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A Structural Equation Modelling approach for Personal Protective Equipment Waste Management behavior among youth in India during covid -19

C. Vijayalakshmi*¹, M. Premalatha ², Arif P ³

^{1,3} Department of Statistics and Applied Mathematics, Central University of Tamil Nadu, Thiruvarur, India.

² Department of Mathematics, Vel Tech Rangarajan Dr. Sagunthala R & D Institute of Science and Technology, Tamil Nadu, India

ABSTRACT:

Personal protective equipment has been widely used by people during the COVID-19 pandemic to protect themselves from infection. The study showed that youths are very concerned about infection and most wore masks to prevent the transmission of the virus. The study examines the PPE waste management behaviour among youth during the COVID-19 pandemic based on the value-identity-personal norm model. Data were gathered from 486 Indian youths, using questionnaires, and analysed structural equation modelling. Factors that affect youth's waste management practises for personal protective equipment during the COVID-19 pandemic in India were analysed. This research obtained the significance of the factors and ways of positively affecting the PPE Waste management behaviour among youth.

The cluster analysis gives insight about data, the individuals are clustered into two groups. Each factor is sufficiently helping to cluster into two groups. This study sheds light on how young people handled PPE trash during the COVID-19 epidemic and what factors should be taken into account to improve their environmentally friendly PPE waste management practices.

Key words: SEM, Norm, cluster analysis, Biospheric, covid-19, factors

1.0 INTRODUCTION:

The COVID-19 outbreak, also known as the coronavirus pandemic, is a global health crisis that began in late 2019 in Wuhan, China. The virus responsible for the outbreak is called SARS-CoV-2, and it primarily spreads through respiratory droplets when an infected person coughs, sneezes, or talks. The outbreak has had a significant impact on public health, the global economy, and daily life for millions of people around the world. The world health organization declared COVID-19 outbreak a pandemic in 2020. To combat the spread of the virus, public health measures such as social distancing, mask-wearing, and vaccinations have been implemented worldwide. Resulting in a significant increase in the usage of personal protective equipment such as masks, disposal gloves, and PPE body suits. PPE is generally made of single-use plastic and designed to protect personnel from infection. They are widely used by the public to prevent transmission of the COVID-19 virus.

*Corresponding author: C.Vijayalakshmi

PPE played a vital role in preventing COVID-19 transmission and protected the people throughout the crisis. Face masks and gloves were mandated by nations across the world in public. Millions of such personal protective equipment are consumed daily around the world. But PPEs are disposable after usage, therefore it creates a new type of waste. The wide usage of such protective equipment created a challenge in managing and disposing of such wastes. Due to the sudden increase in the usage of PPE, existing facilities were unable to handle the situation properly. Since it is a single-use plastic it created a massive amount of solid waste and become problematic in terms of environmental pollution.

Due to the lack of environmental awareness, PPE waste is not disposed of properly. Most of them are thrown into the environment or littered with PPE. Since it is made of plastic and can remain in the environment due low biodegradability of plastic. Mismanagement of PPE leads to high environmental problems. PPE waste also affects the marine ecosystem directly and indirectly. Some aquatic species can become tangled in the elastic ear loops of face masks or trapped inside gloves, limiting their mobility and perhaps causing them to starve. Apart from that, improper PPE waste disposal not only pollutes the environment but also spreads other infectious diseases. So human behaviour is an important thing that can impact environmental problems. Lack of awareness of how plastic will affect environmental stability is a major reason behind the mismanagement of PPE waste. To prevent environmental pollution caused by PPE, we need to study human behaviour toward PPE waste management. the PPE waste continues to increase day by day. effective waste management is needed to overcome the scenario. It is essential for ensuring sustainable development. waste management is not a technical issue, but a social issue too, as it is immediately connected with human behaviour.

