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Factors Encouraging Single Occupant Vehicle Users to Adopt Sustainable Alternative Mode Choice

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Abstract: *Karachi, a megapolis city in specific, has seen a significant increase in urban growth and motorization over the last fifty years. The lack of effective public transportation is a consequence of incredibly reduced operational costs that are reasonable to many of Karachi's habitats, resulting in excessive car use. The study aims to figure out what psychological factors influence motorists' decisions to use sustainable alternative modes of choice. People's movements are strongly linked to their social demographic characteristics, such as age, gender, marital status, profession, education levels, and family activities. For research, data has been collected through a self-administered questionnaire. Partial Least Square Structural Equation Modelling (PLS-SEM) was used. Private Car users of Karachi's CBD were Focused. The descriptive analysis was adopted through SPSS. The "SEM" model was applied through the "PLS" Path Least Square Model. Resultantly, Intention is the crucial factor for the completion of the research.*

Key Words: PLS-SEM; Public Transportation; Mode Choice; Karachi; Sustainable Alternative Mode Choice

Introduction

The crucial aspects of people's daily routine without moving their activities cannot be performed without Transportation (Soomro et al., 2021). *In* the next few decades, the current global car population of one billion will almost double (Gordon & Sperling, 2009). Although becoming a chosen mode of transportation for a variety of reasons, the exponential increase in the number of automobiles has created serious problems. The potential impacts of heavy traffic are road accidents, emissions, and congestion(Qureshi et al., 2022). Because of increased urban sprawl and motorization, the scale of trouble will rise much faster than the city's population(Memon et al., 2020a). Both journeys in terms of space and time are now more distributed, and our knowledge of environmental problems has also changed(Kalwar et al., 2022; Shaikh et al., 2020; Talpur et al., 2016; Talpur et al., 2014). Elderly people are more concerned about pollution, while

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analysts speak about outlying gridlock, and edge cities are also connected to issues such as greenhouse gas emissions and social inequality (Ghaffar et al., 2021; Sahito et al., 2020; Shah et al., 2021a, 2021b). In most cities today, unaffordable problems, mostly in urban mobility networks, are being faced (Bulkeley & Tuts, 2013; Irfan Ahmed et al., 2021; Ki-moon, 2013; Memon, Kalwar, Sahito, & Napiah, 2021; Memon, Kalwar, Sahito, Talpur, et al., 2021; Memon, Napiah, et al., 2016a; Memon, Napiah, Talpur, et al., 2016). Generally, several transportation problems arise when transportation networks fail to meet the needs of urban mobility (Brohi, Memon, et al., 2021; Kalwar et al., 2019; MEMON, 2018a; Memon et al., 2022;

Transit, 2015). People's movements are strongly linked to their social demographic characteristics, such as age, gender, marital status, profession, education levels, and family activities. Job, school, shopping, outdoor sports, etc., all are part of the activities (Bowman et al., 2014). The massive expansion of urban areas has resulted in significant challenges such as increased use of the region, an increasing rate of vehicle dominance, and less efficient motorization (Pojani & Stead, 2015). Expansions in different cities have shown that population is the most important indicator for travel, with travel demand rising in lockstep with population growth (Alkhathlan & Javid, 2013; JAVID et al.). It's been noted that the future planning of Karachi's public transportation system should take into account the city's residents' cultural and social perceptions, as well as the need for protection and separate family carriages (Brohi, Kalwar, et al., 2021a; Gill et al., 2020; Kalwar et al., 2020; Memon et al., 2014; Memon et al., June 2014).

The importance of psychological variables in the modal split model is the subject of this initiative. These characteristics were measured using psychometric methods that were appropriate for discrete option models using a latent variables approach and path analysis (Galdames et al., 2011; MEMON, 2018b).

Problem Background

In classical choice models, selecting a mode of transportation is viewed as an operation involving straight observable variables such as the traveller's physical characteristics such as gender, age, and earnings, as well as aspects of the mode of travel choices such as trip length, trip cost, and so on. Current decision-making model efforts have highlighted the significance of precisely managing psychology-related factors that influence decision-making. (Antonini et al., 2004; Memon, 2010b; Memon et al., June 2014; Memon, Napiah, et al., 2016b; Memon, Napiah, Talpur, et al., 2016). Including psychology-related considerations leads to a more socially rational depiction of the options process and hence increased explanatory capacity (Antonini et al., 2004). According to studies, psychology-related aspects of choosing a mode of transportation are both rational and natural behaviour.

