefs, perceptions and values that employees share in relation to safety" (Cox and Cox, 1991). Also, safety climate in the latest research is clearly correlated to safety behavior of the employees. Safety behavior can be understood as a result of the sociocognitive mediation process described by the theory of a planned behavior (Fugas et al., 2012).

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Diversification of the safety issues in smaller fragments is usually applicable in well-developed western societies, where these items are well known and investigated in details in the last decades. Also, it is typical for large economies with well-developed industrial sectors. On the other hand, safety issues are important for the efficiency of the work process in any society. This way, the contemporary work environment requires the development of safety climate issues even in small economies. The fact is that Serbia is a small country in the southeast part of Europe. Until the beginning of this century, Serbia was under the socialist regime, in which safety climate was not considered as an important part of the working process. This created obstacles in safety culture development as a consequence in the environment based on workers management in all Serbian companies. The process of transition in Serbian economy started at the beginning of the new century, and at the same time this was also the beginning of a real consideration of safety issues in domestic industrial companies. Due to the transition, foreign investors started the privatization of Serbian companies and, together with new technologies, they brought new procedures considering the workplace behavior, including safety issues (Bogićević-Milikić et al., 2012). This led to the process of changing of all Serbian companies, including these that remained in public or state property, including the change of legislative issues in relation to workplace safety, as well. This indicates that the development of safety climate issues in Serbian companies has started; however, it is still in the early stage of development.

The lack of literature on safety climate in Serbian industries, is evident. The only way to start any investigations in this field is to adopt the methodology developed according to the previous international research, but with the intention to adjust it to the Serbian context. The process of adaptation would mostly depend on the influence of different demographic values on the safety climate measurement, since the demographics of Serbian workers should be to some extent different compared to the demographic of workers from other countries. Taking the above into consideration, we have decided to use the methodology that was originally developed according to the Western research, and subsequently adapted to the Chinese context (Lin et al., 2008). The reason for such a choice lies in the fact that China is also a country in transition toward coexisting capitalistic and socialistic systems. There exist both public and private companies. In this kind of situation, the specific working culture as well as the safety climate starts to appear. Serbia goes through the similar transition, where the private capital is present together with publicly owned companies, which have remained since the socialist regime. The Serbian work climate and the safety climate are still far behind the Western society. The necessity for the research presented in this paper can be further supported by the facts that there is no official register presenting the record of work accidents. Also, the accident analyses in Serbian companies have not been conducted on the organized level up to now. The potential occupational hazards for each workplace, included in the investigations presented in this paper, have been defined by the management of each company and the official person responsible for occupational safety issues. The only legislate which is available on the government level are: the Law on occupational safety and health (Web reference). In our previous investigation, we adopted the questionnaire developed by Lin et al. (2008), which they used for the safety climate measurement at workplaces in China. This questionnaire was the base for further adaptation of this model to the Serbian context (Milijić and Mihajlović, 2011). The aim of this earlier investigation was to start the process of developing the safety climate questionnaire that can be used in Serbia.

Considering that the safety climate issue is too broad to be investigated in one research, especially in the narrow field of Serbian economy, it was decided to focus on the following items. Being a small country in the South East part of Europe, with the population of nearly 7 million, Serbia is not a country which has got all industrial sectors equally developed. The most developed sectors are in the field of mining, metallurgy and food industry based on large agricultural potentials. The other industrial sectors are to some extend present, only in some regions of Serbia. The research presented in this paper, was conducted in the central region of Serbia, where the companies are dealing with the following industrial sectors: electrical construction, cement production, shoes manufacturing, food industry, PVC joinery, cosmetic industry, textile industry, recycling and furniture industry. Considering the different scopes of workplaces in all presented industrial sectors, which were investigated, it was supposed that the obtained results will be useful for supporting the hypothesis H_1 (the type of organization has some influence on safety climate indicators). Such interdependence was also investigated and proved by Silva et al. (2004). Also, as another important influence on safety climate was to investigate the position of the employee in the firm. This way, the second research question could be formulated as (hypothesis H_2). “Does the position of the employee in the firm have an important influence on safety climate indicators?” Such a correlation was previously investigated and proved by Prussia et al. (2003), Findley et al. (2007) and Beus et al. (2010), where the most important safety climate measures for the occurrence of the injuries at different work places, were considered.

2. Methods

2.1. Investigated population

The study was conducted in central Serbia (the Morava region). The current study was conducted in nine different organizations representing nine different industrial sectors in Serbia. Considering the fact that Serbia is a small country and that it does not have a large number of industrial capacities in different industrial sectors, it was decided to study the organizations belonging to different industrial fields at the same time. The previously defined final questionnaire (Appendix A) was used for evaluating the opinion of the employees in these organizations.

The final questionnaire has been based on the results of the initial research presented by Milijic et al. (2013). The starting form of the questionnaire was based on the research of Lin et al. (2008), used in the context for the safety climate measurement at workplaces in China. According to the findings presented by Milijic et al. (2013), some regrouping of the questions in the original seven factor loadings was performed. The regrouping resulted after the initial factor analysis, which is described in detail in Milijic et al. (2013). Also, additional demographic subgroups (position in the firm and educational level) were introduced in the final questionnaire. In the initial research, it was concluded that these two items also influenced the final safety climate measurements. This was again confirmed in the results presented in this paper. Considering the fact that Serbia is a small country, the number of potential candidates to be included in the survey, was not that big. This way, all the employees of the companies who were included in the survey, were potential subjects. They were all informed about the survey by the managers of the company and asked to participate. Hence 1311 individual workers, who had been potentially exposed to occupational hazards in those organizations, were selected as the study subjects. The questionnaires were distributed to organizations and 1098 questionnaires were retrieved with a total response rate of 83.75%.

