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STRUCTURAL MODEL OF FACTORS RELATING TO OCCUPATIONAL ACCIDENT OF WASTE PICKERS AT MUNICIPAL SOLID WASTE LANDFILL IN EKS KARESIDENAN BESUKI, EAST JAVA, INDONESIA

與印度尼西亞東爪哇省前卡迪恩別樹市政固體廢物填埋場的拾荒者職業事故有關的因素的結構模型

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Abstract

As the most widespread method of waste management worldwide, municipal solid waste (MSW) landfills have different technology standards in developed and developing countries. Unfortunately, many occupational diseases and health impacts are associated with garbage picking. Therefore, this research aims to explore the factors related to the work accident by waste pickers at the MSW landfill in Eks Karesidenan Besuki, East Java, Indonesia. The research design used was cross-sectional. The construct validity was tested using Exploratory Factor Analysis and Confirmatory Factor Analysis (CFA). In addition, a cross-sectional quantitative study was used to measure 154 waste pickers. The hypothesis was tested, and a risk factor work accident model was developed using Structural Equation Modeling (SEM). The data that has been collected is operated through the IBM® SPSS AMOS version 23.0 program. The results from this study provided information related to landfill management and its impact on the environment and health, especially on work accidents experienced by waste pickers at the MSW landfill in Eks Karesidenan Besuki, Indonesia. The findings of this study confirm that factors related to occupational accidents are workload factors ($p = 0.046$), individual factors ($p = 0.043$), and personal protection equipment (PPE) ($p = 0.001$). The strength of this research is the use of the structural equation model. SEM is a set of statistical techniques that allow the simultaneous testing of a complex set of relationships. This research also produces a model. The model generated from the application shows five covariances that can be additional research.

Keywords: Occupational Accident, Waste Pickers, Municipal Solid Waste Landfill

摘要 作為世界範圍內最普遍的垃圾管理方式，城市固體垃圾填埋場在發達國家和發展中國家有不同的技術標準。不幸的是，許多職業病和健康影響都與撿垃圾有關。因此，本研究旨在探討與印度尼西亞東爪哇前居住地別樹的城市生活垃圾垃圾填埋場的拾荒者工作事故相關的因素。使用的研究設計是橫斷面的。使用探索性因素分析和驗證性因素分析（測試結構效度。此外，一項橫斷面定量研究用於測量 154 名拾荒者。對該假設進行了檢驗，並使用結構方程模型開發了風險因素工傷模型。已收集的數據通過 IBM® SPSS AMOS 23.0 版程序進行操作。這項研究的結果提供了與垃圾填埋場管理及其對環境和健康的影響有關的信息，特別是關於拾荒者在印度尼西亞前居住地別樹的城市生活垃圾垃圾填埋場所經歷的工傷事故。本研究的結果證實，與職業事故相關的因素是工作量因素（p=0.046）、個人因素（p=0.043）和 個人防護設備（p=0.001）。這項研究的優勢在於結構方程模型的使用。結構方程建模是一組統計技術，允許同時測試一組複雜的關係。這項研究還產生了一個模型。從應用程序生成的模型顯示了五個協方差，可以進行額外研究。

关键词: 職業事故，拾荒者，城市固体废物填埋场

I. INTRODUCTION

Waste management has become a global priority and an increasingly important environmental issue. Two reasons for this condition are the rapidly increasing population and urban lifestyle. With population growth and rapid urbanization, annual waste generation is expected to increase by 73% from the 2020 level of 3.88 billion tones by 2050 [1, 2]. As the most widespread method of waste management worldwide, landfills have different technology standards in developed and developing countries [3]. The modern version of the landfill is a system designed to minimize the impact of solid waste on human health and environmental health and operate to achieve deficient emission levels. Compared to developed countries, people in developing countries are more severely impacted by waste that is not managed sustainably. In low-income countries, more than 90% of waste is often disposed of in unregulated landfills or open dumping [3]. In Indonesia, management methods of landfills are still not good, and overcapacity; besides, most of the landfills in Indonesia are still operated by open dumping [4-6].

