The Effect of Campus Physical Environment on Students' Psychological Health: A Study on College Students Using Canonical Correlation Analysis Method

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Abstract* — *The physical environment of a campus is considered a significant factor influencing students' psychological health, yet the complex, multidimensional nature of this relationship remains underexplored in the Indonesian context, particularly using multivariate statistical methods. This study aims to investigate the multivariate relationship between a set of campus physical environment variables and a set of student psychological health variables using Canonical Correlation Analysis (CCA). A quantitative survey was conducted with undergraduate students at Bina Nusantara University, collecting data on 15 environmental indicators (e.g., quality of facilities, safety, learning ambiance) and 15 psychological indicators (e.g., academic stress, motivation, well-being). The measurement model was first validated using Confirmatory Factor Analysis (CFA), confirming its construct validity and reliability. The main analysis was performed using CCA, with the statistical significance of the model evaluated by the Wilk's Lambda test. The CFA results indicated that the measurement model was valid and reliable. However, the Wilk's Lambda test for the CCA yielded a non-significant result (p>0.05), indicating the absence of a statistically significant linear relationship between the set of physical environment variables and the set of psychological health variables. This study concludes that, based on the collected data, there is no evidence of a significant multivariate association between the measured aspects of the campus physical environment and student psychological health. These findings underscore the complexity of student well-being and suggest that other factors may play a more dominant role.

I. Introduction

The campus physical environment has emerged as a significant determinant of student psychological health, especially as universities strive to enhance academic performance and well-being through improved infrastructure [1]. In Indonesia, surveys and empirical studies indicate that a substantial portion of college students experience psychological distress linked to environmental stressors, such as inadequate facilities, poor classroom conditions, and limited access to green spaces [2], [3]. According to a study by Wahyuni et al. (2022), over 40% of students in urban Indonesian universities reported that unsupportive campus environments exacerbated their stress and negatively impacted their academic motivation [2]. The Indonesian Ministry of Health has also highlighted the increasing prevalence of mental health issues among university students, attributing part of the problem to the lack of conducive physical campus settings [4].

While the influence of the physical environment on student mental health is acknowledged, most existing Indonesian studies employ basic correlation or regression methods, often focusing on single dimensions of either the environment or psychological health [2], [5]. This univariate or bivariate approach fails to address the complex, multivariate relationships that exist between various campus environmental factors (e.g., lighting, noise, accessibility) and multiple aspects of psychological health (e.g., stress, well-being, motivation) [6]. Furthermore, few studies utilize robust statistical techniques capable of disentangling these multidimensional relationships in the context of Indonesian higher education.

This study addresses that research gap by applying Canonical Correlation Analysis (CCA) to simultaneously examine the multivariate associations between the campus physical environment and students' psychological health. CCA offers a methodological advantage over traditional approaches by allowing the analysis of two sets of variables and identifying the most influential relationships between environmental factors and psychological outcomes [7], [8]. Recent international research has demonstrated the value of CCA in exploring complex psychosocial phenomena in educational settings [7], yet this technique remains underutilized in Indonesia.

Therefore, the primary objective of this research is to provide a comprehensive analysis of how the physical environment of Indonesian campuses affects the psychological health of students, using CCA to capture the nuanced and multidimensional nature of these relationships. By leveraging robust, up-to-date methods and focusing on the Indonesian context, this study contributes novel insights that can inform campus planning and mental health interventions in higher education.

II. RELATED WORKS

Recent studies have increasingly employed Canonical Correlation Analysis (CCA) to explore the complex and multidimensional relationships between environmental and psychological variables, particularly within higher education settings. For instance, Liu et al. [7] highlighted that the use of CCA in educational psychology revealed strong, statistically significant correlations between classroom environment variables and students' academic engagement, with canonical correlation coefficients reaching up to 0.67 in their large-scale study.

Zhu and Liao [8] specifically utilized CCA to examine the association between campus walkability and students' emotional well-being, revealing that access to green spaces, convenient pathways, and lighting were collectively responsible for explaining over 45% of the variance in students' reported happiness and reduced stress levels.

Similarly, Rieger et al. [9] applied CCA to analyze the interplay between learning environments and student mental health, demonstrating that environmental factors such as classroom layout and noise management accounted for significant improvements in student psychological health indicators, with canonical correlations ranging from 0.54 to 0.61.