2.2. Questionnaire

Five-point Likert-type scale (1 = strongly disagree to 5 = strongly agree) has been used for collecting the workers’ responses to the questions of the questionnaire (presented in Appendix A). The possible way of answering the demographic questions in the survey, included Yes/No responses or a given available categories fields. For indicating the incident involvement, the checkbox field was used (Yes or No response). Also, for gender potential answers were *male* or *female*. For the remaining demographic data assessment, employees were offered to check one of the available categories fields (for example – Educational level ranking from Elementary School to University). The questions in the questionnaire were focused on seven factors: SC1 (safety awareness and competency) – 5 questions, SC2 (safety communication) – 4 questions, SC3 (organizational environment) – 3 questions, SC4 (management support) – 2 questions, SC5 (risk judgment and management reaction) – 3 questions, SC6 (safety precautions and accident prevention) – 2 questions and SC7 (safety training) – 2 questions.

Since the aim of this research was to investigate whether there was a significant difference of safety climate among demographic subgroups or not (as defined by H_1 and H_2 in above text), the following demographic subgroups have been defined: the age groups, employees with a different length of work experience, employees' gender and age, these who have or have not been involved in an occupational accident, the level of employees' education and the most important types of organizations and positions in the organizational structure of the firm.

In this direction, four age groups (<29 y, 30–44 y, 45–54 y, and above 55 y) were treated as a different level of age. In the same manner there were two gender groups, four categories of work experience (<5 y, 6–15 y, 16–25 y, and above 26 y), two incident involvement groups (no accident group and accident group), four positions in the firm groups (Production workers, Workers indirectly related to production, Administrative workers and Managers) and four educational level categories (Elementary school, High school, Higher education and University). This study was conducted in nine different organizations, representing nine different industrial sectors in Serbia.

2.3. Statistical data analysis

The data obtained using the questionnaire were analyzed using the SPSS 18 statistical software. The comparison of the difference of safety climate scores among different demographic groups was performed using the Multiple Analysis of Variances (MANOVA) (Nelder and Wedderburn, 1972; Gooderham et al., 2004; Findley et al., 2007; Wu et al., 2007).

The reliability of the measurement conducted by a questionnaire refers to the internal consistence. The consistency was assessed by the Cronbach α coefficient. The Cronbach α coefficient is used when questions are rated on internal scales such as the five-point Likert scale, used in this investigation and it represents the average correlations among items. According to the coefficient Cronbach alpha, the internal consistence should be above 0.7 (Nunnally, 1994; Leontitsis and Pagge, 2007; Adamson and Prion, 2013) for the entire population, as well as for each group of questions in order to consider the measuring scale reliable.

On the other hand, high Cronbach's Alpha value does not necessarily point to high reliability, as it may be just the result of a high number of items included in the analysis. Taking this into consideration, additional tests of internal consistence were performed. For this purpose, the Spearman–Brown coefficient and Ω coefficient were chosen. The Spearman–Brown coefficient represents the reliability coefficients that can be attained from all the possible combinations of dividing the questions into two sets (split-half). The coefficient Ω is calculated from the factor analysis results (Nunnally, 1994). The minimal proposed value of these coefficients is also 0.7.

The inter-correlations among seven safety climate factors that entered the model were measured using Pearson's coefficients in the frame of the LISREL modeling procedure (Joreskog and Sorbom, 1993; Hsu et al., 2008; Đorđević et al., 2010; Mihajlović et al., 2011a,b).

2.4. Multicriteria decision analysis (MCDA)

To assess the influence of employees' position in the firm and the type of industry on the safety climate measurement, the Multicriteria Decision Analysis (MCDA) has been used, aiming to prove the starting hypothesis H_1 and H_2.

MCDA has been utilized to assist in making complex decisions for a number of decades, as it facilitates the stakeholder participation and collaborative decision-making, and what is more it allows the consideration of multiple criteria in incommensurable units (i.e. combination of qualitative and quantitative criteria). The influencing subjectivities of the input parameters on the MCDA model (i.e. criteria weight (CWs) and criteria performance values (PVs)) have been found to have some influence on the ranking of alternatives (Roy and Vincke, 1981). This was the most important issue why it was decided to use this methodology, since it was intended to investigate the effect of the type of industry and the work position of the employee on the final questionnaire measurements outcome.

Having this in mind, in this paper, the well known PROMETHEE and GAIA methods have been used. The reason for choosing these methods is that, in fact, they fit the problems we have been involved in terms of the work place safety decision-making. These problems have the following features: (1) the number of employees is large, (2) the possibility to obtain the preference information from the employees is generally limited to the weighting of the criteria, and (3) the number of criteria is great. For these reasons, it is not normally possible to build value/utility functions, or to provide trade-off inquires. For these kinds of problems, where a great number of data have to be analyzed simultaneously, the multiple criteria techniques provide, however, a feasible set of tools. On the other hand, this approach was not previously used in the work place safety decision-making, which, according to our opinion, should be an additional merit of this research.

The choice of a certain method cannot be decided at the beginning of the process. The decision must be waited for until the analyst understands the problem, the feasible alternatives, different outcomes and conflicts between the criteria and the level of uncertainty of the data have been defined. This was achieved using the statistical data analysis already described above.