	1	2	3	4	5	6
Year	2002	2003	2004	2005	2006	2007
Total No. Registered Vehicles in Karachi	1113917	1177315	1280349	1431994	1610757	1809500
Annual Increase	30640	63398	102934	151745	178763	198743
Monthly Increase	2553	5283	14897	12645	14897	16562
Daily Increase	84	174	282	415	489	545

Figure 1: Register Vehicles in Karachi from 2002 to 2007 (MEMON, 2018b).

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The metropolitan city of Karachi, in specific, has seen a significant increase in urban growth and motorization over the last fifty years. The absence of adequate public transit in Karachi is due to the very low automobile running expenses that many Karachi residents can afford, resulting in excessive car use. This has been followed by a heavy dependence on private automobiles, resulting in serious car crashes, traffic congestion, and economic, social, and environmental consequences. The registered number of vehicles carrying rickshaws, according to excise and taxation, was 105,684, 6,506 buses, minibuses were 15,807, 104,097 vans/pickups, 47,165 taxis and motorcycles were 1,296,481 (Brohi, Kalwar, et al., 2021b; Irfan Ahmed et al., 2021; MEMON, 2018b; Memon, Kalwar, Sahito, Talpur, et al., 2021; Shah et al., 2021b; Shaharyar et al., 2021)

Research Objective

As stated above, in the context of transportation issues and sustainable alternative mode choices in the city of Karachi, the research poses the question: "What processes and approaches need to be dealt with to guarantee public transport uptake in Karachi?

1. Analysis of the measures that influence the modal choice pattern of private car users.
2. To develop a choice modal to definitive psychosomatic factors.

Literature Review

The four steps of the urban transportation planning system model are trip generation, Trip distribution, Mode-choice, and Route assignment.

Mode choice analysis is measured as the third step in the four-step transportation-forecasting model.

A continuing increase in road traffic congestion leading to driver frustration is disturbing many urban areas' Longer travel times, lower efficiency, more serious accident and car insurance rates, higher fuel consumption, higher cost of transport, and decreased air quality.

The Intention is a key factor affecting behaviour, according to the Planned Behavior theory(Ajzen & Fishbein, 2005). Tpb assumes that deliberate behaviour captures and mediates all motivational factors that influence a person's behaviour. Behavioural values, subjective norms, perceived moral obligation and perceived behavioural regulation all influence the intent of behaviour. Top models have been adopted by numerous studies of travel mode choice Behavior (Hunecke et al., 2007)

Research Methodology

The research design for this study begins with a probing investigation that reviews the literature to assess the research gap and describe the research questions. The research plan is regarded as a logical method as well as a master plan of the research effort that sheds light on research in order to give a solution to the research question(s) (Memon et al., 2020b; Stenson et al., 2003). It presents the researchers with knowledge for the data collection and analyzes in their research and also ensures them that the provided data applies to their effort and deals with the research requirements. This research is established on assembling quantitative facts regarding the upcoming recognition of the anticipated. Karachi inhabitants enforce public infrastructure and policies.

- CBD of Karachi I. I. Chandigarh Road
- Private Car users were focused.
- 100 Sample size questionnaires were collected.
- A self-administered questionnaire Survey was conducted among private transport users.
- Data was entered in “SPSS”.
- Descriptive analysis was done through “SPSS”.
- “SEM” Structural Equation model Through “PLS” Path Least Square Model.

SEM is a fairly generic statistical modelling tool that is commonly utilized in behavioral sciences. This is a combination of factor analysis and regression or path analysis. The importance of SEM is a lot on a hypothetical construct that is corresponded to the latent factors. The relations between the theoretical

constructs are shown between the variables by path or regression coefficients. The structural equation model provides a structure for the covariance between the variables observed and offers modeling of the structure of covariance by another name. However, the model can be further expanded to include experimental means of variables or other things in the model, which allows the modeling of covariance structure a mere precise name. These models are mostly known by many researchers as 'Lisrelmodels' which is often less specific. (LISREL) is abbreviated as Linear Structural Relations is the name of one of Jöreskog's first and most well-known SEM algorithms. Structural equation models must now be nonlinear, and SEM's possibilities extend much beyond the actual Lisrel programme.Like Browne (1993), he presented the possibility of fitting nonlinear curves.

