Metode Penelitian Kuantitatif

Prodi MSTT
MZI

1

Pertemuan 6

METODE ANALITIK PADA PENELITIAN KUANTITATIF DI BIDANG ILMU TRANSPROTASI

2

METODE STATISTIK YANG SERING DIGUNAKAN

Analisis Korelasi: Peason dan Spearman Correlation
Regresi Linear atau Logistic
ANOVA (*Analysis of Variance*)
Analisis Faktor
MIMIC
Regresi Linear dan Analisis Faktor
Path diagram / Analisis Jalur
SEM
Analisis Kluster: K-means, LCCA
Analisis Diskriminan
Model Pemilihan Diskit dan Hibrid

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Analisis Korelasi: Mengindentifikasi hubungan antar variabel

	Pearson	Spearman
Jenis Data	Continuous	Continuous, ordinal atau interval
Distribusi	Normal dan hubungan antar variable harus linear	Tidak normal dan dapat digunakan pada hubungan yang bersifat non-linier.
Sensitivitas	Sensitif terhadap outlier, artinya nilai ekstrem bisa sangat mempengaruhi hasil korelasi.	Lebih tahan terhadap outlier
Hasil	Antara -1 dan +1, di mana +1 menunjukkan korelasi positif sempurna, -1 menunjukkan korelasi negatif sempurna, dan 0 menunjukkan tidak ada korelasi linier.	

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Studi Kasus 1: Peason, Anova, Logistic Linear

Transportation Research Interdisciplinary Perspectives 21 (2023) 100869

Contents lists available at ScienceDirect

Transportation Research Interdisciplinary Perspectives

journal homepage: www.sciencedirect.com/journal/transportation-research-interdisciplinary-perspectives

Responding to customers while driving: Predictors of intention to text among motorcycle-based ride-hailing drivers

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Metode

- Firstly, this study analyzed the correlations between intention, perceived risk, TPB, socio-demographics, and working history variables.
- **A Spearman correlation (*rs*)** was used since the variables are both continuous and categorical (Schober and Schwarte, 2018).
- The value of *rs* ranges between +1, indicating a completely positive correlation, and –1, indicating a completely negative correlation.
- Then, **z-Test** was employed to calculate the significance level. This study used two-tailed testing and set 0.05 as the significance threshold.
- Further, considering the dependent variable is ordinal, and the independent variables are both continuous and categorical, an **ordinal logistic regression (OLR)** was utilized to investigate the determinants of texting while driving intention.
- Meanwhile, similar to Airak et al.'s (2023) study, the independent variables included in the OLR model were determined based on the variables significantly correlating to the intention in Spearman correlation tests.

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Variable	Description	n	%	Mean	St. Dev	Skewness	Kurtosis
Age	Continuous			30.54	9.33	0.89	0.24
Gender	1 for males, 0 for otherwise			0.98	0.15	–6.22	36.82
Education	1 for had a bachelor's degree or higher, 0 for otherwise			0.28	0.45	0.94	–1.12
Daily income (in a thousand IDR)	1 = less than 50 (USD 3.27)	44	8.85%				
	2 = 50–75 (USD 3.27–4.90)	175	35.21%				
	3 = 75–100 (USD 4.90–6.53)	136	27.36%				
	4 = 100–125 (USD 6.53–8.17)	99	19.92%				
	5 = more than 125 (USD 8.17)	43	8.65%				
Full-time workers	1 for yes, 0 for otherwise			0.65	0.48	–0.62	–1.62
Duration of MBRH drivers (year)	Continuous			2.49	1.69	0.62	–0.69
Daily working time (in an hour)	1 = less than 5	14	2.82%				
	2 = 5–8	79	15.90%				
	3 = 8–12	229	46.08%				
	4 = more than 12	175	35.21%				
Daily traveled distance (in km)	1 = less than 50	208	41.85%				
	2 = 50–100	169	34.00%				
	3 = 100–150	93	18.71%				
	4 = more than 150	27	5.43%				
Motorcycle transmission	1 for automatic, 0 for otherwise			0.82	0.38	–1.69	0.88
Motorcycle cubic capacity	1 for 125 cubic capacity and more, 0 for otherwise			0.60	0.49	–0.39	–1.86