Large numbers of people in this world make a living by collecting, classifying, sorting, and then selling materials that have been thrown away as waste [2, 7]. International Labour Office estimated that around 4 million of the 19-24 million people worldwide are formally employed in waste recycling [8]. In low-income countries, waste picking is common for residents to earn an income [2]. Unfortunately, many occupational diseases and health impacts are associated with picking up waste. The risk of health impacts experienced by waste pickers include epidermal (50.0%), communicable disease (46.6%), musculoskeletal (44.8%), respiratory disease (41.4%), non-communicable diseases (39.7%), physiological (34.5%), gastrointestinal (31.0%) and waterborne diseases (17.2%) [2]. A previous study found a significant association between waste picking and dermatological and gastrointestinal symptoms [9].

The condition of waste pickers prone to health problems and work accidents should receive special attention from the government and non-government institutions. However, in specific areas, waste pickers in Indonesia and the former Karesidenan Besuki are still not being cared for properly. It indicates that no waste pickers organizations in Indonesia registered with the world waste pickers organizations. Previous researchers from various countries carried out several studies on landfills. Therefore, it can be used to understand the author's position in research on landfill management and its impact on the environment and health, especially on work accidents experienced by waste pickers at the landfill.

II. RESEARCH METHOD

A. Research Object

The study was conducted at several landfill sites in the former Besuki Residency, namely Landfill in Pakusari Jember, Landfill in Paguan Taman Krocok Bondowoso, and Landfill Sliwung Situbondo. This study involved 154 waste pickers.

B. Data Analysis

The study consists of two stages. The first stage is a preliminary study as a test of the validity and reliability of the research instrument.

The construct validity was tested using Exploratory Factor Analysis and Confirmatory Factor Analysis (CFA). The next step is data validation. The factor analysis process tries to find the relationship between independent variables. CFA is an exploratory statistical method, and it is just that the factor loading for the variables is determined based on previous studies or relevant theories. CFA then processes and measures the suitability of loading in a target matrix. Finally, CFA is carried out, taking into account the factor structure that is already positioned. CFA tests the suitability of a model with a certain number of factors and determines specific items that measure or load each factor [10].

The second stage is hypothesis testing and developing a work accident risk factor model using Structural Equation Modeling (SEM). The second stage aims to analyze the instrument, test hypotheses, and test the structural measurement model.

C. Structural Equation Modeling

Structural Equation Modeling (SEM) can present a comprehensive model and the ability to confirm a concept's dimensions or factors through empirical indicators. Moreover, SEM can measure the influence of factors that exist theoretically. Therefore, SEM is usually seen as factor analysis and regression analysis. It can be applied separately only in factor analysis or in regression analysis.

A previous study revealed that the collected data would be further processed using the Structural Equation Modeling (SEM) program, operated through the IBM® SPSS AMOS version 23.0 program [11]. Structural equation modeling, SEM is a set of statistical techniques that allows the simultaneous testing of a complex set of relationships.

III. Results And Discussion

A. Regression of Weight

Based on the study result, the calculated chi-square value = 826,757 indicates a greater value than the chi-square table = 135.48, which indicates that the model is not fit. It can happen because there are too many variables and indicators, and the research sample is too small. The recommended number of samples in testing using the AMOS 23 multivariate test software, which is good in the Technology Acceptance Model (TAM) method, is between 150 and 400 data [12].

Table 1.
The results of the study using the SPSS AMOS 23 statistical test

Computation of degrees of freedom (Default model)	Results
Number of distinct sample moments	153
Number of distinct parameters to be estimated	45
Degrees of freedom (153 - 45)	108
Result (Default model)	Minimum was achieved
Chi-square	826.757
Degrees of freedom	109
Probability level	0.000

The following result is a descriptive explanation to determine the regression of weight (estimate) of each variable and indicator, as follows:

1) *The Influence of Environmental Aspects on Accident Aspects*

Figure 1 shows that the path coefficient value of the influence of the Environmental Aspects on the Accident Aspect is -1.492 (negative), and the significance value is 0.172 (P > 0.05).

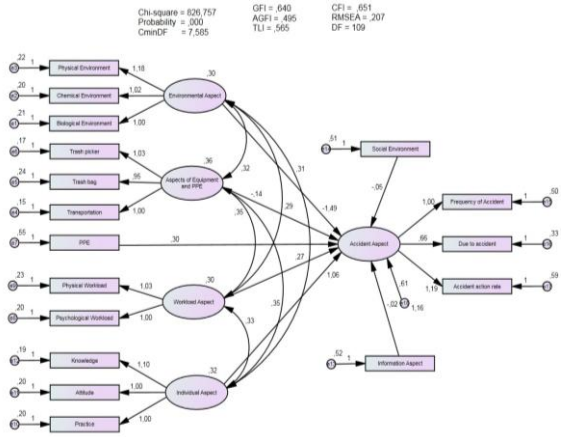

Figure 1. Conceptual model of this study. Rectangles represent measurement variables, and ellipses represent latent variables; ei: measurement error; Di: disturbance or residual

2) *Effect of Equipment on Accident Aspects*

Figure 1 shows that the path coefficient value of the influence of the Equipment Aspect on the Accident Aspect is -0.141 (negative), and the significance value is 0.904 (P > 0.05).