PROMETHEE and GAIA methods have got an important role in the existing outranking multiple criteria methods. A number of practitioners who apply these methods and researches who further develop and/or are interested in the sensitivity aspects of these methods, are increasing year by year as it can be confirmed by the increasing number of papers and conference presentations (Brans and Mareschal, 1994; Behzadian et al., 2010; Hu and Chen, 2011; Ishizaka and Nemery, 2011; Abedi et al., 2012; Vetschera and de Almeida, 2012; Vinodh and Girubha, 2012; Peng and Xiao, 2013; Tavana et al., 2013; Yu et al., 2013).

In PROMETHEE II, the alternatives are ranked on the basis of their net flow values resulting thereby in a complete order. By applying the asset of rules described by Keller et al. (1991), the net out ranking flow, $\phi = (\phi^+) - (\phi^-)$, is calculated. This procedure is known as PROMETHEE II and higher the value of ϕ for an object is, higher is the position in the rank order (Brans and Mareschal, 1994; Albadvi et al., 2007; Anand and Kodali, 2008; Nikolić et al., 2009).

The procedure for a visual display and evaluation of PROMETHEE results is GAIA (Geometrical Analysis for Interactive Aid). It also facilitates the interpretation of the significance of the different variables. A detailed explanation for its interpretation can be found in Epinasse et al. (1997). The GAIA provides some important information about ranking in two-dimensional spaces obtained by the PCA extraction. On the basis of the position of criteria in the GAIA plane (squares), the concord or the conflict between certain criteria can be determined. Also, the positions of alternatives (triangles) determine the strength or the weakness of the properties regarding the criteria, i.e. the closer to the direction of the criterion vectors it is, the better alternative itself, according to that criterion is (Brans and Mareschal, 1994; Nikolić et al., 2009).

One of the reasons for the PROMETHEE popularity is the existence of a very user-friendly software based on this methodology. Increasingly practitioners are using DECISION LAB in order to handle their multiple criteria problems. For the calculations described in this paper, we used DECISION LAB (V.1.01.0388) since it utilizes the PROMETHEE II complete ranking and the GAIA visualization (Brans and Mareschal, 1994; Behzadian et al., 2010, Nikolić et al., 2011).

When the PROMETHEE method is utilized in this software, the user may choose one of the six generalized criterion functions (usual, U-shape, V-shape, level, linear and Gaussian) that have been defined by Brans et al. (1986). Each function type may be described by means of thresholds (p and q). The indifference threshold (q) marks the greatest deviation non-significant for a decision maker. On the other hand, the preference threshold (p) represents the smallest deviation significant for the process of decision-making. The value of the preference threshold (p) should be greater than the indifference threshold (q) (Brans and Vincke, 1985; Nikolić et al., 2009). Also, in combination with the previously conducted statistical analysis, each criterion's absolute weight was defined aiming to present realistically the decision makers' (DMs) preference, which gradually increases from indifference to strict preference, as well as to facilitate the inclusion of the inherent uncertainty in the criteria of the decision analysis process.

2.5. General linear model (GLM)

As for the application of MCDA in this type of investigation, it is impossible to find in any references, so the obtained results were tested in comparison to another, widely used, methodological approach. For that purpose, the general linear model (GLM) was used.

In experiments involving multiple independent variables and two dependent variables, the general linear model (GLM) *bivariate analysis of variance* is usually used to answer the questions about the effects of the independent variables on dependent variables. In the example analyzed in this paper, the effects of seven independent variables (SC1–SC7, in Appendix A) on the dependent variables the type of organization and the position in the firm, were investigated. The GLM bivariate analysis takes into account the interrelation among dependent variables and analyzes the variables simultaneously (Nelder and Wedderburn, 1972; Ho, 2006).

3. Results and discussions

The internal consistence of the questionnaire measurement was assessed according to the Cronbach's alpha test. According to the coefficient Cronbach's alpha, the internal consistence was 0.785 for the entire population. This suggested that the measure of safety climate was on target (Nunnally, 1994). Besides the internal consistence of entire population, the analysis was also performed for each of seven groups of questions. According to the obtained results, the best consistence is presented for the groups SC7 and SC3, while the worst consistence is for groups SC6 and SC5 (Table 1). However, even these groups were in the range of acceptable level of internal consistence.

Table 1
Inter-consistency coefficients of the safety climate questionnaire.

Groups of questions	Number of Items	Cronbach alpha coefficient	Spearman–Brown coefficient	Ω coefficient
SC1	5	0.769	0.794	0.731
SC2	4	0.692	0.693	0.665
SC3	3	0.855	0.858	0.746
SC4	2	0.760	0.698	0.709
SC5	3	0.678	0.678	0.618
SC6	2	0.656	0.664	0.698
SC7	2	0.885	0.895	0.753
GSC	21	0.785	0.746	0.702

The Spearman–Brown coefficient was 0.770 and the Ω coefficient was 0.702 for the entire population. Most coefficients were above the value of 0.7 and adequate for psychometric requirements for the measure. Also, coefficients of three different applied tests were with the similar values. Each coefficient for the individual safety climate scales is shown in Table 1.

The inter-correlations among seven safety climate factors that entered the final model are shown in Table 2. Because of a large sample size, each correlation coefficient was significant and at level 0.01. Most of the coefficients were near or above 0.5, indicating a large inter-correlation among all seven safety climate factors.

Since the main target of this investigation was to assess the influence of different demographic subgroups on the safety climate measurement scale, the demographic subgroups of investigated employees are statistically presented in Table 3.

