International Journal of Occupational Safety and Ergonomics (*JOSE*) 2013, Vol. 19, No. 4, 631–645

Developing a Questionnaire for Measuring Safety Climate in the Workplace in Serbia

Nenad Milijic
Ivan Mihajlovic
Nada Strbac
Zivan Zivkovic

Technical Faculty in Bor, University of Belgrade, Serbia

This study was conducted because a real method for measuring safety climate had never been developed and assessed in Serbian industry. The aim of this paper was to start the process of developing a safety climate questionnaire that could be used in Serbia. As a starting point a 21-item questionnaire was adopted after an extensive literature review. The questionnaire was distributed at several Serbian factories; 1098 workers responded. After a statistical analysis of the data obtained with the questionnaire and a critical comparison with the available reference results, a final questionnaire with 21 questions, divided into 7 groups, was developed. The 7 groups of questions (factors) were safety awareness and competence, safety communication, organizational environment, management support, risk judgment and management reaction, safety precautions and accident prevention, and safety training.

safety climate measurement   construct validity   discriminant validity   reliability

1. INTRODUCTION

After a thorough analysis of the literature on workplace safety climate [1, 2, 3, 4, 5, 6], it can be concluded that since 1980 when Zohar proposed the first comprehensive safety climate model [7], there has neither been a consensus on how many factors were required to measure safety climate nor which factors were the most effective. According to Lin, Tang, Miao, et al. [8], the divergence of factor structures may be explained by the use of different industrial populations or the fact that factor selection is left to the discretion of each researcher.

A few themes recur in most research: worker attitude to safety and risk [6, 9, 10]; management commitment to safety climate [5, 11] and procedures in an existing safety system in the company, e.g., training, compliance and communication.

In recent papers, there have been numerous discussions on the relationship (and differences) between safety climate and safety culture [8, 12]. Mearns and Flin [3] and Lin et al. [8] simply condense the relationship between safety culture and climate. According to those authors, safety climate often has a different meaning depending on the cultural background, and it is differently related to safety culture. Safety culture is part of organizational culture and it tends to focus on deeper and less readily accessible core values and assumptions of the organization on safety and human resources. On the other hand, according to Wiegmann, Zhang and von Thaden [13], since Zohar first used the term [7], the literature has not presented a generally accepted definition of safety climate. In fact, some definitions of safety climate are almost identical to the ones of safety culture. However, many definitions of safety climate and safety culture differ in a number of important ways. One definition of safety climate, which is the most adequate for this paper, is "Safety climate is viewed as an individual

Correspondence should be sent to Nenad Milijic, Vojske Jugoslavije 12, 19210 Bor, Serbia. E-mail: nmilijic@tf.bor.ac.rs.

attribute, which is composed of two factors: management's commitment to safety and workers' involvement in safety" (p. 102) [14]. Safety culture describes the way in which safety is managed in the workplace; it often reflects "the attitudes, beliefs, perceptions and values that employees share in relation to safety" (p. 93) [15].

Having the conceptual difference in mind, it may not be possible to develop an empirically grounded safety climate model in a specific cultural context and expect this model to have ecological validity. Safety climate assessments should be based on factors characteristic for the location of the investigation. A questionnaire developed for investigations in one country (or region) would not be adequate for collecting data in another one. Furthermore, safety climate can have different meanings in different cultures.

Serbia is a small country in south-eastern Europe, where the issue of safety climate in industry is still not well known and understood. The lack of literature on safety climate in Serbian industries is evident. The only way to start investigations of safety climate in such an environment is to adopt methodology developed in earlier research, with an intention to adapt it to the Serbian context. In such a situation, a decision which model would be the most appropriate is necessary. Some models were developed in the west [1, 4, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31], others in the east [32, 33, 34, 35, 36, 37, 38, 39, 40, 41].

Having considered everything, we decided to use methodology originally developed in the west, and subsequently adapted to Chinese context [8]. We did this because China is a country in transition towards coexisting capitalist and socialist systems. There is a wide presence of both public and private companies. In such an environment, a specific working culture and safety climate appear. Serbia is going through a similar transition. In Serbia, private capital exists along publicly owned companies, which remain from the socialist regime. Serbian work climate and safety climate are still far behind the west.

Accordingly, this investigation adopted a questionnaire developed by Lin et al. [8], which had been used to measure safety climate in the workplace in China. This questionnaire was a basis for a further adaptation of this model to the Serbian context. Most items from the original questionnaire remained unchanged; however, some new issues were added. Afterwards, the results of our investigation were compared with Lin et al.'s results [8]. Conclusions on the relevance of the chosen model for measuring safety climate in the workplace in Serbia were drawn.

The investigation in this paper aimed to start the process of developing a safety climate questionnaire that could be used in Serbia. A real method for measuring safety climate had never been developed and assessed in Serbian industry. For this investigation, we decided to use a questionnaire survey of the workers' opinion on important safety climate issues. The following sections present the study population, the development of the questionnaire, methodology, data analysis and a discussion of the results.

2. METHODS

2.1. Population

The study was conducted in central Serbia (the Morava region). Several industrial sectors were selected: food industry, shoe manufacturing, electrical construction, polyvinyl chloride (PVC) joinery, cosmetics industry, textile industry, recycling, cement production and furniture industry. Accordingly, the study was conducted in nine organizations, representing the nine industrial sectors in central Serbia. Since this part of Serbia is relatively small, these nine industrial sectors covered most areas of industrial production of this region. Such a diversity of industrial sectors is required to achieve one universal safety climate questionnaire that, after having its ecological and prognostic validity confirmed, could be used all over Serbia. Subsequently, a random sampling procedure was conducted to select individual workers in each organization; 1311 individual workers of those organizations potentially exposed to occupational hazards were selected. The questionnaires were distributed to organizations; 1098 questionnaires were returned (response rate: 83.75%). Table 1 shows the subjects' demographics.