At the heart of the waste management issue, human behaviour is the primary cause. how we consume, produce, and dispose of has a significant impact on the amount of waste generated. but our disposal practices such as littering and dumping make worsen the problem by creating additional waste and polluting the environment. Human behaviour towards waste management can look into as a Value Identity personal Norm model and have different levels such as Biospheric values, Environmental Self-identity, Personal Norms, and Environmental personal social responsibility. value identity personal norm model has previously been adopted to examine pro-environmental behaviour among people.

Biospheric values are those values that refer to the ethical, cultural, and spiritual values which are associated with the earth's ecosystem and the living beings that inhabit it. these values recognize the instinct worth o the nature and importance of preserving it for its own sake, as well as the well-being of humans and other species. it explains positive pro-environmental behaviour. Environmental Self Identity is the degree to which an individual identifies with environmental values and behaviour. Biospheric values can improve a person's environmental self-identity. it elicits moral obligations to protect the environment. individuals who identify strongly with environmentalism are more likely to view waste as a personal responsibility. Personal norms are the internalized standards and expectations that guide an individual's behaviour in a specific situation. In the context of waste management personal norms can play an important role in shaping an individual's behaviour and promoting sustainable waste management practices

Compared with youths of previous generations, they are having more environmental challenges, especially during the COVID-19 pandemic. Youths have started consuming a considerable amount of PPEs as a reason of viral transmission and protocol insisted by respective authorities, we should not be overlooked in their PPE waste management behaviour. it can change their behaviour for some time. India is a developing country with having rich youth population.65% of the population is of under 35 years old. the pro-environmental behaviour of youth can protect the sustainability of nature and protect the environment from PPE pollution, in the meantime of protecting themselves. Studying the behaviour of a large section of the population can use to picturise how the country is developing and managing its problems. The study aims to examine the PPE waste management behaviour among youth in India during the COVID-19 pandemic and predict their behaviour based on the value identity personal norm model.

2.0 LITERATURE SURVEY

Name of the paper	Author Name	Journal name	Technique Used
Youth and sustainable waste management: a SEM approach and extended theory of planned behaviour	Ava Heidary, Mahdi Kolahi	Journal of material cycles and Waste management (Volume 20,2018)	SEM, Cluster analysis
Food waste behaviour at the house hold level, A conceptual frame work	Fadi Abdelradi	International Journal of Integrated Waste Management, Science and Technology (Volume 71,2018)	SEM
Determinants of proper disposal of single-use masks: knowledge, perception, behaviour, and intervention measures	Dasina Crina Petrescu, Hamid Rasegari, Ioan Valentin Petrescu-Mag, Ruxandra Malina Petrescu-Mag	PeerJ Publications (Volume 11,2023)	SEM, Cluster analysis
The Mechanism of Household Waste Sorting Behaviour-A Study of Jiaxing, China	Bora Ly, Romy Ly	International Journal of Environmental Research and Public Health (Volume 19,2022)	SEM
Waste sorting practices of Cambodians during covid-19	Bora Ly, Romy Ly	International Journal of Sustainable Engineering (Volume 15,2022)	PLS-SEM

Increased plastic pollution due to COVID-19 pandemic: Challenges and recommendations	Ana L. Patrício Silva, Joana C. Prata ,Tony R. Walker, Armando C. Duarte , Wei Ouyang , Damià Barcelò , Teresa Rocha-Santos	Chemical Engineering Journal (Volume 405,2021)	SEM, Descriptive Statistics
The Thought of Death in a Pandemic Era: Can Anxiety Determine the Nexus between the Accessibility, Availability and Use of Personal Protective Equipment (PPE) for COVID-19 and Work Behaviour among Aviation Workers	Edmund Nana Kwame Nkrumah ,Suxia Liu, David Doe Fiergbor, Linda Serwah Akoto	Healthcare (Volume 10,2022)	SEM
Understanding the Gap between Environmental Intention and Pro-Environmental Behavior Towards the Waste Sorting and Management Policy of China	Huilin Wang, Aweewan Magmaechai	International Journal of Environmental Research and Public Health (Volume 18,2021)	SEM
COVID-19 Pandemic: Assessment of Behavior and Attitudes in Medical Waste Management Among Healthcare Workers in Kuwait	Fatimah Al-Dashti , Anwaar Mohammad Alkandari , Shihanah AlMutairi, Ahmed Al-Saber	International Journal of Electronic Government Research (Volume 18, 2022)	SEM

