

1. Background

Vietnam has been flourishing in the past 30 years when it comes to economic, social, and political reform. According to the World Bank, in 1986, the Vietnamese Government launched economic reforms named **Đổi Mới** which means "socialist-oriented market economy". These reforms helped Vietnam grow immensely, over 49 million people rose from below the poverty line in these years. These events have led to urbanization and the development of cities in Vietnam. These cities are now facing adverse environmental and health risks of plastic waste disposal and recycling. Vietnam contributes to 6% of total plastic waste dumping in marine life.¹ (World Bank, updated 2020).

Most of the plastic starts at home, with each household consuming on an average of four bags a day. (BlissSaigon, 2016). These plastics enter the oceans and reduces the mortality rate of fishes and enter human food intake in the form of microplastics. This is a growing concern for Vietnam and it even caught international attention. Vietnam's government realized this predicament and are taking measurable actions to raise awareness among the public to improve their behaviour towards plastic use and waste disposal management.

Abstract

The research aims to analyze factors affecting the attitude and consumer behaviour changes of Vietnamese citizens concerning plastic use and waste disposal. A survey was conducted with **1008** individuals in Vietnam. We wanted to know what respondents feel about their current situation of plastic usage and identify which factors have the most impact on the local people's intention to either rot/recycle/reuse/reduce/ or refuse plastics. After receiving the responses, we cleaned the data in a structured manner for further analysis. Running EFA and PCA with different factor levels to support our hypotheses. Also, the research figured how attitude, age, gender, and subject norms impact the intention to change an individual's concern on plastic waste.

2. Introduction

Plastic waste is considered as a global environmental concern and Vietnam is one of the heaviest stuck by it. According to Le Dinh Tuyen," It is estimated that Vietnam discharges more than 1.8 million tonnes of plastic waste, only 27% of which is recycled, a report from the Ministry of Natural Resources and Environment says".² Each Vietnamese person consumed only 3.8 kg of plastic in 1990, but 28 years later this had risen to 43.1 kg. Vietnam is also the third on the list of the highest plastic consuming countries in ASEAN. Vietnam is also the fourth worst country in

¹ "The World Bank in Vietnam", World Bank Organization, Accessed on April 27, 2020, <https://www.worldbank.org/en/country/vietnam/overview#:~:text=In%202019%2C%20Vietnam's%20economy%20continued.growth%20rates%20in%20the%20region.>

² "Plastic Wastes Pose Threats on Vietnam's Environment", Le Dinh Tuyen, November 6, 2019, *Mit6874*. <https://th.boell.org/en/2019/11/06/plastic-wastes-pose-threats-vietnams-environment>.

terms of plastic waste management. “Sea level rise causes flooding in coastal farmland, forcing farmers to abandon their livelihoods. Plastic waste in the ocean enters the food chain, directly impacting human health”, according to an article on the official Canadian Government’s website.³ (Government of Canada, 2019).

The objective of this study is to analyze how Vietnamese behaviour towards plastic waste disposal changes. In this project, we are trying to study their attitude, knowledge, and impact of social norms on their intentions so that we can build awareness among the public about plastic use and to analyze the participant’s intention to change their behaviour towards plastic products.

Data Cleaning

After comparing our datasets, we decided to go with David Vazquez’s dataset. Only demographic columns such as Gender, Age, Education Occupation, Income, and all questions except Q19 were included in the survey. Those questions that included the option to selected multiple answers were given their dummy variables.

As far as missing values, we filtered every row and the rows that had more than 6% missing values were omitted (85). These row’s missing values were replaced by the MICE (Multiple Imputation by Chained Equations) library using the Random Forest algorithm. To find any outliers, this dataset was examined using the Mahalanobis or Statistical distance with a p-value cutoff point of 0.001. We found 79 outliers and they were removed from the dataset.