Result and Discussion

Assessment of the Structural model with their steps is described in Fig. 2. Step 1 demonstrates collinearity. If any construct has a value greater than five, the construct is collinear, and the query must be rechecked or rewritten. The Variance Inflation Factor (VIF) must be less than five. Step 2, all p Values less than 0.05 are acceptable.

Fig.3 SEM is a univariate statistical analysis used to investigate structural relationships. Exogenous and endogenous variables are used in this model. In this model, the total variation of endogenic factors on exogenic factors was 42%.

In step 3 in step 3, we see access to the value of R^2 the average variance extracted was established. Discriminant validity established. Endogenous variables had a cumulative variance of 42% on exogenous variables. Nonetheless, we should consider the factor and variable that account for 100% variance in the independent variable.

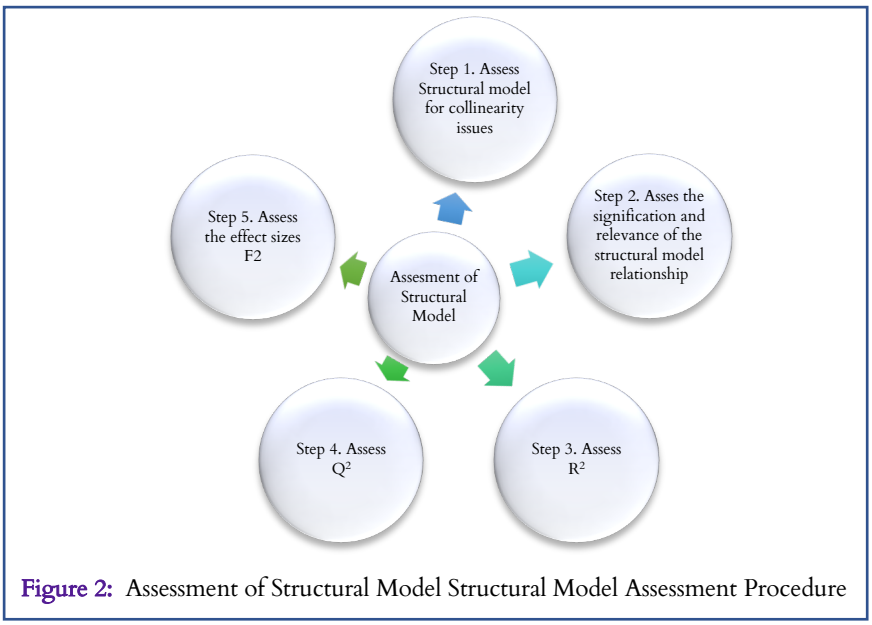

Figure 2: Assessment of Structural Model Structural Model Assessment Procedure

Assessment of the model for collinearity issues was tested as shown in Table 1. As shown in table 1 all factors all less than five.

Table 1. Variance Inflation Factor (VIF)

Variable's	VIF
ATTITUDE3	*1.801*
ATTITUDE 4	*2.202*

Variable's	VIF
ATTITUDE 5	*1.758*
ATTITUDE 7	*1.652*
ENVIROMENT5	*1.000*
IntToPublTrans1	*1.092*
IntToPublTrans2	*1.092*
IntentionpWalking	*1.000*
PercivedNBP2	*1.396*
PercivedNBP3	*1.258*
PercivedNBP1	*1.210*
PercivedWalkingE10	*2.565*
PercivedWalkingE6	*2.979*
PercivedWalkingE7	*2.760*
PercivedWalkingE8	*3.134*
PercivedWalkingE9	*3.471*
Subjectnorm1	*1.180*
Subjectnorm 2	*1.235*
Subjectnorm 3	*1.099*
Trip-Charctere1	*1.123*
Trip-Character 2	*1.123*

Step 4 in Q^2 testing the prediction relevance of our model. Q2 values greater than zero imply that our values are properly rebuilt and that the model is predictive. Intention to use private transport is greater than 0 so 0.206 is established.

