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Model Health, Safety and Work Environment Factors as Prediction of Work Motivation on Construction Projects

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Abstract*: *Construction project work is one of the high-risk jobs. Based on statistical data on construction accidents in the last ten years, it continues to increase, which has an impact on decreasing work productivity and at the same time a threat to the health, safety and environment of the workforce. Efforts to increase awareness of Health, Safety and the Work Environment (HSE)for workers are important to provide encouraging attitudes and safe actions in preventing the risk of accidents and diseases caused by work, thereby increasing worker productivity.Motivation is a form of encouragement from within the employee to behave and act. The productivity of a construction project is closely related to the motivation of the workforce.The purpose of this study is to determine an effective model of health, safety and work environment (HSE) and to know the relationship between HSE factors as a prediction of work motivation to prevent the risk of work accidents.The research method used was a questionnaire survey distributed to 35 construction workers / contractors such as project managers, experts, project implementers, foremen and construction workers in buildings with more than five floors.Data were analyzed using Partial Least Squares. Work accidents affect HSE workers, which then makes work activities delayed, work costs increase, even the quality of work decreases. Therefore, efforts are needed to prevent work accidents through work motivation as psychological interventions in understanding HSE factors for increasing worker productivity on construction projects.The results of this study confirm that the worker's health factors are able to predict work motivation and work motivation in stages of work productivity, meaning that the better the health of workers will increase work motivation and the higher the work motivation, the higher work productivity. Work environment factors indirectly have a positive effect on work productivity, meaning that the better the work environment, the higher the work productivity through work motivation.

Keywords* :*Health, Safety and Work Environment, Work Motivation, Partial Least Squares, Productivity.

I. INTRODUCTION

There have been many HSE studies, especially research in Indonesia identifying the causes of workplace accidents, their relationship with the HSE on productivity and work motivation with significant and insignificant results both simultaneously and partially.Recommendations have been given to prevent work accidents. However, the data show the opposite is an increase in work accidents.

Based on data from the last ten years (2007-2017), work accidents in Indonesia have increased to 123,000 cases where 50% of cases are in construction services [1].In 2018 there were 173,105 work accident cases which were also dominated by the construction industry[2].And there are more than 2.78 million deaths every year.[3]. Generally there are two main causes of work accidents, namely unsafe actions and unsafe conditions. [4],[5],[6],[7].

Meanwhile, from the perspective of psychology according to Maslow that basically every employee has basic needs to be fulfilled, namely the need for safety / security,which is protected from threats or danger.The behavior of workers who are aware of potential threats will be different from those who are not aware of the potential threats to their health, safety or work environment.The expression of awareness is better to be careful repeatedly than to be killed once is important so that workers are always careful in working.

Awareness of the threat becomes important to determine safe actions..Awareness of the need for a sense of security to maintain health, safety and work environment is met, the motivation of workers will be positively influenced to behave alertly to all potential threats that can endanger the safety of the soul at work[9], [10].

A model that describes work motivation as a psychological intervention needs security in understanding HSE factors affecting worker productivity. Model validation using Partial Least Squares.

II. LITERATUREREVIEW

A. Occupational Health

Health is a healthy state that is physically or mentally that allows everyone to live productively. Occupational Health is free from illness, injury and mental and emotional problems that can interfere with work activities. Occupational health refers to conditions that are free from physical, mental, emotional or pain related to the work environment. Indicators of Occupational Health are the Physical Work Environment, Worker's Health Facilities, and Worker's Health Maintenance[11].

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B. Work safety

Work safety refers to conditions that are safe or safe from suffering, damage or loss at work.

Work safety is referring to the protection of one's physical well-being against injuries related to work performance. Occupational health indicators are Personal Protective Equipment (PPE), Work Safety Rules, Workload, Communication, Work Safety Training[12], [13].