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Dependent Variables

Variable	Mean			St. Dev.			Skewness			Kurtosis		
	S1	S2	S3	S1	S2	S3	S1	S2	S3	S1	S2	S3
Attitudes	1.95	2.06	2.72	0.73	0.78	0.74	0.67	0.82	0.06	1.15	1.66	1.49
Subj. norms	2.03	2.12	2.61	0.77	0.83	0.77	0.84	1.19	0.58	1.62	2.44	1.13
PBC	2.67	2.70	2.82	0.90	0.91	0.80	–0.03	0.18	0.06	–0.30	–0.09	0.18
Accident	3.35	3.22	2.78	0.71	0.68	0.91	–0.97	–0.39	0.31	1.33	0.84	–0.18
Fined	3.19	3.09	2.69	0.76	0.79	1.00	–0.11	0.35	0.68	1.21	0.52	0.16
Intention	2.08	2.07	2.69	0.81	0.80	0.72	0.68	0.69	–0.56	1.03	1.16	0.97

S1 = Scenario 1 (smooth traffic), S2 = Scenario 2 (congested traffic), S3 = Scenario 3 (signalized intersections)

- To confirm that smartphone usage across scenarios was viewed as different behaviors by MBRH drivers, a series of one-way repeated measures Analysis of Variance (ANOVA) tests with Bonferroni adjustments were undertaken.
- Across scenarios, all three pairwise comparisons across each of the three scenarios (Scenario 1 vs. Scenario 2, Scenario 1 vs. Scenario 3, and Scenario 2 vs. Scenario 3) were significant with $p. < 0.001$ for all TPB, risk, and intention variables.
- By excluding gender, the skewness and kurtosis of all variables in Tables 1 and 2 ranged between 0.06 and 1.19 and between 0.16 and 2.44, respectively. According to Hair et al. (2010), when the skewness value of a variable is between –2 and +2, and the kurtosis value is between –7 and +7, it can be presumed to be normally distributed. Due to this, except gender, all variables could be included for further analysis.

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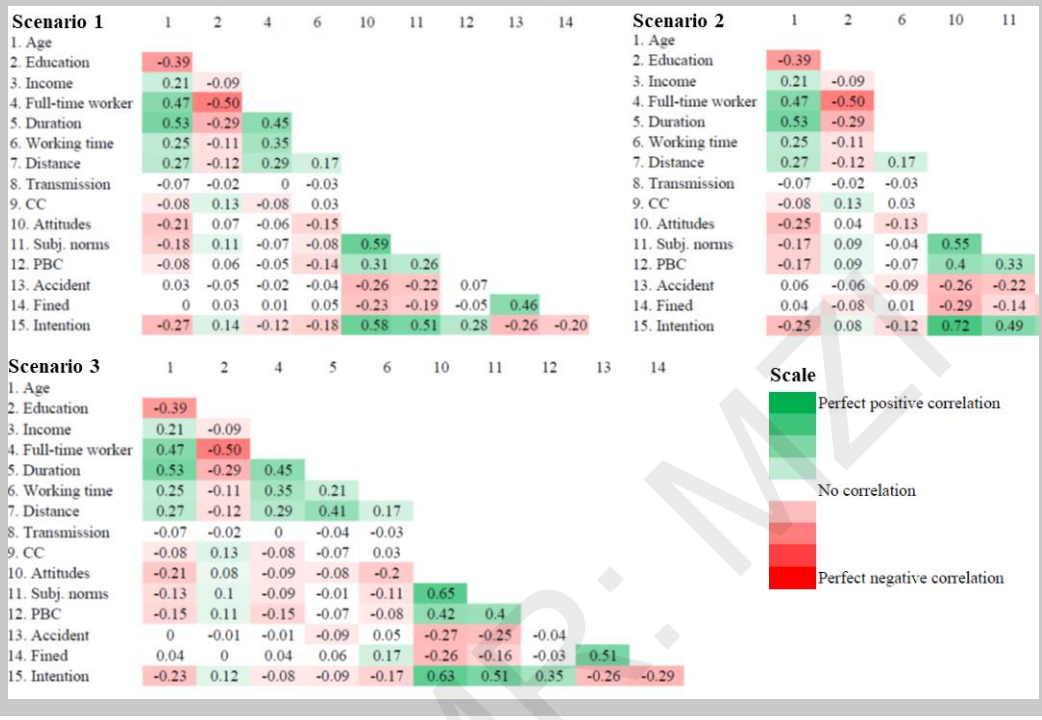
Spearman Correlation test results

- According to Dancey and Reidy (2011), a small, medium, strong, and very strong correlation occurs if the value of Spearman correlation is less than 0.3, between 0.3 and 0.39, between 0.4 and 0.69, and more than 0.69, respectively.