Step 5 shows FS is the effect size whereas an Effect Size of 0.02 is equal to a small effect, 0.15 is equal to a medium effect, and 0.35 is equal to a large effect (Cohen et al., 2013)

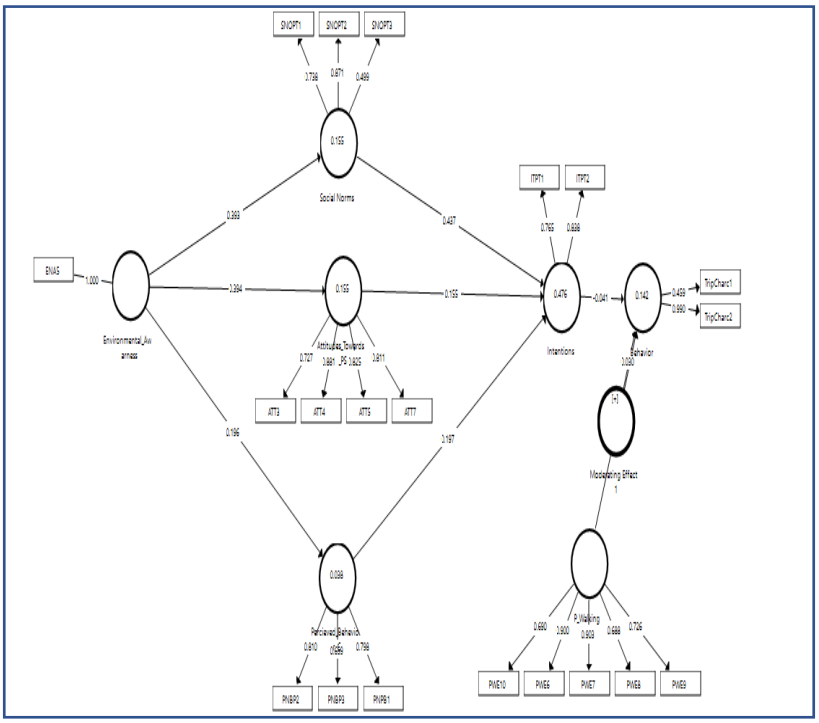

Figure 3: Partial Least Square Structural Equation Model

Assessment of Model for Path Coefficient is shown in Table II. Size of Path-coefficients shows the strength of relationship and importance among constructs

- Attitudes_Towards_PS has a weak relationship with Intentions and is not significant)
- Environmental_Awarness has a strong relationship with Attitudes_Towards_PS and it is significant
- Environmental_Awarness has a weak relationship with Percieved_Behevior_C not significant
- Environmental_Awarness has a weak relationship with Behavior not-significants.
- Moderating Effect 1 has a weak relationship with Behavior not-significants.
- P_Walking -> has a weak relationship with Behavior not-significants.
- Percieved_Behevior_C has a weak relationship with Intentions not-significants

Social Norms have a weak relationship with intentions and are not significant

Table 2. Path Coefficient

	INITIAL TEST (O)	TEST MEAN (M)	Standard Deviation	T-DATA (|O/STDEV|)	P VALUES
ATTI TO PS > INTEN	0.15	0.14	0.26	0.58	0.55
ENV AWAR > ATTI TO PS	0.39	0.39	0.18	2.10	0.03
ENV AWAR > PERCIV BEVR	0.19	0.25	0.23	0.83	0.40
ENV AWAR > SOCI NRM	0.39	0.37	0.23	1.67	0.09
INTEN > BEVR	0.04	0.12	0.23	0.17	0.86
MODERT EFCT-1 > BEVR	0.03	0.04	0.25	0.11	0.90
PERCIV WALK ENV > BEVR	0.36	0.26	0.45	0.79	0.42
PERCIV-BEVR-CON > INTENTION	0.19	0.20	0.20	0.96	0.33
SOCI NRM > INTENTIONS	0.43	0.47	0.25	1.71	0.08

Assessment of R^2 is shown in Fig. 3. PLS-SEM is a variation-based method which accessed the data of R^2 variance in an endogenous construct like Intention it is a very strong value of 40% change, still, there is a need to consider the factor and variable which having 100% variation independent variable. Intention to use private transport has a very strong level of variance (0.425)