In the course of further investigations, the safety climate data were analyzed considering simple statistic differences (see Table 4). The aim was to investigate whether there was or not a significant difference of the safety climate among demographic subgroups.

According to the results presented in Table 4, significant differences of each demographic sub-group appeared in some of seven safety climate factors. For example, in the case of gender, significant differences emerged on four scales of seven factors (SC3, SC4, SC6 and SC7), and no significant differences existed in other safety climate scales. This way, the gender of employees has the influence on their opinion, considering the safety climate questions belonging to factors (SC3, SC4, SC6 and SC7).

More importantly, the results of various groups of demographic parameters (presented in Table 4) demonstrated that the developed safety climate instrument had discriminated all investigated organizations (which are the bases of the hypothesis H_1). It was also related to different risk levels for the work places in different organizations (industrial sectors) and functional departments. Having this in mind, different risk levels could be associated with various tasks and activities among different positions in the firm (which is considers the hypothesis H_2).

Since the type of the industrial sector and the workers position in the firm have a significant influence on employees' opinion on

Table 2
Inter-correlations among seven safety climate factors which entered the final model.

Coefficient	SC1	SC2	SC3	SC4	SC5	SC6	SC7
SC1	1.00						
SC2	0.52	1.00					
SC3	0.62	0.44	1.00				
SC4	0.43	0.74	0.48	1.00			
SC5	0.51	0.51	0.62	0.56	1.00		
SC6	0.49	0.61	0.53	0.67	0.56	1.00	
SC7	0.58	0.44	0.72	0.52	0.64	0.56	1.00

Table 3
The demographics of the study sample.

Variables	Category	N	Percentage (%)
Organizations	1. Food industry (I1)	312	28.41
	2. Shoes manufacture (I2)	66	6.01
	3. Electrical construction (I3)	168	15.30
	4. PVC joinery production (I4)	39	3.55
	5. Cosmetic industry (I5)	81	7.38
	6. Textile industry (I6)	135	12.30
	7. Recycling (I7)	69	6.28
	8. Cement production (I8)	135	12.30
	9. Furniture industry (I9)	93	8.47
Position in the firm	Production workers (WP4)	750	68.3
	Workers indirectly related to production (WP3)	114	10.4
	Administrative workers (WP2)	153	13.9
	Managers (WP1)	81	7.4
Educational level	Elementary school	246	22.4
	High school	756	68.9
	Higher education	48	4.4
	University	48	4.4
Years of work experience	Less than 5 years	600	54.6
	6–15 years	321	29.2
	16–25 years	96	8.7
	Above 26 years	81	7.4
Gender	Male	564	51.4
	Female	534	48.6
Age	Less than 29 years	282	25.7
	30–44 years	627	57.1
	45–54 years	150	13.7
	Above 55 years	39	3.6
Accident involvements	Yes	168	15.3
	No accident	930	84.7

each of the safety climate questions (Table 4), these demographic parameters were used as the grouping variables in our further investigations, aiming to prove the two starting hypotheses.

As already indicated, the detailed analysis of these two demographic parameters on safety climate measurement, is conducted using the PROMETGEE/GAIA MCDA methodology. The first stage of the MCDA approach involves the translation of the decision analysis situation into a set of alternatives and criteria. The MCDA is a traditional decision analysis method used to determine the total values of the alternatives and hence the ranking of each alternative for each set criterions, using the selected MCDA technique (Brans and Mareschal, 1994).

The outranking method PROMETHEE (Gelderman and Zhang, 2001) utilizes a function in terms of the degree of preference of one alternative over another; along with the degree of disadvantage that same alternative with respect to some other alternative, a comparison is to be made against. Starting data are an input in a spreadsheet form, as shown in Table 5. These values are the average ratings of the individual group of questions done by workers belonging to different groups of industries and performing different working tasks. It should be noted that some of the organizations didn't have all work places (Electrical construction and Recycling).

PROMETHEE requires weights for each criterion to be entered, as well as the criteria functions types to be selected (Table 6). The weights are meant to be rough indications of relative importance of each criterion. The adoption of weights in this case was conducted according to the Cronbach's alpha coefficients of each safety climate subgroups. The decision to use this tests result is based on the fact that the values have been also proved by the Spearman–Brown coefficient and the Ω coefficient, which resulted with similar outputs. The normalization of weight coefficient was measured, so that their sum is one (Tables 1 and 6).

There are six potential preferential functions allowing the user to express meaningful differences by minimum gaps between observations. In the investigations, presented in this paper, function type 4 was used. The preference level function was chosen as the best solution for the description of the analyzed data. These data are qualitative essentially, and in the analysis their quantitative analogue was used (five-degree scale from one "bad" to five "excellent"). The value thresholds were chosen $p = 0.5$ and $q = 1.5$, which corresponds to the factors from very bad to excellent (Vego et al., 2008). The Min/Max opinion was based on the type of questions belonging to each subgroup (Appendix A).

Observing the results obtained on the base of the responses of the participants in the survey, it is possible to rank work places (safety climate) merely according to one criterion. By selecting different criteria, we would get different results each time. On the other hand, the application of the multicriteria analysis enables ranking in relation to several criteria simultaneously, which provides a priority list and an exhaustive analysis of the proposed problem.

The above prepared data in Table 5 were analyzed using the software Decision Lab 2000. Obtained results for PROMETHEE II complete ranking are presented in Table 7.

According to the results of MCDA, presented in Table 7 and Fig. 1, it can be noticed that only the employees who work in the

Table 4
Safety climate comparisons by ages, gender, years of work experience, position in the firm, level of education, accident involvements and organizations (discriminant validity).

