Journal of Mathematics and Mathematics Education
https://jurnal.uns.ac.id/jmme

p-ISSN 2089-8878; e-ISSN 2715-8276
Vol. 13, No. 2, December 2023

APPLICATION OF AHP METHOD IN DETERMINING PRIORITY WORK ACCIDENT AREAS AT CV PESONA MEBELINDO

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Abstrak: Penelitian ini bertujuan untuk mengetahui urutan prioritas area kecelakaan kerja pada usaha furniture di CV Pesona Mebelindo. Salah satu urgensi penelitian ini adalah angka kecelakaan kerja di Indonesia masih tergolong tinggi sehingga diperlukan upaya pencegahan untuk meminimalkan angka kecelakaan kerja. Metode yang digunakan dalam penelitian ini adalah *Analytical Hierarchy Process* (AHP). Dalam metode tersebut, terdapat tiga bagian penting yaitu tujuan, kriteria, dan alternatif. Tujuan dalam penelitian ini adalah menentukan prioritas area kecelakaan kerja. Kriteria dalam penelitian ini meliputi pekerja, lingkungan, dan peralatan. Sedangkan alternatif dalam penelitian ini meliputi ruang barang mentah, ruang material, ruang amplas, *finishing*, *packing*, *dan stuffing*. Proses pengambilan data diperoleh dari kuesioner yang diisi oleh pekerja di CV Pesona Mebelindo yang diolah menjadi matriks perbandingan berpasangan, normalisasi matriks, penentuan bobot kepentingan, dan perhitungan rasio konsistensi dengan ketentuan nilai CR harus dibawah 10%. Dengan menggunakan metode *Analytical Hierarchy Process* (AHP) diperoleh urutan prioritas area kecelakaan kerja di CV Pesona Mebelindo yaitu ruang amplas, *finishing*, *packing*, *stuffing*, ruang material, dan ruang barang mentah.

Kata kunci : *Metode AHP, Area Kecelakaan Kerja, CV Pesona Mebelindo*

Abstract: This research aims to determine the priority order of work accident areas in the furniture business at CV Pesona Mebelindo. One of the urgencies of this research is that the number of work accidents in Indonesia is still relatively high, so prevention efforts are needed to minimize the number of work accidents. The method used in this research is Analytical Hierarchy Process (AHP). In this method, there are three important parts, namely goals, criteria and alternatives. The aim of this research is to determine priority areas for work accidents. The criteria in this research include workers, environment and equipment. Meanwhile, alternatives in this research include the raw goods room, material room, sanding room, finishing, packing and stuffing. The data collection process was obtained from questionnaires filled out by workers at CV Pesona Mebelindo which were processed into a pairwise comparison matrix, matrix normalization, determining importance weights, and calculating consistency ratios with the condition that the CR value had to be below 10%. By using the Analytical Hierarchy Process (AHP) method, the priority order of work accident areas at CV Pesona Mebelindo was obtained, namely the sanding, finishing, packing, stuffing, materials room and raw goods room.

Keywords: *AHP Method, Work Accident Areas, CV Pesona Mebelindo*

Accepted: january 31, 2023 Approved: october 03, 2023 Published: December 01, 2023
DOI: https://dx.doi.org/10.20961/jmme.v13i2.83471

p-ISSN 2089-8878; e-ISSN 2715-8276

INTRODUCTION

Decision support systems are oriented towards decision making using mathematical calculations. There are several methods in decision support systems (Decision Support Systems), including the Fuzzy Logic Method, Expert System Method, and Analytical Hierarchy Process (AHP) Method (Riotisna, Sukarsa, Srinadi, & Kencana, 2023).

The Analytical Hierarchy Process (AHP) method is a decision support method that breaks down complex multi-criteria problems into a hierarchy. The Analytical Hierarchy Process (AHP) method is not only used for government or private institutions but can be applied for research purposes related to policy or determining priorities.