TABLE 1. Subjects' Demographics

Variable	*N*	%
Organization		
food industry	312	28.4
shoe manufacturing	66	6.0
electrical construction	168	15.3
PVC joinery	39	3.5
cosmetics industry	81	7.4
textile industry	135	12.3
recycling	69	6.3
cement production	135	12.3
furniture industry	93	8.5
Position in company		
production workers	750	68.3
workers indirectly involved in production	114	10.4
administrative workers	153	13.9
managers	81	7.4
Education		
primary	246	22.4
secondary	756	68.9
tertiary	96	8.7
Work experience (years)		
<5	600	54.7
6–15	321	29.2
16–25	96	8.7
>26	81	7.4
Gender		
male	564	51.4
female	534	48.6
Age (years)		
<29	282	25.7
30–44	627	57.1
45–54	150	13.7
>55	39	3.5
Accident involvement		
yes	168	15.3
no	930	84.7

Notes. PVC = polyvinyl chloride.

Compared to Lin et al.'s [8] demographic indicators, we added two items: position in the company and educational level. It is an interesting finding that almost all demographic indicators were in the same ranges for both Chinese and Serbian workplaces. For example, 85.4% of the investigated Chinese workers had been involved in some sort of accident event.

2.2. Questionnaire

Our first questionnaire was Lin et al.'s [8]. At the beginning of our investigation, we adopted it with the aim to make a conclusion about its applicability to measuring safety climate in the Serbian workplace. Before using the original questionnaire among the selected population, we ran a pilot study among 300 workers in the food industry (56 participants), shoe manufacturing (65 participants), electrical construction (58 participants), PVC joinery (60 participants) and cement production (61 participants). The trial and first-run exploratory factor analysis showed that the original 21-item questionnaire, after a small regrouping of questions within the factors, could be used as a safety climate scale in Serbian factories.

A 5-point Likert-type scale (1 = *strongly disagree*, 5 = *strongly agree*) was used to collect the workers' responses. Yes/no responses, lists of options, check-the-box responses, etc., were used to self-report incident involvement and demographic data. Since the questionnaire used questions and answers based on scales, we included a not-applicable option for situations in which the respondents did not know what to respond or did not have an opinion on the issue. They rarely used this option. Many studies had used that format [42, 43, 44, 45], thus it was also acceptable for this research.

2.3. Construct Validity

In the original version of the questionnaire, the questions focused on seven factors [8]: SC1 (safety awareness and competence): 5 questions; SC2 (safety communication): 4 questions; SC3 (organizational environment): 3 questions; SC4 (management support): 3 questions; SC5 (risk judgment): 2 questions; SC6 (safety precautions): 2 questions; SC7 (safety training): 2 questions.

After the first run of the principal component factor analysis, some factors remained unchanged, whereas some questions had to be redistributed between the factors, compared to the original questionnaire. SC1, SC2, SC3 and SC7 were not changed. On the other hand, some questions from SC4, SC5 and SC6 had to be rearranged. Thus, we developed the final questionnaire (Appendix A). The names of factors SC1, SC2, SC3, SC4 and SC7 remained unchanged; the other two were changed: SC5 risk judgment and management reaction, SC6 safety precautions and accident prevention.

2.4. Validity and Reliability

Sampling adequacy was measured with the Kaiser–Meyer–Olkin test. Bartlett's test of sphericity was used for evaluating correlations among safety climate items. Construct validity was tested with exploratory factor analysis, and discriminant validity was checked by comparing the safety climate scores among groups varying in age, work experience, accident involvement, position in the company, educational and the type of the organization. To evaluate the internal consistency of the safety climate questionnaire, we used Cronbach's α, Spearman–Brown coefficient and Ω. Cronbach's α is used when questions are rated on internal scales such as a 5-point Likert scale, used in this investigation; it represents mean correlations among items. Spearman–Brown coefficient represents the reliability coefficients that can be attained from all possible combinations of dividing the questions into two sets (split-half). For example, you divide the questionnaire into odd and even numbered questions and correlate them. Ω is calculated from the factor analysis results [46]. The minimal proposed value of these coefficients is .70.

2.5. Data Analysis

The data obtained using the questionnaire were analyzed with SPSS 18. The comparison of the difference in safety climate scores among different demographic groups (age, work experience, gender, position in the company, education, accident involvement, type of organization) was done with the multiple analysis of variances (MANOVA). To define the final safety climate model, the principal component analysis was performed retaining all the factors with Eigenvalue greater than one. Once the factors were extracted, the Varimax rotation was performed. Further structural analysis and final defining of the safety climate model were done with LISREL 8.30 software[1].

The analyses showed that the Kaiser–Meyer–Olkin measure of sampling adequacy was .81 indicating that these data were appropriate for factor analysis [47]. Bartlett's test of sphericity was significant ($\chi^2 = 2974.56$, $p < .001$), which indicated that there were correlations among safety climate items and the correlation matrix was not a unit matrix.

3. RESULTS AND DISCUSSION

3.1. Safety Climate Factors and Demographic Subgroups

The final questionnaire, resulting from the first run of the factor analysis, was used to evaluate the opinion of the entire population (1098 Serbian workers). The second run of the principal component factor analysis was performed on the data obtained with the questionnaire. After the Varimax rotation, seven common factors were extracted and accounted for 69.93% variance. The common factors were determined with Eigenvalue greater than one and the screen plot. Table 2 shows principal component extraction of 21 items of safety climate.

During further investigations, the safety climate data were analyzed considering simple statistic differences (Table 3). The aim was to investigate whether there was a significant difference in safety climate among the demographic subgroups. To do so, we distinguised four age groups, two gender groups, four categories of work experience, two accident involvement groups, four positions in the company groups and four educational level categories (Table 1).

