Research article

Psychosocial risk assessment using COPSOQ II questionnaire - A case study with maintenance workers in a metal plant in Istanbul Turkey

Nalan Baç a,*, Ismail Ekmeçbi

a Occupational Health and Safety Program Graduate School of Science and Engineering Istanbul Commerce University, Küçükçay, Istanbul, Turkey
b Department of Mechanical Engineering, Faculty of Engineering and Design, Istanbul Commerce University, Küçükçay, Istanbul, Turkey

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ABSTRACT

Background: Psychosocial risks are among the significant risks at the workplace. This study aims to assess psychosocial risks for the first time in a metal processing plant in Istanbul, Turkey by applying Copenhagen Psychosocial Questionnaire (COPSOQ II) to maintenance workers, and comparing risks scores by Fine Kinney and Analytic Hierarchy Process (AHP) methods.

Method: The COPSOQ II questionnaire was applied to all 120 maintenance workers. All items in COPSOQ II questionnaire were used as psychosocial hazards in risk assessments. Risk scores obtained by Fine Kinney and AHP methods are compared.

Results: AHP and Fine Kinney methods indicate that "demands at work" and "offensive behavior" domains in COPSOQ II have relatively higher priorities in the workplace. The most effective sub criteria in demands at work domain are: quantitative demands and work pace. Comparison of risk classes show that AHP scores are usually higher than those by Fine Kinney.

Conclusion: Fine Kinney risk scores and classes are considered more realistic than AHP since they include actual responses of the maintenance workers to the COPSOQ II questionnaire. These results provide a useful tool for the management to implement psychosocial hazards in their risk assessment and a roadmap for action plans.

1. Introduction

Psychosocial risk factors are considered among significant risks at the workplace. Although occupational health and safety best practices continue to evolve, accidents and health issues at the workplace remain as a major problem for management and employees. In principle, all personnel are responsible to practice safety as stated in article 19 of Turkish Occupational Health and Safety Law number 6331 [1]. Our focus in this study is the blue-collar maintenance workers at a metal processing plant since these workers tend to have increased exposure to occupational accidents, health issues or psychological stress. The metal processing industry is classified as one of the most hazardous categories, due to its complicated system structure, and is a significant sector worldwide, as well as in Turkey [2].

There are many factors such as chemical, physical, biological, ergonomic, and psychosocial factors that may impair work safety and human health at the workplace. It is likely that people who work in hazardous jobs are more prone to be exposed to psychological stress and may be more vulnerable to psychosocial risks. Although psychosocial risks are stated in the Occupational Health and Safety Risk Assessment regulation in Turkey, there are no clear regulations on how to identify and mitigate psychosocial risks in the legislation [1]. So, psychosocial risks may be overlooked relative to others.

Psychosocial risk factors include the following: Individual factors arising from the employee, conflicts (confusion, error, forgetfulness), sadness, family problems, occupational problems, economic difficulties, insecurity, negative social communication in the workplace, gossip, conflicts with other employees. Ignoring the assessment and management of psychosocial risks can cause a decrease in employee performance, poor working discipline, unhealthy personal relationships as well as poor mental and physical health [3].

Stress at the workplace can cause psychosocial hazards. The International Labor Organization (ILO) defined psychosocial factors (hazards), in terms of “interactions between and among workplace environment, job content, organizational conditions and workers’ capacities, needs, culture, personal extra-job considerations that may, through perceptions and experience, influence health, work performance and job satisfaction” [4].

* Corresponding author.
E-mail address: nalanbac@gmail.com (N. Baç).

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In general, causes of accidents at the workplace are related to human errors, unexpected events or natural disasters or to current physical conditions. Most of the human factors and employee-related errors may occur during the maintenance phase. Maintenance work in the industry highly depends on human skills and quality of maintenance depends on the performance of the person doing the job [5].