C. Work environment

Work Environment is an environment where workers do their jobs, cleanliness of the workplace, a conducive environment that provides a sense of security at work and allows workers to do their jobs optimally. Indicators of the work environment are a conducive workplace atmosphere, job security, work culture, physical environment.Non-physical work environment is a condition that is around workers that can affect psychologically in workers, including a safe and comfortable work atmosphere to increase morale, avoid stress / emotional stress symptoms that can affect safety at work[14], [15], [16].

D. Work motivation

Motivation is a psychological phenomenon in the form of an intrinsic or extrinsic drive for someone to do something consciously for a certain purpose[17],[18]. According to Armstrong, motivation is related to factors that influence a person to behave in certain ways to achieve the required goals[19]. Motivationis a series of processes that take into account the intensity, direction, and persistence of individuals to achieve a goal[20].

E. Work productivity

Productivityis efficient that is working by using appropriate resources and energy without waste, safe, timely and effective, that is, doing something in accordance with what was previously determined successfully achieved[21],[22].Productivity is a combination of efficiency and effectiveness (productivity = efficiency + effectiveness)[23],[24].

The success of a construction project is very dependent on achieving effective and efficient goals with certain resources in terms of timeliness of completion of the work, right on the overall cost of the project, quality that has been planned and without work accidents (Zero Accident).

III. RESEARCH METHODOLOGY

Primary data were collected from construction workers with a questionnaire on a medium-rise building construction project. Secondary data were obtained from literature studies in the form of books and journals.The data obtained were analyzed by the Partial Least Square method using SmartPLSver 3 for windows software to determine the influential and significant factors. Data collection was conducted from June to July 2019 and there were 35 valid samples. All respondents of construction work involved in the project (project manager, project implementer, expert, foreman, worker).

This survey consists of five parts: (1) occupational health factors, (2) occupational safety factors, (3) work environment factors, (4) work motivation factors, (5) work productivity factors. Subvariables or dimensions for the questionnaire are a combination of various sources. Questionnaire measurement using a four-point Likert scale starting from 1 = Strongly Disagree is the lowest level and 4 = Strongly Agree is the highest level.Research Flow Diagram as shown in Figure 1.

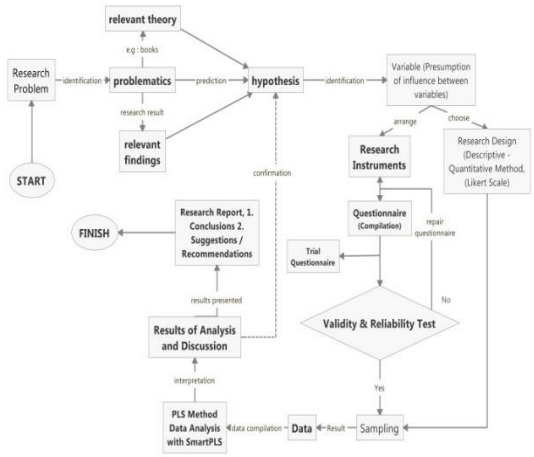

Fig. 1. Research Flowchart

Evaluate the measurement of reflective models Partial Least Squares there are two stages (TableI).The first stage evaluates the outer model, if the evaluation is suitable for the quality of the measurement, it continues with the second stage of evaluating the structure of the model or inner model[25].

Table- I: Measurement ot the Reflective Model

Step 1	Step 2
▪ Indicator Reliability ▪ Internal Consistency Reliability ▪ Convergent Validity ▪ Discriminant Validity	Collinearity Coefficient of Determination (R2) Predictive Relevance or Cross Validation Redundancy (Q2) Effect Size or f-Square Path Coefficient

IV. RESULT & DISCUSSION

Structural Equation Model with Partial Least Square (PLS).

A. The Concept of Path Charts

The conceptual framework of the study is based on the Structural Equation model (Figure 2).