3) *Effect of Workload on Accident Aspects*

Figure 1 shows that the path coefficient value of the influence of the Workload Aspect on the Accident Aspect is 0.274 (positive), and the significance value is 0.046 (P < 0.05).

4) *The Influence of Individual Factors on Accident Aspects*

Figure 1 shows that the path coefficient value of the influence of the Individual Factor Aspect on the Accident Aspect is 1.058 (positive), and the significance value is 0.043 (P < 0.05).

5) The Influence of Information Aspects on Accident Aspects

Figure 1 shows that the path coefficient value of the influence of the Information Aspect on the Accident Aspect is -0.018 (negative), and the significance value is 0.832 (P > 0.05).

6) Effect of Social Environment on Accident Aspects

Figure 1 shows that the path coefficient value of the influence of the Social Environment on the Accident Aspect is -0.046 (negative), and the significance value is 0.601 (P > 0.05).

7) Effect of Personal Protective Equipment (PPE) on the Accident Aspect

Figure 1 shows that the path coefficient value of the influence of Individual Personal Protective Equipment (PPE) on the Accident Aspect is 0.301 (positive). The significance value is *** or below 0.001 (P < 0.05).

B. Verification of Reliability and Validity

1) The Results of Confirmatory Factor Analysis (CFA)

CFA is used to test the construct measurement model's unidimensional validity and reliability that cannot be measured directly. The measurement model or the Ferdinant descriptive model is also called Measurement Theory [13] or Confirmatory Factor Model [14]. It shows the operationalization of variables or research constructs into measurable indicators formulated into measurable indicators in the form of equations and or specific path diagrams.

The CFA process refers to the RMT model, so the first step is to examine the theory about the construct to be measured. Then, the theoretical concepts and constitutive definitions (theoretical definitions) of the construct to be measured are obtained from the theory. Furthermore, the dimensions or measurable indicators can be identified as a reflection or manifest of the construct as follows:

a) Environmental Aspect in CFA

Figure 1 shows three indicators (latent variable) forming the environmental aspect (construct variable): the physical environment with a value of 1.18, the chemical environment with a value of 1.02, and the biological environment with a value of 1.00. The three indicators show a product-moment value > 0.6, so the three indicators are valid and reliable. Then it can be said that the three indicators contribute simultaneously to form the Environmental Aspect. The physical environment is the most significant contribution to shaping the Environmental Aspect, with a product-moment value of 1.18. For every 1.0 standard deviation increase in the Environmental Aspect, the physical environment increases by 1.18 standard deviations.

b) Equipment Aspect in CFA

Figure 1 shows three indicators (latent variable) forming the Equipment Aspect (construct variable): waste picker tool with a value of 1.03, trash bag with a value of 0.95, and transportation with a value of 1.00. The three indicators show a product-moment value > 0.6, so the three indicators are valid and reliable. Then it can be said that the three indicators contribute simultaneously to form the equipment.

c) Workload Aspects in CFA

Figure 1 shows that two indicators (latent variables) built the Workload Aspect (construct variable): physical with a value of 1.03 and psychological workload with a value of 1.00. The two indicators show a product-moment value > 0.6, so both are valid and reliable. However, the most significant contribution to form the workload aspect is physical workload, with a product-moment value of 1.03. In other words, for every 1.0 standard deviation increase in workload, the physical workload increases by 1.03 standard deviations.

d) The Individual Factor in CFA

Figure 1 shows three indicators (latent variables) forming the individual factors (construct variables): knowledge with a value of 1.10, attitude with a value of 1.00, and action with a value of 1.00.