3.0 OBJECTIVES AND RESEARCH HYPOTHESIS

The data is collected from youth from India to identify the Personal Protective Equipment waste management behaviour during the COVID-19 pandemic. The Primary objective is to construct the Structural Equation modelling on the Value-identity-personal norm model and predict the Behaviour of youth, and to find out influencing factors. The hypothesis for the study has been formulated as follows

H1: Biospheric values are positively related to environmental personal social responsibility

H2: Biospheric value is positively related to environmental self-identity

H3: Personal norm is positively related to PPE waste management behaviour

H4: Environmental personal social responsibility is positively related to PPE waste management behaviour

H5: environmental Personal Social responsibility is positively related to personal norm

H6: Environmental personal social responsibility is positively related to PPE waste management behaviour.

4.0 MATHERIALS AND METHODS

Then exploratory data Analysis was carried out to clean the data for analysis. Cleaning data includes dealing with missing data, checking for outliers, and dealing with them. And respondent misconducted responses were found and removed by using standard deviation.

Measurement Instrument:

The questionnaire contains a dependent variable (PPE waste management behaviour), predictor latent variables (Biospheric values, Environmental self-identity, Environmental social responsibility and Personal norm) and a predictor manifest variable (Age, gender) Age is measured on an interval scale. And gender is measured on categorical. The factors were measured on a five-point Likert scale which is ranging from strongly disagree (1) to strongly agree (5).

5.0 DATA ANALYSIS

Descriptive statistics such as frequencies, mean and standard deviation is calculated. Cronbach alpha is used to analyse the reliability of each construct. The value 0.6 is generally acceptable and 0.8 or higher is good reliability. Factor loading is the correlation between a latent variable and its measured indicators. Recommended value of factor loading is 0.5. In order to evaluate the multicollinearity among each indicator, the variance inflation factor (VIF) can be used. According to Hair et al [1], multicollinearity is not a problem for VIF below 5. In Construct validity, we have two sections, convergent validity and discriminant validity.

The Average Variance Extracted (AVE) metric to assess convergent reliability. . The observed variable converges to measure the factor if the AVE value is above or equal to 0.50, and convergent validity is confirmed. Generally, outer Loading with 0.4 to 0.7 shall be considered to remove if the deletion result increase in AVE value beyond the threshold. For discriminant validity Hetrotrait-monotrait ratio (HTMT) and Fornell & Lacker criterion are used. The threshold for HTMT is all the values should be less than 0.9. after establishing the fitness of proposed model the relationship between the independent and dependent variable were evaluated by SEM. The model's explanatory and predictive power are evaluated through R square and Q square values.

The clustering method is applied to classify the individual into relatively similar groups based on the construct of value identity personal norm model. Partition around the medoid algorithm is used to cluster the individuals. By the silhouette method, the optimum number of clusters 2 is found. The goodness of fit of cluster analysis measured through average silhouette

width and Dunn index. They found it significant. ggplot is used to evaluate between-group differences in the demographic characteristics and constructs through graphically. The data were statistically analysed using SmartPLS4 and R studio packages.

6.0 NUMERICAL CALCULATIONS AND GRAPHICAL REPRESENTATIONS

Respondent's demographic information

A total of 458 youths participated in the study; 62.2 % were male, and the remaining were female (37.8%). Most of the respondents belong to the 15-20 (65.9%) age category. And 91% of them have college/university education qualifications.