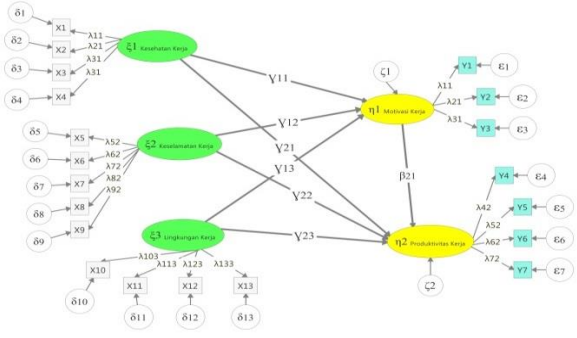

Fig. 2. Diagram Jalur.

The path diagram in Figure 2 is converted to the equation in each variable / construct for the outer model and inner model (table II) and (table III).

- Outer Model,

Table- II: Outer Model Equation

Exogenous latent variable X1	Exogenous latent variable X2	Exogenous latent variableX3	Endogenous latent variable Y1	Endogenous latent variable Y2
$X_1 = \lambda_{11} \xi_1 + \delta_1$	$X_5 = \lambda_{52} \xi_2 + \delta_5$	$X_{10} = \lambda_{103} \xi_3 + \delta_{10}$	$Y_1 = \lambda_{11}\eta_1 + \varepsilon_1$	$Y_4 = \lambda_{42}\eta_2 + \varepsilon_4$
$X_2 = \lambda_{21} \xi_1 + \delta_2$	$X_6 = \lambda_{62} \xi_2 + \delta_9$	$\mathbf{X_{11} = \lambda_{113} \xi_3 + \delta_{11}}$	$Y_2 = \lambda_{21}\eta_1 + \varepsilon_2$	$Y_5 = \lambda_{52}\eta_2 + \varepsilon_5$
$X_3 = \lambda_{31} \xi_1 + \delta_3$	$X_7 = \lambda_{72} \xi_2 + \delta_7$	$X_{12} = \lambda_{123} \xi_3 + \delta_{12}$	$Y_3 = \lambda_{31}\eta_1 + \varepsilon_3$	$Y_6 = \lambda_{62}\eta_2 + \varepsilon_6$
$X_4 = \lambda_{41} \xi_1 + \delta_4$	$X_8 = \lambda_{82} \xi_2 + \delta_8$	$X_{13} = \lambda_{133} \xi_3 + \delta_{13}$		$Y_7 = \lambda_{72}\eta_2 + \varepsilon_7$
	$X_9 = \lambda_{92} \xi_2 + \delta_9$			

- Inner Model,

Table- III: Inner Model Equation

$\eta_1 = \gamma_{11}\xi_1 + \gamma_{12}\xi_2 + \gamma_{13}\xi_3 + \zeta_1$
$\eta_1 = \gamma_{11}\xi_1 + \gamma_{12}\xi_2 + \gamma_{13}\xi_3 + \beta_{21}\eta_1 + \zeta_2$

The stage of evaluating the outer model and evaluating the structure of the model or inner model,

B. Measurement Model(Goodnes of Fit Outer Model)

- **Reliability test**,the indicator X11 must be eliminated from the **measurement** model (see figure 3) because the loading value (λ) is smaller than 0.6.The Cronbach alpha reliability test resultsare> 0.6 (see table III). Loading values (λ) above 0.6 or 0.7 indicate that the construct can explain more than 50% of the indicator variance[26],[27].

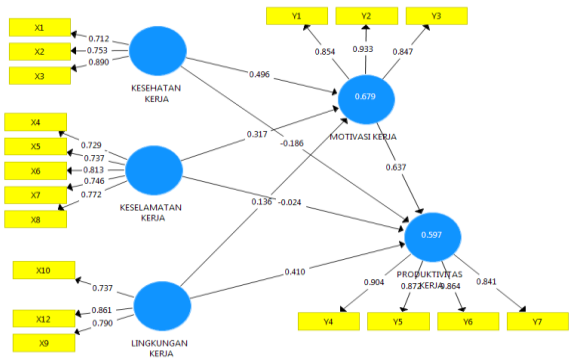

Fig. 3.Fit Path Coefficient Results.

