Scientific Foundation SPIROSKI, Skopje, Republic of Macedonia
Open Access Macedonian Journal of Medical Sciences. 2022 Oct 07; 10(E):1779-1783.
https://doi.org/10.3889/oamjms.2022.9155
eISSN: 1857-9655
Category: *E - Public Health*
Section: *Public Health Disease Control*

Since 2002

OPEN ACCESS

Structural Equation Modeling using Partial Least Squares for Occupational Safety and Health Factors and Work Environment Factors Toward Occupational Diseases on Labors in Industry X Cimahi City

Ati Nurhayati, Lubis Bambang Purnama, Pujiono Pujiono, Salma Aripin*

Department of Environmental Health, Bandung Health Polytechnic, Bandung, Indonesia

Edited by: Sasho Stoleski
Citation: Nurhayati A, Purnama LB, Pujiono P, Aripin S. Structural Equation Modeling using Partial Least Squares for Occupational Safety and Health Factors and Work Environment Factors Toward Occupational Diseases on Labors in Industry X Cimahi City. Open Access Maced J Med Sci. 2022 Oct 07; 10(E):1779-1783. https://doi.org/10.3889/oamjms.2022.9155
Keywords: OSH factors; Work environment factors; Occupational diseases
***Correspondence:** Salma Aripin, Department of Environmental Health, Bandung Health Polytechnic, Bandung, Indonesia. E-mail: salma.aripin@gmail.com
Received: 01-Mar-2022
Revised: 15-Mar-2022
Accepted: 26-Sep-2022

Funding: This study was supported by Bandung Health Polytechnic
Competing Interests: The authors have declared that no competing interests exist

Abstract

BACKGROUND: Work, work tools, materials, procedures, and the work environment can all contribute to occupational diseases. In the manufacturing industry, efforts to control risk factors during the manufacturing process are critical. For environmental prevention and management, these efforts are carried out through monitoring and measuring the work environment. Technical control, administrative control, and the use of personal protective equipment (PPE) are some of the measures taken to maintain workers' health and protect them from work-related illnesses and bad effects.

AIM: Using Partial Least Square Structural Equation Modeling, this study aims to determine how to model occupational safety and health (OSH) variables, persons, and the work environment that can cause occupational diseases in workers (PLS-SEM).

METHODS: This study has a sample size of 50 workers (respondents). The analysis used is Chi-square and PLSSEM.

RESULTS: The results showed a significant relationship between the PPE use, years of service, air dust levels, illness history, and noise factor with the incidence of occupational diseases. Finally, there is a link between OSH variables (PPE use and noise factor) and occupational diseases, as well as between individual factors (years of service and illness history) and occupational diseases, and between work environment factors (air dust levels).

CONCLUSION: In suggestion, a control over workplace environmental parameters that exceeded the threshold value is required, such as dust, noise, lighting, temperature, and humidity levels. Further, research on other risk factors that can affect the incidence of occupational diseases is required, such as gas parameters, ventilation, and the application of OSH management systems.

Introduction

One of the diseases caused by the work environment can be suffered by a person when inhaling compounds or materials used in an industrial environment. Work, work tools, materials, procedures, and the work environment can all contribute to occupational disorders [1]. In the manufacturing industry, efforts to control risk factors during the manufacturing process are critical these efforts which are carried out through the monitoring and measurement of the working environment to undertake environmental prevention and management. Technical control, administrative control, and the use of personal protective equipment (PPE) are some of the measures taken to maintain workers' health and protect them from work-related illnesses and bad effects.

Exposure to pollutants in the manufacturing industry can cause health problems for workers. It occurs due to risk factors from the work environment and individuals (workers), as well as occupational safety and health (OSH) factors. Risk factors from the work environment include physical factors (noise, lighting, temperature, and humidity), chemical factors (total dust level and dust exposure duration), biological factors, psychosocial factors, and ergonomics [2]. Gender, age, years of service, disease history, dietary status, smoking habits, exercise habits, and use of PPE are all individual risk factors [3]. Another influential factor is the OSH factors, which includes the PPE provision and OSH infrastructure, OSH training/counseling, and its workload. Efforts to monitor and measure the work environment are required to prevent and control the work environment against health problems for workers in the manufacturing industry.

These efforts can protect workers from occupational diseases and work accidents caused by working conditions, and by doing so, the workers' productivity will be optimal [4]. Workers are healthy individuals who are free from illness, injury, and even mental and emotional problems that can interfere with their daily activities in general [5]. OSH in companies is important, because the impacts of accidents and occupational diseases do not only harm workers, but also the industry [6]. The industry has to bear the workers' medical and hospital costs, the loss of work time or even illness due to work from the workers, or even the funeral costs if the worker dies due to work-related- accidents or illness [7], [8].