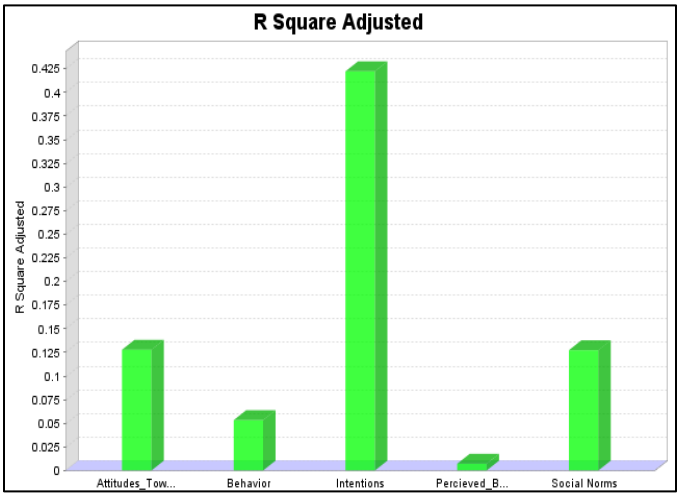

Figure 3: Shows Assessment of R^2

Assessing Predictive Relevance (Q^2) is presented in Table III. In which it is presented that Intention to use private transport is greater than 0 so (0.206) it is Established.

Table 3. Blindfolding Results in Predictive Relevance.

	Sso	Sse	Q^2 (=1-Sse/Sso)
ATTI TO PS	132	126.28	0.05
BEHAVIOR	66	72.35	0.08
ENV AWAR	33	33	
INTENTS	66	52.39	0.20
MODERT EFCT-1 >	33	33	
PERCIV WALK ENV	165	165	
PERCIV BEVR	99	98.08	0.00
SOCI NRM	99	96.93	0.01

Bootstrapping Results are Hypothesis Testing

Table 4. Bootstrapping: Hypothetical Testing

	Initial Test (O)	Test Mean (M)	Standard Deviation	T Statistics (IO/STDEVI)	P Values
ATTI TO PS > INTEN	0.156	0.150	0.260	0.590	0.560
ENV AWAR > ATTI TO PS	0.394	0.399	0.188	2.101	0.036
ENV AWAR > PERCIV BEVR	0.196	0.255	0.235	0.832	0.406
ENV AWAR > SOCI NRM	0.393	0.375	0.235	1.674	0.094
INTEN > BEVR	-0.041	-0.124	0.236	0.173	0.862
MODERT EFCT-1 > BEVR	0.030	-0.041	0.255	0.117	0.907

PERCIV WALK ENV > BEVR	-0.363	-0.262	0.455	0.797	0.425
PERCIV-BEVR-CON > INTENTION	0.197	0.206	0.205	0.961	0.337
SOCI NRM > INTENTIONS	0.437	0.473	0.254	1.718	0.086

- Attitudes_Towards_PS has no significant relationship with Intentions)
- Environmental_Awarness positive and significant relationship with Attitudes_Towards_Private Transport use
- Environmental_Awarness has no significant relationship with Percieved_Behevior_C
- Environmental_Awarness has no significant relationship with Behaviour
- Moderating Effect 1 has no significant relationship with Behaviour
- Percived_Walking -> has no significant relationship with Behaviour
- Percieved_Behevior_C has no significant relationship with the Intention to use private transport
- Social Norms have no significant relationship with the Intention to use private transport Effect Size f^2

The guidelines for assessing f^2 values

Effect Size

LOW EFFECT = 0.02

MEDIUM EFFECT = 0.15

HIGH EFFECT = 0.35

(Cohen, 1988)

Assessing Effect Size of F^2 (Predictive) is expressed in Table V.

Table 5. Effect Size of F^2

ATTI TO PS	0.019 Less Effect
ENV AWAR	0.180 Modest
INTENTS	0.002 Less Effect
MODERT EFCT-1 >	0.002 Less Effect
PERCIV WALK ENV	0.130 Modest
PERCIV-BEVR-CON	0.041 Less Effect
SOCIAL Norms	0.176 Modest

The goodness of the Fit index

The goodness of Fit (GoF)

$GOF=\sqrt{\text{average R2 x average communality}}GOF=\sqrt{0.183 \text{ x } 0.702} = 0.35$

Analysis of GoF is finest considered 0, 0.35 proposes good GoF. As per results, if it is 0.7 >then it indicates poor GoF.