Compared to Lin et al. [8], we included three new demographic parameters. The first one was gender. Significant differences emerged on four scales (SC3, SC4, SC6 and SC7); there were no significant differences on the other safety climate scales. The position in the company was another

[1] http://www.ssicentral.com/

TABLE 2. 21-Item Safety Climate Factor Loadings and Community

Item Code		Factor Loading							
Original Questionnaire [8]	Final Questionnaire (This study)	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7	Community
SC1-1	SC1-1	**.605**	.004	.470	–.170	–.046	–.429	–.099	.812
SC1-2	SC1-2	**.624**	.066	.456	–.208	–.010	–.368	–.171	.810
SC1-3	SC1-3	**.574**	.152	.126	–.244	–.053	.122	–.322	.549
SC1-4	SC1-4	**.537**	.134	.368	–.259	.028	.482	.139	.761
SC1-5	SC1-5	**.396**	.199	.531	–.194	.117	.394	.013	.684
SC2-1	SC2-1	.134	**.565**	.134	.266	.312	.131	–.118	.585
SC2-2	SC2-2	.010	**.731**	.010	–.223	.191	.336	–.089	.742
SC2-3	SC2-3	.078	**.607**	.078	–.183	.266	.388	–.215	.676
SC2-4	SC2-4	–.147	**.634**	–.147	–.128	.059	.263	–.042	.657
SC3-1	SC3-1	.022	–.220	**.785**	–.097	.007	–.064	–.162	.706
SC3-2	SC3-2	–.001	–.280	**.773**	–.290	.023	–.068	–.026	.766
SC3-3	SC3-3	.050	–.276	**.789**	–.191	–.114	–.124	–.029	.766
SC4-1	SC4-1	.071	–.073	–.107	**.582**	.016	–.090	.250	.746
SC4-3	SC4-2	.334	.391	.144	**.647**	.006	.095	.042	.671
SC4-2	SC5-1	–.409	.160	–.039	–.179	**.667**	.242	–.025	.570
SC5-1	SC5-2	–.414	–.440	–.191	.011	**.578**	–.220	.095	.709
SC6-1	SC5-3	–.159	–.249	–.191	.001	**.652**	–.066	.111	.574
SC5-2	SC6-1	.010	.117	.251	.111	–.169	**.520**	.011	.764
SC6-2	SC6-2	–.066	–.159	–.191	.001	.262	**.659**	.001	.632
SC7-1	SC7-1	.112	–.027	–.540	–.067	.005	–.047	**.473**	.767
SC7-2	SC7-2	.246	.096	–.553	.124	.009	.016	**.442**	.739

Notes. SC1-1 … SC7-2 = see Appendix A. The values in bold are the highest values of factor loadings for each variable (question), which determines in which group it should be allocated.

TABLE 3. Safety Climate by Age, Gender, Work Experience, Position in the Company, Education, Accident Involvement and Organization (Discriminant Validity)

Demographic	Significance	SC1	SC2	SC3	SC4
Gender	*F*	9.06	8.36	2.82	10.38
	p	*ns*	*ns*	.005	<.001
Age	*F*	4.73	4.78	1.30	4.97
	p	.050	.023	*ns*	.005
Work experience	*F*	8.81	10.94	3.83	20.26
	p	.002	<.001	.015	<.001
Position in company	*F*	4.28	2.49	7.86	3.05
	p	.003	*ns*	<.001	*ns*
Education	*F*	0.89	0.92	3.74	2.73
	p	*ns*	*ns*	.027	.035
Accident involvement	*F*	9.48	0.55	1.50	3.25
	p	.038	*ns*	*ns*	<.001
Organization	*F*	11.89	8.61	7.72	23.20
	p	.001	.002	<.001	<.001

Demographic	Significance	SC5	SC6	SC7	GSC
Gender	*F*	4.83	3.09	2.99	6.13
	p	*ns*	<.001	.018	*ns*
Age	*F*	1.84	5.92	2.20	3.87
	p	*ns*	.013	*ns*	*ns*
Work experience	*F*	2.68	15.80	4.44	8.56
	p	*ns*	<.001	.007	.013
Position in company	*F*	9.47	7.77	4.01	5.79
	p	<.001	<.001	.046	.048
Education	*F*	2.60	2.07	0.56	2.12
	p	*ns*	*ns*	*ns*	*ns*
Accident involvement	*F*	2.43	1.78	12.12	4.36
	p	*ns*	<.001	*ns*	*ns*
Organization	*F*	7.31	32.23	8.05	14.25
	p	.015	<.001	<.001	.002

Notes. SC1 = safety awareness and competence, SC2 = safety communication, SC3 = organizational environment, SC4 = management support, SC5 = risk judgment, SC6 = safety precautions, SC7 = safety training, GSC = general safety climate.

new demographic parameter. There were significant differences in five of the seven factors (SC1, SC3, SC5, SC6 and SC7). The level of education was the third new parameter. For this parameter, there were significant differences only on two scales (SC3 and SC4).

This study was conducted in nine organizations representing nine industrial sectors of this region of central Serbia. The results of the analysis were highly significant on all scales. If we were to compare these results with Lin et al.'s [8], only scale SC7 did not have any statistical significance in their work. Furthermore, in their investigations, age was not statistically significant on any scale. Accident involvement had almost the same significance in both investigations.

The results of various groups of demographic parameters (work experience, position in the company and organization) demonstrated that the developed safety climate instrument had discriminant validity which was higher in some organizations than in others. This may be related to different risk levels in different organizations (industrial sectors) and departments. Moreover, different risk levels are associated with various tasks and activities among different positions in the company.

TABLE 4. Interconsistency Coefficients of the Safety Climate Questionnaire

Scale	No. of Items	Cronbach's α	Spearman–Brown Coefficient	Ω
SC1	5	.769	.794	.731
SC2	4	.692	.693	.665
SC3	3	.855	.858	.746
SC4	2	.760	.698	.709
SC5	3	.678	.678	.618
SC6	2	.656	.664	.698
SC7	2	.885	.895	.753
GSC	21	.785	.746	.702

Notes. SC1 = safety awareness and competence, SC2 = safety communication, SC3 = organizational environment, SC4 = management support, SC5 = risk judgment, SC6 = safety precautions, SC7 = safety training, GSC = general safety climate.