Based on BPJS Employment data, there has been an increase in the number of work accidents since the 2020 to 2022 pandemic, which is around 200 thousand cases. It can be seen in the table below that in 2020 there were 221,740 work accident cases, while in 2021 there were 234,270 work accident cases. Until November 2022, the number of work accidents reached 265,334 cases (Syaharani, 2023). Quoting from the National K3 Profile Book in Indonesia 2022, work accident cases most often occur in the various industrial business sectors at 22.3% and are followed by four other sectors, namely trade and services, fisheries and plantations, consumer goods industry, basic industry and chemicals.

The industrial sector is one of the business sectors that has quite good development in the realm of export trade with high market demand. On the other hand, the industrial sector has a fairly high potential for work accidents. This can be caused by several factors such as workers, the environment, and the equipment used.

CV Pesona Mebelindo is one of the exporters in Indonesia which operates in the furniture sector, especially in making furniture such as TV stands, dining tables, chairs, cupboards, buffets, nightstands, beds, and so on. The company is located on Jl. Raya Telukan, Sonorejo, District. Sukoharjo, Sukoharjo Regency, Central Java. The company's main focus is designing and developing various materials for indoor furniture, home decoration and accessories. Based on information obtained through interviews with Mr. Ari Supriyanto as President Director, the company has standard operating procedures (SOP) that apply to all workers. The number of workers in the company is 40 people. During the production process, several work accidents were found experienced by workers, such as being hit by objects, being scratched by polishing tools, having their fingers scratched by wood sandpaper, and so on.

Work accidents can result in losses for the company, both in terms of financial, human and material resources. Work safety is something that needs to be considered by an industry for the sake of the interests and productivity of workers in accordance with Law No. 1 of 1970 concerning Work Safety, one of which states that everyone in the workplace needs to have their safety guaranteed.

Based on the background that has been described, the author wishes to assist CV Pesona Mebelindo in determining the priority order of work accident areas in the production process using the Analytical Hierarchy Process (AHP) method. Through this research, it is hoped that it will be able to produce information regarding which work areas have high accident rates so that it can be used as a priority target to prevent and reduce cases of work accidents that occur in this industrial sector.

RESEARCH METHOD

The data collection process begins by conducting observations and interviews with the Director of CV Pesona Mebelindo according to the required data. The research methodology used is a quantitative method by taking data in the form of questionnaires from respondents. The number of respondents in this study was 10 respondents.

The results of interviews and filling out questionnaires by respondents were then used as data which was processed using the Analytical Hierarchy Process (AHP) method, in order to obtain results in the form of a priority order for work accident areas at CV Pesona Mebelindo.

AHP Weighted Method (Mukharir & Wardoyo, 2021):

The first step of the AHP method is to perform pairwise comparisons by creating a pairwise comparison matrix based on the Saaty fundamental scale using equation (1).

$$\begin{bmatrix} a_{11} & \cdots & a_{1n} \\ \vdots & \ddots & \vdots \\ a_{n1} & \dots & a_{nn} \end{bmatrix} \quad (1)$$

The next step is to normalize the matrix with pairwise comparisons with the equation (2).

$$r_{ij} = \frac{a_{ij}}{\sum_{i=1}^{n} a_{ij}} \quad (2)$$

Then calculate the weight of each criterion by adding horizontally and then dividing by many criteria using equation (3).

$$w_i = \frac{\sum_{j=1}^{n} r_{ij}}{n} \quad (3)$$

After the weights between criteria are obtained, the next step is to check the consistency of the weights by calculating the Consistency Ratio (CR) value. To get the CR value, the first step is to calculate the WSV value with equation (5). Equation (4) is used to obtain a pairwise comparison matrix that has been multiplied by the weight of the criteria obtained. The pairwise comparison matrix subjected to the function is the matrix before normalization.

$$s_{ij} = a_{ij}\, w_j \quad (4)$$

 p-ISSN 2089-8878; e-ISSN 2715-8276

$$WSV_i = \sum_{j=1}^{n} s_{ij} \quad (5)$$

After the WSV value is obtained, then calculate the Consistency Vector (CV) value by dividing the WSV by the weight of the criteria corresponding to the row using equation (6).

$$CV_i = \frac{WSV_i}{w_i} \quad (6)$$

Then calculate the maximum eigenvalue (λmax) by adding up the CV values and then dividing by many criteria using equation (7).

$$\lambda_{maks} = \frac{\sum_{i=1}^{n} CV_i}{n} \quad (7)$$

The next step is to calculate the Consistency Index (CI) value with equation (8).

$$CI = \frac{(\lambda_{maks} - n)}{n-1} \quad (8)$$

Then the Consistency Ratio (CR) value is calculated using equation (9).

$$CR = \frac{CI}{RI} \quad (9)$$

If the CR value is less than 0,1 then the comparison is considered consistent and the weights can be used for calculations in making decisions. If not, it is necessary to re-comparison until the CR value is less than 0,1.