The Correlation Coefficient of Latent Variables is shown in Table VI.

Table 6. Correlation Coefficient of Latent Variables

	Attitudes Towards PS	Behaviour	Environmental_ Awareness	Intentions	Moderating Effect 1	P Walking	Perceived Behavior C	Social Norms
ATTITUDES TOWARDS PS	1.00							

	Attitudes Towards PS	Behaviour	Environmental_ Awareness	Intentions	Moderating Effect 1	P Walking	Perceived Behavior C	Social Norms
BEHAVIOR	-0.01	1.00						
ENVIRONMENT AWARENESS	0.39	0.14	1.00					
INTENTIONS	0.50	0.16	0.44	1.00				
MODERATING EFFECT 1	-0.24	0.02	0.32	0.56	1.00			
P_WALKING	0.18	-0.37	0.23	0.27	0.08	1.00		
PERCEIVED BEHAVIOR C	0.62	0.01	0.19	0.51	0.26	0.27	1.00	
SOCIAL NORMS	0.71	0.06	0.39	0.64	0.49	0.13	0.51	1.0

Findings

Table 5 shows a strong correlation between the latent exogenous constructs and the latent endogenous construct.

Table 7. Correlation Coefficient of Latent Variables

	Initial Test (O)	Test Mean (M)	Standard Deviation	T Statistics	P-value	Relation	Significance	Test
Attitudes Towards PS Behaviour	0.150	0.150	0.260	0.590	0.560	Positive	Not Significant	Rejected
Environmental Awareness Attitudes towards PS	0.394	0.399	0.188	2.101	0.036	Positive	Significant	Accepted
Environmental Awareness Perceived Behavior	0.196	0.255	0.235	0.832	0.406	Positive	Not Significant	Rejected
Environmental Awareness Social Norms	0.393	0.375	0.235	1.674	0.094	Positive	Not Significant	Rejected
Intentions Behavior	-0.041	-0.124	0.236	0.173	0.862	Negative	Not Significant	Rejected
Moderating Effect	0.04	-0.040	0.255	0.118	0.910	Positive	Not Significant	Rejected
Walking	-0.360	-0.260	0.460	0.780	0.430	Negative	Not Significant	Rejected
Perceived Behavior Intentions	0.197	0.206	0.205	0.961	0.337	Positive	Not Significant	Rejected
Social Norms	0.440	0.480	0.250	1.719	0.090	Positive	Not Significant	Rejected

The measurement model was assessed through Correlation Coefficient. The composite reliability of all values was established. The average variance extracted was established. Discriminant validity established. Endogenous variables had a cumulative variance of 42% on exogenous variables.

The Structural Model was evaluated using the F^2 effect size, which revealed that all independent variables have a very small effect size, except for the Intention to use private transportation. Except for Environmental-Awareness, none of the independent variables had a significant size or importance. The R^2 impact of all independent variables on the dependent variable was extremely high at 42 per cent.

The Q^2 value was higher than 0 (0.206), indicating a predictive value.

The goodness of fit index was 0.35, which shows that empirical data fits the model satisfactorily. Except for Environmental-Awareness, all hypotheses are dismissed using the bootstrapping method. The part of the Intention is very important for the accomplishment of the research. Such as the Intention to use private transport is satisfactory.

According to the study's results, Intention is the most important factor.

Conclusion

This study was performed on factors influencing private transport users to shift towards public transport. The result shows that Environmental_Awarness has a strong relationship with an attitude toward public transportation (Attitudes_Towards _PS) and its significance.

The interpersonal model was assessed through composite reliability in which average variance was applied. Discriminant validity is satisfactory according to the Fornel – Lacher cetteiorn.

The average variance extracted was established. Discriminant validity established. Endogenous variables had a cumulative variance of 42% on exogenous variables.

The Structural Model was evaluated using the F^2 effect size, which revealed that all independent variables have a very small effect size, except for the Intention to use private transportation. Except for Environmental-Awareness, none of the independent variables had a significant size or importance. The R^2 impact of all independent variables on the dependent variable was extremely high at 42 per cent.

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