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ORL model results

Variable	Scenario 1		Scenario 2		Scenario 3	
	Estimate	Std.Error	Estimate	Std.Error	Estimate	Std.Error
Socio-demographics						
Age	–0.030	0.011*	–0.030	0.012*	–0.040	0.013*
Education	0.198	0.239	–0.042	0.252	0.331	0.245
Working history						
Full-time worker	0.090	0.247	N/A	N/A	0.575	0.266*
Duration of MBRH drivers	N/A	N/A	N/A	N/A	–0.028	0.068
Daily working time	–0.228	0.130*	–0.152	0.145	–0.107	0.135
TPB						
Attitudes	1.358	0.166*	2.023	0.190*	1.566	0.168*
Subjective norms	0.718	0.148*	0.336	0.169	0.596	0.145*
PBC	0.265	0.112	0.516	0.149*	0.354	0.125*
Risk perceptions						
Accident	–0.362	0.151*	–0.449	0.134*	–0.236	0.164
Fined	–0.067	0.139	–0.247	0.121	–0.466	0.146*
Threshold						
Extremely Unlikely | Unlikely	–0.146	0.896	0.151	0.991	0.064	0.870
Unlikely | Neutral	3.113	0.899	3.064	0.990	3.599	0.872
Neutral | Likely	6.244	0.970	8.571	1.063	6.992	0.974
Likely | Extremely Likely	7.152	1.021	10.759	1.185	7.868	1.031
Statistics						
Final log-likelihood	888.674		668.1		827.704	
McFadden R2	0.221		0.326		0.268	
Nagelkerke R2	0.444		0.556		0.509	

* Significant at $p. < 0.05$, N/A means the variables are excluded from the OLR model

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Studi Kasus 2: CFA, SEM

Transportation (2022) 49:529–553
https://doi.org/10.1007/s11116-021-10185-5

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Exploring activity-travel behavior changes during the beginning of COVID-19 pandemic in Indonesia

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Accepted: 22 February 2021 / Published online: 11 March 2021

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Faktor Analisis

- Analisis faktor merupakan sebuah teknik statistik yang digunakan untuk mengidentifikasi struktur yang mendasari dari kumpulan variabel yang terobservasi.
- Salah satu pentingnya faktor analisis adalah memudahkan analisis data dengan mengurangi jumlah variabel menjadi sejumlah faktor yang lebih kecil namun informatif.
- Metode Analisis Faktor

Analisis Faktor Eksploratori (EFA)

- Tujuan: Untuk mengeksplorasi data dan mengidentifikasi struktur faktor yang mendasarinya.
- Pendekatan: Mengelompokkan variabel yang berkorelasi tinggi ke dalam faktor yang sama tanpa asumsi awal tentang jumlah atau komposisi faktor.

Analisis Faktor Konfirmatori (CFA)

- Tujuan: Untuk menguji hipotesis atau teori tentang struktur faktor yang sudah ada.
- Pendekatan: Menggunakan model faktor yang sudah ditentukan berdasarkan teori atau penelitian sebelumnya dan menguji seberapa baik data empiris cocok dengan model tersebut.

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Analisis Faktor Principal Component (PCA)

- Tujuan: Untuk mengurangi dimensi data dengan mempertahankan sebanyak mungkin variasi dari data asli.
- Pendekatan: Mengidentifikasi komponen utama yang menjelaskan variasi terbesar dalam data.

Analisis Faktor Aksial (Axis Factoring)

- Tujuan: Untuk mengidentifikasi faktor yang berkorelasi di antara variabel dengan meminimalkan jumlah faktor yang diperlukan untuk menjelaskan data.
- Pendekatan: Rotasi faktor untuk mencapai struktur yang lebih interpretabil.

