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Relation Visualization of Environmental Quality Index with Environmental Resource Indicators Using Multiple Indicators Multiple Causes Model

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Abstract

This research aims to visualize the model of environmental resource factors on the constituent factors of the environmental quality index using the multiple indicators multiple causes (MIMIC) method, using secondary data sourced from IKLH 2020. The predictor variables in this study include air quality, water quality, land cover quality, and environmental quality. Some of the indicators in this research are Conservation Forest Area, Limited Production Forest Area, Fixed Production Forest Area, Protection Forest Area, Coral Reefs, and Mangroves. Data Analysis using MIMIC Model generated by JASP Software, showing a very significant baseline and model factor. Some predictor coefficients have low standard error (close to zero), as well as significant indicators coefficients, except coral reefs, with a p-value of 0.736. The form model is worth using, since the RMSEA is worth 0.188. With a P-Value of 0.005. A high R-Squared is given by two indicators, namely Limited Production Forest Area, and Fixed Production Forest Area, respectively valued at 0.968 and 0.790.

Keywords: MIMIC Model, Environmental Resources, Environmental Quality Indices, Math Modelling

Introduction

Multiple Indicators Multiple Causes Model known as one of flexible model in statistics. MIMIC models are useful in that they can be used for continuous, categorical, or mixes of continuous and categorical outcomes. Throughout this manuscript we provide examples and equations for dichotomous outcomes only. Because MIMIC models are estimated in a SEM framework model fit indices (RMSEA, SRMR, Hoelter's Critical, GFI, MFI, ECVI) are available for these models. However, many models fit statistics are only valid for model with continuous outcomes [1]. Montoya and Joen note that though conceptualizing uniform and non-uniform DIF MIMIC models within a mediation and moderation framework can be very

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useful, we caution against using this framework to make causal inferences without thoroughly investigating the assumptions needed to do so [2].

The MIMIC model is the most popular method used to detect DIF in recent studies, such as research conducted by Finch [3], Shih & Wang [4], Finch & French [5], and Cheng, Shao & Lathrop [6]. In Statistical Procedure, The Multiple Indicators Multiple Causes (MIMIC) model has several criteria namely, Model fitting indices indicate the good establishments of the MIMIC model of sustainable development indicators, where $\chi 2/df$ is less than 1, the RMSEA is less than 0.05, and the values of the goodness of fit index (GFI), the comparative fit index (CFI), and the Tucker–Lewis index (TLI) were greater than 0.9. (Dehghani, et al, 2023).

The MIMIC Model Formulation [8]:

$$\acute{\eta} = Y_1X_1 + Y_2X_2 + \ldots + Y_qX_q + \zeta \quad (1)$$

$$y_1 = \lambda_1\acute{\eta} + \varepsilon_1;$$
$$y_2 = \lambda_2\acute{\eta} + \varepsilon_2;$$
$$(\ldots)$$
$$y_p = \lambda_p\acute{\eta} + \varepsilon_p. \quad (2)$$