Total Number of observations before cleaning data: 1008

Total Number of observations after cleaning data: 844

3. Methodology and Research Model

Methodology

The research is a combination of both quantitative and qualitative data. Initially, interviews were conducted personally then a software platform was developed to gather responses. To identify the factors that impact on public awareness to change their intention about plastic waste, we analyzed a survey which was conducted in 2019 and employed the Theory of Planned Behaviour to our dataset. In psychology, TPB is a theory that links ones’ beliefs and behaviour. The theory states human actions are guided by three kinds of considerations: attitude (behavioural belief), subjective norms (normative belief), and perceived behaviour control (control belief) with their knowledge, in combination forms an individual’s behavioural intention⁴. The survey was initially created to create a TPB model; however, our team will further analyze what other latent variables in addition to Social Norms, Attitude, and Perceived Behavioural Control affect Intention to reduce plastic in the future and present plastic reduction behaviour.

³ “Combating Plastic Waste in Vietnam”, Government of Canada, 25th April 2019, <https://www.international.gc.ca/world-monde/stories-histoires/2019/vietnam-waste-dechets.aspx?lang=eng>

⁴ “Constructing a TPB Questionnaire”. Izek Azjen, Sept 2020, <https://pdfs.semanticscholar.org/0574/b20bd58130dd5a961f1a2db10fd1fcbac95d.pdf>

In the survey, data was gathered on the following subjects

Demographic information of the responders.

Knowledge on

- Impact of plastic on human health
- Impact of plastic on the environment
- Current situation of plastic disposal in Vietnam
- Plastic related regulations

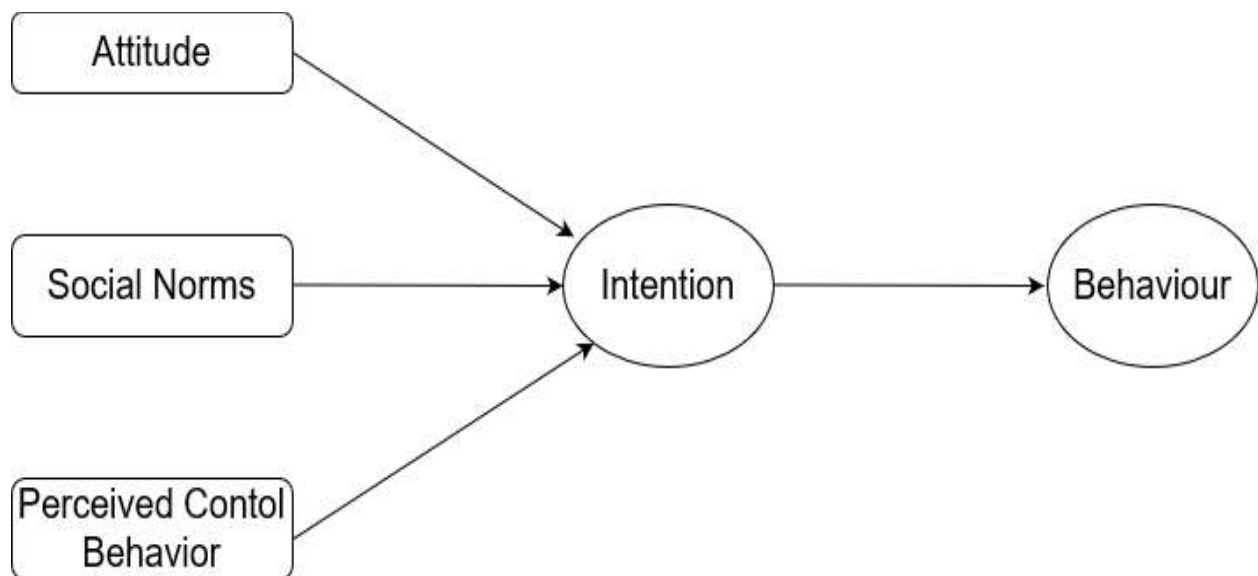
Attitude and Perception: The information generated helps us understand the affective attitude and instrumental attitude of the respondents.