Demographic	Significance	SC1	SC2	SC3	SC4	SC5	SC6	SC7	SCG
Gender	F	9.06	8.361	2.815[a]	10.379[a]	4.825	3.091	2.987[a]	6.131
	p	n.s	n.s	0.005	0.000	n.s	0.000	0.018	n.s
Ages	F	4.725[a]	4.747[a]	1.299	4.965[b]	1.836	5.916[a]	2.199	3.869
	p	0.05	0.023	n.s	0.005	n.s	0.013	n.s	n.s
Years of work experience	F	8.810[b]	10.9[b]	3.827[a]	20.26[b]	2.675	15.80[b]	4.44[b]	8.564[b]
	p	0.002	0.000	0.015	0.000	n.s	0.000	0.007	0.013
Position in the firm	F	4.275[b]	2.488	7.86[b]	3.048	9.47[b]	7.769[b]	4.013[a]	5.786[a]
	p	0.003	0.001	0.000	0.023	0.000	0.000	0.046	0.048
Level of education	F	0.886	0.922	3.739[a]	2.726[a]	2.597	2.069	0.563	2.123
	p	n.s	n.s	0.027	0.035	n.s	n.s	n.s	n.s
Accident involvement	F	9.476[a]	0.548	1.498	3.244**	2.427	1.778[b]	12.118	4.356
	p	0.038	n.s	n.s	0.000	n.s	0.000	n.s	n.s
Organizations	F	11.88[b]	8.61[b]	7.72[b]	23.199[b]	7.311[a]	32.233[b]	8.052[b]	14.246[b]
	p	0.001	0.002	0.000	0.000	0.015	0.000	0.000	0.002

n.s. – Non-significance.
[a] Statistically significant at 0.01 level.
[b] Statistically significant at 0.05 level.

field of PVC joinery industry in Serbia, are satisfied considering the safety climate issues at their workplaces at all four levels (all Work Places – WP – have positive Φ values in Table 7). The second place belongs to workers in shoes manufacturing. Employees indirectly related to production (I2WP3), from this field of industry are the most satisfied with the safety climate aspects at all levels ($\Phi = 0.4805$). On the other hand, the workers who strongly emphasize the negative issues of their organizational environment, compared to other industrial sectors, belong to the recycling industry and the cement production. As expected, those are the employees who are directly and indirectly related to the production, while the managers and administrative stuff are more satisfied. This can be considered as a proof for both starting hypotheses (H_1 and H_2).

Table 5
Starting data for the PROMETHEE MCDA techniques.

Criteria	Alternatives						
	Safety awareness (SC1)	Safety communication (SC2)	Organizational environment (SC3)	Management support (SC4)	Risk judgment and management reaction (SC5)	Safety precautions and accident prevention (SC6)	Safety training (SC7)
Food industry, manager (I1WP1)	4.68	4.22	3.17	3.88	2.05	4.06	4.75
Food industry, administrative worker (I1WP2)	4.65	3.53	2.85	3.83	2.02	4.13	3.36
Food industry, workers indirectly related to production (I1WP3)	4.75	4.20	2.98	3.83	2.58	4.13	4.73
Food industry, production worker (I1WP4)	4.36	3.84	3.19	4.05	2.81	3.41	4.52
Shoes manufacture, manager (I2WP1)	4.80	5.00	3.17	4.00	1.66	4.50	4.50
Shoes manufacture, administrative worker (I2WP2)	4.40	3.44	3.33	3.00	1.75	4.62	1.87
Shoes manufacture, workers indirectly related to production (I2WP3)	4.60	4.25	1.00	5.00	1.00	5.00	5.00
Shoes manufacture, production worker (I2WP4)	4.65	3.79	2.94	3.91	2.15	4.12	3.90
Electrical constructions, workers indirectly related to production (I3WP3)	4.40	4.37	2.00	4.75	1.66	4.25	3.00
Electrical constructions, production worker (I3WP4)	4.64	3.68	3.99	3.97	3.09	3.52	4.32
PVC joinery production, manager (I4WP1)	4.80	4.66	2.55	4.50	1.22	5.00	5.00
PVC joinery production, administrative worker (I4WP2)	4.45	4.37	2.92	5.00	1.33	5.00	5.00
PVC joinery production, workers indirectly related to production (I4WP3)	4.60	4.00	4.00	4.00	1.33	3.50	5.00
PVC joinery production, production worker (I4WP4)	4.64	4.15	2.66	4.50	2.53	4.40	4.50
Cosmetic industry, manager (I5WP1)	4.10	3.62	3.83	4.25	2.17	4.25	2.75
Cosmetic industry, administrative worker (I5WP2)	4.20	3.37	2.83	4.46	2.25	4.21	3.58
Cosmetic industry, workers indirectly related to production (I5WP3)	4.20	4.75	4.00	5.00	1.67	4.00	1.00
Cosmetic industry, production worker (I5WP4)	4.32	3.83	3.31	4.08	2.67	3.91	2.66
Textile industry, manager (I6WP1)	3.66	2.58	3.22	3.67	3.00	3.83	3.16
Textile industry, administrative worker (I6WP2)	4.50	4.37	4.33	5.00	1.50	5.00	5.00
Textile industry, workers indirectly related to production (I6WP3)	4.80	4.50	4.67	5.00	4.67	5.00	4.50
Textile industry, production worker (I6WP4)	4.49	4.04	4.40	4.77	3.21	4.54	4.83
Recycling, manager (I7WP1)	3.60	4.00	3.00	4.00	3.00	3.50	4.00
Recycling, workers indirectly related to production (I7WP3)	3.60	3.25	2.67	3.12	3.00	3.37	3.87
Recycling, production worker (I7WP4)	3.41	2.96	2.59	2.77	2.29	2.66	3.55
Cement production, manager (I8WP1)	4.68	4.45	3.27	4.40	3.53	3.60	4.60
Cement production, administrative worker (I8WP2)	4.60	4.00	3.83	4.75	4.33	4.00	4.25
Cement production, workers indirectly related to production (I8WP3)	3.65	2.75	2.91	2.50	3.12	2.68	3.36
Cement production, production worker (I8WP4)	4.36	3.42	3.37	2.60	3.33	2.98	3.46
Furniture industry, Manager (I9WP1)	4.93	3.67	1.89	4.50	2.11	4.16	4.66
Furniture industry, administrative worker (I9WP2)	4.68	4.02	1.83	3.95	1.25	4.79	3.79
Furniture industry, workers indirectly related to production (I9WP3)	4.10	2.00	2.83	2.00	3.00	2.00	2.25
Furniture industry, production worker (I9WP4)	4.49	3.07	3.43	3.33	3.35	3.97	4.11