Using Partial Least Square Structural Equation Modeling, this study tries to figure out how to model OSH variables, persons, and the work environment that can cause occupational diseases in workers (PLS-SEM).

Methods

Using Partial Least Square Structural Equation Modeling, this study tries to figure out how to model OSH variables, PLS-SEM. The proportionate sampling approach was used to choose the sample, which involved sampling a list of workers from each production section.

The variables in this study consisted of independent variables, namely, the indicator variables of the Occupational Health and Safety factor construct (the use of PPE/PPE, ergonomics, OSH training, and working time), the physical environment (noise, lighting, dust, humidity, and room temperature), individual factors (age, gender, length of work, nutritional status, smoking habits, and exercise habits), and the dependent variable of occupational diseases with indicators of health problems and their illness record.

The participants in this study were factory workers who were at risk of dust exposure. The sample size in this study was 50 respondents [9]. The research flow is described in the form of a picture as follows:

The research flow in this study is described in Figure 1. Data collection of respondent data and environmental data was obtained through interviews and measurements. Data analysis in this study includes univariate analysis that consists of frequency distribution overview on the independent and dependent variables, the data are presented in tabular form and interpreted, the link between the independent and dependent variables is analyzed using bivariate analysis [10], [11]. This study analyzed the relationship between OSH factors (the use of PPE, OSH training, ergonomics, and work duration), individual factors including (years of service, exercise habits, smoking habits), and work environment factors (total dust level, air temperature, humidity, and lighting) as independent variables with occupational disease (dependent variable). Because the data were categorical, a Chi-square test for analysis was required to establish the relationship between the independent and dependent variables.

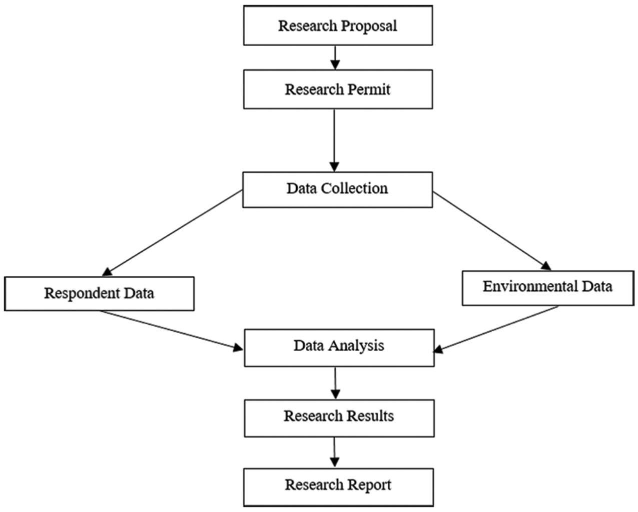

Figure 1: Research flow

Results

The research was conducted by measuring the total dust content, room temperature, humidity, noise, and lighting. Individual factor data were obtained from the respondents by filling out questionnaires to determine age, exercise habits, smoking habits, years of service, work duration, and illness records; meanwhile, the use of PPE was observed directly.

Respondents were from PT. X Cimahi's production division of the manufacturing business. Painting, welding, warehouse, assembly, frame, chrome plating and polishing, woodline, nailing, and bending are all part of PT. X Cimahi's manufacturing industry's production division. The results of the study are as follows:

Table 1 shows that male respondents are 44 (88%), aged over 40 years old are 28 people (56%), nutritional status does not meet the requirements (BMI

Table 1: Research subject characteristics

Characteristics	n	%
Gender		
Male	44	88.00
Female	6	12.00
Age		
<40 years old	22	44.00
>40 years old	28	56.00
Nutritional status		
Not eligible (BMI <18.5 or BMI >25)	15	30.00
Eligible (BMI ≥18.5–BMI ≤25)	35	70.00
Having illness history		
No	40	80.00
Yes	10	20.00
Smoking habits		
Smoking	30	60.00
Non-smokers	20	40.00
Having exercise habits		
No	31	62.00
Yes	19	38.00
Using PPE		
No	15	30.00
Yes	35	70.00
Years of service		
<10 years	21	42.00
≥10 years	29	58.00
Working duration		
≤8 h/day	42	84.00
>8 h/day	8	16.00