Table 1

Factor	Frequency	Percentage
Age		
15-20	302	65.9
21-25	108	23.6
26-30	30	6.6
31-35	18	3.9
Gender		
Male	285	62.2
Female	173	37.8
Education Qualification		
College/University	389	84.9
Secondary/ High School	69	15.1

6.1 Measurement model

Reliability and validity:

The measurement model fit indices reliability and construct validity indices. the Cronbach alpha, composite reliability and Average Variance Extracted are above the threshold 0.5. The results of internal reliability and construct validity among items were summarized in the Table 4. The results of Cronbach's alpha reliability show that the coefficients of biospheric values, environmental self-identity, environmental personal social responsibility, personal norm, PPE waste management behaviour were 0.660,0.747,0.645,0.61 and 0.537 respectively. The survey indicates sufficient reliability in between 0.5 to 0.75. and the composite reliability demonstrates a degree to which the observed variable displays the latent variable. And composite reliability ranges from 0.76 to 0.85, exceeding the recommended threshold of 0.6.as a next step convergent validity of items was examined by AVE. And AVE values for all constructs are above the threshold of 0.5. Here, an indicator from Biospheric values (B4, factor loading = 0.400) and Environmental Self Identity (EP3, factor loading = 0.465) are deleted to

achieve the threshold of factor loadings. Generally, outer Loading with 0.4 to 0.7 shall be considered to remove if the deletion result increase in AVE value beyond the threshold. So, to get the threshold value of AVE, an indicator from PPE waste management behaviour (PPE3, factor loading = 0.635, AVE=0.463) is deleted. which indicate that latent variables have good validity.

Table 2

Determinants	Indicators
Biospheric Values (B)	B1 : We respect nature and coexist peacefully with all other creatures.
	B2 : I feel that I am a part of the nature.
	B3: Environmental protection and preservation are practiced in nature.
	B4 : There is no pollution in the environment or nature.
Environmental Self-Identity (ES)	E1: I handle PPE Waste with eco-friendly manner
	E2: I tend to handle PPE garbage in an environmentally appropriate manner
	E3 : I consider myself to be a PPE waste management person that cares about the environment.
Personal Norm (P)	P1 : I believe I have a moral obligation to properly dispose of PPE trash.
	P2: I would feel bad if I didn't act in an environmentally friendly manner.
	P3 : I'd be a better individual if I behaved in a more environmentally conscious manner.
PPE Waste Management behavior (PPE WMB)	PPE1 : I appropriately dispose of PPE trash (masks, gloves, face shields, hazard suits, etc.) in disposal bins rather than on the ground, in drains, in rivers, etc.
	PPE2 : I separate waste that is recyclable from PPE waste.
	PPE3 : I don't burn PPE trash as a way of disposal.
	PPE4 : When going out is unnecessary, I stay at home to reduce my use of PPE.
Environmental Personal Social Responsibility (EP)	EP1: In my daily life, I pay attention to environmental protection and the usage of PPE.
	EP2 : I make sacrifices to lessen the pollution caused by PPE trash
	EP3 : I don't handle PPE trash in a way that could be harmful to the environment.
	EP4: For environmental concerns, I have ceased all PPE waste mishandling activities.

Table 3

	B	EP	ES	P	PPE WMB
B1	0.842				
B2	0.778				
B3	0.780				
EP1		0.861			
EP2		0.749			
EP4		0.661			
E1			0.764		
E2			0.836		
E3			0.843		
P1				0.755	
P2				0.766	
P3				0.732	
PPE1					0.671
PPE2					0.736
PPE4					0.746

Table 4

	Cronbach's alpha	Composite reliability	AVE
BIOSPHERIC VALUES	0.66	0.812	0.592
ENVIRONMENTAL PERSONAL SOCIAL RESPONSIBILITY	0.645	0.804	0.58
ENVIRONMENTAL SELF IDENTITY	0.747	0.856	0.664
PERSONAL NORM	0.616	0.795	0.564
PPE WASTE MANAGEMENT BEHAVIOR	0.537	0.762	0.516

Table 5

	B	EP	ES	P	PPE WMB
BIOSPHERIC VALUES	0.77	0.524	0.455	0.403	0.341
ENVIRONMENTAL PERSONAL SOCIAL RESPONSIBILITY	0.348	0.761	0.734	0.673	0.813
ENVIRONMENTAL SELF IDENTITY	0.33	0.535	0.815	0.712	0.668
PERSONAL NORM	0.27	0.455	0.491	0.751	0.841
PPE WASTE MANAGEMENT BEHAVIOR	0.206	0.516	0.427	0.484	0.718