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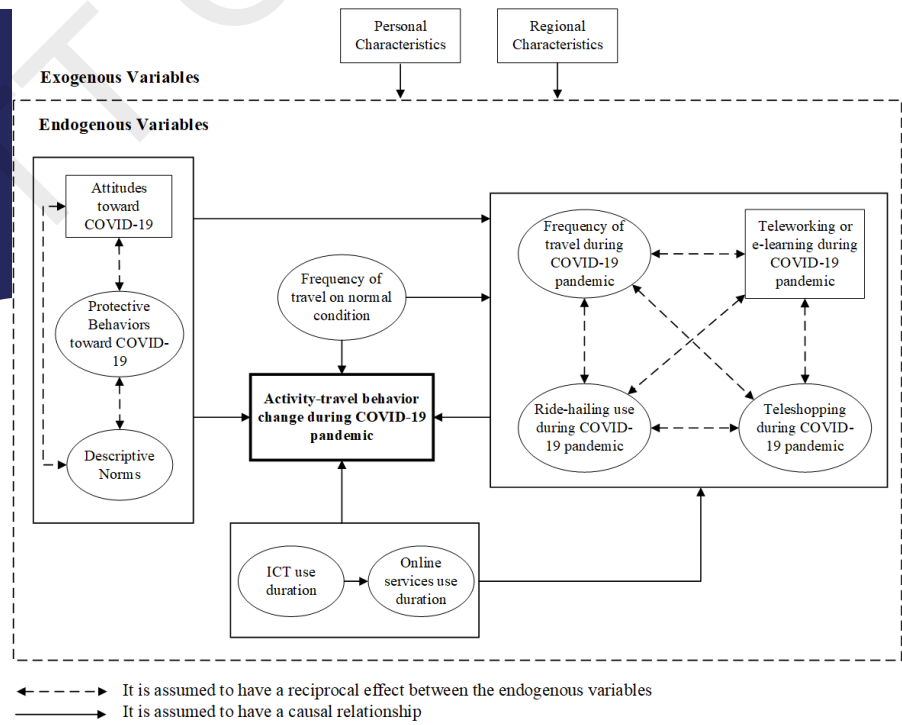
Proposed modeling framework



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Conceptual model

- Based on the literature reviewed above, a model framework was constructed to explain possible changes in activities-travel behavior triggered by the COVID-19 pandemic, as shown in Figure 1.
- In achieving the objectives of this study, the modeling procedure involved 6 steps.
- **Firstly,** the study assumed that the endogenous variables of attitudes toward COVID-19, descriptive norms, protective behaviors toward COVID-19, ICT and online service experience, and travel frequency under normal conditions directly influenced activity-travel behavior changes and use of ICT.
- In terms of protective behaviors toward COVID-19, this research includes several COVID-19 prevention actions suggested by WHO (2020) to protect the body from this virus, such as physical distancing, use of face masks when participating in out-of-home activities, regular handwashing with soap/sanitizer, and keeping the body healthy through regular exercise, adequate sleep, and nutritious diet.
- Meanwhile, although WHO stated that sunbathing does not prevent the spread of this virus, this study considered that activity as a way to increase the body's immune system (González Maglio et al., 2016).

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- **Secondly,** the study argues that reciprocal relationships exist between attitudes toward COVID-19, protective behaviors toward COVID-19, and descriptive norms.
- Although previous studies have discussed how attitudes influence behavior, some studies have criticized that notion by indicating a causality relationship.
- For example, Kroesen et al. (2017) investigated the possibility of a bidirectional relationship and found that attitudes and behavior have mutual influence over time.
- van Wee et al. (2019) stated that travel behavior and builds environment influences attitude over time.
- In addition, Kroesen and Chorus (2020) report that researchers need to be careful in interpreting the statistical results of attitude toward behavior for policy recommendations due to the existence of inadequate information on their causality relationships.
- **Thirdly,** this research assumes that ICT experience affects online services.
- ***The three steps above aim to reach the first objective of the study.***
- **Fourthly,** the study hypothesized that travel frequency during the COVID-19 pandemic and the use of ICT in teleworking or e-learning, teleshopping, and ride-hailing directly affects the activity-travel behavior changes of individuals during the COVID-19 outbreak.
- **Fifthly,** this study also argues for reciprocal relationships between travel frequency, teleworking or e-learning, teleshopping, and the use of ride-hailing.
- ***The fourth to fifth step above is used to answer the second objective.***

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- In attaining the last objective, the research argues that exogenous variables of spatial demography and socio-demographics consisting of gender, age, education, income, and job type impact on all endogenous variables. In terms of spatial attributes, each region or province was determined as a dummy variable.

