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Application of the Finite Mixture Partial Least Square (FIMIX-PLS) Method for Clustering Performance Data of MBKM Internship Participants at PT United Tractors Tbk

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ABSTRACT

Merdeka Belajar Kampus Merdeka (MBKM) is a policy from the Minister of Education, Culture, Research, and Technology aimed at encouraging students to master various skills useful for entering the workforce. This study aims to determine the relationship between the performance of MBKM internship participants at PT United Tractors Tbk and work discipline, work motivation, and work environment, and to classify them based on these factors using SEM-PLS and FIMIX-PLS methods. SEM-PLS is an analytical method used to test relationships between variables. FIMIX-PLS is an analytical method used to classify variables and address heterogeneity. The results show that work discipline (X_1) and work environment (X_3) significantly affect performance (Y), while work motivation (X_2) does not significantly affect performance (Y). Classification using FIMIX-PLS yielded the best segment with k = 3, having the highest EN value. Segment 1, consisting of 68 MBKM internship participants, shows the greatest contribution from the work environment (X_3) to performance (Y) at 0,362. Segment 2, consisting of 22 MBKM internship participants, shows the greatest contribution from work motivation (X_2) to performance (Y) at 0,614. Segment 3, consisting of 10 MBKM internship participants, shows the greatest contribution from work discipline (X_1) to performance (Y) at 0,976.

Keywords: *FIMIX-PLS. MBKM, Performance, PT United Tractors Tbk, SEM-PLS,*

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1. Introduction

Merdeka Belajar Kampus Merdeka (MBKM) is a policy from the Minister of Education, Culture, Research, and Technology, aimed at encouraging students to master various fields of knowledge that are useful for entering the workforce. This MBKM policy aligns with Permendikbud (Minister of Education and Culture Regulation) No. 3 of 2020 concerning the National Standards for Higher Education. Article 18 states that the fulfillment of the duration and learning load for undergraduate or applied undergraduate students can be carried out by: (a) participating in the entire learning process within the study program at the higher education institution according to the duration and learning load, or (b) participating in the learning process within the study program to fulfill part of the duration and learning load, with the remaining part being completed through other learning activities [1].

One of the activities in the MBKM program designed to prepare students for the workforce is the Certified Internship and Independent Study (MSIB). The Certified Internship under Kampus Merdeka is an accelerated program with a well-designed learning experience [2]. In the Certified Internship and Independent Study (MSIB) program, there are many institutions/companies that prospective interns can choose from. One of the institutions/companies collaborating with the Merdeka Belajar Kampus Merdeka (MBKM) program is PT United Tractors Tbk.

PT United Tractors Tbk is one of the largest companies in Indonesia, with a service network that reaches various industries and sectors. The company is known as the largest heavy equipment distributor in Indonesia, having been established in 1972 with its headquarters in East Jakarta, Indonesia. Today, PT United Tractors Tbk has grown to become one of the key players

in the domestic sector and industry through six business pillars: construction machinery, mining contracting, coal mining, gold mining, construction industry, and energy. The program at PT United Tractors Tbk aims to provide work experience, enhance work insights, and develop character for students across Indonesia [3].

As the industry evolves, PT United Tractors Tbk recognizes that the people aspect is one of the critical elements that has always been integral to the company's growth. Human resource (HR) development programs, corporate culture, and people management have now become necessities that must be given greater attention. Efforts in HR development can be made through training and development for interns, careful selection in the recruitment of interns, and the implementation of efficient performance management. Additionally, it is important to consider other factors that may affect performance, such as work discipline, a conducive and comfortable work environment, intern motivation, adequate benefits, and a positive work culture [4]. This statement is supported by whose research explains that work discipline is a crucial factor that can influence performance efficiency, while the work environment can affect employee work quality, and motivation is essential for maintaining good performance to achieve excellent results [5].

Work discipline is reflected in the attitude and actions of individuals in completing tasks or jobs consistently, on time, and in accordance with established procedures [6]. A less than optimal level of discipline is apparent in the time management of the MBKM interns at PT United Tractors Tbk. It is still common to find individuals or even groups of people who are not punctual in coming to work, wear attire that does not comply with company procedures, and experience various delays in executing work programs.

Motivation is the drive, whether internal or external, to perform a task with awareness and enthusiasm to achieve specific goals [7]. The work motivation reflected in the internship activities at PT United Tractors Tbk still shows deficiencies, particularly related to various factors such as project targets that require excessive lead time, lack of communication between employees, mentors, and even among fellow interns, as well as limited development in friendship and leadership skills.