Toker and Avci [10] reinforced these findings by showing that classroom environment characteristics, including perceived supportiveness and safety, were closely related to psychological well-being, with their CCA revealing a canonical function that explained 38% of the shared variance.

Furthermore, Liu et al. [11] employed CCA to identify key urban environmental stressors, such as noise pollution and overcrowding, that predicted mental health outcomes among college students, finding that the first canonical variate explained 42% of the covariance between stressors and psychological distress.

Finally, Singh et al. [12] expanded this scope by investigating the role of institutional support structures in fostering psychological well-being in Asian universities, with CCA results showing that access to counseling, academic support, and inclusive campus policies were significantly linked to reduced anxiety and higher life satisfaction, accounting for over 40% of the shared variance. Collectively, these studies establish CCA as a powerful statistical approach for investigating the multifaceted associations between campus physical environments and student psychological health, and they empirically demonstrate its ability to quantify and interpret such complex relationships.

III. METHODOLOGY

This research adopts a quantitative survey design to examine the relationship between campus physical environment factors and students' psychological health at Bina Nusantara University. Data were collected through an online questionnaire distributed to undergraduate students at the university. The instrument included validated items covering multiple aspects of the campus physical environment (e.g.,Comfort & Security of the Campus Environment, Learning Environment Ambience & Comfort, Lighting & Ventilation of Learning Spaces,Accessibility & Mobility in Campus Area) and psychological health dimensions (e.g., well-being, stress, motivation, emotional stability)..

Prior to analysis, data screening was performed to address missing values and outliers. The reliability and validity of measurement constructs were assessed using Cronbach's alpha, Composite Reliability (CR), and Average Variance Extracted (AVE). Descriptive statistics were generated to summarize the sample characteristics and main study variables.

The core analytical technique employed in this study is Canonical Correlation Analysis (CCA). CCA is utilized to simultaneously investigate the linear relationships between two multivariate variable sets: (1) campus physical environment indicators and (2) psychological health indicators. The adequacy of the CCA model is evaluated by examining canonical correlation coefficients, Wilks' lambda, and redundancy indices. Additional tests, including Bartlett's test of sphericity and measures of sampling adequacy, are performed to confirm the appropriateness of the data for multivariate analysis.

All statistical analyses are conducted using R software. Results from CCA are interpreted to identify the most salient physical environment factors associated with students' psychological health, thus providing insights into effective campus planning and mental health strategies.

A. Latent Variables

In this study, the choice of campus physical environment and student psychological health as latent variables is supported by recent research. Liu et al. [11] used canonical correlation analysis to show that environmental stressors significantly affect student mental health, with the primary canonical variate explaining a substantial portion of the shared variance. Likewise, Singh et al. [12] found that institutional support is closely linked to lower anxiety and improved well-being. These studies underscore the importance of both campus environment and support systems in influencing student psychological health, and demonstrate the suitability of CCA for analyzing these relationships [11][12]

B. Dataset

The dataset utilized in this study was primary data collected through a structured questionnaire distributed via Google Forms. The questionnaire contained 15 items, with 3 questions per latent variable to ensure comprehensive measurement. A six-point Likert scale ranging from 1 (Strongly Disagree) to 6 (Strongly Agree) was used to encourage more definitive responses [13]. This scale is commonly used in social science research for its reliability in assessing attitudes and perceptions. Table I displays how the 15 selected questions are distributed across five latent variables associated with the campus physical environment.

TABLE I. Campus physical environment latent & question

Latent	Question
Quality of Facilities	1. The campus parking area is spacious enough and does not cause difficulties during peak hours 2. Classrooms (including desks, chairs, and whiteboards) are in good condition and comfortable to use.. 3. Well-maintained campus facilities contribute to the improvement of my academic performance.
Comfort & Security of the Campus Environment	1. I feel safe walking alone on campus at night. 2. The campus area has good lighting at night. 3. The presence of security personnel makes me feel comfortable.
Learning Environment Ambience & Comfort	1. A quiet classroom environment helps me focus better on studying. 2. The campus layout supports my learning comfort. 3. The noise in the campus environment disrupts my concentration while studying.
Lighting & Ventilation of Learning Spaces	1. The natural and artificial lighting in the classrooms is adequate. 2. The ventilation in the learning spaces keeps the air fresh and not stuffy. 3. I feel easily fatigued when studying in a room with poor ventilation.
Accessibility & Mobility in Campus Area	1. Pathways between buildings are easily accessible and safe for all users. 2. Campus directions and location information are easy to find and understand. 3. Mobility facilities (stair ramps, lifts, shuttles) facilitate access between campus locations.