Structural model

Because the measurement model fits data well, the goodness of fit of the proposed theoretical framework can be evaluated by the structural model. Path analysis is used to test the hypothesis, such that to confirm the proposed relationships between latent variables. Here, we performed 5000 samples of the PLS-SEM model using the Bootstrapping procedure, and we achieved results for model significance. t-statistics larger than 1.96 indicates that the path coefficients are statistically significant. From the result, we can see that all the latent variables, including Biospheric values, Environmental self-identity, Environmental social responsibility and Personal norms, explain the PPE waste management behaviour.

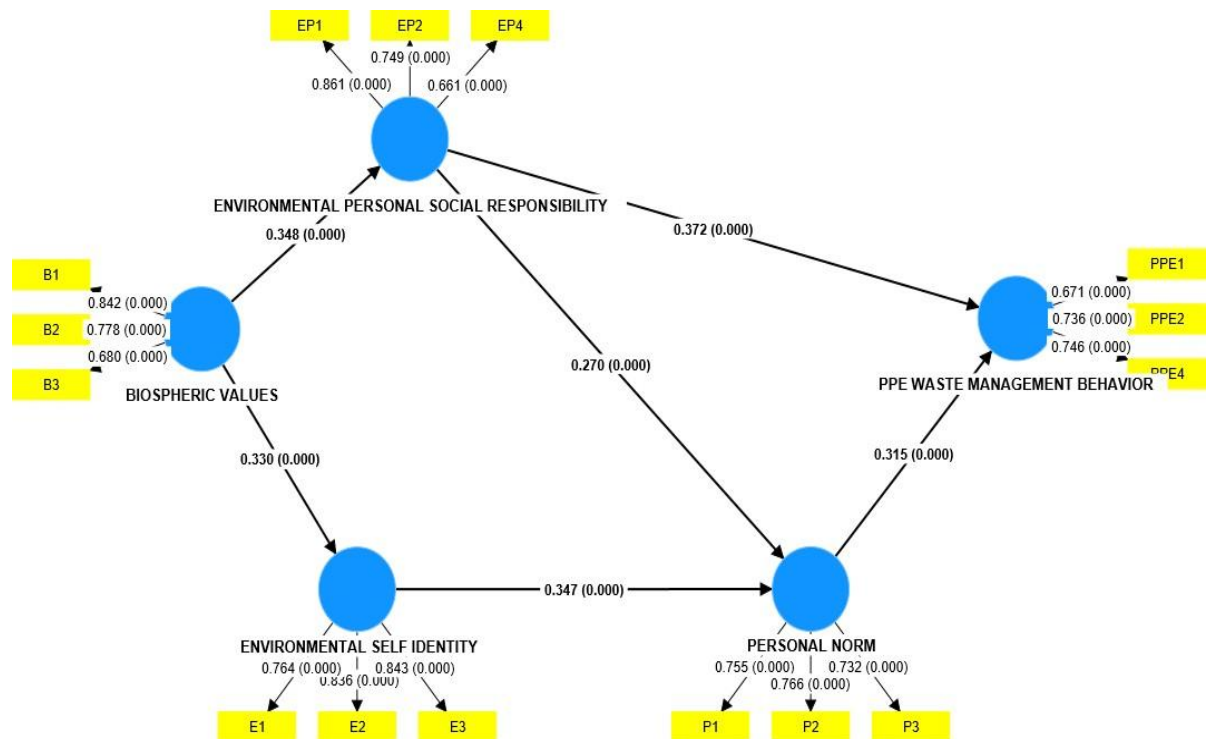


figure.1 PLS-Structural Equation Model

Table 6

Paths (Direct effect)	Coefficient s	Standard deviation (STDEV)	t statistics
B -> EP	0.348*	0.052	6.708
B -> ES	0.330*	0.052	6.307
EP -> P	0.270*	0.042	6.357
EP -> PPE WMB	0.372*	0.055	6.812
ES-> P	0.347*	0.048	7.250
P -> PPE WMB	0.315*	0.056	5.643