The work environment encompasses all facilities that affect a person's work, including tools, materials, work methods, individual and group work arrangements, and the surrounding environment [8]. Poor conditions in the workplace, such as temperature, noise, lighting, cleanliness, and comfort, can negatively impact the productivity of interns and make it difficult for them to settle into the workspace. The work environment is a significant factor influencing the performance of interns, especially for those who are not accustomed to or feel uncomfortable with the people around them.

Based on the issues observed with the MBKM batch 5 interns in 2023 at PT United Tractors Tbk, coupled with the lack of actual data from the Person In Charge (PIC) since the beginning of the MBKM implementation to the present, there is no supporting argument for conducting an evaluation. Therefore, research is needed to strengthen the argument in identifying the factors affecting intern performance and to categorize interns based on these factors [9]. The Structural Equation Modeling Partial Least Square (SEM-PLS) and Finite Mixture in Partial Least Square (FIMIX-PLS) methods are appropriate choices for conducting this research.

Structural Equation Modeling (SEM) is a method that combines two analytical models: factor analysis and regression analysis. SEM is divided into two models: Covariance Based Structural Equation Modeling (CB-SEM) and Structural Equation Modeling Partial Least Square (SEM-PLS) [10][11]. The goal of the SEM-PLS method is to test the relationships among variables in a model, both between latent variables and indicator variables, as well as among latent variables [12]. SEM-PLS has fewer assumptions, is more flexible, and powerful in explaining the relationships among variables. However, the SEM-PLS method does not account for heterogeneity within the observation units for latent variables [10][13]. One method that can account for heterogeneity in latent variables is Structural Equation Modeling (SEM) with Finite Mixture Partial Least Square (FIMIX-PLS) [14].

Finite Mixture Partial Least Square (FIMIX-PLS) is an extension of Structural Equation Modeling (SEM) analysis used to cluster latent variables based on indicator variables [15], [16]. FIMIX-PLS is employed because it can provide better conclusions and account for heterogeneity among latent variables through segmentation. FIMIX-PLS is reliable in identifying specific customer segments with estimated characteristics for relationships among latent variables in the structural model [17]. FIMIX-PLS is useful for multigroup path analysis in research and also beneficial for sequential clustering strategies. Based on this description, the researcher is interested in conducting a study titled "Application of the Finite Mixture Partial Least Square (FIMIX-PLS) Method for Clustering Performance Data of MBKM Interns at PT United Tractors Tbk."

2. Method Details

2.1 Data Collection

The data collection for this research will take place at PT United Tractors Tbk, East Jakarta, over a period of 1 month, specifically in December 2023. The research implementation will be conducted at the Department of Mathematics, Universitas Pattimura, over a period of 3 months, specifically in January, February, and March 2023.

2.2 Research Variables

The research variables used can be seen in Table 1.

Table 1. Research Variables

Latent variables	Indicator
Work discipline (X_1)	Complying with company regulations (x_{11}) Implementing and adhering to the provided SOP (x_{12}) Being cautious in using work tools (x_{13}) Being punctual in check-in and check-out (x_{14}) Attending mentoring sessions twice a month (x_{15})
Work motivation (X_2)	The incentives provided are proportional to the internship work performed (x_{21}) Health insurance in the form of medical check-ups (x_{22}) Training and personal development in project execution (x_{23}) Recognition and support from the mentor during the internship (x_{24}) Awards to be received at the end of the internship (x_{25})
Work environment (X_3)	Good relationships between employees and mentors (x_{31}) Security system implemented at the company (x_{32}) Air circulation conditions in the workspace (x_{33}) Lighting conditions in the workspace (x_{34}) Seating conditions in the workspace (x_{35}) Supporting facilities (e.g., prayer room, pantry, canteen, etc.) conditions (x_{36})
Performance (Y)	Project targets are completed precisely according to the given specifications (y_1) Projects are completed without lead time (y_2) Maximizing accuracy and neatness in work (y_3) Maintaining a professional appearance (y_4) Leading the project effectively (y_5) Maximizing teamwork on project teams (y_6)

2.3 Structural Equation Modeling Partial Least Square (SEM-PLS)

The SEM-PLS model is used to predict and develop theories, which differs from covariance-based SEM or CB-SEM, which is aimed at theory testing and confirmation. In SEM with PLS, the latent variable values can be estimated according to a linear combination of indicators related to a latent variable and treated as a substitute for the indicator variables [11].