Since the type of industrial sector had a significant influence on workers' opinions on each safety climate question (Table 3), this demographic parameter was used as the grouping variable. Because of the large number of data lines, the workers' responses to safety climate questions, grouped according by industrial sector, are presented in Appendix B (Table A1). The results in Table A1 show that compared to the other industrial sectors, workers in recycling strongly emphasized the negative issues of their organizational environment. On the other hand, the most satisfied workers with regard to safety climate were the ones from PVC joinery production.

3.2. Reliability of Measuring Safety Climate

The reliability of the measurement method depends on its internal consistency. As already indicated, the consistency was assessed with Cronbach's α, Spearman–Brown coefficient, and Ω. According to Cronbach's α, internal consistency was .79 for the entire population. Spearman–Brown coefficient was .77 and Ω = .70. Most coefficients were higher than .70 and adequate for psychometric requirements for a measurement. Thus, the method for measuring safety climate was appropriate. Table 4 shows each coefficient of the safety climate scales.

3.3. Structure of Safety Climate Model

Figure 1 presents the results of the structural analysis. To make it clearer, it shows only the values of the structural equation, but not the measuring models. In accordance with the suggestions and indicators given by Hair et al. [48], the goodness-of-fit (GF) model had to be considered first. Within a GF model, it is required to consider three indicators: the measure of absolute fit, the measure of increased fit and the measure of decreased fit. Table 5 presents the results for the proposed model together with the recommended values for satisfactory fit [49].

Due to the absolute correspondence of the models, the indicators that can be applied in an incompetent strategic analysis are GFI (goodness-of-fit index) and the index of corresponding values and approximate error expressed as RMSEA (root-mean-square error of approximation). In GFI, the

TABLE 5. Summary of Fit Values

Statistic	Value	
	This Model	Recommended
χ^2/df	2.55	<3.0
RMSEA	.09	.08–.10
GFI	.92	>.90
AGFI	.96	>.90
NFI	.96	>.90
NNFI	.92	>.90
CFI	.93	>.90
IFI	.92	>.90
RFI	.92	>.90

Notes. RMSEA = root-mean-square error of approximation, GFI = goodness-of-fit index, AGFI = adjusted goodness-of-fit index, NFI = normed fit index, NNFI = non-normed fit index, CFI = comparative fit index, IFI = incremental fit index, RFI = relative fit index.

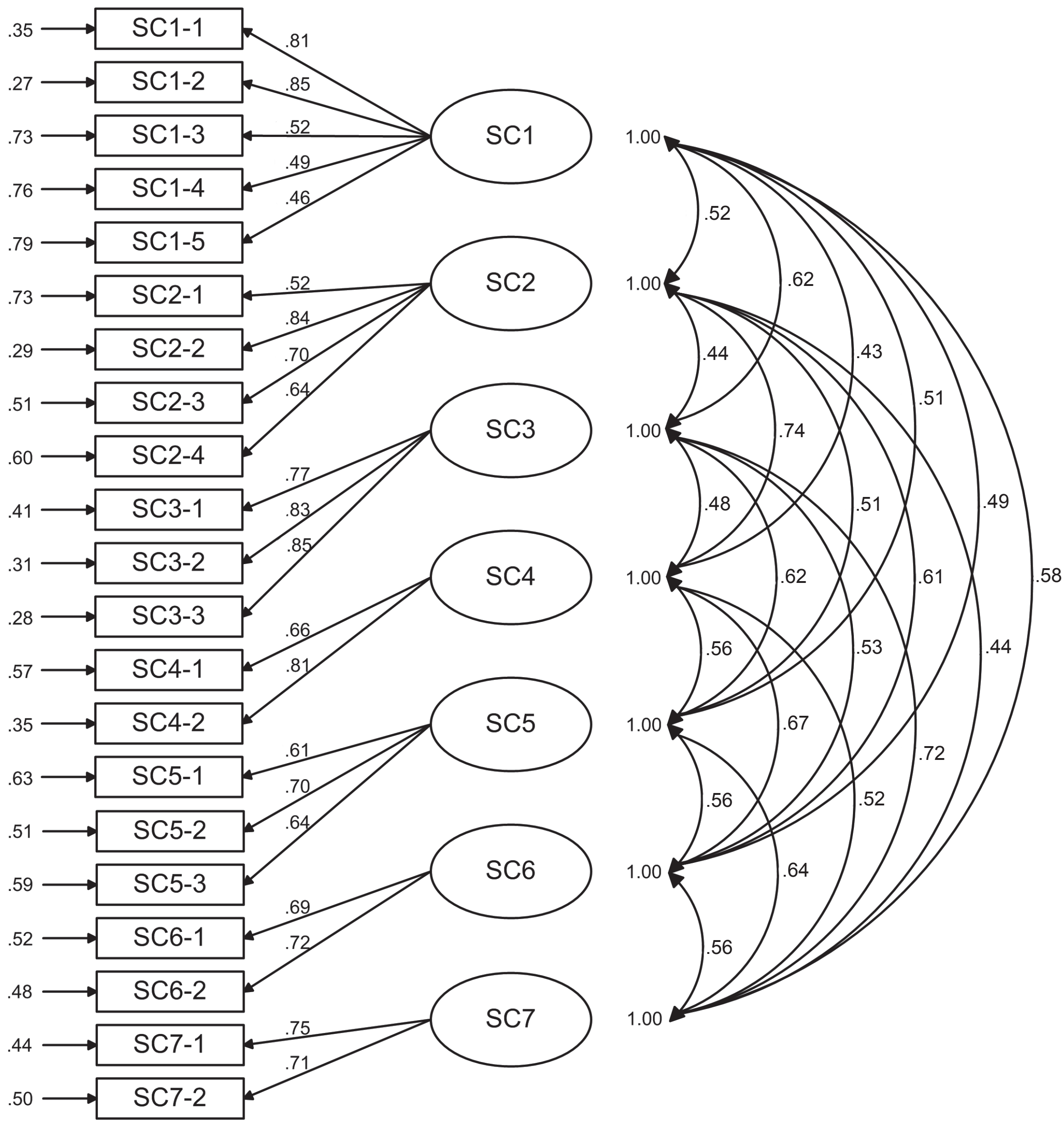

Figure 1. Structural model of investigated safety measurement scales. *Notes.* SC1 = safety awareness and competence, SC2 = safety communication, SC3 = organizational environment, SC4 = management support, SC5 = risk judgment, SC6 = safety precautions, SC7 = safety training; SC1-1 … SC7-2 = see Appendix A.