In this study, each questionnaire item is conceptualized as an empirical indicator, or observed variable, which serves to operationalize a specific latent construct. To ensure clarity and analytical rigor, a systematic alphanumeric coding scheme was established. To illustrate this scheme, the set of items measuring the 'Quality of Facilities' construct are denoted by the identifiers A1, A2, and A3. Following this convention, the subsequent construct, 'Comfort & Security of the Campus Environment', is represented by its respective indicators B1, B2, and B3. This methodological approach, which assigns a unique alphabetical prefix to each construct's set of indicators, was systematically employed for all variables within the research model.

Table II displays how the 15 selected questions are distributed across five latent variables associated with the student psychological health.

TABLE II. Student psychological health latent & question

Latent	Question
Academic Stress	1. I often feel overwhelmed by my academic workload. 2. Tight deadlines cause me stress during college. 3. I have difficulty managing academic stress.
Daily Mood & Emotions	1. I often experience mood swings during my campus activities. 2. I feel easily angry or frustrated in the campus environment 3. I often have days with negative feelings during my studies.
Learning Motivation	1. I feel motivated to complete my academic assignments on time. 2. I study because I enjoy the learning process itself. 3. I have clear academic goals, which motivate me to study.
General Mental Well-being	1. I generally feel that I have good mental health. 2. I am satisfied with the balance between my academic life and personal life. 3. I feel happy with my life as a student.
Emotion Regulation Capability	1. I am able to control my emotions when facing academic pressure. 2. I can stay calm when dealing with difficult situations on campus. 3. I can process negative emotions in a healthy way.

C. Data Preparation

In this study, we utilized R tools to prepare the raw data obtained from the questionnaire. The data was organized into two main sets for analysis: the Campus Physical Environment (X) and Psychological Health (Y). The Campus Physical Environment set comprises 15 observed variables, grouped under five latent constructs:

- Quality of Facilities, which includes variables such as parking space, classroom conditions, and the impact of well-maintained facilities on academic performance (A1, A2, A3).
- Comfort & Security of the Campus Environment, covering factors like safety and lighting on campus (B1, B2, B3).
- Learning Environment Ambience & Comfort, including aspects like classroom quietness and the impact of the campus layout on learning (C1, C2, C3).
- Lighting & Ventilation of Learning Spaces, addressing classroom lighting and ventilation (D1, D2, D3).
- Accessibility & Mobility in Campus Area, which involves campus pathways and the ease of movement (E1, E2, E3).

The Psychological Health set consists of 15 observed variables grouped into five latent constructs:

- Academic Stress, including workload and time management difficulties (F1, F2, F3).
- Daily Mood & Emotions, covering mood swings and frustration levels in the campus environment (G1, G2, G3).
- Learning Motivation, including intrinsic motivation and goal setting for academic success (H1, H2, H3).
- General Mental Well-being, addressing overall mental health and life satisfaction (I1, I2, I3).
- Emotion Regulation Capability, focusing on emotional control under academic pressure (J1, J2, J3).

Standardizing the data ensures that all the variables are on the same scale, especially when combining variables from different sets.Formula for standardizing each observed variable:

$$Z = \frac{X - \mu}{\sigma}$$

Where Z is the standardized score, X is the raw score (original value), μ is the mean of the observed variable, and σ is the standard deviation of that variable. This transformation is applied to each observed variable in the study, such as A1, A2, ..., J3, across both the Campus Physical Environment and Psychological Health sets. By standardizing the data, we ensure that the variables are comparable, even if they originally had different scales or units of measurement, which is essential for accurate analysis in multivariate methods like Canonical Correlation Analysis (CCA).

D. Validity Check

The construct validity of the measurement model was established using Confirmatory Factor Analysis (CFA). As a theory-driven technique within the Structural Equation Modeling (SEM) family, CFA was employed to statistically verify that the empirical data fits the pre-specified measurement model. This process confirms that the observed indicator variables reliably load onto their intended latent constructs as hypothesized [15].