2.4 Finite Mixture Partial Least Square (FIMIX-PLS)

The FIMIX-PLS method is a clustering method that can be applied to models containing latent variables or variables that cannot be directly measured. According to Vinzi, Trinchera, Squillacciotti, and Tenenhaus in 2008, heterogeneity can be detected by an index called the closeness index (GOF index), calculated from the residual communality of the model [18]. Vinzi developed the Response Base Unobserved Sample Partial Square model, later known as REBUS-PLS. In FIMIX-PLS, the statistical measure used to determine the best number of segments is the Normed Entropy (EN). EN is a criterion used to analyze the class specification results from FIMIX-PLS, with values ranging from 0 to 1. The closer the EN value is to 1, the better the separation quality, and the model can be interpreted [14]. The assumption in FIMIX-PLS is that if observation units have been separated according to their strata, heterogeneity will not occur in the structural model [14].

In theory, the EN value can be calculated using the formula in Equation (1) below [15].

$$EN = 1 - \frac{\sum_{i-1}^{I}\sum_{k=1}^{K} -P_{ik}ln(P_{ik})}{I\ ln(K)} \quad (1)$$

Explanation:

EN : normed entropy, a relative measure ranging from 0 to 1

i : number of observations

k : number of segments or groups

P_{ik} : probability of the *i*-th observation in the *k*-th segment.

To determine the optimal number of segments (k), the researcher can compare the EN criteria value that is the highest among the various segmentation tests or experiments conducted. The results of this segmentation can reveal the number of samples in each segment formed with the FIMIX path coefficient value.

3. Results and Discussion

3.1. General Overview of Respondents

The respondents in this study are MBKM batch 5 interns at PT United Tractors Tbk, characterized as all respondents being students, as obtained through the distribution of online and offline research questionnaires. From the questionnaire responses, the characteristics of respondents based on work placement (venue) are as follows:

Table 2. Characteristics of respondents based on venue

Venue	Amount
Basecamp (BP Lt.2)	35
UTHO	31
Yayasan (MBUT, KMC, YKBUT)	9
UT *School*	3
UT *Call*	3
CORPU	16
Branch	3
Total	100

Table 2 shows that the total number of respondents is 100, distributed across 7 work placements (venues). Basecamp (Bina Pertiwi floor 2) has 35 respondents, United Tractors Head Office (UTHO) has 31 respondents, Yayasan (MBUT, KMC, YKBUT) has 9 respondents, United Tractors School (UTS) has 3 respondents, United Tractors Call (UTC) has 3 respondents, Corporate University (CORPU) has 16 respondents, and

Branch has 3 respondents. Based on the total population of MBKM batch 5 interns at PT United Tractors, which is 238, and the sample size of 100 respondents, the error rate in sampling can be calculated as follows:

$$n = \frac{N}{1 + Ne^2}$$

$$e = \sqrt{\frac{N - n}{nN}}$$

$$e = \sqrt{\frac{238 - 100}{23800}}$$

$$e = \sqrt{\frac{138}{23800}} \quad e = 0{,}076$$

The error rate in sampling is 0,076. The sampling was conducted to minimize time and to address issues such as the lack of concern or awareness among MBKM batch 5 interns at PT United Tractors Tbk in filling out the distributed questionnaire link.

3.2. Validity and Realibility Tests

Validity testing is used to see wheter the indicators for each variable are valid and can be used in the model. The results of the validity testing are presented in Table 3.

Table 3. Validity Test Results

Variabel	*P-value*	Description
x_{11}	0,000	Valid
x_{12}	0,000	Valid
x_{13}	0,000	Valid
x_{14}	0,000	Valid
x_{15}	0,000	Valid
x_{21}	0,000	Valid
x_{22}	0,000	Valid
x_{23}	0,000	Valid
x_{24}	0,000	Valid
x_{25}	0,000	Valid
x_{31}	0,000	Valid
x_{32}	0,000	Valid
x_{33}	0,000	Valid
x_{34}	0,000	Valid
x_{35}	0,000	Valid
x_{36}	0,000	Valid
y_1	0,000	Valid
y_2	0,000	Valid
y_3	0,000	Valid
y_4	0,000	Valid
y_5	0,000	Valid
y_6	0,000	Valid

Table 3 shows that the validity test on the questionnaire with 22 indicator variables is valid because the P-value for all indicator variables is less than 0,05 (P-value < 0,05). The reliability test results can be seen based on Cronbach's alpha value. The Cronbach's alpha results are provided in Table 4.