Table- III: Reliability Test Results

Variable	Score	Information
Occupational Health (H)	0.708	Reliabel
Work safety (S)	0.817	Reliabel
Work environment (E)	0.713	Reliabel
Work motivation (Mt)	0.852	Reliabel
Work productivity (Pro)	0.893	Reliabel

- **Internal consistency reliability**, composite reliability values 0.6 - 0.7 have good reliability[27]. The test results show reliable indicators to measure latent constructs in this study (see table IV).

Table- IV: Reliability Composite Test Results

Variable	Score	Information
Occupational Health (H)	0.830	Reliabel
Work safety (S)	0.872	Reliabel
Work environment (E)	0.839	Reliabel
Work motivation (Mt)	0.911	Reliabel
Work productivity (Pro)	0.926	Reliabel

- **Convergent Validity**, the Average Variance Extracted (AVE) value is equal to 0.5 or more [27]. The results of the AVE value> 0.5 indicate that the construct can explain 50% or more of the variance of the items (See table V).

Table- V: Convergent Validity Test Results

Variable	Score	Information
Occupational Health (H)	0.622	Valid
Work safety (S)	0.578	Valid
Work environment (E)	0.636	Valid
Work motivation (Mt)	0.773	Valid
Work productivity (Pro)	0.758	Valid

- **Discriminant validity**, the square root value of each construct is greater than the correlation value between constructs and other constructs in the model, the model is said to have a good discriminant validity value. (see table VI).

Table- VI: Discriminant Validity Test Results

Fornell-Larcker Criterion	H	S	E	Mt	Pro
Occupational Health (H)	**0.789**				
Work safety (S)	0.645	**0.760**			
Work environment (E)	0.596	0.363	**0.798**		
Work motivation (Mt)	0.781	0.686	0.546	**0.879**	
Work productivity (Pro)	0.541	0.442	0.639	0.700	**0.871**

C. Structural Model (Goodnes of Fit Inner Model)

- **Collinearity Test**,between constructs with Variance Inflation Factor (VIF). VIF value <5, if> 5 indicates collinearity between constructs[7],[22]. The results of the inner-outer VIF value <5 (see table VII) indicate there is no collinearity between constructs so that the model's predictive ability is better.

Table- VII: Collinearity Statistics Test Results

Inner VIF Value	H	S	E	Mt	Pro
Occupational Health (H)				2.308	3.074
Work safety (S)				1.714	2.027
Work environment (E)				1.552	1.610
Work motivation (Mt)					3.118
Work productivity (Pro)					

- **Coefficient of determination (R2)**, The criterion values of R^2 are 0.67, 0.33 and 0.19 as strong, moderate, and weak[28].The results of the coefficient of determination test the value of work motivation 0.679 and work productivity 0.597 (see table VIII) then the model formed is categorized as a good / strong model, where work health, work safety and work environment simultaneously have a strong influence on work motivation by 67.9% Likewise, it has a strong effect on work productivity by 59.7%.

Table- VIII: Test Results Coefficient of determination

Dependent Variable	R Square
Work motivation (Mt)	0.679
Work productivity (Pro)	0.597

- **Cross Validated Redundancy (Q2) (Predictive Redundancy)**, Q2 value> 0 indicates that the model has accurate predictive relevance to certain constructs while Q2 value <0 indicates that the model lacks predictive relevance. [22]. Value of 0.02 (small), 0.15 (moderate) and 0.35 (large).The results of Q2 predictive relevance of work motivation 0.506 and work productivity 0.431 value> 0.35 (large), this shows good exogenous latent variables (appropriate) as explanatory variables that are able to accurately predict endogenous variables of 50.6% and 43.1%. (see table IX).