The relationship between the observed indicators and latent constructs in a CFA model is defined by the measurement model equation, expressed in its general matrix form as:

$$X = \Lambda x \xi + \delta$$

Where:

- *X is the vector of observed indicator variables.*
- Λx (Lambda) is the matrix of factor loadings, representing the strength of the relationship between the latent constructs and the indicators.
- ξ (Ksi) is the vector of latent constructs or factors.
- δ (Delta) is the vector of unique measurement errors for each indicator.

The primary objective of the analysis is to determine how well the collected data fits this specified model. The adequacy of the model fit was not judged by a single criterion but was assessed against a battery of widely accepted goodness-of-fit (GoF) indices. Following contemporary best-practice recommendations [16], a model is considered to have an acceptable fit if it meets the following thresholds:

- Comparative Fit Index (CFI) and Tucker-Lewis Index (TLI): Values for both CFI and TLI should be ≥ 0.90 for an acceptable fit, and ≥ 0.95 for an excellent fit.
- Root Mean Square Error of Approximation (RMSEA): A value of ≤ 0.08 indicates a reasonable fit, while a value of ≤ 0.06 indicates a good fit.
- Standardized Root Mean Square Residual (SRMR): A value of ≤ 0.08 is generally considered indicative of a good model fit.

By meeting these established GoF criteria, the measurement model demonstrates strong construct validity, providing a sound foundation for the subsequent analysis.

E. Reliability Check

The reliability of the measurement model was evaluated to ensure the internal consistency and stability of the constructs. This assessment was conducted using two key metrics: Construct Reliability (CR) and Variance Extracted (VE).

1) *Construct Reliability*

The primary measure for the internal consistency of the indicators for each construct was Construct Reliability (CR). The CR value is calculated to assess the degree to which the set of indicators consistently measures the same underlying latent variable. The formula for Construct Reliability is as follows:

$$CR = \frac{(\sum std.loading)^2}{(\sum std.loading)^2 + \sum E_j}$$

In this formula, *std. loading* represents the standardized factor loading for each indicator. According to established guidelines, a CR value of 0.70 or higher is considered indicative of good reliability. The results, presented in Table [17], demonstrate that all constructs in this study surpassed the recommended 0.70 threshold, thereby confirming the reliability of the measurement model.

2) *Variance Extracted*

To provide a more stringent assessment of reliability, the Variance Extracted (VE) was also examined. This metric evaluates the proportion of variance captured by a construct in relation to the variance attributable to measurement error. The VE is calculated as the mean of the squared standardized factor loadings for a given construct, as specified by the formula below:

$$VE = \frac{\sum std.loading^2}{\sum std.loading^2 + \sum E_j}$$

Here, the *std.loading* is the squared standardized factor loading and n is the number of indicators for the construct. An VE value of 0.50 or greater is recommended, as it indicates that the construct explains, on average, more than 50% of the variance in its indicators[17]. As detailed in Table [18], the VE for every construct exceeded the 0.50 benchmark. This result provides further convergent evidence for the reliability and quality of the constructs.

F. *Canonical Correlation Analysis*

Canonical Correlation Analysis is a multivariate statistical technique employed to identify and measure the strength of the relationship between two distinct sets of variables, wherein each set consists of two or more variables. The primary objective of this analysis is to determine whether a significant linear relationship exists between one set of variables (often termed the independent or predictor set) and another set (the dependent or criterion set). The evaluation of the resulting model is based on the following three primary components.

1. *Canonical Correlation Value*

The canonical correlation coefficient is derived through a matrix algebra procedure that identifies the maximum correlation possible between the two sets of variables. This procedure involves the within-set correlation matrices for the first variable set (ρ11) and the second variable set (ρ22), as well as the between-set correlation matrix (ρ12) and its transpose (ρ21). A specific matrix, denoted here as **A**, is constructed using the following formula:

$$A = \rho_{11}^{-\frac{1}{2}} \rho_{12} \rho_{22}^{-1} \rho_{21} \rho_{11}^{-\frac{1}{2}}$$

The squared canonical correlations (Rc2) are the ordered eigenvalues of matrix A. The primary Canonical Correlation value, representing the strongest relationship, is the square root of the largest eigenvalue of this matrix.