Leka and Jain state psychosocial risks as a priority in an overview report of the World Health Organization [6]. Stress due to psychosocial factors occurs when the employee exceeds his/her capacity to cope with those requests that cannot be managed in the workplace. Negative impacts that can be listed are: poor performance, increase in calling in sick or coming to work while sick, increasing rates of accidents and injuries. Skipping work due to stress tends to last longer than absence caused by other causes.

A report of the European Agency for Safety and Health at Work is focused on expert forecasts on psychosocial risks related to occupational safety and health [7]. The forecast on psychosocial risks was established through experts’ surveys carried out in three consecutive survey rounds in 2003 and 2004. Some of the psychosocial risks identified in the 127 pages report are: high emotional demands, work intensification, job insecurity due to new forms of contracts, bullying, poor work-life balance and irregular working hours.

All businesses should consider work-related stress and psychosocial risks. Another study by European Agency for Safety and Health at Work indicates that on the average, 51% of employees think that work-related stress is common at work. In very small enterprises with fewer than ten workers, 51% of workers think that work-related stress is common; in larger organizations, this is increased to 60 % of employees. The perception for common causes of work-related stress are job reorganization or job insecurity and hours worked or workload [8].

Maintenance work is an important function in operation, and is significant in all manufacturing sectors. Maintenance work typically include repair, inspection, testing, adjustment or part replacement. Workers undertaking maintenance jobs are usually exposed to more serious and frequent accidents than production workers. Sheikhalishahi et al., reviewed new approaches that take into account human factors in maintenance workers undertaking maintenance jobs are usually exposed to more serious and frequent accidents than production workers. Sheikhalishahi et al., reviewed new approaches that take into account human factors in maintenance. They state that the maintenance aspect, should be taken into consideration from the design stage of the equipment and organization as a human factor. This would to ensure the continuity of production and reduce maintenance workload, downtime, fatigue and work injuries [9].

When we look at human errors in the metal processing sector, these generally take place in three categories. Skills based ones are often due to failure from lack of skills or overconcentration as a human factor. This would to ensure the continuity of production and reduce maintenance workload, downtime, fatigue and work injuries [9].

Burr et al. [13], indicated that a significant number of psychosocial risk factors for mental health were not included in current workload and effort-reward imbalance models. In Gutenburg Health Study, Nüebling et al., compared two of these tools, namely the “effort-reward imbalance model”, and COPSOQ for compliance and internal validity. They observed similar results for most occupational groups, but noted that especially burnout was slightly better predictable by COPSOQ. Today, the COPSOQ scales are known to include the elements that can assess all available psychosocial risks [14].

Haratau et al., emphasized that the purpose of using the COPSOQ Questionnaire was to facilitate the rapid and regular assessment of the psychological work environment without the need for a computer or other technology. They recommended that all three versions of the Copenhagen questionnaire are useful for assessing work-related psychosocial factors [15]. An extensive list of literature related to various applications of COPSOQ questionnaire in journals, books and theses is given in copsoq-network.org web site [16].

In this study, the aim is to assess psychosocial risk factors for all maintenance workers (n = 120) in a metal plant operating in Istanbul for the first time, by applying the COPSOQ II questionnaire and using AHP, Fine Kinney methods to compare the results.

2. Methods

2.1. Copenhagen Psychosocial Questionnaire COPSOQ II

The management at the plant does not share the health surveillance records of employees contacted during the psychosocial risk assessment, or workplace inspection results, occupational accident records, near-miss incident records and personal exposure measurement results, with third parties. Therefore, COPSOQ II questionnaire was applied to all 120 maintenance workers with their consent to get information about their psychosocial status. The COPSOQ II questionnaire was distributed as hard copies and all of them were answered and returned. The only demographic information the plant management provided for the 120 maintenance workers who responded were that they were all male.

The long version of COPSOQ II questionnaire is composed of five-point Likert scales for all 121 items except the 6 items in “self-efficacy” scale. These six items are converted from four to five-point Likert scale. In the questionnaire the most positive answer was assigned 5 points, and the most negative was assigned 1 point. The answers were converted from qualitative to quantitative and then this scale was converted to the range between 0 and 100 (0, 25, 50, 75 and 100) in psychosocial analysis [11].