higher the value, the higher the correspondence. In this case, the obtained value was .92. This indicator is acceptable since it is over .90 [42]. RMSEA is an indicator based on an appreciative error that occurs due to the expected degree of freedom within the population. The lower the indicator, the higher the correspondence. Acceptable correspondence is under .08. Some authors accept this value as even under .10. In our model, this indicator has the value of .09 which, according to the latter group of authors, is an indicator of good correspondence.

Table 6 shows intercorrelations among the seven safety climate factors that were entered into the final model. Because of the large sample size, each correlation coefficient was significant at .01. Most coefficients were near or over .50, indicating high intercorrelation among all seven safety climate factors.

TABLE 6. Intercorrelations Among the 7 Safety Climate Factors Entered Into the Final Model

Coefficient	SC1	SC2	SC3	SC4	SC5	SC6	SC7
SC1	1.00						
SC2	.52	1.00					
SC3	.62	.44	1.00				
SC4	.43	.74	.48	1.00			
SC5	.51	.51	.62	.56	1.00		
SC6	.49	.61	.53	.67	.56	1.00	
SC7	.58	.44	.72	.52	.64	.56	1.00

Notes. SC1 = safety awareness and competence, SC2 = safety communication, SC3 = organizational environment, SC4 = management support, SC5 = risk judgment, SC6 = safety precautions, SC7 = safety training.

3.4. Demographics and Safety Climate Factors

As indicated in section 3.1., one aim of this research was to investigate whether there was a significant difference in safety climate among the demographic subgroups. Table 3 shows there were significant differences in each demographic subgroup in some of the seven safety climate factors. For example, for gender, there were significant differences on four scales (SC3, SC4, SC6 and SC7), but not on the other scales. Thus, gender influenced opinions on questions on those four factors. Figure 2 presents the influence of gender on the answers to questions on SC3. It shows that female workers strongly emphasized the negative issues of the organizational environment, compared to their male co-workers.

An identical analysis was performed for all demographic subgroups that influenced workers' opinions on safety climate factors (Table 3). However, presenting all the results in this manuscript would require too much space. Therefore, they will be discussed in detail in another manuscript, a continuation of this one.

4. CONCLUSIONS

A study of safety climate in Serbian industrial settings, like the one in this paper, had never been conducted before. We attempted to measure the value of and beliefs on safety among Serbian workers. The study presented evidence that the perception of safety climate in Serbian industrial settings can be reliably measured with a 21-item questionnaire, involving seven factors (safety awareness and competency, safety communication, organizational environment, management support, risk judgment and management reaction, safety precautions and accident prevention, and safety training). This paper suggested that, compared to the previous research, Serbian workers put more emphasis on safety training, organizational environment, safety awareness and competency, and management support. Therefore, the factor of safety training is the first of the seven factors, and explains the largest variance in the perception of safety climate. According to Serbian workers, other factors such as safety communications, risk judgment and management reaction, and safety precautions and accident prevention have less influence on general safety climate. To establish a general tool for measuring safety climate in the workplace in Serbia, our subjects came from several industrial sectors. Thus, the developed 21-item questionnaire can be used as a safety measurement tool for the whole of Serbian industry. This tool was based on the results from different parts of the world and then modified to fit Serbian workplaces.

Further research will focus on a structural equation model, which will result from the structural analysis presented in this work [50]. An additional factor, the level of safety in one workplace, will have to be included. It will determine the workers' attitude towards the risk level at their workplace and real occupational accidents that took place there. Subsequently, the seven factors from this study will be used to form a hypothetical frame of the structural equation model.

Additionally, as already indicated, each demographic subgroup had strong influence on some