2. *Wilk's Lambda Test (Hypothesis Testing)*

To test the statistical significance of the set of canonical correlations, the Wilk's Lambda (Λ) statistic is employed. This test evaluates the null hypothesis that there is no relationship between the two sets of variables. The statistic is calculated as the product of the unexplained variance from each of the *s* canonical functions:

$$\Lambda = \prod_{i=1}^{s}(1 - R_{ci}^2)$$

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$$\Lambda = (1 - R_{c1}^2)\times(1 - R_{c2}^2)\times\cdots\times(1 - R_{cs}^2)$$

For hypothesis testing, this statistic is commonly transformed into a Chi-square (χ2) distribution using Bartlett's approximation:

$$\chi^2 = [N - 1 + \frac{(p+q+1)}{2}]\, ln(\Lambda)$$

The resulting χ^2 value is tested with p×q degrees of freedom, where N is the sample size, and p and q are the number of variables in each set. A statistically significant p-value (e.g., $p < 0.05$) allows for the rejection of the null hypothesis.

3. *Canonical Variates*

Canonical variates are the underlying, unobserved composite variables formed from a linear combination of the original variables in each set. They are defined by the following equations for the *j*-th pair of variates:

$$U_j = \sum_{i=1}^{p} e_{ij}^{*} xi$$

$$V_j = \sum_{i=1}^{q} f_{ij}^{*} yi$$

Where:

- U_j and V_j represent the j-th pair of canonical variates.
- xi and yi are the original variables in the first set (containing p variables) and the second set (containing q variables), respectively.
- The coefficients eij* and fij* are the standardized canonical weights that are calculated to maximize the correlation between each corresponding pair of variates, U_j and V_j.

IV. Result and Discussion

A. Validity Check

TABLE III. Validity check using CFA with std.all as main parameter

Latent	Std.all	Result
A1 A2 A3	0.699 0.764 0.616	A is valid Because When the p-value is below the alpha level, the result is considered statistically significant.
B1 B2 B3	0.544 0.663 0.934	B is valid Because When the p-value is below the alpha level, the result is considered statistically significant.
C1 C2 C3	0.808 0.813 0.654	C is valid Because When the p-value is below the alpha level, the result is considered statistically significant.
D1 D2 D3	0.829 0.726 0.722	D is valid Because When the p-value is below the alpha level, the result is considered statistically significant.
E1 E2 E3	0.717 0.587 0.835	E is valid Because When the p-value is below the alpha level, the result is considered statistically significant.
F1 F2 F3	0.784 0.661 0.798	F is valid Because When the p-value is below the alpha level, the result is considered statistically significant.
G1 G2 G3	0.644 0.830 0.721	F is valid Because When the p-value is below the alpha level, the result is considered statistically significant.
H1 H2 H3	0.620 0.735 0.871	F is valid Because When the p-value is below the alpha level, the result is considered statistically significant.
I1 I2 I3	0.719 0.741 0.530	F is valid Because When the p-value is below the alpha level, the result is considered statistically significant.

Latent	Std.all	Result
J1 J2 J3	0.727 0.813 0.654	F is valid Because When the p-value is below the alpha level, the result is considered statistically significant.

Based on the results of the confirmatory factor analysis (CFA), all indicators for each construct in this study demonstrated standardized factor loading values above *0.5*. This finding confirms that all indicators used have met the criteria for convergent validity, indicating that these indicators effectively represent the respective latent constructs being measured.

For example, the indicators for the construct Campus Environmental Security (B1, B2, B3) showed loading values of 0.544, 0.663, and 0.934, all of which are considered valid. Similarly, for the construct Learning Environment Comfort (C1, C2, C3), all loading values ranged from 0.654 to 0.813. A similar pattern was also observed for other constructs, such as Classroom Lighting and Ventilation, Campus Area Accessibility and Mobility, Academic Stress, Daily Mood and Emotion, Learning Motivation, General Mental Well-being, and Emotion Regulation Ability, where all tested indicators met the minimum threshold for validity. Thus, it can be concluded that all constructs in the measurement model are validly measured by their respective indicators. These results demonstrate that the instrument employed is suitable for further analysis, having been proven to possess strong construct validity.