The three indicators show a product-moment value > 0.6. So, the three indicators are valid and reliable. Knowledge is the most significant contribution to forming the Individual Factor, with a tool with a product-moment value of 1.03. For every 1.0 standard deviation increase in the Equipment Aspect, the waste pickers tool increases by 1.03 standard deviations.

e) Accident Aspect in CFA

Figure 1 shows that three indicators (latent variables) make up the individual factors (construct variables), namely the frequency of accidents with a value of 1.00, due to work accidents with a value of 0.66, and post-accident. The actions have a value of 1.19. The three indicators show a product-moment value > 0.6, so three indicators are valid and reliable. However, the most

significant contribution to forming the Accident Aspect is post-accident action with a product-moment value of 1.19. In other words, for every 1.0 standard increase in the accident aspect, the post-accident action increases by 1.19 standard deviations.

Table 2.
Reliability after eliminating variables and confirmatory factor analysis

Reliability analysis factor	Cronbach's alpha	Confirmatory factor analysis	Component							
		Observed variables	1	2	3	4	5	6	7	8
Environmental Aspect	0.831	Physical Environment	0.811							
		Chemical Environment	0.802							
		Biological Environment	0.759							
Aspects of Equipment and PPE	0.880	Trash picker		0.853						
		Trash bag		0.759						
		Transportation		0.855						
		PPE			0.846					
Aspects of Workload	0.740	Physical Workload				0.793				
		Psychological Workload				0.824				
Social Environment and Information Aspect	0.826	Social Environment					0.851			
		Information Aspect						0.874		
Individual Factor	0.837	Knowledge							0.853	
		Attitude							0.804	
		Practice							0.830	
Accident Aspect	0.701	Frequency of accidents								0.799
		Due to accident								0.767
		Accident action rate								0.812

In the modeling, several indicators were removed, and insignificant effects were removed so that the model fit with the help of the modification indicator feature with the AMOS 23 statistical software [15, 16]. The model also explains the relationship between indicators outside of the indicator variables. The model generated from the application shows five covariances that can be additional research for further development/explanation.

It is achieved based on all the fit model requirements (Table 5). It shows that the model is fit and can be accounted for validity and reliability in the subsequent studies. The model's relationships and effects can be assessed, and parameter estimates standardized. Once the parameter estimates are standardized, they can be interpreted as a reference for other parameters in the model, and the relative strength of the paths in the model can be compared.

Table 3.
Result (Default model)

Computation of degrees of freedom (Default model)	Result
Number of distinct sample moments	78
Number of distinct parameters to be estimated	34
Degrees of freedom (78 - 34)	44
Result (Default model)	Minimum was achieved
Chi-square	37.262
Degrees of freedom	44
Probability level	0.754

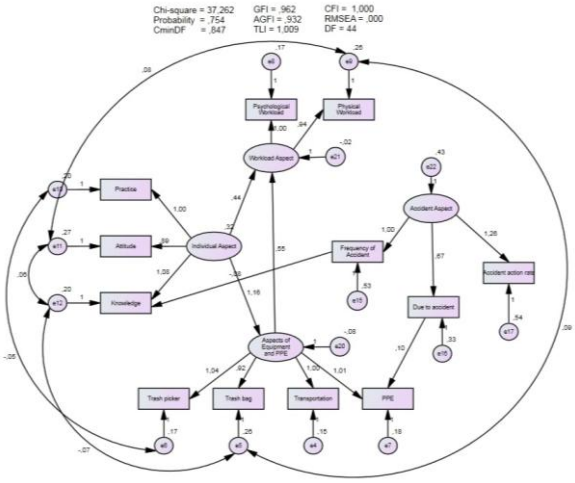

Figure 2. Modeling analysis using SPSS AMOS 23

Table 4.
Covariances (Group number 1 - Default model)

Aspects			Estimate	S.E.	C.R.	P
e11	<-->	e12	.059	.021	2.822	.005
e9	<-->	e11	.078	.020	3.879	***
e5	<-->	e9	.087	.023	3.859	***

Continuation of Table 4						
e5	<-->	e12	-.066	.017	-3.764	***
e6	<-->	e10	-.045	.017	-2.672	.008
Note:						
e11	<-->	e12	Aspects of attitudes related to aspects of knowledge			
e9	<-->	e11	Aspects of attitude related to physical workload			
e5	<-->	e9	Physical workload related to trash bag			
e5	<-->	e12	Knowledge aspect related knowledge aspect			
e6	<-->	e10	Waste Picker Tool related to Knowledge Aspect			