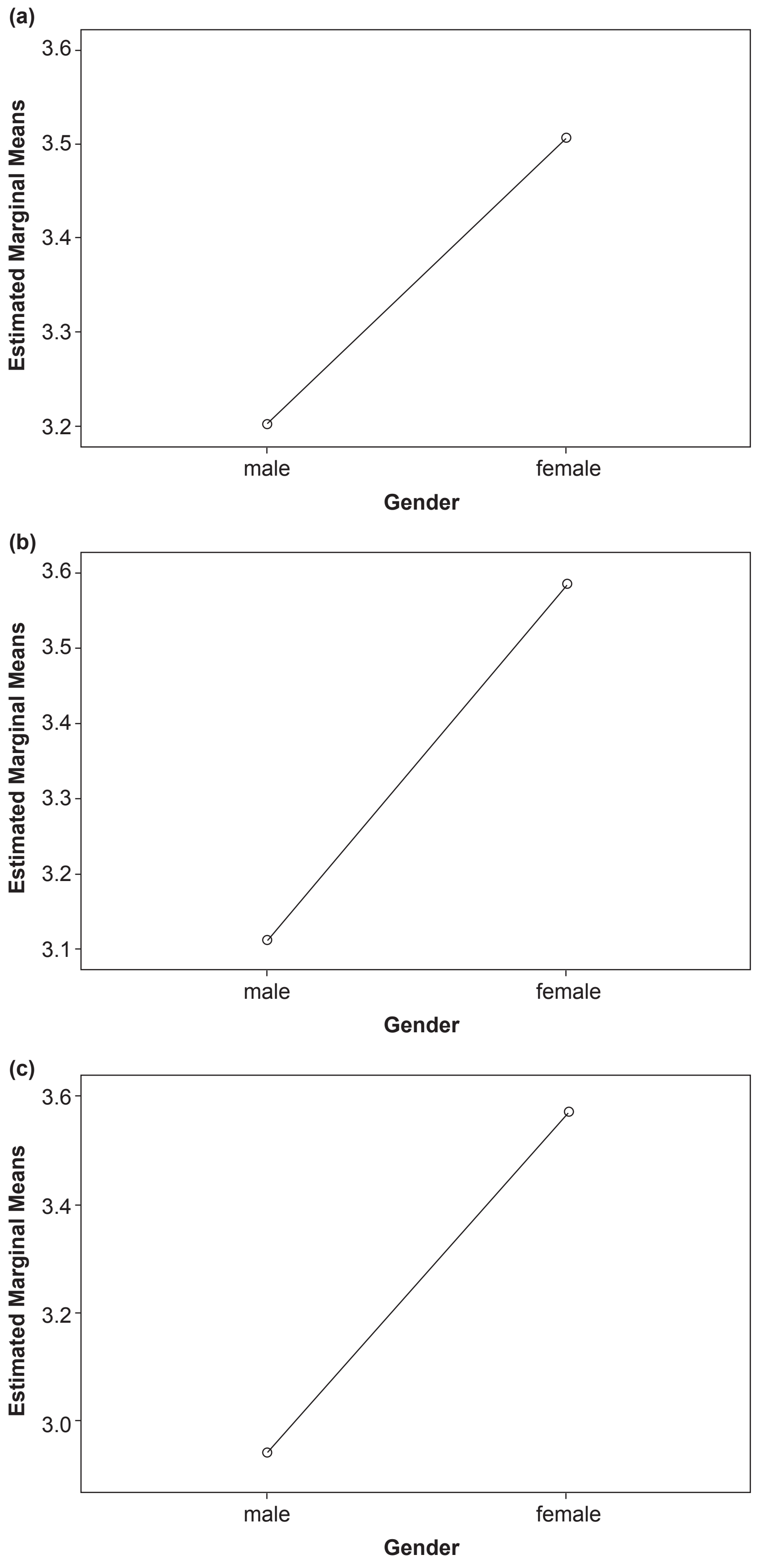

Figure 2. Workers' opinions on organizational environment (SC3) by gender: (a) "Sometimes there is too much work to do without following safety procedures", (b) "Sometimes work pace is too fast to follow safety procedures", (c) "Sometimes I have to ignore safety requirements for the sake of production".

of the seven factors. This will be analysed in detail and discussed in a future study. This study considered workers from nine industrial sectors, so the type of organization was one of the demographic variables. Consequently, the influence of this variable on all seven safety climate factors will be studied in future. This will include testing the ecological validity of the new questionnaire: the questionnaire will be used in each of the nine sectors separately, with larger groups of workers in each sector. The results will then be compared among each other and with the results obtained in the present work. The ecological and prognostic validity of the model developed in this work will be assessed in this way. Moreover, the results will have practical value for occupational health prevention in each sector.

This study suggests that using the new questionnaire may improve safety climate in Serbian companies. According to the workers, it is now easy to isolate the most significant safety climate issues for each industrial sector and to address them in practice. Also, workers from all the investigated sectors would like to see an improvement in the safety training. Representatives of all companies involved in this investigation will see the results.

REFERENCES

1. Coyle IR, Sleeman SD, Adams N. Safety climate. J Safety Res. 1995;26(4):247–54.
2. Williamson AM, Feyer AM, Cairns D, Biancotti D. The development of a measure of safety climate: the role of safety perceptions and attitudes. Saf Sci. 1997; 25(1–3): 15–27.
3. Mearns KJ, Flin R. Assessing the state of organization safety—culture or climate? Curr Psychol. 1999;18(1):5–17. Retrieved August 22, 2013, from: http://link.springer.com/content/pdf/10.1007%2Fs12144-999-1013-3.pdf.
4. Silva S, Lima ML, Baptista C. OSCI: an organisational and safety climate inventory. Saf Sci. 2004;42(3):205–20.
5. Snyder LA, Krauss AD, Chen PY, Finlinson S, Huang YH. Occupational safety: Application of the job demand–control–support model. Accident Anal Prev. 2008; 40(5):1713–23.
6. Makin AM, Winder C. A new conceptual framework to improve the application of occupational health and safety management systems. Saf Sci. 2008;46(6):935–48.
7. Zohar D. Safety climate in industrial organizations: theoretical and applied implications. J Appl Psychol. 1980;65(1): 96–102.
8. Lin SH, Tang WJ, Miao JY, Wang ZM, Wang PX. Safety climate measurement at workplace in China: a validity and reliability assessment. Saf Sci. 2008;46(7):1037–46.
9. Guldenmund FW. The nature of safety culture: a review of theory and research. Saf Sci. 2000;34(1–3):215–7.
10. Mihajlovic I, Zivkovic Z, Prvulovic S, Strbac N, Zivkovic D. Factors influencing job satisfaction in transitional economies. Journal of General Management. 2008; 34(2):71–87.
11. Flin R, Mearns K, O'Connor P, Bryden R. Measuring safety climate: identifying the common features. Saf Sci. 2000;34(1–3): 177–92.
12. Shannon HS, Norman GR. Deriving the factor structure of safety climate scales. Saf Sci. 2009;47(3):327–9.
13. Wiegmann DA, Zhang H, von Thaden T. Defining and assessing safety culture in high reliability systems: an annotated bibliography. Savoy, IL, USA: Aviation Research Lab; 2001.
14. Dedobbeleer N, Beland F. A safety climate measure in construction sites. J Safety Res. 1991;22(2):97–103.
15. Cox S, Cox T. The structure of employee attitudes to safety: a European example. Work Stress. 1991:5(2):93–106.
16. Brown KA, Willis PG, Prussia GE. Predicting safety employee behavior in the steel industry: development and test a sociotechnical model. Journal of Operations Management. 2000;18(4):445–65.
17. Cox SJ, Cheyne AJT. Assessing safety culture in offshore environments. Saf Sci. 2000;34(1–3):111–29.
18. Rundmo T. Safety climate, attitudes and risk perception in Norsk Hydro. Saf Sci. 2000;34(1–3):47–59.