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Variable	n	%	Mean	SD	
Personal characteristics					
Gender	0 = Female	470	44.26%		
	1 = Male	592	55.74%		
Age	1 = < 18 years old	12	1.13%		
	2 = 18–25 years old	345	32.49%		
	3 = 26–40 years old	473	44.54%		
	4 = 41–60 years old	216	20.34%		
	5 = > 60 years old	16	1.51%		
Income	1 = < 1 million IDR	235	22.12%		
	2 = 1–2.5 million IDR	163	15.35%		
	3 = 2.6–5 million IDR	264	24.86%		
	4 = 5.1–7.5 million IDR	145	13.65%		
	5 = 7.5–10 million IDR	100	9.42%		
	6 = > 10 million IDR	155	14.60%		
Education	1 = High school or lower	99	9.32%		
	2 = Bachelor or professional courses	544	51.22%		
	3 = Master or PhD	419	39.45%		
Workers / Students	1 = yes, 0 = otherwise			0.87	0.34
City living (dummy variable)					
Greater Jakarta (Used as reference province group)	226	21.28%			
Special Region of Yogyakarta (1 for yes, 0 for otherwise)	378	35.59%			
West Java (1 for yes; 0 for otherwise)	92	8.66%			
East Java (1 for yes; 0 for otherwise)	59	5.56%			
Center Java (1 for yes; 0 for otherwise)	119	11.21%			
Other provinces (1 for yes; 0 for otherwise)	188	17.70%			
Activity-travel behavior change					
1 = No change	12	1.13%			

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Variable	n	%	Mean	SD	
2 = Less significant change	39	3.67%			
3 = Significant change	168	15.82%			
4 = Very significant change	757	71.28%			
5 = Fully stay at home	86	8.10%			
Attitudes toward COVID-19					
1 = Not dangerous at all	2	0.18%			
2 = Less dangerous	76	7.16%			
3 = Dangerous	29	2.73%			
4 = Very dangerous	489	46.05%			
5 = Extremely dangerous	466	43.88%			
Protective Behaviors toward COVID-19					
Sunbathing				3.32	1.16
Using a face mask when out of home	1 = Never			3.71	1.17
Doing sport	2 = Seldom			3.29	1.06
Physical distancing	3 = Sometimes			4.24	0.86
Washing hand with soap/sanitizer	4 = Often			4.57	0.68
Enough sleeping (8 h)	5 = Always			4.03	0.91
Eating nutritious food				4.27	0.81
Descriptive norms					
People outside of the province	1 = Nothing			2.85	0.80
People outside of the city	2 = Less moderate			3.12	0.71
People in the city	3 = Moderate			3.10	0.76
People in the neighborhood	4 = Extreme			3.20	0.84
People in the household	5 = Very extreme			3.48	0.68

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Variable	n	%	Mean	SD	
Frequency of travel during COVID-19 pandemic					
Work/school trips	0 = never			2.15	1.95
Shopping trips	1 = 1 trip/week			2.48	1.30
Eating outside	2 = 2 trips/week			1.57	1.30
Sightseeing trips	…			1.56	1.11
Social trips	7 = 7 trips/week or more			1.31	0.84
Frequency of travel before COVID-19 pandemic					
Work/school trips	0 = never			5.86	1.51
Shopping trips	1 = 1 trip			3.66	1.67
Eating outside	2 = 2 trips			3.76	1.96
Sightseeing trips	…			3.06	1.65
Social trips	7 = 7 trips/week or more			2.79	2.79
Teleworking and e-learning					
0 = Stop doing	0	0%			
1 = Do less than usual	58	5.46%			
2 = Do as usual	158	14.88%			
3 = Do more than usual	846	79.66%			
Teleshopping					
Online shopping					
0 = Stop doing	327	30.79%			
1 = Do less than usual	396	37.29%			
2 = Do as usual	229	21.56%			
3 = Do more than usual	110	10.36%			
Fresh food and drink with same-day delivery					
0 = Stop doing	317	29.85%			