Table 2: Work environment factors

Work environment factors	n	%
OSH training experience		
Yes	33	66.00
No	17	34.00
Ergonomic		
Yes	40	80.00
No	10	20.00
Air temperature		
Eligible	32	64.00
Not eligible	18	36.00
Humidity		
Eligible	10	20.00
Not eligible	40	80.00
Lighting		
Eligible	47	94.00
Not eligible	3	6.00
Noise		
Eligible	35	70.00
Not eligible	15	30.00
Air dust level		
Eligible	31	62.00
Not eligible	19	38.00

<18.5 or BMI >25) as many as 15 people (30%), did not have an illness history as many as 40 people (80%), had smoking habits as many as 30 people (60%), did not exercise regularly as many as 31 people (62%), and years of service for more than 10 years as many as 29 people (58%) and 42 workers (84%) work 8 h/day. The variable of adherence to the use of PPE, especially masks, was 35 workers or 70%.

Table 2 shows that the number of workers who have attended OSH training is 33 people or 66%, 40 people or 80% of workers who work in an ergonomic work position, 32 people or 64% of workers work at an eligible air temperature, the number of workers who work in an ineligible air humidity is 40 people or 80%, and the number of workers who work in a work environment with eligible noise is 35 people or 70%, while workers who work in a work environment with eligible dust levels are 31 people or 62%.

With p = 0.035 and an odds ratio of 5.333, Table 3 reveals that there is a significant link between the use of PPE and the occurrence of occupational diseases, workers in a work environment with a total dust level >3 mg/L are 5.333 times more prone to be affected than workers in a work environment with a dust level <3 mg/L. The findings also revealed a significant link between years of service and reduced lung function, with p = 0.027 and odds ratio of 0.225, indicating that workers with more than 10 years of service are at a 0.225 times higher risk than those with <10 years of service. With p = 0.00, there is a significant relationship between noise and the occurrence of occupational illnesses. With p = 0.000, there is a significant relationship between dust levels and the incidence of occupational diseases, as well as p = 0.40 between illness history and the incidence of occupational diseases.

Table 3: Bivariate analysis result

Variables	p-value	Description
Gender	0.518	Non-significant
Age	0.828	Non-significant
Nutritional status	1.000	Non-significant
Exercise habits	0.657	Non-significant
Smoking habits	1.000	Non-significant
Years of service	0.027	Significant
Illness record	0.040	Significant
The use of PPE	0.035	Significant
OSH Training	1.000	Non-significant
Working durations	0.889	Non-significant
Ergonomic	1.000	Non-significant
Noise	0.000	Significant
Lighting	0.886	Non-significant
Humidity	0.523	Non-significant
Air temperature	0.293	Non-significant
Air dust level	0.000	Significant

In this study, individual factors included gender, length of work, nutritional status, exercise habits, smoking habits, and age. The environmental factors studied include noise, air dust content, lighting, humidity, and air temperature. K3 factors include working time, ergonomics, training, and use of PPE, while occupational diseases are represented by two indicators, namely, health problems and illness history.

Based on the PLS-SEM analysis in Figure 2, the results obtained are 0.519, which means that the influence of work environment factors, individual factors, and OSH factors affect 51.97% of the incidence of occupational diseases, while 48.1% is caused by other factors not studied.

Discussion

The objective of this study was to figure out what factors influence occupational diseases. The environment, individual workers, and OSH characteristics all contribute to these risk factors. Respondents with years of service above 10 years were 29 people and for years of service below 10 years were 21 people. Workers will suffer occupational diseases if they are exposed to dust for an extended period of time, therefore the longer they work, the more likely they will suffer from occupational diseases. In this study, the working duration variable is a risk factor for occupational illnesses. This is likely because workers' immune systems are compromised as a result of prolonged exposure to dust in the air.

Data on whether they had a record of work-related illnesses such as asthma, bronchitis, TB, or dust allergies are available. According to the data collected, ten people had a record of respiratory sickness, while 40 people said that they had no such record. In this study, illness history was found to be a risk factor for occupational diseases. This is possible since the respondent's disease history frequently recurs, and ten persons suffer from work-related diseases.