19. Glendon AI, Litherland DK. Safety climate factors, group differences and safety behaviour in road construction. Saf Sci. 2001;39(3):157–88.
20. Mearns K, Whitaker SM, Flin R. Safety climate, safety management practice and safety performance in offshore environments. Saf Sci. 2003;41(8):641–80.
21. Prussia GE, Brown KA, Willis PG. Mental models of safety: do managers and employees see eye to eye? J Safety Res. 2003;34(2): 143–56.
22. DeJoy DM, Schaffer BS, Wilson MG, Vandenberg RJ, Butts MM. Creating safer workplaces: assessing the determinants and role of safety climate. J Safety Res. 2004; 35(1):81–90.
23. Johnson SE. The predictive validity of safety climate. J Safety Res. 2007;38(5): 511–21.
24. Hahn SE, Murphy LR. A short scale for measuring safety climate. Safety Sci. 2008; 46(7):1047–66.
25. Tharaldsen JE, Olsen E, Rundmo T. A longitudinal study of safety climate on the Norwegian continental shelf. Safety Sci. 2008;46(3):427–39.
26. Turnberg W, Daniell W. Evaluation of a healthcare safety climate measurement tool. J Safety Res. 2008;39(6):563–8.
27. Gyekye SA, Salminen S. Workplace safety perceptions and perceived organizational support: do supportive perceptions influence safety perceptions? International Journal of Occupational Safety and Ergonomics (JOSE). 2007;13(2):189–200. Retrieved August 22, 2013, from: http://www.ciop.pl/21990.
28. Gyekye SA, Salminen S. Educational status and organizational safety climate: does educational attainment influence workers' perceptions of workplace safety? Saf Sci. 2009;47(1):20–8.
29. Håvold JI, Nesset E. From safety culture to safety orientation: validation and simplification of a safety orientation scale using a sample of seafarers working for Norwegian ship owners. Saf Sci. 2009; 47(3):305–26.
30. Henning JB, Stufft CJ, Payne SC, Bergman ME, Mannan MS, Keren N. The influence of individual differences on organizational safety attitudes. Saf Sci. 2009;47(3):337–45.
31. Keren N, Mills TR, Freeman SA, Shelley MC 2nd. Can level of safety climate predict level of orientation toward safety in a decision making task? Saf Sci. 2009;47(10): 1312–23.
32. Fang DP, Xie F, Huang XY, Li H. Factor analysis-based studies on construction workplace safety management in China. International Journal of Project Management. 2004;22(1):43–9.
33. Siu OL, Phillips DR, Leung TW. Safety climate and safety performance among construction workers in Hong Kong: the role of psychological strains as mediators. Accid Anal Prev. 2004;36(3):359–66.
34. Wu TC, Liu CW, Lu MC. Safety climate in university and college laboratories: impact of organizational and individual factors. J Safety Res. 2007;38(1):91–102.
35. Baek JB, Bae S, Ham BH, Singh KP. Safety climate practice in Korean manufacturing industry. Journal of Hazardous Materials. 2008;159(1):49–52.
36. Lu CS, Tsai CL. The effects of safety climate on vessel accidents in the container shipping context. Accid Anal Prev. 2008;40(2): 594–601.
37. Lu CS, Tsai CL. The effect of safety climate on seafarers' safety behaviors in container shipping. Accid Anal Prev. 2010;42(6): 1999–2006.
38. Zhou Q, Fang D, Wang X. A method to identify strategies for the improvement of human safety behavior by considering safety climate and personal experience. Saf Sci. 2008;46(10):1406–19.
39. Vinodkumar MN, Bhasi M. Safety climate factors and its relationship with accidents and personal attributes in the chemical industry. Safety Sci. 2009;47(5):659–667.
40. Hsu SH, Lee CC, Wu MC, Takano K. The influence of organizational factors on safety in Taiwanese high-risk industries. Journal of Loss Prevention in the Process Industries. 2010;23(5):646–53.
41. Jiang L, Yu G, Li Y, Li F. Perceived colleagues' safety knowledge/behavior and safety performance: safety climate as a

moderator in a multilevel study. Accid Anal Prev. 2010;42(5):1468–76.

42. Molina ML, Lloréns-Montes J, Ruiz-Moreno A. Relationship between quality management practices and knowledge transfer. Journal of Operations Management. 2007;25(3):682–701.
43. Kale P, Singh H, Perlmutter H. Learning and protection of proprietary assets in strategic alliances: building relational capital. Strategic Management Journal. 2000;21(3):217–37.
44. Kayank H. The relationship between total quality management practices and their effects on firm performance. Journal of Operations Management. 2003;21(4): 405–35.
45. Tari JJ, Molina JF, Castejón JL. The relationship between quality management practices and their effects on quality outcomes. European Journal of Operational Research. 2007;183(2):483–501.
46. Nunnally JC, Bernstein IH. Psychometric theory. 3rd ed. New York, NY, USA: McGraw-Hill; 1994.
47. Kaiser HF. An index of factorial simplicity. Psychometrika. 1974;39(1):31–6.
48. Hair JF, Anderson RE, Tatham RL, Black WC. Multivariate data analysis with reading. 5th ed. Englewood Cliffs, NJ, USA: Prentice Hall; 1998.
49. Ho DCK, Duffy VG, Shih HM. An empirical analysis of effective TQM implementation in the Hong Kong electronics manufacturing industry. Human Factors & Ergonomics in Manufacturing. 1999;9(1):1–25.
50. Fornell C, Lacker DF. Evaluating structural equation models with unobservable variables and measurement error. Journal of Marketing Research. 1981;18:39–50.