Table 4. Reliability Test Results

Cronbach's alpha	Amount of indicator variables
0,867	22

Table 4. shows that the reliability test with 22 indicator variables and 100 respondents is reliable because Cronbach's alpha = 0,867 > 0,6.

3.3. Research Hypotheses

Hypothesis 1:

H_0: Work discipline (X_1) does not significantly affect performance (Y)

H_1: Work discipline (X_1) significantly affects performance (Y)

Hypothesis 2:

H_0: Work motivation (X_2) does not significantly affect performance (Y)

H_1: Work motivation (X_2) significantly affects performance (Y)

Hypothesis 3:

H_0: Work environment (X_3) does not significantly affect performance (Y)

H_1: Work environment (X_3) significantly affects performance (Y)

3.4. Contructing Path Diagrams

The relationships between latent variables and indicator variables in this study are measured based on two models: reflective and formative. The relationships measured reflectively are work discipline (X_1) and performance (Y). The relationships measured formatively are work motivation (X_2) and work environment (X_3). The constructed path diagram illustrating the relationships between variables can be seen in Figure 1.

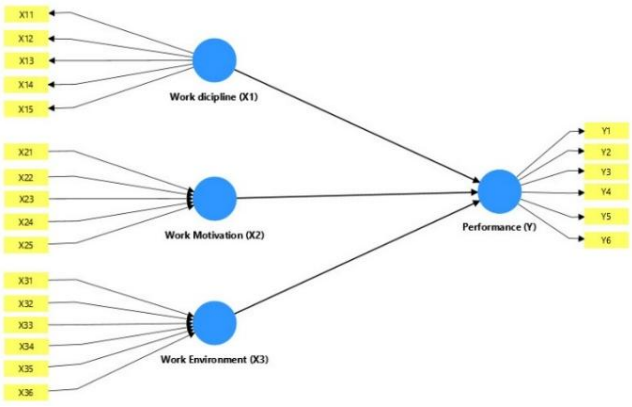

Figure 1. Path diagram with SmartPLS 3

3.5. Evaluation of the Measurement Model (Outer Model)

The evaluation of the measurement model was conducted on both the reflective and formative models.

3.5.1. Reflective Relationships Model

Measurement model for reflective relationship can analyze from convergent validity for loading factor.

Table 5. Convergent validity for loading factor values

Reflective relationship between indicator variables and latent variables	*Loading factor*
$x_{11} \leftarrow X_1$	0,813
$x_{12} \leftarrow X_1$	0,830
$x_{13} \leftarrow X_1$	0,640
$x_{14} \leftarrow X_1$	0,502
$x_{15} \leftarrow X_1$	0,444
$y_1 \leftarrow Y$	0,710
$y_2 \leftarrow Y$	0,675
$y_3 \leftarrow Y$	0,764
$y_4 \leftarrow Y$	0,691
$y_5 \leftarrow Y$	0,697
$y_6 \leftarrow Y$	0,612

Table 5 shows that all indicator variables, except for x_{15} which has a reflective relationship with its latent variable, are valid because they have a loading factor value > 0,5. The indicator variable x_{15} has a loading factor value of 0,444 < 0,5, indicating it is not valid and should be removed or excluded from the model.

Table 6. Reflective latent variable reliability

Reflective latent variable	Composite reliability
Work discipline (X_1)	0,789
Performance (Y)	0,847

Table 6 shows that the latent variables work discipline (X_1) and performance (Y) are reliable because they have composite reliability values > 0,7. This indicates consistency and stability in the latent variables with reflective relationships.

3.5.2. Formative Relationships Model

Evaluation of the measurement model for formative relationships can show in significance of weights.

Table 7. Significance of weight values (outer weight)

Formative indicator variables and latent variables	*P-value*	*Loading factor*
$x_{21} \rightarrow X_2$	0,625	0,346
$x_{22} \rightarrow X_2$	0,179	0,577
$x_{23} \rightarrow X_2$	0,006	0,753
$x_{24} \rightarrow X_2$	0,004	0,704
$x_{25} \rightarrow X_2$	0,981	0,444
$x_{31} \rightarrow X_3$	0,084	0,719
$x_{32} \rightarrow X_3$	0,066	0,709
$x_{33} \rightarrow X_3$	0,073	0,319
$x_{34} \rightarrow X_3$	0,001	0,684
$x_{35} \rightarrow X_3$	0,658	0,377
$x_{36} \rightarrow X_3$	0,266	0,497

Table 7 shows that the significant indicator variables are x_{23}, x_{24}, and x_{34} because they have P-value < 0,05. The non-significant indicator variables are x_{31}, x_{32}, x_{33}, x_{35}, and x_{36} because they have P-value > 0,05. However, based on the explanation in the previous chapter about the significance weight measurement criteria, which states that non-significant indicator variables with P-value > 0,05 should still be included in the model if they have a loading factor > 0,5, and vice versa [19]. Therefore, the variables that are non-significant and should be removed from the model are x_{21}, x_{25}, x_{33}, x_{35}, and x_{36}, because they have P-value > 0,05 and loading factor < 0,5. The outer collinearity among indicator variables can show on Table 8.