Table 6
Preference function and weight coefficient for each criterion.

Criterion	SC1	SC2	SC3	SC4	SC5	SC6	SC7
Weight coefficient	0.1450	0.1310	0.1610	0.1440	0.1280	0.1240	0.1670
Preference function	Level	Level	Level	Level	Level	Level	Level
Min/Max	MAX	MAX	MIN	MAX	MIN	MAX	MAX

The alternatives (Table 5) (mean values of marks for the answers to questions according to groups) and criteria for the PROMETHEE II complete ranking were presented in the GAIA plane, in Fig. 1. The percentage of data collection in the GAIA plane, i.e. of the reliability of graphic interpretation is greater than 60% (Δ: 70.10%) (Brans and Mareschal, 1994). As it is shown in the GAIA plane, criteria SC5 and SC3 had the greatest significance regarding their position in the GAIA plane, so that they were the most effective for ranking the alternatives. On the other hand, according to its closeness to the coordinate beginning SC1 criterion appeared as neutral in the decision-making. The quality of chosen criteria showed non-existence of conflicts among them (there were no two criteria standing against each other in the GAIA plane).

At the GAIA plane, displayed in Fig. 1, one notices that the most satisfied, with the condition of safety climate at their workplaces, are administrative workers and managers at the PVC woodwork industry (I4WP2, I4WP1). Moreover, the highest satisfaction with the safety climate at their workplaces is shown by managers and workers indirectly connected to the footwear industry production (I2WP1, I2WP3), as well as managers and administrative workers at the furniture industry (I9WP1, I9WP2). This situation is expected considering the very nature of the workplaces, however, the extremely positive attitude by managers is probably affected by the satisfaction of production workers, as well.

On the other hand, observing the GAIA plane, one notices that the most dissatisfied ones with the safety climate at their workplaces, are production workers and workers indirectly connected to the cement industry production (I8WP4, I8WP3), as well as production workers and workers indirectly connected to the recycling production (I7WP4, I7WP3). As expected, these are the workplaces with the worst ranking of the safety climate. However, it seems interesting that the workers indirectly connected to furniture industry production (I9WP3) evaluate the safety climate at their workplaces as very bad. Furthermore, seemingly unexpectedly unsatisfactory mark of the safety climate at workplaces is given by administrative workers at the footwear industry (I2WP2). Nevertheless, having in mind that the offices of administrative workers at the footwear industry are right next to the production halls, it is obvious that the chemicals from the sheds affect the health of the afore mentioned group of workers. If considering the fact that, in contrast to production workers, administrative workers do not wear any protection clothes and devices, this outcome can also be explained.

Considering that the application of MCDA techniques in the field of the safety climate measurement cannot be found in the references, the obtained results were tested and compared to others using the General Linear Model (GLM) approach that is in much wider use nowadays.

Table 8, presents the results for four different multivariate tests of significance (Pillai's, Wilks', Hotelling's, and Roy's) in terms of main effects between two dependent variables: the type of the organization and the position in the firm. According to the obtained values ($p < 0.05$) it is obvious that both dependant variables do have statistical significance for the obtained measures of seven safety climate issues (SC1–SC7).

Table 9 presents the information about the direct influence of two independent variables on seven predictors of safety climate measurements (SC1–SC7) in more details.

According to the presented results, the type of the organization has got the statistical influence on all investigated safety climate predictors, except for the group of questions SC3: Organizational environment ($p > 0.05$). The identical situation is obtained when analyzing the influence of the position in the firm. However, when analyzing the interrelation among dependent variables, even the influence on SC3 becomes statistically significant. In this constellation, only the group of questions SC6: Safety precautions and the accident prevention, is not influenced simultaneously by two investigated independent variables. However, altogether, results presented in Tables 8 and 9, can be regarded as an adequate proof of the results obtained by MCDA, presented in previous text. Accordingly, two proposed hypotheses can be considered additionally confirmed, according to the GLM method.