Method

This research aims to visualize the model of environmental resource factors on the constituent factors of the environmental quality index using the multiple indicators multiple causes (MIMIC) method, using secondary data sourced from Indeks Kualitas Lingkungan Hidup (IKLH) at 2020. This Research focused to explore IKLH of Provinces in four Islands in Indonesia (Java Island, Sumatra Island, Borneo Island, and Sulawesi Island). The predictor variables in this study include air quality, water quality, land cover quality, and environmental quality. Some of the indicators in this research are Conservation Forest Area, Limited Production Forest Area, Fixed Production Forest Area, Protection Forest Area, Coral Reefs, and Mangroves. Data Analysis using MIMIC Model generated by JASP Software:

```
Y =~ lambda1*Conservation_Forest + lambda2*Limited_Production_Forest +
lambda3*Fixed_Production_Forest + lambda4*Protection_Forest +
lambda5*Coral_Reefs + lambda6*Mangrove

Y ~ beta1*Air_Quality + beta2*Water_Quality + beta3*Land_Cover_Quality +
beta4*Environmental_Quality
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Result

This research analysis given in Table 1 – Table 7 and also Figure 1. Data Analysis using MIMIC Model generated by JASP Software, showing a very significant baseline and model factor. Some predictor coefficients have low standard error (close to zero), as well as significant indicators coefficients, except coral reefs, with a p-value of 0.736. The form model is worth using, since the RMSEA is worth 0.188. With a P-Value of 0.005. A high R-Squared is given by two indicators, namely Limited Production Forest Area, and Fixed Production Forest Area, respectively valued at 0.968 and 0.790.

Table 1. Chi Square Test

	df	χ^2	p
Baseline model	45	311.023	0.000
Factor model	29	55.536	0.002

Table 2. Predictors Coefficients

					95% Confidence Interval		Standardized		
Predictor	Estimate	Std. Error	z-value	p	Lower	Upper	All	LV	Endo
Kualitas_Udara	0.070	0.102	0.685	0.493	−0.130	0.270	0.358	0.060	0.060
Kualitas_Air	0.138	0.105	1.312	0.190	−0.068	0.343	0.876	0.118	0.118
Kualitas_Tutupan_Lahan	0.180	0.142	1.269	0.204	−0.098	0.459	2.719	0.155	0.155
Kualitas_Ljngkungan_Hidup	−0.362	0.339	−1.067	0.286	−1.026	0.303	−2.960	−0.310	−0.310

Table 3. Indicators Coeeficients

					95% Confidence Interval		Standardized		
Indicator	Estimate	Std. Error	z-value	p	Lower	Upper	All	Latent	Endo
Hutan_Konservasi	107.253	43.687	2.455	0.014	21.629	192.878	0.461	125.159	0.461
Hutan_Produksi_Terbatas	973.494	144.863	6.720	1.816×10^{-11}	689.567	1257.420	0.984	1136.020	0.984
Hutan_Produksi_Tetap	846.072	147.684	5.729	1.011×10^{-8}	556.617	1135.526	0.889	987.324	0.889
Hutan_Lindung	517.210	103.263	5.009	5.480×10^{-7}	314.819	719.601	0.815	603.559	0.815
Terumbu_Karang	5.162	15.288	0.338	0.736	−24.802	35.126	0.067	6.024	0.067
Mangrove	27.926	7.837	3.563	3.662×10^{-4}	12.565	43.286	0.633	32.588	0.633

Table 4. Fit Indices

Index	Value
Comparative Fit Index (CFI)	0.900
Tucker-Lewis Index (TLI)	0.845
Bentler-Bonett Non-normed Fit Index (NNFI)	0.845
Bentler-Bonett Normed Fit Index (NFI)	0.821
Parsimony Normed Fit Index (PNFI)	0.529