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Variable	n	%	Mean	SD	
1 = Do less than usual	448	42.18%			
2 = Do as usual	180	16.95%			
3 = Do more than usual	117	11.02%			
Ride-hailing use					
Using motorcycle-based ride-hailing					
0 = Stop doing	740	69.68%			
1 = Do less than usual	252	23.73%			
2 = Do as usual	52	4.90%			
3 = Do more than usual	18	1.69%			
Using car-based ride-hailing					
0 = Stop doing	791	74.48%			
1 = Do less than usual	209	19.68%			
2 = Do as usual	42	3.95%			
3 = Do more than usual	20	1.88%			
ICT use duration					
Laptop use duration	1 = < 6 months 2 = 6–12 months 3 = 1–2 years			4.85	1.58
Smartphone use duration	4 = 2–4 years 5 = 4–6 years 6 = > 6 years			4.99	1.38
Online services use duration					
Online shopping use duration	1 = < 6 months 2 = 6–12 months			3.43	1.59
Ride-hailing use duration	3 = 1–2 years 4 = 2–4 years			3.23	1.31

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CFA

- Before performing the SEM, we had to first check whether the observed variables constructing the latent variables satisfied the minimum value of Cronbach's alpha.
- As shown in Table 2, except for the latent variable of travel frequency during the COVID-19 pandemic (0.67), the Cronbach's alpha values for all latent variables ranged from 0.707 to 0.90, exceeding the critical value of 0.7, indicating that it has good internal consistency (Nunnally 1978).

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Table 2 Standardized parameter estimates of the observed indicators for the latent variables

Latent variables	Standardized parameter	Standard error	Cronbach's alpha
Ride-hailing use during COVID-19 pandemic			0.82
Using motorcycle-based ride-hailing	0.778[a]		
Using car-based ride-hailing	0.9	0.065	
Teleshopping during COVID-19 pandemic			0.74
Online shopping	0.785[a]		
Fresh food and drink with same-day delivery	0.757	0.059	
Frequency of travel during COVID-19 pandemic			0.672
Work/school trips	0.473[a]		
Shopping trips	0.406	0.058	
Eat outside	0.667	0.075	
Sightseeing trips	0.682	0.067	
Social trips	0.682	0.051	
Frequency of travel before COVID-19 pandemic			0.707
Work/school trips	0.409[a]		
Shopping trips	0.486	0.483	
Eating outside	0.621	0.708	
Sightseeing trips	0.775	0.761	
Social trips	0.69	0.608	
Protective Behaviors toward COVID-19			0.77
Sunbathing	0.478[a]		
Using a face mask when out of home	0.552	0.117	
Doing sport	0.509	0.088	
Physical distancing	0.621	0.098	
Washing hand with soap/sanitizer	0.765	0.086	
Enough sleeping (8 h a day)	0.584	0.093	
Eating nutritious food	0.61	0.093	
Descriptive norms			0.721
People outside of the province	0.628[a]		
People outside of the city but within the province	0.881	0.063	
People in the city	0.799	0.059	
People in the neighborhood	0.546	0.062	
People in the household	0.452	0.045	
ICT use duration			0.813
Laptop use duration	0.865[a]		
Mobile phone use duration	0.795	0.040	
Online services use duration			0.90
Online shopping	0.699[a]		
Fresh food and drink with same-day delivery	0.938	0.039	
Ride-hailing	0.914	0.041	

[a]Item fixed on 1.00 for unstandardized

- Table 2 shows the standardized parameter estimates of the indicators constructing the latent variables.
- In estimating the indicators' parameter, we determined that the first indicator of each latent variable is fixed as one as suggested by Hox and Bechger (1998).
- They explained that one of its observed indicators constructing a latent variable must be fixed on one aiming to normalize the estimated parameters. Judging by the standard error, all observed indicators for the latent variables performed well.

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SEM

- This study adopted several models' fit criteria in the assessment of SEM output.
- The results show that the root mean square error of approximation value of 0.036 **was less than 0.05**, indicating a good fit.
- The goodness of fit index was 0.921,
- while the adjusted goodness of fit index was 0.901,
- and the comparative fit index was 0.926.
- **The results of all parameters varied from 0 to 1, and values of 0.9 or higher were acceptable.**
- The relative Chi-square corrected for degrees of freedom (Chi-square/df) was 2.372, where **values of 3 or less indicate a good fit.**