The painting room had the highest total dust levels in the working section, according to the measurements. This indicates that it has above the 0.150 mg/m^3 threshold value. Other than the painting

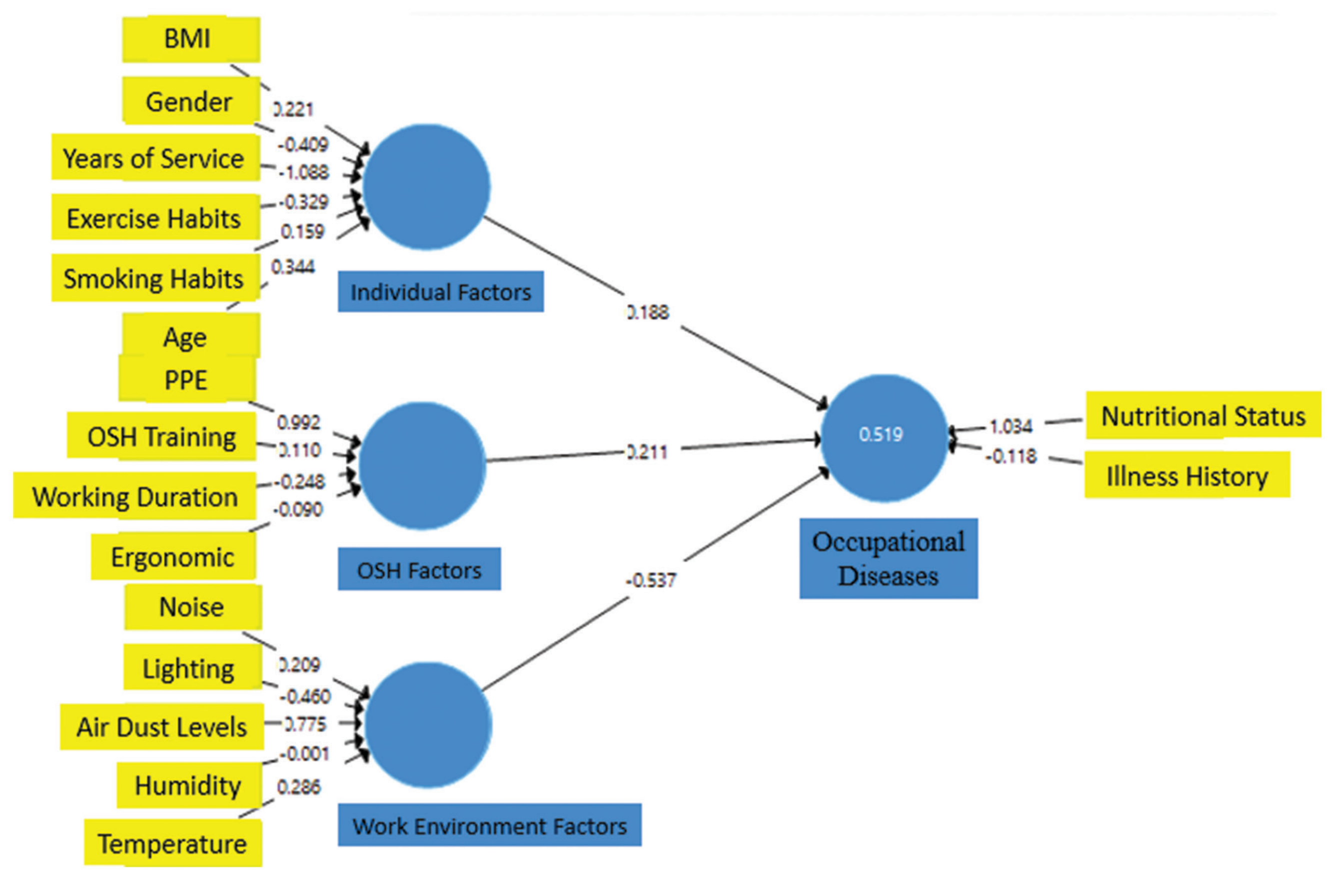

Figure 2: PLS-SEM modeling

room, the labor parts where total dust levels surpass the threshold value are nailing, assembling, welding, bending, and warehousing. The activity of polishing metal surfaces and painting furniture frames, as well as the production process that produces dust, smoke, and vapor, is the processes that cause high levels of total dust in the room. High levels of total dust can cause health problems, dust levels are a risk factor for occupational diseases in this study.

The following is the mechanism by which dust enters the lungs: dust is breathed as dust particles, dust measuring 5–210 microns is retained by the upper respiratory tract, and dust measuring 3–5 microns is retained by the middle airway. Respirable dust is specified as 1–3 microns in size. Respirable dust is the most harmful, because it sticks to the surface of the alveoli/mucous membrane and causes pulmonary fibrosis, whereas dust with a size of 0.1–1-micron floats on the surface of the alveoli and causes pulmonary fibrosis. Lung function abnormalities due to exposure to dust can affect productivity and work quality.

PPE, particularly masks, is used to protect workers from dust exposure in the workplace; most workplaces have dust levels above the threshold (>3 mg/m^3). According to the results, up to 35 workers were not used to wearing personal protection equipment at work, putting them at danger of being exposed to dust that would build up in their lungs. Workers refuse to wear personal protection equipment for a variety of reasons, including discomfort while wearing it, breathing difficulties, and unfamiliarity.