Considering that the most critical issue, in applying the PROMETHEE method, is in the determination of required weights for each criterion, our future research work will include focusing on the combination of quantitative analysis methods (entropic method) and PROMETHEE. The design of the weight is one of the important items in the PROMETHEE analysis, as it would have a profound effect on the obtained results. In this work, the determination of the weight of every indicator was based on the Cronbach's alpha coefficient of the factor loadings. As an alternative method for the accurate determination of weights for each

Table 7
Results for PROMETHEE II Complete ranking of the workplaces in different industries according to the safety climate measurement.

Rank	Alternatives	Φ^+	Φ^-	Φ	Rank	Alternatives	Φ^+	Φ^-	Φ
1	I2WP3	0.4805	0.0020	0.4785	18	I1WP4	0.1432	0.1497	−0.0064
2	I4WP1	0.3743	0.0126	0.3617	19	I1WP2	0.1470	0.1573	−0.0103
3	I4WP2	0.3444	0.0146	0.3298	20	I8WP2	0.1484	0.2076	−0.0583
4	I9WP1	0.2957	0.0487	0.2470	21	I5WP3	0.2000	0.2636	−0.0635
5	I2WP1	0.2714	0.0401	0.2313	22	I7WP1	0.1108	0.2032	−0.0924
6	I9WP2	0.3028	0.0748	0.2280	23	I3WP4	0.1113	0.2208	−0.1094
7	I6WP2	0.3113	0.0851	0.2262	24	I5WP4	0.1015	0.2163	−0.1148
8	I4WP4	0.2326	0.0524	0.1802	25	I5WP1	0.1073	0.2653	−0.1579
9	I3WP3	0.2852	0.1092	0.1760	26	I2WP2	0.1202	0.2832	−0.1630
10	I1WP1	0.2007	0.0790	0.1217	27	I9WP4	0.0942	0.2594	−0.1652
11	I1WP3	0.1934	0.0835	0.1099	28	I7WP3	0.1013	0.3238	−0.2226
12	I4WP3	0.2057	0.1320	0.0738	29	I7WP4	0.1074	0.3713	−0.2639
13	I6WP4	0.2010	0.1597	0.0413	30	I6WP1	0.0660	0.3340	−0.2679
14	I2WP4	0.1555	0.1161	0.0393	31	I8WP4	0.0590	0.3581	−0.2991
15	I8WP1	0.1797	0.1409	0.0388	32	I8WP3	0.0508	0.4387	−0.3879
16	I5WP2	0.1620	0.1460	0.0160	33	I9WP3	0.0431	0.5649	−0.5219
17	I6WP3	0.2369	0.2317	0.0052					

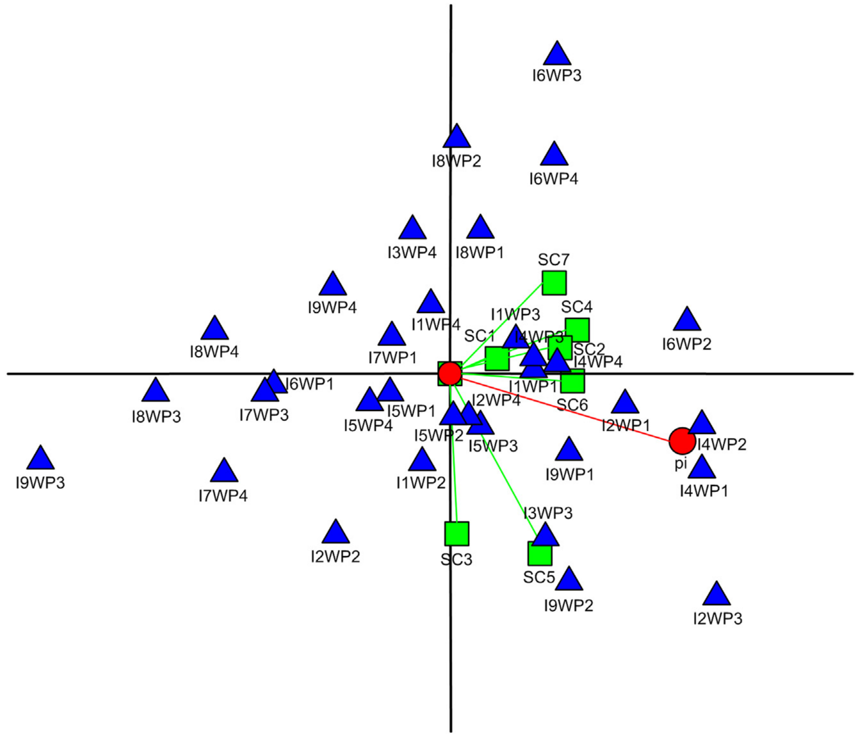

Fig. 1. GAIA Planes biplot presentation of workplaces ranking according to the safety climate measurement in different industries.

criterion, the entropy method could be used (Zhi-hong et al., 2006; Li et al., 2011). The determination of the weight by calculating the entropy means to choose the best indicators which could reflect the different assessment level among the investigated groups of factors.

4. Conclusions

In this paper an attempt has been made to measure the value and beliefs regarding some safety climate issues among Serbian workers, as well as to use the multicriteria analysis and ranking of the obtained results. The safety climate study, even at the level as presented in this paper, has never been conducted in Serbian industrial settings before. This study presents the evidence that the safety climate perception in Serbian industrial settings can be reliably measured with a questionnaire presented in this paper, which was developed as the result of our previous investigations and based on world's best practice of safety climate measurements. In order to establish a general tool in measuring the safety climate at workplaces in Serbia, the population studied included nine different industrial sectors. Hence, one of the grouping demographic variables was the type of organization (9 possibilities) and the other one was the employees' position in the company (4 possibilities). To prove the two starting hypotheses, the results obtained at four potential work positions, in all nine organizations, were compared to each other. The results obtained using MCDA, have the practical occupational health prevention merit for each of the investigated industrial sectors. As the result of this analysis, it was concluded which of the industrial sectors in Serbia has got the worst safety climate, according to the opinions of the employees. Since this methodological approach is not usually applied for measuring safety climate issues, it was necessary to support the obtained results using other, more common approaches. The validation of obtained results was performed using the GLM method.