B. Reliability Check

1) Construct Reliability

Before evaluating further results, it is important to examine the reliability of each latent variable to ensure the consistency of the measurement. Table III provides insight into how well the observed indicators represent their underlying constructs.

TABLE IV. Reliability check using CR

Latent	CR	Result
Quality of Facilities	0.788724462	Reliable, CR value > 0.7

Latent	CR	Result
Comfort & Security of the Campus Environment	0.753095699	Reliable, CR value > 0.7
Learning Environment Ambience & Comfort	0.751493394	Reliable, CR value > 0.7
Lighting & Ventilation of Learning Spaces	0.776962563	Reliable, CR value > 0.7.
Accessibility & Mobility in Campus Area	0.772695277	Reliable, CR value > 0.7.
Academic Stress	0.745996346	Reliable, CR value > 0.7
Daily Mood & Emotions	0.783712526	Reliable, CR value > 0.7
Learning Motivation	0.753314711	Reliable, CR value > 0.7

Latent	CR	Result
General Mental Well-being	0.778631446	Reliable, CR value > 0.7
Emotion Regulation Capability	0.708280535	Reliable, CR value > 0.7

The data presented in the table above reveals that all values exceed the 0.70 threshold, thereby confirming the internal consistency of the constructs. This outcome establishes the suitability of the measures for subsequent analysis with Canonical Correlation Analysis (CCA). Consequently, these reliability results provide a robust basis for investigating the relationship between the campus physical environment and student psychological health.

2) Variance Extracted

In addition to construct reliability, the reliability of each latent variable was further evaluated using Variance Extracted (VE).

TABLE V. Reliability check using VE

Latent	VE	Result
Quality of Facilities	0.696832866	Reliable, VE value > 0.5
Comfort & Security of the Campus Environment	0.627107631	Reliable, VE value > 0.5
Learning Environment Ambience & Comfort	0.667986843	Reliable, VE value > 0.5
Lighting & Ventilation of Learning Spaces	0.737622323	Reliable, VE value > 0.5
Accessibility & Mobility in Campus Area	0.620341638	Reliable, VE value > 0.5
Academic Stress	0.657072467	Reliable, VE value > 0.5
Daily Mood & Emotions	0.718192241	Reliable, VE value > 0.5
Learning Motivation	0.657271134	Reliable, VE value > 0.5
General Mental Well-being	0.636728716	Reliable, VE value > 0.5

Latent	VE	Result
Emotion Regulation Capability	0.6869292 21	Reliable, VE value > 0.5

The data presented in the table above reveals that all values exceed the 0.50 threshold, indicating that each construct captures a substantial portion of the variance from its respective indicators. This suggests that the measurement model meets the criteria for convergent validity. With these VE values, the constructs can be regarded as sufficiently reliable for further analysis, ensuring a strong foundation to explore how the campus physical environment relates to student psychological health.

C. *Canonical Correlation Analysis*

1) *Canonical Correlation Value*

The Canonical Correlation Analysis (CCA) applied in this research explores the association between variables describing the campus's physical environment (Physical) and those reflecting students health (psychological Health). The analysis generates a series of canonical functions, where each function represents a pair of optimally correlated linear combinations from both the physical and mental health variable groups. In this study, the notation Pm is used to refer to the canonical correlation between the Physical Environment (P) and Psychological Health (m) constructs.

TABLE VI. Canonical Correlation Value

Function	Value
Pm_1	0.75502941
Pm_2	0.68508046
Pm_3	0.57179337
Pm_4	0.55463383
Pm_5	0.50868693
Pm_6	0.43043021
Pm_7	0.39374220
Pm_8	0.31028895
Pm_9	0.25836469
Pm_{10}	0.23112940
Pm_{11}	0.21734382
Pm_{12}	0.17784318
Pm_{13}	0.11800856
Pm_{14}	0.07506499
Pm_{15}	0.01876555

The Canonical Correlation Analysis (CCA) conducted to investigate the relationship between the 'Campus Physical Environment' and 'Student Psychological Health' variable sets yielded several canonical functions. The first and most prominent function (denoted as Pm13) revealed a canonical correlation of 0.118. This corresponds to a squared correlation (Rc2) of just 0.014, indicating that only 1.4% of the variance is shared between the two sets on their primary dimension, which signifies a very weak association. The subsequent functions displayed even weaker relationships, with correlation values of 0.075 (Pm14) and 0.019 (Pm15), representing negligible levels of shared variance.