Social norms affecting plastic changing intention and behaviour: This information helps us understand how a respondent would reflect on social norms, these norms are subjective, descriptive, and injunctive norms that will affect consumer behaviour.

Perceived behaviour control over plastic usage, intention, and behaviour change. These questions challenge the respondent to test their confidence in their behaviour.

After performing initial data cleaning and wrangling, we have applied the Factor Analysis dimension reduction and classification technique to discover the latent variables hidden beneath the data.

Hypothesized Research Model



4. Descriptive Analysis

Knowledge: The consumer's knowledge of environmental problems and the existing alternatives and solutions is another factor that has sometimes proved to affect the consumer's behaviour (Elena Fraj-Andrés & Eva Martínez-Salinas 2007)⁵. These questions comprise of past experience and basic information available with them that show the impact on attitude and intention to change.

Question	Options	Frequency	Interpretation
1. Do you know what conventional plastic is made from?	Rubber	40.28%	At least 51% of the participants answered correctly
	Fossil Fuel	51.89%	
	Paper	0.11%	
	Food	0.47%	
	No idea	7.27%	
2. Do you know what single used plastic items in the following products?	Plastic Straw	97%	97% answered right.
	Water supply tube	1%	
	Kids toys	1%	
	No idea	1%	
3. Do you know how many types of plastics are available?	2	33.41%	Only 6.75% of people knew that 7 types of plastic are available
	4	42.65%	
	7	6.75%	
	No idea	17.18%	
4. Do you know any plastic wastes' impact on human health?	I know	72%	72% were aware of health concerns
	I don't know	28%	
5. Where do you think sources of plastics impacting health may come from?	In drinking water	87.32%	Most Participants believed that human intake of plastic is from food or water
	In food	90.87%	
	In the air	56.39%	
	In soil	61.13%	
	In clothes	37.44%	
	In cosmetics	74.17%	
	Sea Salt	00.71%	
6. Do you know plastic wastes' impact on the environment?	I know		72% were aware of health concerns
	I don't know	86.25%	
		13.74%	
	Recycled	46.20%	

⁵ "Impact of Environmental Knowledge on Ecological Consumer Behaviour, Journal of International Consumer Marketing,". Elena Fraj-Andrés & Eva Martínez-Salinas, Sept 07 2008, https://doi.org/10.1300/J046v19n03_05

7. Do you know what happens with most of the plastic after you dispose of plastic waste?	Dumped at landfill	42.89%	Participants assume that more plastic is recycled than it actually is.
	Litter the environment	48.81%	
	No idea	0.47%	
8. Where is the position of Vietnam in the list of countries disposing the plastic waste to the marine?	Top 5	42.18%	At least 42% of participants knew the plastic waste conditions in Vietnam
	Top 10	8.76%	
	Top 50	25.35%	
	No idea	23.69%	
9. Do you know any regulations on plastics reduction at your community/workplace/school?	Yes	34.47%	Participants show lack of regulations regarding plastic reduction
	No	65.52%	

The respondents scored high on knowledge in general, scoring low when it comes to types of plastic (6.75%). While 65% are unaware of regulations on plastic reduction at the workplace or community. These responses will help us drawing suggestions through our analysis.

Attitude: Attitude towards the behaviour refers to the degree at which a person has a favourable or unfavourable evaluation or appraisal of the behaviour in question (Ajzen, 1991). Social psychologists take the information processing approach to attitude formation according to the expectancy-value model (Fishbein and Ajzen, 1975). Expectancy value model suggests that attitudes towards a product develop reasonably from the beliefs people hold about a certain behaviour, plastic reduction in our case.). In the case of attitudes toward a behaviour, each belief links the behaviour to a certain outcome, or to some other attribute such as the cost incurred by performing the behaviour. Depending on it being positive or negative, we automatically and simultaneously acquire an attitude towards plastic reduction behaviour (Ajzen, 1991)⁶.