Table- IX: Cross Validated Redundancy Test Results (Q2)

	SSO	SSE	Q-<(=1-SSE/SSO
Occupational Health (H)	105.000	105.000	
Work safety (S)	175.000	175.000	
Work environment (E)	105.000	105.000	
Work motivation (Mt)	105.000	51.865	**0.506**
Work productivity (Pro)	140.000	79.672	**0.431**

- **Effect size or f-square (f2)**, The f2 value is 0.02 as small, 0.15 as moderate, and 0.35 as large. Values less than 0.02 can be ignored or considered to have no effect[25]. The results of the effect size (f2) occupational health on work motivation 0.332 (large) work safety 0.183 (moderate) and work environment 0.037 (small). (see table X).

Table- X: Effect size or f-square Test Results

f Square	H	S	E	Mt	Pro
Occupational Health (H)				0.332	0.028
Work safety (S)				0.183	0.001
Work environment (E)				0.037	0.260
Work motivation (Mt)					0.324
Work productivity (Pro)					

- **Path Coefficients**, path coefficient values indicate the significance of the relationship between latent constructs. Valid t-table values are 2.03 (TINV; n-4) and P value <0.05. The Bootrapping procedure produces t-statistics on each path used to test the hypothesis.

Table- XI: Path coefficient, Test Results

Path Coefficients	Ori (O)	Mean (M)	STERR	T Statistik	P Value
Occupational Health → Work Motivation	0.496	0.463	0.185	**2.684**	0.008
Occupational Health → Work Productivity	-0.186	-0.196	0.221	0.843	0.400
Work Safety → Work Motivation	0.317	0.351	0.171	1.854	0.064
Work Safety → Work Productivity	-0.024	-0.019	0.229	0.104	0.917
Work Environment → Work Motivation	0.136	0.151	0.111	1.224	0.221
Work Environment → Work Productivity	0.410	0.445	0.178	**2.307**	0.021
Work Motivation → Work Productivity	0.637	0.595	0.232	**2.747**	0.006

- If the t-statistic value is smaller than the t-table value (t-statistic <2.03) then there is no influence relationship and if the t-statistic value is greater or equal to t-table (t-statistic> 2.03) then there is an influence relationship.

Table- XII: Indirect Effects Test Results

Indirect Effects	H	S	E	Mt	Pro
Occupational Health (H)	1.000				**0.316**
Work safety (S)		1.000			**0.202**
Work environment (E)			1.000		**0.087**
Work motivation (Mt)				1.000	
Work productivity (Pro)					1.000

- Indirect effect, is the influence of exogenous variables on endogenous variables through work motivation variables.Indirect Effect test results are,
  - The indirect effect of occupational health on work productivity through work motivation was 31.6%.
  - The indirect effect of work safety on work productivity through work motivation is 20.2%.
  - The indirect effect of the work environment on work productivity through work motivation is 8.7%.

D. Discussion

This study is to overcome the gap of previous research and explain the relationship between HSE and work productivity in construction projects with work motivation as a mediator, where HSE factors are positively and significantly related to work motivation, as well as work motivation with worker productivity. Work motivation is based on workers' intrinsic awareness. This explains how the perception of the importance of HSE awareness influences worker behavior / actions and productivity. That the better HSE will provide impetus to work more effectively and efficiently so that construction project targets can be achieved, completed on time, on cost, on quality and safety without accidents thereby increasing work productivity.

The findings of this study also partially emphasize the importance of work motivation in worker health factors (t-statistic 2.684) due to the fact that work motivation successfully predicts worker productivity (t-statistic 2.747).

This finding recognizes work motivation as a determinant of worker productivity with occupational health.

Thus fulfilling or developing higher work motivation with HSE awareness, especially occupational health, can result in safe worker behavior and a lower number of accidents and increase worker productivity.

V. CONCLUSION

Based on the results of the analysis it can be concluded as follows:

- There is a significant effect of occupational health on work motivation (t-statistic 2.684), this shows the better the health of workers, the better the motivation for work will affect. The opposite happens if the health of workers is disturbed.
- There is a significant influence of the work environment on work productivity (t statistics 2.307), this shows that the better the work environment, the higher the work productivity.
- The indirect effect of occupational health on work productivity through work motivation was 31.6%.

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