All the 127 of the COPSOQ II items are treated as psychosocial hazards for psychosocial risk assessment. AHP and Fine Kinney methods were evaluated in collaboration with external expert opinions of a team consisting of medical doctors, psychologists and the occupational health and safety experts.

2.2. Analytic Hierarchy Process

AHP is a decision-making tool widely used in multi-criteria decision making, introduced by Saaty [17, 18, 19]. AHP is a structured technique to organize and analyze complex decisions based on mathematics and psychology. It includes a useful technique to check the consistency of decision-making assessments and thereby reduce bias in the decision-making process. AHP is used in many different sectors such as business, industry, health, finance, education and communication.

AHP involves the following steps. The decision hierarchy structure is formed including goal and objectives from a broad perspective. Pairwise comparison matrices are constructed, and each item in an upper level is compared with the items in the level immediately below. The priorities obtained from the comparisons are used to weight the priorities in the level immediately below. This is repeated for every item. Then the weighted values for each item yields its overall priority. This process of...
weighing is continued until the final priorities of the alternatives are obtained [19]. In binary comparisons, decisions in AHP are converted to a binary comparison matrix using the severity of importance, such as equal, weak, strong etc. Relative weights are obtained by comparing the alternatives, and priority ranking is achieved [20].

In this study, the order of importance of the 7 domains and their 41 items in COPSOQ II are determined by the AHP method. Each individual item is compared with respect to one another. Pairwise comparisons are used to determine the relative importance of each item.

The consistency ratio (CR) of the hierarchy and decision-making process is calculated with AHP and provides information about the validity of the entire process and the hierarchy. If this ratio is greater than 0.1, comparison decision makers should review their decisions. Thus, the AHP method enables decision-makers to examine their decisions while improving them [21].

Aminakhsh et al., used the AHP method to identify hazards and risks in the management of construction projects. They concluded that the AHP method serves as a control tool to reduce the inconsistency in risk severity and is a sound method of prioritizing risks, and provide realistic targets without compromising security [22].

### 2.3. Fine Kinney method

Fine-Kinney method is a widely used assessment technique for identifying priority of risks, and the level of acceptance of hazards using risk scores. The first introduction of the method by Fine [23] was further modified by Kinney and Wiruth [24]. The risk assessment by Fine Kinney involves three parameters: the probability (P) of a hazardous event, the exposure frequency (F) and consequence (C). The probability (P) ranges from the lowest value of 0.1 (almost impossible) to a maximum of 10 (might well be expected). Exposure frequency (F) ranges from 0.5 (very rare or yearly) to 3 (occasional or weekly) with a maximum value of 10 (continuous). Consequence (C) is expressed in terms of the gravity of outcome. Consequence values start at 1 (noticeable), to 3 (important), 7 (with serious injury), 15 (very serious, fatality) to a maximum of 100 (catastrophic with many fatalities).
Multiplication of these three parameters ($P \times F \times C$) gives the risk score. A hazard with a risk score less than 20 is an “acceptable risk” and no action is needed. Attention is needed for risk scores between 20-70 (“possible risks”). Hazards with risk scores between 70-200 are named “severe risks”, and those between 200-400 have “high risks” requiring immediate need for improvement. If the risk score is greater than 400, it involves “extremely high risk” and that action must be stopped [24].