Table 7

Paths (Indirect effects)	Original sample (O)	Standard deviation (STDEV)	t statistics	P values
B -> ES-> P	0.114	0.026	4.375	0.001
EP-> P -> PPE WMB	0.085	0.020	4.183	0.001
B -> EP -> PPE WMB	0.130	0.029	4.445	0.001
B-> ES-> P-> PPE WMB	0.036	0.012	3.051	0.002
B -> EP -> P-> PPE WMB	0.030	0.009	3.326	0.001
B -> EP -> P	0.094	0.022	4.288	0.001
ES -> P -> PPE WMB	0.109	0.027	4.054	0.001

Table 8

Latent Variables	Path	Direct Effect	Indirect Effect	Total Effects
B	ES	0.330		0.330
	EP	0.348		0.348
	P		0.208	0.208
	PPE WMB		0.195	0.195
ES	P	0.347		0.347
	PPE WMB		0.109	0.109
EP	PPE WMB	0.372	0.085	0.457
	P	0.27		0.270
P	PPE WMB	0.315		0.315

R square value is used to interpret the variance explained by the endogenous variable. That is, one or more independent variables can measure a little change in the dependent variable. Additionally, it measures the ability of a model for the explanation. According to Falk and Miller (1992) [8] and Cohen, J. (2013) [2], R square values of 0.10 or above are sufficient to explain the endogenous variable. The difference in the R square value caused by the removal of an exogenous variable from the model is known as the f square value. Different variables can affect the variables in a structural model. If an external variable is eliminated, the dependent variable might change. Q square is a measure the predictive relevance of the structural equation model. It describes the predictive relevance of each endogenous variable. Q square values over zero signify that the model has predictive power.

Here PPE waste management behaviour is moderately explained by the three latent variables environmental self-identity, environmental social responsibility and personal norm.

Also, Q square values of latent variables are above the threshold. the model has explanatory power.

Table 9

	R-square	Q ² predict
ENVIRONMENTAL PERSONAL SOCIAL RESPONSIBILITY	0.133	0.123
ENVIRONMENTAL SELF IDENTITY	0.136	0.106
PERSONAL NORM	0.295	0.066
PPE WASTE MANAGEMENT BEHAVIOR	0.355	0.143

Table 10

	f-square
B -> EP	0.154
B -> ES	0.131
EP -> P	0.070
EP -> PPE WMB	0.183
ES -> P	0.123
P -> PPE WMB	0.119

Cluster analysis

Cluster analysis is utilized as an explanatory statistical method to specify whether the value identity personal norm construct could characterise and distinguish homogenous subgroups. the cluster information is given in the table

Table 11

	Size	max_diss	av_diss	diameter	separation
Cluster 1	300	0.611	0.146	0.75	0.04167
Cluster 2	158	0.375	0.141	0.486	0.04167

The cluster's average silhouette width is 0.2. and silhouette width for each clusters are

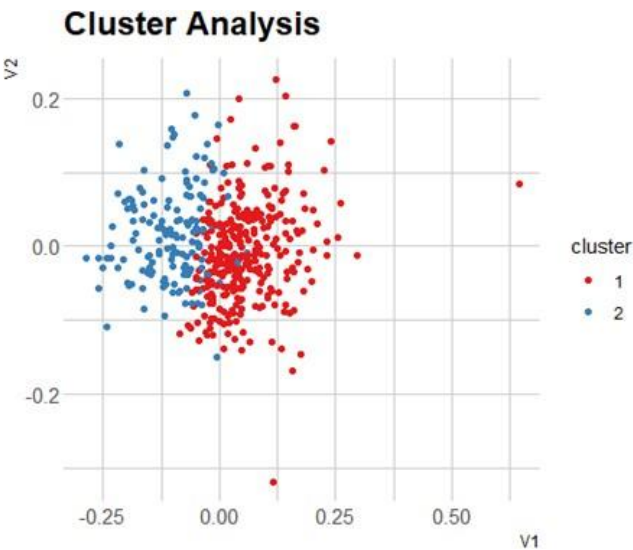
cluster	Size	Average silhouette width
1	300	0.18
2	158	0.23