Table 8. Outer collinearity of formative indicator variables

Formative indicator variable	*VIF*
$x_{22} \rightarrow X_2$	1,150
$x_{23} \rightarrow X_2$	1,174
$x_{24} \rightarrow X_2$	1,036
$x_{31} \rightarrow X_3$	1,455
$x_{32} \rightarrow X_3$	1,383
$x_{34} \rightarrow X_3$	1,122

Table 8 shows that the indicator variables in the formative relationship model have VIF < 10, indicating that all formative indicator variables are considered good because they do not experience multicollinearity.

3.6. Modelling

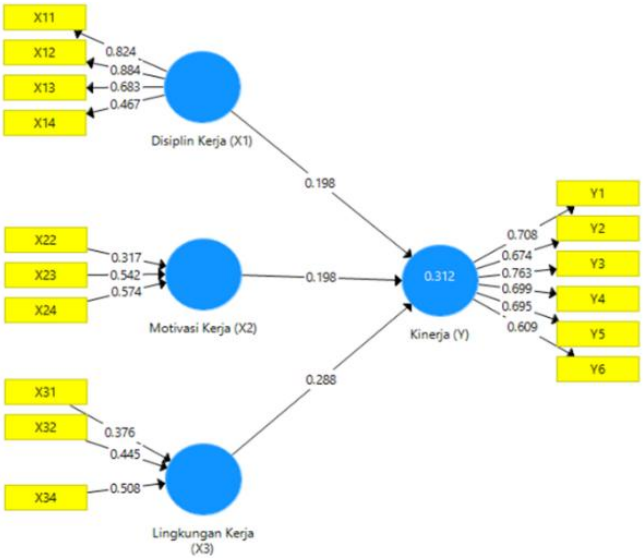

Figure 2 Path diagram with loading factors

Figure 2 illustrates the model of reflective and formative relationships between indicator variables and latent variables, showing loading factor values and coefficients of relationships between exogenous latent variables and endogenous latent variables. After obtaining the path diagram model with loading factor values, it can be converted into the measurement model equations.

3.7. Evaluation of the Structural Model (Inner Model)

Based on Figure 2, the structural model equation can be formulated as follows:

$$Y = 0{,}198(X_1) + 0{,}198(X_2) + 0{,}288(X_3) + \zeta$$

3.7.1. Inner Collinearity Among Latent Variables

Table 9. Collinearity of latent variables

Latent Variable	VIF
Work discipline (X_1)	1,467
Work motivation (X_2)	1,625
Work environment (X_3)	1,438

Table 9 shows that the structural model equation is considered good because there is no multicollinearity. This is indicated by the VIF values, where all latent variables have VIF < 10.

3.7.2. Significance of Path Coefficients

Table 10. Path Coefficients

Relationship between latent variables	*P-value*	*Loading factor*
Work discipline (X_1) → performance (Y)	0,042	0,198
Work motivation (X_2) → performance (Y)	0,080	0,198
Work environment (X_3) → performance (Y)	0,006	0,288

Based on Table 10 decisions regarding research hypotheses can be made as follows:

- **Hypothesis 1 decision**
  The exogenous latent variable X_1 has a path coefficient of 0,198 and a P-value of 0,042 < 0,05. Therefore, the decision for Hypothesis 1 is to reject H_0. This means that work discipline (X_1) significantly affects performance (Y) of MBKM batch 5 interns at PT United Tractors Tbk.
- **Hypothesis 2 decision**
  The exogenous latent variable X_2 has a path coefficient of 0,198 and a P-value of 0,080 > 0,05. Therefore, the decision for Hypothesis 2 is to accept H_0. This means that work motivation (X_2) does not significantly affect performance (Y) of MBKM batch 5 interns at PT United Tractors Tbk.
- **Hypothesis 3 decision**
  The exogenous latent variable X_3 has a path coefficient of 0,288 and a P-value of 0,006 < 0,05. Therefore, the decision for Hypothesis 3 is to reject H_0. This means that the work environment (X_3) significantly affects performance (Y) of MBKM batch 5 interns at PT United Tractors Tbk.