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	Dependent variables										
	Activity-travel behavior	Freq. of travel during pandemic	Teleworking/e-learning	Teleshopping	Ride-hailing use	Attitudes	Descriptive norms	Protective behaviors	ICT use duration	Online services use duration	Freq. of travel before pandemic
Endogenous variables											
Freq. of travel during pandemic	−0.121+										
Teleworking/e-learning	0.055*										
Teleshopping											
Ride-hailing use			−0.063*	0.531+							
Attitudes	0.154+ (0.037*)	−0.135+ (0.081#)			−0.068* (0.066#)		0.56*				
escriptive norms		0.092+ (0.053*)			0.1+ (0.018+)	−0.55+ (0.109#)		−0.127*			
Protective behaviors	0.103+ (0.059*)	−0.172+ (−0.015+)	0.083* (0.007+)		−0.129+ (−0.001#)	0.282+					
ICT use duration	(0.015*)	−0.117+			−0.162+ (0.045#)					0.445+	
Online services use duration				0.23+ (0.054*)	0.102*						
Freq. of travel before pandemic	(−0.031+)	0.26+									
Exogenous variables											
Gender (male)		0.159+ (0.056+)			0.078* (0.013+)			−0.18+		−0.098+	0.087*

(1) + means $p<0.01$ (2) * means $0.01\leq p<0.05$ (3) # means $0.05\leq p<0.1$ (4) an empty cell means the coefficient is insignificant at the 0.1 level (5) The numbers in parentheses are indirect effects

Studi Kasus 4: LCCA

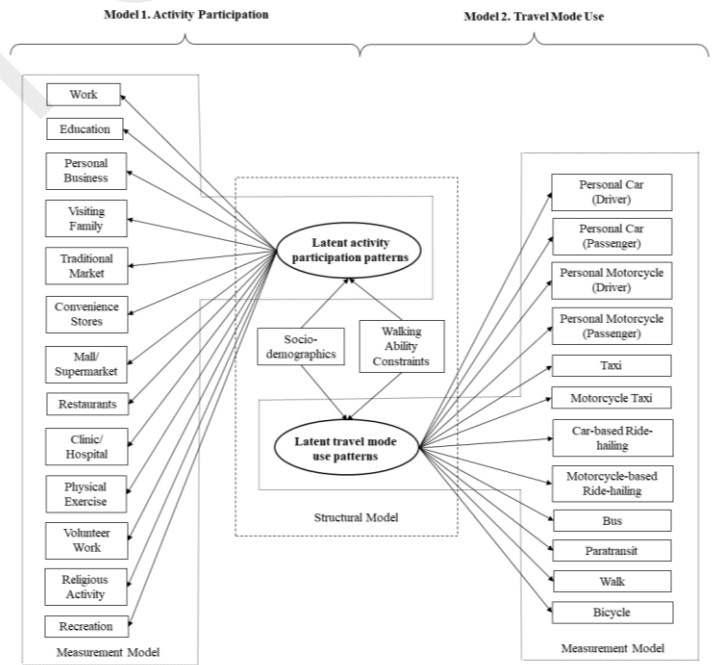

Table 1. Goodness-of-Fit Indices of the LCCA Models

Model	No. of class	AIC	BIC	LL	Npar	Share of each class					
						1	2	3	4	5	6
Model 1. Activities participation	1	9119.8	9313.1	−4507.9	52	100%					
	2	8591.5	8981.8	−4190.8	105	42%	58%				
	3	8475.4	9062.7	−4079.7	158	48%	37%	15%			
	4	8527.6	9311.9	−4052.8	211	24%	23%	17%	36%		
	5	8493.3	9474.6	−3982.7	264	24%	16%	33%	19%	8%	
	6	8430.0	9608.3	−3898.0	317	12%	20%	8%	27%	21%	12%
Model 2. Travel mode use	1	6144.0	6318.7	−3025.0	47	100%					
	2	5899.0	6252.2	−2854.5	95	76%	24%				
	3	5821.9	6353.4	−2767.9	143	74%	13%	13%			
	4	5834.0	6544.0	−2726.0	191	36%	28%	14%	22%		
	5	5926.6	6814.9	−2724.3	239	4%	14%	36%	15%	31%	
	6	5949.6	7016.4	−2687.8	287	7%	44%	4%	16%	22%	7%

AIC = Akaike information criterion, BIC = Bayesian information criterion, LL = final log-likelihood, Npar = number of parameters

- The study concludes that the four-class option gives the most interpretable patterns for both activity participation and travel mode use.
- With the four-class solution, the lowest class is not too small; therefore, it does not separate out a few extreme cases.