And the Dunn index for thhe cluster is 0.1021. there are 28 individuals are incorrectly clustered. With the help of multidimensional scaling PAM is plotted in to two-dimensional scale

The demographic features of each cluster are shown in the table 12

Table 12

Demographics		Cluster 1,n	Cluster 2, n
Age	15-20	199	103
	21-25	70	38
	26-30	21	9
	31-35	10	8
Gender	Male	196	89
	Female	104	69



From the results and graphs, individuals from cluster 2 have high waste management behaviour, and the cluster is made on the basis of having the respondents strongly agreeing towards the PPE waste management behaviour. Cluster 2 is made by taking the clustering centre as strongly agreeing towards PPE waste management. Cluster 1 is the cluster containing moderate PPE waste managing people made by taking cluster centre as “Agree”. The distribution of individuals in each clusters based on each construct are graphically represented.

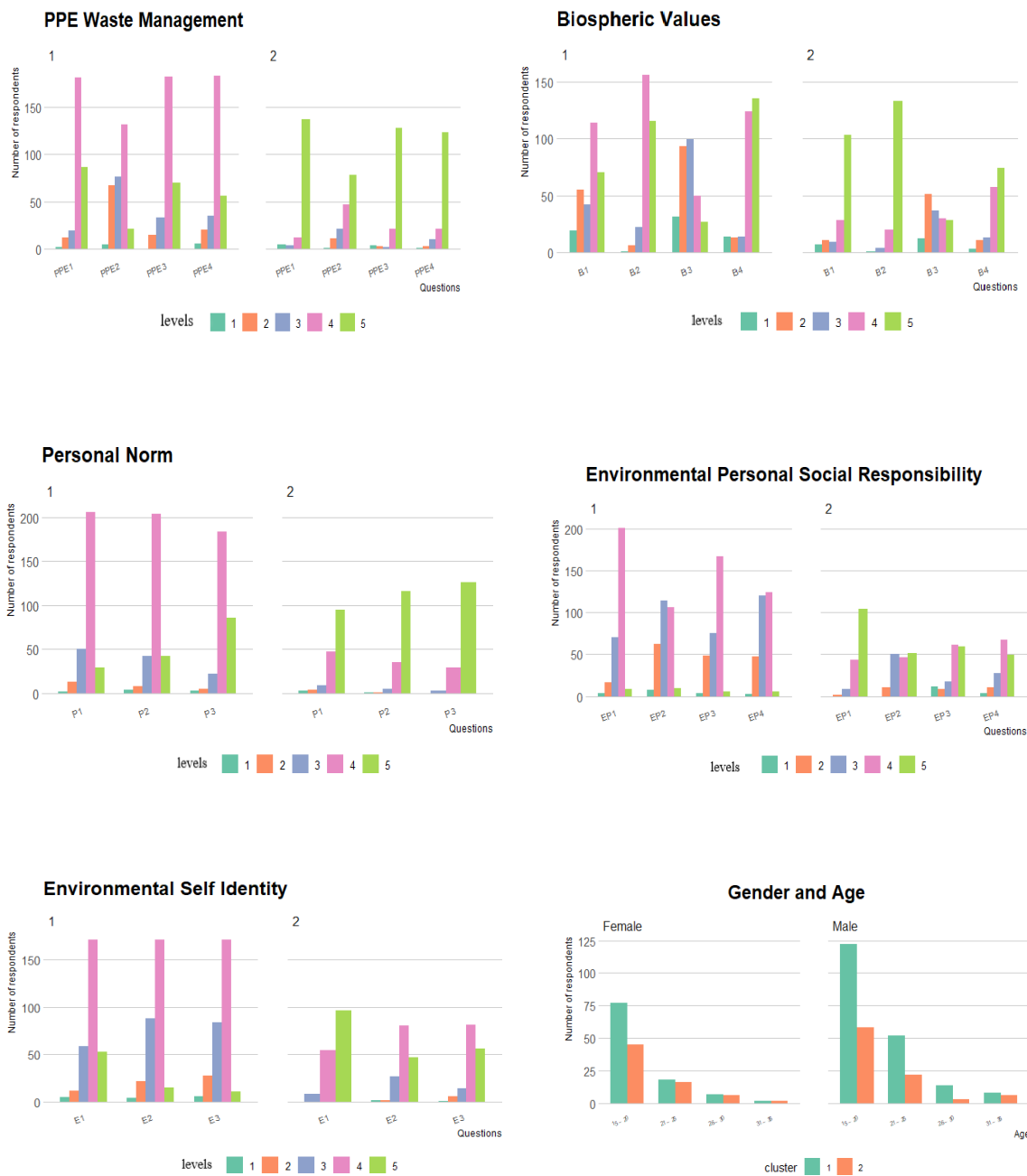


figure 2

For Biospheric values, cluster 1 contains those who responded to Biospheric values as “Agree” and have moderate Biospheric values. In the second cluster, individuals have Biospheric values. Similarly, in cluster 1, individuals having moderate environmental self-identity, Environmental personal social responsibility and Personal norm are clustered. But in cluster 2, individuals having a high attitude towards factors are clustered.

The clustering centres for each cluster are shown below

Table 3.3.2 Cluster centres

Cluster	B1	B2	B3	B4	E1	E2	E3	P1	P2	P3
1	3	4	3	4	4	4	4	4	4	4
2	5	5	3	4	5	4	4	5	5	5

Cluster	PPE1	PPE2	PPE3	PPE4	EP1	EP2	EP3	EP4
1	4	4	4	4	4	3	4	3
2	5	5	5	5	5	3	5	4

Where rating scale is 1-“Strongly disagree”, 2- “Disagree”, 3- “Neither agree nor disagree”, 4- “Agree”, 5-“Strongly agree”.

CONCLUSION

The goal of the study is to identify the factors that affect youth's waste management practises for personal protective equipment during the COVID-19 pandemic in India, Based on the value identity personal norm model. The study concluded that the factors Biospheric values, Environmental self-identity, Environmental Personal Social Responsibility and Personal norms