Table 2. Normalized Risk scores for AHP and Fine Kinney.

| Risk Class | Risk Score | Risk Situation |
|------------|------------|----------------|
| 1          | <0.02      | Acceptable risk |
| 2          | 0.02-0.07  | Possible risk   |
| 3          | 0.07-0.2   | Severe risk     |
| 4          | 0.2-0.4    | High risk       |
| 5          | >0.4       | Extremely high risk |

Table 3. Risk scores and risk classes by AHP and Fine Kinney Methods.

| Scale | AHP Score | AHP Class | Kinney Score | Kinney Class |
|-------|-----------|-----------|--------------|-------------|
| 1     | 0.26239   | 4         | 5            | 0.46800     |
| 2     | 0.43868   | 5         | 5            | 0.57000     |
| 3     | 0.06671   | 2         | 2            | 0.012000    |
| 4     | 0.11207   | 3         | 2            | 0.003000    |
| 5     | 0.14024   | 3         | 2            | 0.062000    |
| 6     | 0.03775   | 2         | 2            | 0.005000    |
| 7     | 0.30567   | 4         | 3            | 0.084000    |
| 8     | 0.10534   | 3         | 3            | 0.078000    |
| 9     | 0.08595   | 3         | 2            | 0.062000    |
| 10    | 0.46528   | 5         | 2            | 0.063000    |
| 11    | 0.37173   | 4         | 3            | 0.039000    |
| 12    | 0.11112   | 3         | 2            | 0.028000    |
| 13    | 0.19758   | 3         | 3            | 0.084000    |
| 14    | 0.09759   | 3         | 3            | 0.007500    |
| 15    | 0.03852   | 2         | 2            | 0.002000    |
| 16    | 0.11352   | 2         | 2            | 0.035000    |
| 17    | 0.04839   | 2         | 1            | 0.017000    |
| 18    | 0.07589   | 3         | 3            | 0.061000    |
| 19    | 0.46132   | 5         | 3            | 0.136000    |
| 20    | 0.34789   | 4         | 2            | 0.068000    |
| 21    | 0.12452   | 3         | 4            | 0.024000    |
| 22    | 0.06627   | 2         | 2            | 0.031000    |
| 23    | 0.18163   | 3         | 4            | 0.028000    |
| 24    | 0.30203   | 4         | 2            | 0.064000    |
| 25    | 0.37879   | 4         | 3            | 0.112000    |
| 26    | 0.13755   | 3         | 2            | 0.047250    |
| 27    | 0.02577   | 2         | 2            | 0.054000    |
| 28    | 0.04525   | 2         | 2            | 0.056000    |
| 29    | 0.11758   | 3         | 3            | 0.072000    |
| 30    | 0.13593   | 3         | 2            | 0.063000    |
| 31    | 0.15779   | 3         | 2            | 0.055000    |
| 32    | 0.43016   | 5         | 2            | 0.069000    |
| 33    | 0.05220   | 2         | 2            | 0.066000    |
| 34    | 0.03533   | 2         | 2            | 0.051000    |
| 35    | 0.34450   | 4         | 3            | 0.120000    |
| 36    | 0.02805   | 2         | 3            | 0.084000    |
| 37    | 0.11438   | 3         | 5            | 0.480000    |
| 38    | 0.06124   | 2         | 3            | 0.180000    |
| 39    | 0.08234   | 3         | 3            | 0.180000    |
| 40    | 0.30828   | 4         | 5            | 0.480000    |
| 41    | 0.06122   | 2         | 3            | 0.084000    |

Babut et al. [25], used the Fine Kinney method in occupational risk assessment in management with quantification of risks and assessment of prevention actions. The points that were neglected in Fine Kinney method were considered and possible treats that may be encountered are investigated. Kokangil et.al. used AHP and Fine Kinney methods to assess risk factors in a machine production case. Their study developed an approach regarding the use of risk class intervals in the Fine Kinney method for the results obtained with AHP [26].

All 127 items in COPSOQ II are used as inputs of psychosocial hazards in the Fine Kinney analyses. Probability values in the Fine Kinney method was selected as the worst probability, since psychosocial risk assessment was done for the first time at the metal processing plant studied. The worst probability in our case is a value of 6 corresponding to “quite possible” [24]. The exposure values were decided by taking into account responses of all maintenance workers to the COPSOQ II questionnaire. In addition, the consequence values were evaluated with a little pessimism. An example to little pessimism involves an approach like, when a...
consequence value is estimated as 3 (important), one level higher value of 7 (with serious injury) is selected. The team of physicians and psychologists recommend that consequence values are not estimated to be lower than they actually are. This is a safe approach in Fine Kinney analysis when there is no previous risk assessment related to that work place.