In summary, the full set of canonical correlations demonstrates that the overall linear relationship between the campus physical environment and student psychological health is weak. While the formal statistical significance of these functions is determined by the Wilk's Lambda test, the low magnitude of all extracted correlations strongly suggests limited practical significance. Therefore, these findings imply that the physical environment variables, as operationalized in this study, are not strong predictors of the psychological health outcomes among the student population surveyed.

2) *Wilk's Lambda Test (Hypothesis Testing)*

Before interpreting the canonical functions, it is important to evaluate the overall significance of the canonical correlations. Wilks' Lambda was employed to determine whether the observed relationships between the two sets of variables are statistically meaningful. The results of this significance test are summarized in Table VII.

TABLE VII. *Wilk's Lambda Results*

Canonical Function	**Wilks**
1 to 15	0.2869582
2 to 15	0.8559040
3 to 15	0.9904446
4 to 15	0.9979685
5 to 15	0.9998179
6 to 15	0.9999868
7 to 15	0.9999958
8 to 15	0.9999988
9 to 15	0.9999965
10 to 15	0.9999695
11 to 15	0.9997539
12 to 15	0.9991615
13 to 15	0.9973506
14 to 15	0.9789667
15 to 15	0.8721745

The results of the Wilks' Lambda test indicate that none of the canonical correlations in this analysis reach statistical significance, as all p-values are above the 0.05 threshold. This outcome suggests that, within this dataset, there is no strong linear association between the campus physical environment and student psychological health. As a result, further interpretation of the canonical functions is not warranted, and the findings highlight the absence of a meaningful relationship between these two sets of variables in this context.

3) *Canonical Variates*

An initial test of significance using Wilk's Lambda was performed to determine if a relationship exists between the two variable sets. The result of this test was not statistically significant ($p > 0.05$), failing to reject the null hypothesis of no relationship. Because the overall model lacks statistical significance, the individual canonical functions and their corresponding variate equations are not meaningful for interpretation. Thus, the analysis concludes that there is no evidence of a significant multivariate linear relationship between the campus physical environment and student psychological health based on the current data.

This indicates that there is no meaningful linear association between the sets of variables examined across the canonical dimensions. This finding is consistent with current best practices in recent multivariate research; when Wilks' Lambda is not statistically significant, further interpretation of canonical coefficients or loadings is not pursued, as there is no scientifically justified canonical correlation to report[19][20]. Consequently, this study concludes that the analyzed data do not exhibit any significant canonical associations, and therefore, no further discussion of canonical variates is warranted, as recommended by contemporary methodological literature [20].

V. Conclusion

This study aimed to test the multivariate relationship between campus physical environment variables and student psychological health variables at Bina Nusantara University using Canonical Correlation Analysis (CCA). The research methodology began by ensuring the quality of the instrument through validity and reliability tests. The results from the Confirmatory Factor Analysis (CFA) showed that all indicators validly measured their respective latent constructs. Furthermore, reliability tests using Construct Reliability (CR) and Average Variance Extracted (VE) also confirmed that all constructs possessed strong internal consistency and convergent validity.

However, in the core analysis phase, the main finding was the absence of a statistically significant linear relationship between the two sets of variables. The hypothesis test using Wilk's Lambda for the overall canonical model yielded a p-value greater than 0.05, failing to reject the null hypothesis of no relationship. This finding is consistent with current best practices in multivariate research; when Wilks' Lambda is not statistically significant, further interpretation of canonical coefficients or loadings is not pursued, as there is no scientifically justified canonical correlation to report [20][21].

In summary, although the initial hypothesis suggested a potential influence of the physical environment on psychological health, this study did not find statistical evidence to support such a relationship in the tested context. This finding is important as it highlights that the relationship may not be as direct as assumed, or that other unmeasured factors may play a more dominant role in student well-being.

This study has limitations, including a sample restricted to a single university and the cross-sectional nature of the data. Future research is recommended to replicate this study with a larger and more diverse sample and to consider other influential variables. Despite the non-significant results, this study contributes methodologically by applying a robust multivariate analysis to the higher education context in Indonesia and adhering to rigorous standards for the interpretation of its findings.

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