APPENDIX A. Safety climate questionnaire (21 items)

SC1: Safety awareness and competency

SC1-1 I am clear about what my responsibilities are for the workplace safety
SC1-2 I understand the safety rules in my job
SC1-3 I can deal with safety problems in 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 most important thing

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

SC3: Organizational environment

SC3-1 Sometimes there is too much work to do without following the safety procedures
SC3-2 Sometimes work pace is too fast to follow safety procedures
SC3-3 Sometimes I have to ignore safety requirements for the sake of production

SC4: Management support

SC4-1 Management believes safety is of the same importance as production
SC4-2 Management takes care of safety problems in 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 in 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 those dangerous jobs, there are always measures to prevent accidents

SC7: Safety training

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

APPENDIX B. Responses to the safety climate questions by industrial sector

TABLE A1. Responses to Safety Climate Questions By Industrial Sector

		Safety Climate Measures																			
		SC1-1		SC1-2		SC1-3		SC1-4		SC1-5		SC2-1		SC2-2		SC2-3		SC2-4		SC3-1	
Industrial Sector	*N*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Food industry	312	4.49	0.70	4.62	0.73	4.24	0.86	4.46	0.73	4.64	0.61	3.97	1.15	3.82	1.09	3.59	1.21	4.14	1.14	3.26	1.25
Shoes manufacture	66	4.78	0.52	4.74	0.54	4.30	0.77	4.52	0.59	4.74	0.62	3.96	1.30	3.87	1.01	3.48	1.12	4.13	1.01	2.87	1.25
Electrical construction	168	4.62	0.65	4.67	0.58	4.38	0.83	4.75	0.62	4.75	0.70	3.85	1.31	3.91	1.18	3.02	1.28	4.05	1.11	3.96	1.02
PVC joinery production	39	4.85	0.38	4.54	0.52	4.31	0.48	4.54	0.52	4.85	0.38	3.92	0.64	4.46	0.78	4.08	0.86	4.85	0.38	2.54	0.97
Cosmetic industry	81	3.96	1.02	4.19	0.68	4.26	0.59	4.52	0.58	4.30	0.91	3.19	1.30	3.78	1.16	3.33	1.18	4.30	1.03	3.22	1.16
Textile industry	135	4.51	0.73	4.49	0.76	4.51	0.66	4.56	0.62	4.13	0.79	3.91	0.87	4.33	0.83	3.71	0.94	3.91	0.97	4.07	0.39
Recycling	69	3.87	0.55	3.78	0.67	3.35	0.83	3.22	0.80	3.04	0.71	2.96	0.83	2.70	0.82	2.57	0.84	3.22	0.74	2.74	0.62
Cement production	135	4.30	0.96	4.37	0.93	3.91	1.17	4.02	1.04	4.53	0.86	3.63	1.45	3.23	1.36	3.47	1.26	3.26	1.33	3.40	1.16
Furniture industry	93	4.63	0.60	4.54	0.56	4.46	0.74	4.63	0.60	4.60	0.65	3.31	1.30	3.71	1.36	2.49	1.04	4.03	1.27	2.77	1.42
total	1098	4.46	0.76	4.49	0.73	4.23	0.87	4.41	0.80	4.46	0.82	3.72	1.22	3.77	1.18	3.33	1.21	3.96	1.15	3.35	1.19

	Safety Climate Measures																					
	SC3-2		SC3-3		SC4-1		SC4-2		SC5-1		SC5-2		SC5-3		SC6-1		SC6-2		SC7-1		SC7-2	
Industrial Sector	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Food industry	2.96	1.27	3.11	1.27	4.04	1.30	3.91	1.31	2.33	1.51	2.75	1.36	2.73	1.19	3.42	1.42	3.92	1.11	4.33	1.25	4.47	0.96
Shoes manufacture	3.30	1.52	2.65	1.47	4.35	0.89	3.26	1.42	1.87	1.01	1.83	1.11	2.26	1.05	4.04	0.93	4.52	0.59	3.35	1.85	3.96	1.67
Electrical construction	3.93	1.39	3.85	1.19	4.11	1.13	3.89	0.99	3.16	1.53	2.98	1.38	2.96	1.09	3.25	1.29	3.84	0.96	4.04	1.39	4.51	0.92
PVC joinery production	3.31	0.48	2.62	0.96	4.69	0.48	4.54	0.88	2.31	1.03	1.46	0.97	1.54	1.05	4.54	0.97	4.77	0.60	4.69	0.63	4.92	0.28
Cosmetic industry	3.04	1.06	3.22	1.12	4.48	0.80	4.11	1.16	2.37	1.21	1.81	1.04	3.04	1.06	4.30	1.03	3.85	0.82	2.70	1.68	3.33	1.54
Textile industry	4.42	0.66	4.49	0.92	4.84	0.48	4.58	0.99	3.91	1.33	2.42	1.42	3.11	1.45	4.53	0.84	4.51	0.92	4.82	0.68	4.62	0.61
Recycling	2.61	0.72	2.52	0.85	3.04	0.88	2.74	0.96	2.43	0.66	2.43	1.12	2.48	0.79	2.78	1.04	2.87	1.06	3.70	0.77	3.57	0.73
Cement production	3.28	1.24	3.12	1.26	3.16	1.36	2.60	1.33	3.67	1.29	3.12	1.18	3.26	0.98	2.81	1.18	3.23	1.07	3.42	1.20	3.79	1.28
Furniture industry	2.97	1.69	2.40	1.50	3.63	1.40	3.51	1.44	2.40	1.63	2.17	1.56	2.43	1.42	4.00	1.03	4.31	0.99	3.63	1.72	4.26	1.29
total	3.34	1.33	3.25	1.36	4.02	1.23	3.72	1.34	2.80	1.51	2.54	1.37	2.78	1.22	3.62	1.31	3.93	1.09	3.96	1.42	4.24	1.15

Notes. PVC = polyvinyl chloride; SC1-1 … SC7-2 = see Appendix A.