The AHP and Fine Kinney method results are analyzed statistically by SPSS statistical package IBM version 25.0 [27]. SPSS package provides tools like Cronbach alpha coefficient, t-test and Levene’s test. Cronbach’s alpha is a measure used to assess the reliability, or internal consistency, of a set of scale or test items in a survey [28]. The independent samples t-test compares the means of two independent groups in order to determine whether there is statistical evidence that the means are significantly different. Levene’s test indicates whether the variances across the two groups are equal or not.

2.4. Ethics considerations

The use of COPSOQ II Questionnaire is approved by the Ethics committee of Istanbul Commerce University. The final ratification is granted by Vice President of Research of Commerce University on March 17, 2020.

3. Results and discussion

A measure of psychosocial situations that determine the consistency of the COPSOQ II survey responses is the Cronbach Alpha (α) value. This coefficient is calculated by SPSS version 25 [27]. Cronbach Alpha coefficient of the 41 scales in seven domains in the COPSOQ II questionnaire are given in Table 1. The majority of the scales showed satisfactory Cronbach’s alphas, ranging from 0.846 to 0.977. The following two scales had coefficients slightly less than 0.70: family-work conflict (0.636) and mutual trust between employees (0.686) which are acceptable. The results indicate that each section have high internal consistency. The Fine Kinney risk scores were normalized so that the lower and upper limits of both methods are standardized, and risk class limits are given in Table 2. The consistency ratio (CR) was calculated as 0.073 by AHP. A CR value less than 0.1 indicates the validity of decisions.

The results of AHP and Fine Kinney methods in Table 3 are shown as a reference during the psychosocial risk assessment, the results of the Fine Kinney method are statistically analyzed by SPSS package IBM version 25.0. The results indicate that each section have high internal consistency. The Fine Kinney risk scores were normalized so that the lower and upper limits of both methods are standardized, and risk class limits are given in Table 2. The consistency ratio (CR) was calculated as 0.073 by AHP. A CR value less than 0.1 indicates the validity of decisions.

The results of AHP and Fine Kinney methods in Table 3 are shown as a reference during the psychosocial risk assessment, the results of the Fine Kinney method are statistically analyzed by SPSS package IBM version 25.0. The results indicate that each section have high internal consistency. The Fine Kinney risk scores were normalized so that the lower and upper limits of both methods are standardized, and risk class limits are given in Table 2. The consistency ratio (CR) was calculated as 0.073 by AHP. A CR value less than 0.1 indicates the validity of decisions.

Table 4. AHP and Fine Kinney Results of commitment to the workplace (CW), job insecurity (JI), job satisfaction (JS), trust regarding management (TM), somatic stress (SO).