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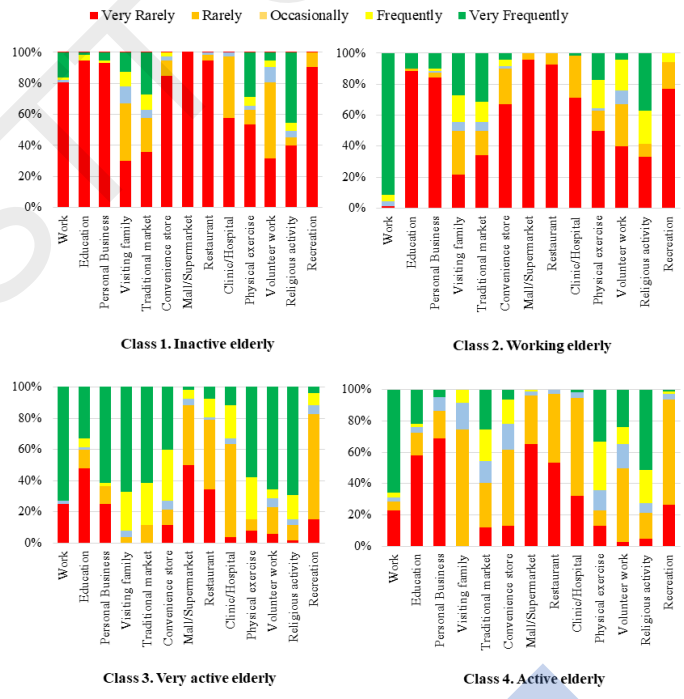

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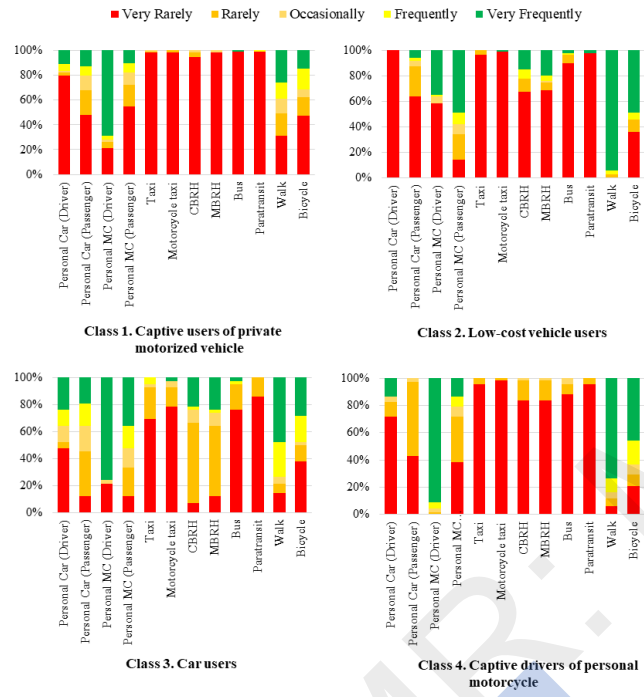

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Variable	Inactive elderly	Working elderly	Very active elderly	Active elderly	Sample	
					Percentage	Mean
Class share (%)	24.01%	23.03%	17.11%	35.86%	100%	
Class size (n)	73	70	52	109		304
Gender (males)	42.47%	55.71%	44.23%	56.88%	50.99%	
Age (mean)	65.77	54.61	57.49	58.21		59.02
Smartphone users (yes)	34.25%	72.86%	**98.08%**	84.40%	72.04%	
Monthly income						
< 1 million IDR (< USD 67)	**67.12%**	28.57%	28.85%	12.84%	32.24%	
1–1.99 million IDR (USD 67–132)	15.07%	**34.29%**	21.15%	14.68%	20.39%	
2–4 million IDR (USD 133–267)	10.96%	7.14%	26.92%	**33.03%**	20.72%	
> 4 million IDR (> USD 267)	6.85%	30.00%	23.08%	**39.45%**	26.64%	
Education (Bachelor's degree or higher)	64.38%	78.57%	78.85%	**94.50%**	80.92%	
Number of household members						
< 13 years old	**0.59**	0.31	0.58	0.54		0.51
13–17 years old	0.12	0.28	**0.43**	0.29		0.28
18–60 years old	2.16	3.04	**3.42**	2.97		2.90
Ability to walk						
Easy	79.45%	100%	96.15%	**100%**	94.41%	
Somewhat difficult	**16.44%**	0.00%	3.85%	0.00%	4.61%	
Difficult	**4.11%**	0.00%	0.00%	0.00%	0.99%	

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