Personal protection equipment (PPE) is necessary for employees and other visitors accessing the workplace. The final alternative is for workers to wear PPE if the four stages of the risk control hierarchy in the work environment which include elimination, substitution, engineering, and administration are not fulfilled, so there are still hazards/potential hazards that can interfere with the health of the workforce. PPE must meet certain criteria, including being pleasant to wear, not interfering with work, not restricting worker movement, providing effective protection, and meeting esthetic requirements. PPE, particularly masks, must meet the standard, which specifies the type of respirator mask capable of filtering dust up to 2.5 microns.

Occupational diseases are associated to non-compliance with PPE. The findings of this study are consistent with those of Nazikhah's research, which found a link between the use of PPE (masks) and lung function disorders, as well as Putri's research, which found a link between the use of PPE (masks) and impaired lung function. This study is also in accordance with the research undertaken by Nurul in Malaysia, which found a link between wearing masks at work and reduced lung function in steel workers. Workers wearing masks will minimize the dangers of dust exposure, allowing them to maintain high production while also increasing their life expectancy.

The industry's noise level affects work-related diseases, this is possible due to noise disturbances, and there will be psychological disturbances in sleeping comfort for workers at home so that it can reduce body resistance. This is in line with Darlani's research which states that workers who are exposed to noise at work can experience sleep disturbances. Chemical environmental risk factors in the manufacturing industry of PT. X Cimahi City apart from exposure to dust there are also vapor and gas [12], [13]. Risk factors of Vapors and gasses can cause occupational diseases. Vapor and gas in this study are not included in the variables studied so further studies regarding exposure to vapors and gasses are needed.

Conclusions

1. There is a significant relationship between occupational safety and health factors (PPE use and noise factor) with occupational diseases
2. There is a significant relationship between individual factors (years of service and illness history) with occupational diseases
3. There is a significant relationship between work environment factors (air dust levels) and occupational diseases
4. The effect of occupational safety and health factors, individual factors, and work environment factors on the incidence of occupational diseases is 51.9%.

Suggestions

1. Control is required for workplace environmental parameters that exceed the threshold value, such as dust, noise, lighting, temperature, and humidity levels
2. Further, research is needed on other risk factors that can affect the incidence of occupational diseases such as gas parameters, ventilation, and the application of occupational safety and health management systems.

References

1. Dani C. Occupational Health and Safety, Keselamatan dan Kesehatan Kerja. Yogyakarta: Gosyen; 2014.
2. Ramdan I. Industrial Hygiene, Higiene Industri. Yogyakarta: Bimotry; 2013.
3. Riyadi S. Epidemiology Fundamentals, Dasar-Dasar Epidemiologi. Jakarta: Salemba; 2014.
4. Soemarko D. Occupational Disease: Occupational Identification and Rehabilitation, Identifikasi dan Rehabilitasi Kerja. Jakarta: Fakultas Kedokteran Universitas Indonesia; 2012.
5. Daryanto S. SHE Practical Guidelines, Pedoman Praktis K3LH. Yogyakarta: Gava Media; 2018.
6. Republic of Indonesia. Law Number 1 of 1970 Concerning The Work and Safety Act. Jakarta; Government of Indonesia: 1970.
7. Republic of Indonesia. Law Number 36 of 2009 Concerning Health. Jakarta; Government of Indonesia: 2009.
8. Irzal MK. Basics of Occupational Health and Safety, Dasar-dasar Kesehatan dan Keselamatan Kerja. Jakarta: Kencana; 2016.
9. Hastono SP. Data Analysis in the Health Sector, Analisa Data Pada Bidang Kesehatan. Depok: Fakultas Kesehatan Masyarakat Universitas Indonesia; 2017.
10. Haryono S. SEM Amos Lisrel PLS Method, Metode SEM Amos Lisrel PLS. Jakarta: Luxima; 2017.
11. Juliandi A. Structural Equation Model Partial Least Square (SEM PLS) using SMARTPLS, Structure Equation Model Partial Least Square (SEM PLS) dengan SMARTPLS. Medan: University of Sumatera Utara; 2018.
12. Ashwini S, Swathi K, Shaik HS. Effect of Cement dust on pulmonary function test parameters. Acta Biomed Sci. 2015;3(1):71-4.
13. Susanto AD, Yunus F, Ikhsan M, Fitriani F. Occupational Lung Diseases and the Environment, Penyakit Paru Kerja dan Lingkungan. Jakarta: Fakultas Kedokteran Universitas Indonesia; 2017.