| Item | Hazards | AHP | F.Kinney | AHP Risk Class | F.Kinney Risk Class |
|------|---------|-----|----------|----------------|---------------------|
| CW1  | do not enjoy telling others about your place of work | 0.0429 | 0.036 | 2 | 2 |
| CW2  | feel that your place of work is of great importance to you | 0.3316 | 0.126 | 4 | 3 |
| CW3  | do not recommend a good friend to apply for a position at your workplace | 0.1803 | 0.036 | 3 | 2 |
| CW4  | consider looking for work elsewhere | 0.4452 | 0.054 | 5 | 2 |
| JI1  | being worried about becoming unemployed | 0.1799 | 0.252 | 3 | 4 |
| JI2  | being worried about new technology making you redundant | 0.1281 | 0.042 | 3 | 2 |
| JI3  | being worried about it being difficult for you to find another job if you became unemployed | 0.6185 | 0.126 | 5 | 3 |
| JI4  | being worried about being transferred to another job against your will | 0.0735 | 0.126 | 3 | 3 |
| JS1  | being displeased your work prospects | 0.1333 | 0.018 | 3 | 1 |
| JS2  | being displeased with the physical working conditions | 0.5663 | 0.126 | 5 | 3 |
| JS3  | being displeased with the way your abilities are used | 0.0936 | 0.084 | 3 | 3 |
| JS4  | being displeased with your job as a whole everything taken into consideration | 0.2069 | 0.042 | 4 | 2 |
| TM1  | the management do not trust the employees to do their work well | 0.0737 | 0.021 | 3 | 2 |
| TM2  | cannot trust the information that comes from the management | 0.4955 | 0.021 | 5 | 2 |
| TM3  | the management withholds important information from the employees | 0.2959 | 0.108 | 4 | 3 |
| TM4  | the employees are not able to express their views and feelings | 0.1348 | 0.108 | 3 | 3 |
| SO1  | had stomach ache during the last month | 0.2168 | 0.054 | 4 | 2 |
| SO2  | had a headache during the last month | 0.2987 | 0.126 | 4 | 3 |
| SO3  | had palpitations during the last month | 0.4231 | 0.042 | 5 | 2 |
| SO4  | had tension in various muscles during the last month | 0.0615 | 0.054 | 2 | 2 |
be satisfied with the work environment, working conditions, in short, with their work. However, when the AHP method was used, since only hazards were evaluated, AHP risk class results were usually higher than most Fine Kinney risk classes.

The independent t test and Levene’s test was used to further compare the risk scores obtained by AHP and Fine Kinney methods in the seven domains separately, and in the overall results in Table 3. The group statistics are given in Table 5 and Levene’s test for equality of variances and t-test results are given in Table 6. Table 5 indicates relatively slight differences between the mean and standard deviation values of AHP and Fine Kinney scores for the “demands at work”, “offensive behavior” domains and the “overall” case. Other domains in Table 5 had significant differences in the mean and standard deviation results with AHP and Fine Kinney methods. Table 6 shows the results of Levene’s test for equality of variance analysis and independent t-test. The cases where the value of Sig is greater than 0.05 (demands at work, interpersonal relations and leadership, work-individual interface, offensive behavior, and overall) indicate that the variability of the two methods are about the same. For others with Sig values less than 0.05, the variances for the two cases are different.

When the p values (sig-2 tailed) are considered in Table 6, we check for those that are less than or equal to 0.05. The low p-value (0.018) in the “values at the workplace” domain indicate that the data for AHP and Fine Kinney are statistically different and did not occur by chance. For all the other groups, and the overall case in Table 6 p-values are greater than 0.05. This implies that the results of AHP and Fine Kinney methods do not seem to be statistically different but may be either due to chance or due to the fact that Fine Kinney results involve actual inputs from the maintenance workers responding to the COPSOQ II questionnaire.

This study is to provide the management a useful tool to assess psychosocial hazards in the maintenance operations at the workplace that should be extended to all other operations. The management has new knowledge about psychosocial risks of its maintenance employees. As a practical implication, the management is advised to implement the psychosocial hazards identified in this work in their risk assessment and develop preventive action plans. This has not been considered at the current metal processing plant previously.

### Conclusion

Application of the COPSOQ II questionnaire to all maintenance workers in the metal processing plant in Istanbul, Turkey for the first time was helpful in considering psychosocial hazards. AHP and Fine Kinney methods enabled assessment of risk scores and ranks in terms of risk classes. Risk scores by AHP appeared to be higher than Fine Kinney.
method in most of the scales. Fine Kinney risk scores and classes are considered more realistic since they include actual responses of the maintenance workers to the questionnaire. This pilot study provides a useful procedure for the management to implement psychosocial hazards in their risk assessment and a roadmap for action plans.

Declarations

Author contribution statement

Nalan Baç: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Ismail Ekmekçi: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Data availability statement

The data that has been used is confidential.

Data availability statement

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