RESULTS AND DISCUSSION

1. Application of the Analytical Hierarchy Process (AHP) Method in Determining Priority Work Accident Areas in the CV Pesona Mebelindo

Weight calculation and consistency test for criteria

Based on the respondents assessments, a pairwise comparison matrix for the criteria shown in the following table :

Table 1. Pairwise Comaparison Matrix for Criteria

Criteria	Worker	Environment	Equipment
Worker	1,000	3,016	3,501
Environment	0,332	1,000	2,449
Equipment	0,286	0,408	1,000
Sum	1,617	4,424	6,950

Table 2. Normalize Matrix and Eigen Vectors for Criteria

Criteria	Worker	Environment	Equipment	Eigen Vector
Worker	0,618	0,682	0,504	0,601
Environment	0,205	0,226	0,352	0,261

Equipment	0,177	0,092	0,144	0,138
Sum	1,000	1,000	1,000	

The first step to carry out a consistency test is to calculate the WSV and CV values.

Table 3. WSV and CV for Criteria

Criteria	WSV	CV
Worker	1,871	3,111
Environment	0,797	3,054
Equipment	0,416	3,023

With the help of Excel software, the maximum eigenvalue was obtained, namely λ max = 3,063 and the CI value = 0,031. After getting the CI value, proceed with calculating the CR. For n=3 then RI=0,58. So the CR value = 0,054.

Based on the calculations above, a consistency ratio (CR) value <0.1 is obtained. So the results of calculating the criteria weights are consistent.

Weight calculation and consistency test alternatives for worker criteria

Based on the respondents assessments, a pairwise comparison matrix alternatives for the worker criteria shown in the following table :

Table 4. Pairwise Comaparison Matrix Alternatives for Worker Criteria

Alternatives	Raw goods room	Materials room	Sanding	Finishing	Packing	Stuffing
Raw goods room	1,000	0,392	0,140	0,138	0,238	0,222
Materials room	2,551	1,000	0,153	0,142	0,291	0,262
Sanding	7,125	6,536	1,000	0,461	3,898	3,519
Finishing	7,246	7,065	2,169	1,000	4,129	3,622
Packing	4,205	3,442	0,257	0,242	1,000	0,443
Stuffing	4,507	3,812	0,284	0,276	2,259	1,000
Sum	26,634	22,247	4,003	2,259	11,814	9,068

Table 5. Normalize Matrix and Eigen Vector Alternatives for Worker Criteria

Alternatives	Raw goods room	Materials room	Sanding	Finishing	Packing	Stuffing	Eigen Vector
Raw goods room	0,038	0,018	0,035	0,061	0,020	0,024	0,033
Materials room	0,096	0,045	0,038	0,063	0,025	0,029	0,056
Sanding	0,268	0,294	0,250	0,204	0,330	0,388	0,409
Finishing	0,272	0,318	0,542	0,443	0,349	0,399	0,279
Packing	0,158	0,155	0,064	0,107	0,085	0,049	0,129
Stuffing	0,169	0,171	0,071	0,122	0,191	0,110	0,094
Sum	1,000	1,000	1,000	1,000	1,000	1,000	

The first step to carry out a consistency test is to calculate the WSV and CV values.

Table 6. WSV and CV Alternatives for Worker Criteria

p-ISSN 2089-8878; e-ISSN 2715-8276

Alternatives	WSV	CV
Raw goods room	0,204	6,184
Materials room	0,341	6,058
Sanding	2,716	6,637
Finishing	1,875	6,721
Packing	0,840	6,537
Stuffing	0,589	6,261

With the help of Excel software, the maximum eigenvalue was obtained, namely λ max = 6,400 and the CI value = 0,080. After getting the CI value, proceed with calculating the CR. For n=3 then RI=1,24. So the CR value = 0,064.