3.8. Clustering with FIMIX-PLS

In determining the best group or segment, it can be assessed based on the highest normed entropy (EN) value. Segmentation was performed five times, starting from segment k = 2, k = 3, k = 4, k = 5, and k = 6, with each corresponding normed entropy (EN) value as shown in Table 11.

Table 11. Normed entropy (EN) values

Fit indices	k = 2	k = 3	k = 4	k = 5	k = 6
NE	0,270	0,791	0,779	0,695	0,770

Based on Table 11, it shows a comparison of the EN values for k = 2, k = 3, k = 4, k = 5, and k = 6. From these results, it is known that the highest EN value is at k = 3, which is 0,791, indicating that the best grouping or segment is k = 3. For the segment size, it shows in Table 12.

Table 12. Segment Size

k	Segment 1	Segment 2	Segment 3
3	0,711	0,178	0,111

Table 12 shows the distribution in each segment, which represents the probability values of grouping the performance of internship participants into a certain segment. Segment 1 has a probability value with a percentage of 71,1%, segment 2 is 17,8%, and segment 3 is 11,1%. This indicates that segment 1 has the highest number of MBKM internship participants.

The segmentation results in 3 segments, each with a probability value of MBKM internship participants. A probability value close to 1 indicates a better segment. The segmentation results can be presented in Table 13.

Tabel 13. Segmentation results

MBKM Intern	Segment 1	Segment 2	Segment 3
1	0,218	0,782	0
2	0,779	0	0,221
3	**1**	0	0
4	**1**	0	0
5	0,423	0,577	0
6	**1**	0	0
7	0,259	0,741	0
8	**1**	0	0
9	0,809	0,191	0
10	0,568	0,432	0
.	.	.	.
.	.	.	.
.	.	.	.
100	0,302	0,698	0

Based on Table 13, the probability values for each MBKM intern in their respective segments are shown. The highest probability value indicates which segment the MBKM intern belongs to. Therefore, MBKM internships can be identified and grouped, and the number of members in each segment can be displayed in Table 14.

Table 14. Number of Member in Segments

Segment	Number of Member
1	68
2	22
3	10

Based on Table 14, the grouping of MBKM interns is obtained based on the formed segments, resulting in 3 segments with Segment 1 consisting of 68 MBKM interns, Segment 2 consisting of 22 MBKM interns, and Segment 3 consisting of 10 MBKM interns from Batch 5 at PT United Tractors Tbk.

Table 15. FIMIX Path Coefficient

Relationship between Latent Variables	Path coefficient		
	Segment 1	Segment 2	Segment 3
$X_1 \rightarrow Y$	0,014	0,511	0,976
$X_2 \rightarrow Y$	0,167	0,614	-0,421
$X_3 \rightarrow Y$	0,362	-0,075	0,353

Based on Table 15, it compares the coefficients in the structural equation for each segment. In Segment 1, the largest contribution between latent variables is X_3 to Y, which is 0,362 meaning that the work environment in Segment 1 has the most significant influence on performance. In Segment 2, the largest contribution is X_2 to Y, which is 0,614 meaning that work motivation has the most significant influence on performance. Meanwhile, in Segment 3, the largest path coefficient is the latent variable X_1 to Y, which is 0,976 meaning that work discipline has the most significant influence on performance.

4. Conclusion

Based on SEM-PLS analysis, work discipline and work environment have positive and significant effects on the performance of MBKM interns at PT United Tractors Tbk, with path coefficients of 0.198 and 0.288, respectively. In contrast, work motivation does not have a significant effect on performance. FIMIX-PLS segmentation identified three optimal segments (k = 3). In Segment 1 (68 interns), the work environment has the strongest influence on performance (0.362). In Segment 2 (22 interns), work motivation shows the largest contribution (0.614). In Segment 3 (10 interns), work discipline has the strongest effect on performance (0.976).

Author Contributions Statement

Author 1: Conceptualization, Methodology
Author 2: Data Collection and Curation, Investigation, Visualization,
Author 3: Preparation of the original draft or writing of the review and editing
Author 4: Supervision of Manuscripts, Validation, Resource Provision

Conflict of Interest Statement

☒ The authors declare that they have no known competing financial interests or known personal relationships that could be considered to influence the work reported in this article.

☐ The authors declare the following financial/personal relationships that may be considered competing interests.

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