Table 5.
Model fit index

The goodness of fit indices cut–off value	Indices cut–off value	Model modification results	Description
X^2 Chi-Square	Expected Small	37,262	Good
Probability	≥ 0,05	0,754	Good
RMSEA	≤ 0,08	0.000	Good
GFI	≥ 0,80	0,962	Good
AGFI	≥ 0,90	0,932	Good
CMIN/DF	≤ 2,00	0,847	Good
TLI	≥ 0,95	1,009	Good
CFI	≥ 0,95	1,000	Good

C. Discussion

Pakusari landfill in Jember, Taman Krocok landfill in Bondowoso, and Sliwung landfill in Situbondo are managed under the Environmental Service of each Regional Government. The basis for regional level regulations also exists, namely Regional Regulations on Waste Management, except for Jember Regency, which does not yet have a regional regulation in solid waste. The role of local governments is vital in issuing policies on waste management like [17]. Management institutions also have a significant role. The Hygiene Section still manages the Pakusari landfill and Taman Krocok landfill.

Besides, The Technical Implementation Unit has managed the Sliwung landfill in Situbondo (UPT). Organizing activity is an effort to determine and rearrange resources, units, and methods that lead to efforts to realize policies into outcomes following the goals and objectives of the policy [18]. Technically, the landfill management method, only the Sliwung landfill in Situbondo has implemented a sanitary landfill. At the same time, the Pakusari landfill is still a Controlled Landfill; even Taman Krocok landfill is still open dumping. According to Law Number 8 of 2018, a final waste processing site (landfill) is a place to safely process and return waste to environmental media for humans and the environment. The dumping method can potentially contaminate groundwater, soil, and air pollution, including the production of greenhouse contaminate groundwater, soil, and air pollution, including the production of greenhouse gases [19, 20].

Open dumping can be a habitat for animals that can potentially transmit diseases. Mammals congregating in landfills can acquire pathogens and transmit zoonotic diseases [21]. To run the landfills program, that is necessary to support landfill management. A document should guide the landfill, especially environmental management and occupational health and safety (health safety and environment). Modern landfills can be located, operated, and monitored to ensure the program runs well with federal regulations [22].

The environmental conditions of the landfill include physical, chemical, and biological conditions that can potentially endanger waste pickers during their activities in the landfill. The results showed that most of the landfill area's physical, chemical, and biological conditions (85.1%) were unsafe. Physically and chemically hazardous conditions include piles of trash, holes, burning trash, heavy equipment lines, and methane gas pipelines. Biologically dangerous conditions that are visible to the naked eye are the presence of animals that have the potential to harm waste pickers. In addition, biologically hazardous conditions can occur with the naked eye, namely bacteria, fungi, and endotoxins of small sizes (104 CFU/m^3 and 10 E.U./m^3) [23].

Waste picker tools, trash bags, and transportation are variables in this study that contribute to the Equipment Aspect simultaneously. The greatest contribution to shaping the Equipment Aspect was waste pickers' tools. A waste picker tool is a hook tool used by waste pickers to clamp or pick up trash, making it easier to pick up the waste. It can reduce hand contact with waste. Based on previous study, waste pickers have risk to developing disease such as epidermal (50.0%), communicable disease (46.6%), musculoskeletal (44.8%), respiratory disease (41.4%), non-communicable diseases (39.7%), physiological (34.5%), gastrointestinal (31.0%) and waterborne diseases (17.2%) [2].

Based on the study results, most respondents have a moderate workload. The workload

includes physical capacity, targets at work, duration, and length of work. Workload relates to performance, which will also be related to work performance [24]. A previous study found that a workload that is considered quite heavy can affect a person's physical and psychological condition [25]. Another study also explained that a workload affects the motivation and performance of employees [26].

Based on the study results, 6.5% felt a good social environment, 48.1% felt a moderate social environment, and 45.5% felt a bad social environment. A previous study explained that the social environment would affect the respondents' satisfaction. Therefore, if the social environment is good, the respondent's satisfaction will be achieved and vice versa [27].

The overall respondent's access to information was not good. Most respondents did not participate in counseling, outreach, or obtain other information directly or through the mass media. Information about Occupational Health and Safety was obtained through counseling, socialization, and the media increased respondents' knowledge and attitudes [28].