Based on the calculations above, a consistency ratio (CR) value <0.1 is obtained. So the results of calculating alternative weights for worker criteria are consistent.

Weight calculation and consistency test alternatives for environment criteria :

Based on the respondents assessments, a pairwise comparison matrix alternatives for environment criteria shown in the following table :

Table 7. Pairwise Comaparison Matrix Alternatives for Environment Criteria

Alternatives	Raw goods room	Materials room	Sanding	Finishing	Packing	Stuffing
Raw goods room	1,000	0,315	0,136	0,142	0,249	0,194
Materials room	3,178	1,000	0,146	0,151	0,381	0,328
Sanding	7,369	6,865	1,000	2,449	4,544	4,112
Finishing	7,031	6,619	0,408	1,000	3,812	3,646
Packing	4,012	2,625	0,220	0,262	1,000	0,425
Stuffing	5,144	3,051	0,243	0,274	2,352	1,000
Sum	27,734	20,474	2,153	4,279	12,338	9,705

Table 8. Normalize Matrix and Eigen Vector Alternatives for Environment Criteria

Alternatives	Raw goods room	Materials room	Sanding	Finishing	Packing	Stuffing	Eigen Vector
Raw goods room	0,036	0,015	0,063	0,033	0,020	0,020	0,031
Materials room	0,115	0,049	0,068	0,035	0,031	0,034	0,055
Sanding	0,266	0,335	0,464	0,572	0,368	0,424	0,405
Finishing	0,254	0,323	0,190	0,234	0,309	0,376	0,281
Packing	0,145	0,128	0,102	0,061	0,081	0,044	0,094
Stuffing	0,185	0,149	0,113	0,064	0,191	0,103	0,134
Sum	1,000	1,000	1,000	1,000	1,000	1,000	

The first step to carry out a consistency test is to calculate the WSV and CV values.

Table 9. WSV and CV Alternatives for Environment Criteria

Alternatives	WSV	CV
Raw goods room	0,193	6,161
Materials room	0,336	6,085
Sanding	2,679	6,616
Finishing	1,877	6,686
Packing	0,584	6,242
Stuffing	0,859	6,402

With the help of Excel software, the maximum eigenvalue was obtained, namely λ max = 6,365 and the CI value = 0,073. After getting the CI value, proceed with calculating the CR. For n=3 then RI=1,24. So the CR value = 0,059.

Based on the calculations above, a consistency ratio (CR) value <0.1 is obtained. So the results of calculating alternative weights for environmental criteria are consistent.

Weight calculation and consistency test alternatives for equipment criteria :

Based on the respondents assessments, a pairwise comparison matrix alternatives for equipment criteria shown in the following table :

Table 10. Pairwise Comaparison Matrix Alternatives for Equipment Criteria

Alternatives	Raw goods room	Materials room	Sanding	Finishing	Packing	Stuffing
Raw goods room	1,000	0,392	0,140	0,138	0,238	0,222
Materials room	2,551	1,000	0,153	0,142	0,291	0,262
Sanding	7,125	6,536	1,000	0,461	3,898	3,519
Finishing	7,246	7,065	2,169	1,000	4,129	3,622
Packing	4,205	3,442	0,257	0,242	1,000	0,443
Stuffing	4,507	3,812	0,284	0,276	2,259	1,000
Sum	26,634	22,247	4,003	2,259	11,814	9,068

Table 11. Normalize Matrix and Eigen Vector Alternatives for Equipment Criteria

Alternatives	Raw goods room	Materials room	Sanding	Finishing	Packing	Stuffing	Eigen Vector
Raw goods room	0,038	0,018	0,035	0,061	0,020	0,024	0,033
Materials room	0,096	0,045	0,038	0,063	0,025	0,029	0,049
Sanding	0,268	0,294	0,250	0,204	0,330	0,388	0,289
Finishing	0,272	0,318	0,542	0,443	0,349	0,399	0,387
Packing	0,158	0,155	0,064	0,107	0,085	0,049	0,103
Stuffing	0,169	0,171	0,071	0,122	0,191	0,110	0,139
Sum	1,000	1,000	1,000	1,000	1,000	1,000	

The first step to carry out a consistency test is to calculate the WSV and CV values.