Bollen's Relative Fit Index (RFI)	0.723
Bollen's Incremental Fit Index (IFI)	0.906
Relative Noncentrality Index (RNI)	0.900

Table 5. Information Criteria

	Value
Log-likelihood	−1428.527
Number of free parameters	26.000
Akaike (AIC)	2909.054
Bayesian (BIC)	2942.745
Sample-size adjusted Bayesian (SSABIC)	2861.974

Table 6. RMSEA and Other Fit Measures

Metric	Value
Root mean square error of approximation (RMSEA)	0.188
RMSEA 90% CI lower bound	0.111
RMSEA 90% CI upper bound	0.262
RMSEA p-value	0.005
Standardized root mean square residual (SRMR)	0.134
Hoelter's critical N (α = .05)	20.924
Hoelter's critical N (α = .01)	24.215
Goodness of fit index (GFI)	0.754
McDonald fit index (MFI)	0.600
Expected cross validation index (ECVI)	4.136

Table 7. R - Squared

	R^2
Hutan_Konservasi	0.213
Hutan_Produksi_Terbatas	0.968
Hutan_Produksi_Tetap	0.790
Hutan_Lindung	0.664
Terumbu_Karang	0.004
Mangrove	0.401
Y	0.266

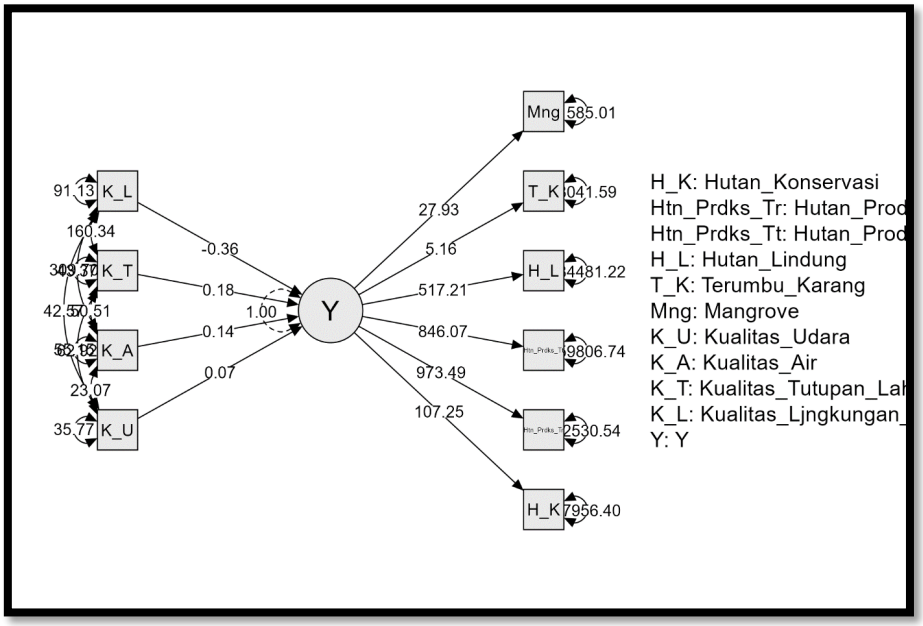

Figure 1. Visualize of MIMIC Model

Conclusion

Based on path diagram of MIMIC model, so we can get the model of Environmental Quality Index with Environmental Resource Indicators Using Multiple Indicators Multiple Causes as:

$$Y =\sim 107.253*Conservation\_Forest + 973.494*Limited\_Production\_Forest + 846.072*Fixed\_Production\_Forest + 517.210*Protection\_Forest + 5.165*Coral\_Reefs + 27.926*Mangrove$$

$$Y \sim 0.070*Air\_Quality + 0.138*Water\_Quality + 0.180*Land\_Cover\_Quality – 0.362*Environmental\_Quality$$

References:

[1] Yun, C.-Y. (2002). Evaluating cutoff criteria of model fit indices for latent variable models with binary and continuous outcomes (Unpublished doctoral dissertation). University of California Los Angeles.

[2] Montoya, A.K., & Joen, M. (2020). MIMIC models for uniform and non-uniform DIF as moderated mediation models. University of California, Los Angeles.

[3] Finch, H. (2005). The MIMIC model as a method for detecting DIF: Comparison with Mantel– Haenszel, SIBTEST, and the IRT likelihood ratio. Applied Psychological Measurement, 29, 278–295. https://doi.org/10.1177/0146621605275728.

[4] Shih, C.-L., & Wang, W.-C. (2009). Differential item functioning detection using the multiple indicators, multiple causes method with a pure short anchor. Applied Psychological Measurement, 33(3), 184 – 199.

[5] Finch, W.H., & French, B.F. (2012). Parameter estimation with mixture item response theory models: A Monte Carlo comparison of maximum likelihood and Bayesian methods. Journal of Modern Applied Statistical Methods, 11(1), 14.

[6] Cheng, Y., Shao, C., & Lathrop, Q.N. (2016). The mediated MIMIC model for understanding the underlying mechanism of DIF. Educational and Psychological Measurement, 76(1), 43-63. https://doi.org/10.1177/0013164415576187

[7] Dehghani, H.; Bascompta, M.; Khajevandi, A.A.; Farnia, K.A. A Mimic Model Approach for Impact Assessment of Mining Activities on Sustainable Development Indicators. Sustainability 2023, 15, 2688. https:// doi.org/10.3390/su15032688.

[8] Gasparėnienė, L.; Remeikienė, R. 2015. Digital shadow economy: a critical review of literature, Mediterranean Journal of Social Sciences 6(6S5): 402–409.