The majority of respondents have a productive age which is the age range of respondents between 15 to 64 years. Productive age tends to have more jobs than those who do not. A comparison of productive age who works and productive age who does not work has a ratio of 2:1 [29]. A previous study found that ages belonging to the productive age usually have a higher level of productivity than those who are old. Hence, their physical possessions become weak and limited [30].

The Dictionary of Education explains that education is how a person develops the ability, attitudes, and other forms of behavior in community groups. Based on the study results, most of the respondents had low education. That is, they did not finish elementary school. The low level of education causes the knowledge possessed will below. The higher a person's education, the easier it is to absorb the information provided.

Conversely, low education will hamper the absorption of information [31]. Likewise, education also correlates with economic status. Someone with low education will have a low economic status [32].

Moreover, waste pickers do not use PPE in the form of masks. It is in line with research conducted that the respiratory problems experienced by waste pickers are caused by waste pickers not using PPE. Dust in the landfill area will be inhaled and cause respiratory problems. Inhalation disorders felt by waste pickers are also possible because some waste pickers are smokers. Smoking and gangs ss much as 5.8% of respondents experienced visual disturbances. The visual impairment experienced was caused by the respondent not using PPE in the form of glasses when working [32].

Based on the results of the study that 47.4% have good knowledge, 39% have moderate knowledge, and 13.6% have poor knowledge. Good knowledge will influence attitudes and actions. A previous study on the application of occupational health and safety (OHS) stated that the respondent's knowledge would affect the respondent's attitude and application/action [33]. It is relevant to several studies that reveal a significant relationship between a person's knowledge of OHS and attitudes and actions. Knowledge is the basis of the formation of attitudes. One cannot be kind to something when one does not have good knowledge [33].

Most respondents have a good attitude, 19.5% have a moderate attitude, and 4.5% have a bad attitude. Attitude results from knowledge and can influence a person's actions. Attitude is one of the social cognitive factors controlled and managed by the individual, closely related to the behavior and health behavior of the individual [34].

Based on the study results, most respondents had a good practice, 24% had moderate practice, and 6.5% had a bad practice. Knowledge and attitudes can influence a person's actions will change [35]. Similar research states that the better the knowledge and attitude of a person, the better the health behavior of that person [36].

Based on the study results, the aspect of work accidents is classified in the excellent category with 98.1%. The respondents already have good knowledge of OHS, with a percentage of 47.4%. It is in line with previous research conducted before those good OHS insights can minimize work accidents in the workplace [37].

IV. CONCLUSION

Based on the results of this study, three variables had a statistically significant effect on work accidents on waste pickers. The three variables namely workload factors ($p = 0.046$), individual factors ($p = 0.043$), and personal protection equipment (PPE) ($p = 0.001$). Most respondents have a moderate workload. The workload, namely physical capacity, targets at work, duration, and length of work. Waste picker tools, trash bags, and transportation are variables in this study that contribute to the Equipment Aspect simultaneously. The greatest contribution to shaping the Equipment Aspect was waste

picker tools. A waste picker tool is a hook tool used by waste pickers to clamp or pick up trash, making it easier to pick up the waste. It can reduce hand contact with waste.

Good knowledge will influence attitudes and actions. These findings indicate that workload, individual factors, and personal protective equipment (PPE) are factors that influence the occurrence of work accidents in waste pickers. Therefore, this variable can be used as a reference for controlling work accidents for waste pickers. By knowing the risk factors for work accidents, the government can make rules to reduce the number of work accidents among waste pickers. The government can also work with media partners and the private sector to increase the knowledge of waste pickers.

This research also produces a model. The model generated from the application shows five covariances that can be additional research for further research to be developed/explained. It is achieved based on all the fit model requirements (Table 5). It shows that the model is fit and can be accounted for validity and reliability in the subsequent studies.

Workload, individual factors, and personal protective equipment have a statistically significant effect on the incidence of work accidents. By knowing the risk factors for work accidents, the government can make policies to reduce the number of work accidents among waste pickers. The government can periodically monitor and assist with personal protective equipment (PPE). The government can work with media partners and the private sector to increase the knowledge and help ensure the availability of personal protective equipment for waste pickers.

The model's relationships and effects can be assessed, and parameter estimates are standardized. Once the parameter estimates are standardized, they can be interpreted as a reference for other parameters in the model, and the relative strength of the paths in the model can be compared. The subsequent studies can develop other variables related to the physical and social environment by increasing the number of samples. This research also produces a model that can be used as additional research to be developed.

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