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Table 12. WSV and CV Alternatives for Equipment Criteria

Alternatives	WSV	CV
Raw goods room	0,201	6,164
Materials room	0,298	6,056
Sanding	1,912	6,621
Finishing	2,527	6,526
Packing	0,639	6,210
Stuffing	0,895	6,431

With the help of Excel software, the maximum eigenvalue was obtained, namely λ max = 6,335 and the CI value = 0,067. After getting the CI value, proceed with calculating the CR. For n=3 then RI=1,24. So the CR value = 0,054.

Based on the calculations above, a consistency ratio (CR) value <0.1 is obtained. So the results of calculating alternative weights for equipment criteria are consistent.

Table 13. Eigen Vectors for Alternatives

	Worker	Environment	Equipment
Raw goods room	0,033	0,031	0,033
Materials room	0,056	0,055	0,049
Sanding	0,409	0,405	0,289
Finishing	0,279	0,281	0,387
Packing	0,129	0,094	0,103
Stuffing	0,094	0,134	0,139

Then multiply the alternative eigenvector matrix against the criterion eigenvector.

2. Results of the Application of the Analytical Hierarchy Process (AHP) Method in Determining Priority Work Accident Areas in the CV Pesona Mebelindo

Based on the results of the calculations above, the weights of each alternative are obtained which are presented in the following table:

Table 14. Calculation Results and Ranking

Alternatives	Eigen Vector	Persentase	Ranking
Raw goods room	0,032	3,241%	6
Materials room	0,055	5,498%	5
Sanding	0,392	39,155%	1
Finishing	0,294	29,432%	2
Packing	0,116	11,588%	3
Stuffing	0,111	11,079%	4

In this way, the priority order of work areas that have the potential to experience work accidents is obtained, namely the sanding, finishing, packing, stuffing, materials room and raw goods room.

CONCLUSIONS AND SUGGESTIONS

Data analysis in the AHP method uses mathematical calculations such as eigenvectors, comparison matrices, consistency ratios, and other concepts. One application of the AHP method is determining the priority order of work accident areas in the CV Pesona Mebelindo furniture industry. In terms of criteria, the order of priority is workers, environment and equipment. Meanwhile, in terms of alternatives, the priority order for work accident areas is the sanding room, finishing, packing, stuffing, material room and raw goods room.

CV Pesona Mebelindo is expected to pay more attention or give special attention to the sanding and finishing room area considering that this area has a high priority order for work accidents compared to other areas. This can be used as an effort to minimize the number of work accidents in the company. For further research, it is recommended to use a decision-making system method such as the fuzzy logic method or other methods to determine the weighted value of each work area that has the potential to experience work accidents.

ACKNOWLEDGMENTS

The author would like to thank Mr. Ari Supriyanto as director of CV Pesona Mebelindo who has given research permission and helped in providing data and information for this research. In addition, the author would like to thank Dr. Laila Fitriana, S.Pd., M.Pd., as the supervisor who provided direction and suggestions for this research.

REFERENCES

Adiratna, Y., et al. (2022). *Profil Keselamatan dan Kesehatan Kerja Nasional Indonesia Tahun 2022.* Jakarta Selatan: Kementerian Ketenagakerjaan Republik Indonesia.

Anton, H., & Rorres, C. (2014). *Elementary Linear Algebra Applications Version, 11th Editions.* Canada: Wiley.