According to the results obtained in this investigation it is now possible to measure the workers attitude toward different aspects

Table 8
Multivariate significance test for main effects between two dependent variables.

Effect		Value	*F*	Hypothesis df	Error df	Sig.
Type of organization	Pillai's Trace	0.232	4.166	21.000	1044.000	0.000
	Wilks' Lambda	0.782	4.244	21.000	994.075	0.000
	Hotelling's Trace	0.263	4.309	21.000	1034.000	0.000
	Roy's Largest Root	0.169	8.406(b)	7.000	348.000	0.000
Position in the firm	Pillai's Trace	0.160	2.805	21.000	1044.000	0.000
	Wilks' Lambda	0.845	2.853	21.000	994.075	0.000
	Hotelling's Trace	0.177	2.898	21.000	1034.000	0.000
	Roy's Largest Root	0.129	6.407(b)	7.000	348.000	0.000
Type of organization × position in the firm	Pillai's Trace	0.300	2.254	49.000	2464.000	0.000
	Wilks' Lambda	0.728	2.320	49.000	1761.005	0.000
	Hotelling's Trace	0.337	2.365	49.000	2410.000	0.000
	Roy's Largest Root	0.182	9.149(b)	7.000	352.000	0.000

b The statistic is an upper bound on F that yields a lower bound on the significance level.

Table 9
Results of GLM, influence of two independent variables on all investigated predictors of safety climate in investigated organizations.

Source	Dependent variable	Type III sum of squares	df	Mean square	*F*	Sig.
Type of organization	SC1: Safety awareness and competency	3.937	3	1.312	4.963	0.002
	SC2: Safety communication	6.970	3	2.323	3.178	0.024
	SC3: Organizational environment	0.583	3	0.194	0.171	0.916
	SC4: Management support	21.663	3	7.221	7.468	0.000
	SC5: Risk judgment and management reaction	23.759	3	7.920	8.204	0.000
	SC6: Safety precautions and accident prevention	29.638	3	9.879	13.332	0.000
	SC7: Safety training	17.378	3	5.793	5.283	0.001
Position in the firm	SC1: Safety awareness and competency	3.941	3	1.314	4.967	0.002
	SC2: Safety communication	6.743	3	2.248	3.075	0.028
	SC3: Organizational environment	3.965	3	1.322	1.164	0.323
	SC4: Management support	9.408	3	3.136	3.244	0.022
	SC5: Risk judgment and management reaction	8.412	3	2.804	2.905	0.035
	SC6: Safety precautions and accident prevention	11.955	3	3.985	5.378	0.001
Type of organization × position in the firm	SC7: Safety training	17.139	3	5.713	5.210	0.002
	SC1: Safety awareness and competency	8.281	7	1.183	4.473	0.000
	SC2: Safety communication	12.270	7	1.753	2.398	0.021
	SC3: Organizational environment	17.135	7	2.448	2.157	0.037
	SC4: Management support	21.012	7	3.002	3.105	0.003
	SC5: Risk judgment and management reaction	17.501	7	2.500	2.590	0.013
	SC6: Safety precautions and accident prevention	7.555	7	1.079	1.457	0.182
	SC7: Safety training	24.232	7	3.462	3.157	0.003

included in the safety climate at their work places. Also, according to the employees' responses, it is now possible to insulate the most significant safety climate issues for each selected industrial sectors and to practically assign this issue to workplaces.

The results presented in this paper were offered to the representatives of all companies that were involved in this investigation. The authors do hope that the companies' management will take them seriously and use to improve the safety climate in their organizations.

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Appendix A. Safety climate questionnaire (21 items)

SC1: Safety awareness and competency
- SC1-1: I am aware of what my responsibilities are for the workplace safety
- SC1-2: I understand the safety rules for my job
- SC1-3: I can deal with safety problems at my workplace
- SC1-4: I comply with the safety rules all the time
- SC1-5: When I am at work, I think safety is the top important issue

SC2: Safety communication
- SC2-1: I am involved in safety issues at work
- SC2-2: Co-workers often exchange tips to one other on how to work safely
- SC2-3: I often discuss safety issues with my supervisors
- SC2-4: I can get the safety information from the company

SC3: Organizational environment
- SC3-1: Sometimes there is too much work to do without following the safety procedure
- SC3-2: Sometimes the work pace is too quick to follow the safety procedures
- SC3-3: Sometimes I have to give up the safety requirements for the production sake

SC4: Management support
- SC4-1: Management considers safety to be of the same importance as the production
- SC4-2: Management takes care of safety problems at my workplace

SC5: Risk judgment and management reaction
- SC5-1: Management acts only after accidents have occurred
- SC5-2: I am sure it is a matter of time before an accident occurs at my workplace
- SC5-3: There are conflicts between production procedures and safety measures

SC6: Safety precautions and accident prevention
- SC6-1: My job is quite safe
- SC6-2: In these dangerous jobs, there are always precaution measures to prevent accidents

SC7: Safety training
- SC7-1: I am trained for safety knowledge
- SC7-2: Safety training fits my job

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