are significant and positively affect the PPE Waste management behaviour among youth. Most people of the young age category widely use PPE because of high social activity. The attitude towards waste management among this group of people is crucial for the environment on a worldwide scale. The model evaluated through the PLS-SEM algorithm shows that all relationship is significant. We found six relationships in this study (1) Biospheric values are positively related to Environmental personal social responsibility (2) Biospheric value is positively related to environmental self-identity (3) Personal norm is positively related to PPE waste management behaviour (4) Environmental personal social responsibility is positively related to PPE waste management behaviour(5) Environmental Personal Social responsibility is positively related to the personal norm (6) Environmental personal social responsibility is positively related to PPE waste management behaviour. Environmental personal social responsibility and PPE waste management practises have the largest relationship, while environmental personal social responsibility and Biospheric values are second. Least relationship is Environmental personal social responsibility and Personal norms. The cluster analysis gives insight about data, the individuals are clustered into two groups. People in Cluster 1 who manage PPE very well and those in Cluster 2 who manage waste more moderately. Each factor is sufficiently helping to cluster into two groups. Cluster 1 is made of individuals whose having moderate behaviour towards each factor. Cluster 2 is made with a high degree of positive attitude toward the factors. This study sheds light on how young people handled PPE trash during the COVID-19 epidemic and what factors should be taken into account to improve their environmentally friendly PPE waste management practices. According to the study, raising an individual's Biospheric values improves their Environmental self-identity, Personal norms, and Environmental personal social responsibility, and eventually influences how they handle PPE waste.

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