Azhar, Z., & Handayani, M. (2018). Analisis Faktor Prioritas Dalam Pemilihan Perumahan KPR Menggunakan Metode AHP. *Jurnal Manajemen Informatika & Sistem Informasi*, 1(2), 19-22. https://doi.org/10.36595/misi.v1i2.38

Darmanto, E., Latifah, N., & Latifah, N. (2014). Penerapan Metode AHP (Analythic Hierarchy Process) Untuk Menentukan Kualitas Gula Tumbu. *Jurnal SIMETRIS*, 5(1), 75-82. https://doi.org/10.24176/simet.v5i1.139

Fadillah, R., Dur, S., & Cipta, H. (2021). Penerapan Metode Analytical Hierarchy Process dalam Menentukan Gaji Bonus Karyawan pada PTPN III Sei Putih. *Jurnal Sains Matematika dan Statistika*, 7(1), 73-84. http://dx.doi.org/10.24014/jsms.v7i2.12968

Kurniawan, A. (2020). Sistem Pengambilan Keputusan Peringkatisasi Mitra Penyedia Talenta Digital Menggunakan Metode Analytical Hierarchy Process (AHP) Pada Tribe Enterprise Wholesale Digitalization. *Jurnal Nasional Informatika*, 1(1), 13-29. Retrieved from https://ejournal-ibik57.ac.id/index.php/junif/article/view/12

Mukharir, M., & Wardoyo, R. (2021). Decision Support System for Laptop Selection Using AHP Method and Profile Matching. *IJCCS (Indonesian Journal of Computing and Cybernetics Systems)*, 15(3), 307-316. https://doi.org/10.22146/ijccs.67811

Nugroho, A. O., & Veronica, R. B. (2021). Penerapan Metode AHP Sebagai Sistem Pendukung Keputusan Pemilihan Tempat Kerja. *UNNES Journal of Mathematics* , 10(1), 47-54. https://doi.org/10.15294/UJM.V10I1.44631

Pribadi, D., Saputra, R. A., Hudin, J. M., & Gunawan. (2020). *Sistem Pendukung Keputusan.* Yogyakarta: Graha Ilmu.

Rahmansyah, N., & Lusinia, S. A. (2021). *Sistem Pendukung Keputusan.* Padang: Pustaka Galeri Mandiri.

Riotisna, I. M., Sukarsa, I. K., Srinadi, I. G., & Kencana, I. P. (2023). Penentuan Prioritas Atribut Produsen Minuman Instan Dengan Menggunakan Metode Analytic Hierarchy Process. *E-Jurnal Matematika*, 12(3), 234-241. https://doi.org/10.24843/MTK.2023.v12.i03.p424

Sudradjat, A., Sodiqin, M., & Komarudin, I. (2020). Penerapan Metode Analytical Hierarchy Process Terhadap Pemilihan Merek CCTV. *Jurnal Infortech*, 2(1), 19-30. https://doi.org/10.31294/infortech.v2i1.7660

Sulistyaningsih, E., & Nugroho, A. (2022). Analisis Penyebab Kecelakaan Kerja Dengan Menggunakan Metode Analytic Hierarchy Process (AHP) di PT BSPL . *INSOLOGI: Jurnal Sains dan Teknologi*, 1(4), 376-384. https://doi.org/10.55123/insologi.v1i4.701

Suryadi, A., & Harahap, E. (2017). Pemeringkatan Pegawai Berprestasi Menggunakan Metode AHP (Analytic Hierarchy Process) di PT. XYZ. *Jurnal Matematika*, 16(2), 17-28. https://doi.org/10.29313/jmtm.v16i2.2698

Syaharani, M. (2023, February 21). *Jumlah Kecelakaan Kerja Indonesia dalam 8 Tahun Terakhir*. Retrieved from goodstats.id: https://data.goodstats.id/statistic/melasyhrn/jumlah-kecelakaan-kerja-indonesia-dalam-8-tahun-terakhir-sjo5X

Wardani, N. P., & Sulaiman, R. (2023). Penentuan Prioritas Perbaikan Jembatan Pada Jaringan Jalan Provinsi Jawa Timur Menggunakan Metode Integrasi AHP-Topsis. *Jurnal Ilmiah Matematika*, 11(2), 235-245. https://doi.org/10.26740/mathunesa.v11n2.p235-245

Widada, B., Vulandari, R. T., & Yusuf, M. (2022). Implementasi Analytical Hierarchy Process (Ahp) Pada Pemilihan Karyawan Teladan. *Journal of Mathematics Education and Sains*, 5(1), 37-43. https://doi.org/10.32665/james.v5i1.403