Our participants showed that around 68% of respondents answered that they were concerned for their health and animal health through ingestion (Q10.1 and 10.5) and over 70% are concerned about damage to nature (Q10.6). The SD is not significantly large which means other respondents have a similar opinion. The mean of over 3.5 suggests that the majority is concerned with plastic. Refer Attitude table (page 21) in the Appendix for more details.

Social Norms: The second predictor is a social factor; it refers to the perceived social pressure to perform or not to perform the behaviour (Ajzen, 1991). Normative beliefs constitute the underlying determinants of social norms. Some previous studies have found a strong correlation between descriptive norms and intention (Rivis and Sheeran, 2003) and some have found weak or even insufficient. We also notice that subjective norms positively impact consumer's intention to buy sustainable products. (Chen, 2007).⁷

⁶ "Theory of Planned Behaviour", Icek Ajzen (1991), University of Massachusetts at Amherst, https://www.dphu.org/uploads/attachements/books/books_4931_0.pdf

⁷ "The role of subjective norms in forming the intention to purchase green food", Marija Ham, Marina Jeger & Anita Frajman Ivković (2015), Economic Research-Ekonomska Istraživanja, <https://doi.org/10.1080/1331677X.2015.1083875>

In our descriptive analysis, we notice that most of the participants (97%) have agreed to follow suit, low standard deviation and high means suggest most respondents agree with the social norms surrounding plastic. Refer Social Norms table (page 22) in the Appendix for more details.

Perceived Control Behaviour: Perceived Behaviour Control refers to “perceived ease or difficulty of performing the behaviour, and it is assumed to reflect experience as well as anticipated impediments and obstacles” (Ajzen, 1991). It is one’s own belief or confidence in what they can do. The relative importance of intentions and perceived behavioural control in the prediction of behaviour is expected to vary across situations and different behaviours.

Participants responded that (Q13.5) Health consciousness is the main reason they choose to reduce plastic (90%) and (Q15.5) shows that 95% of the respondents think it is individual consumer’s responsibility to reduce plastic wastes shows a positive intent for consumers to change. (SD=0.22). Refer PCB table (page 22) in the Appendix for more details.

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Descriptive Statistics of Demographic Variables

Variable	Factors	Frequency	Proportion
Language Preference Of Survey Participant	English	273	32.34%
	French	2	0.002%
	Vietnamese	567	67.18%
	Japanese	2	0.002%
Gender	Male	211	25%
	Female	633	75%
Occupation	Student	282	33.41%
	White-Collar Workers	360	42.65%
	Blue Collar Workers	57	6.75%
	Other	145	17.18%
Income in VD	<10M	121	0.23%
	10-30M	210	59.83%
	30-40M	20	32.58%
	>40M	53	7.35%
Education	School	120	14.21%
	Graduation	565	66.94%
	Post-Graduation	159	18.83%
Age	16-28 years	390	46.20%
	29-40 years	269	31.87%
	41-52 years	107	12.67%
	Over 52 years	32	3.78%

Language: As expected, most of the respondents chose Vietnamese to answer the survey accounting to 67.2%, followed by English at 32.3% and Japanese and French was at 0.2% respectively.

Gender: In our dataset, most respondents are female, accounting to 75% and male respondents are 25%

Occupation: Respondents belong to various occupations in the sample, White-collar workers accounted for 42.65% of the sample, students accounted for 33.4% of the sample, Blue-collar workers accounted for 6.7% and others were 17.1%

Income (monthly/yearly?): 59.8% of the sample has an income between 10-30 Million VND, 32.5% of the sample has an income of 30-40 Million VND, 7.3% of the sample has an income of over 40 Million VND and 0.2% of the sample have an income of less than 10 Million VND.

Education: This sample seems well-educated with 66.9% of Graduates, 18.8% Postgraduates and 14.2% school level candidates.

Age: Respondents of age 16 to 28 account to 46.2% of the sample, respondents of age 29 to 40 account to 31.8% of the sample, respondents aged 41 to 52 account to 12.6% and respondents over 52 years old account to 3.7%

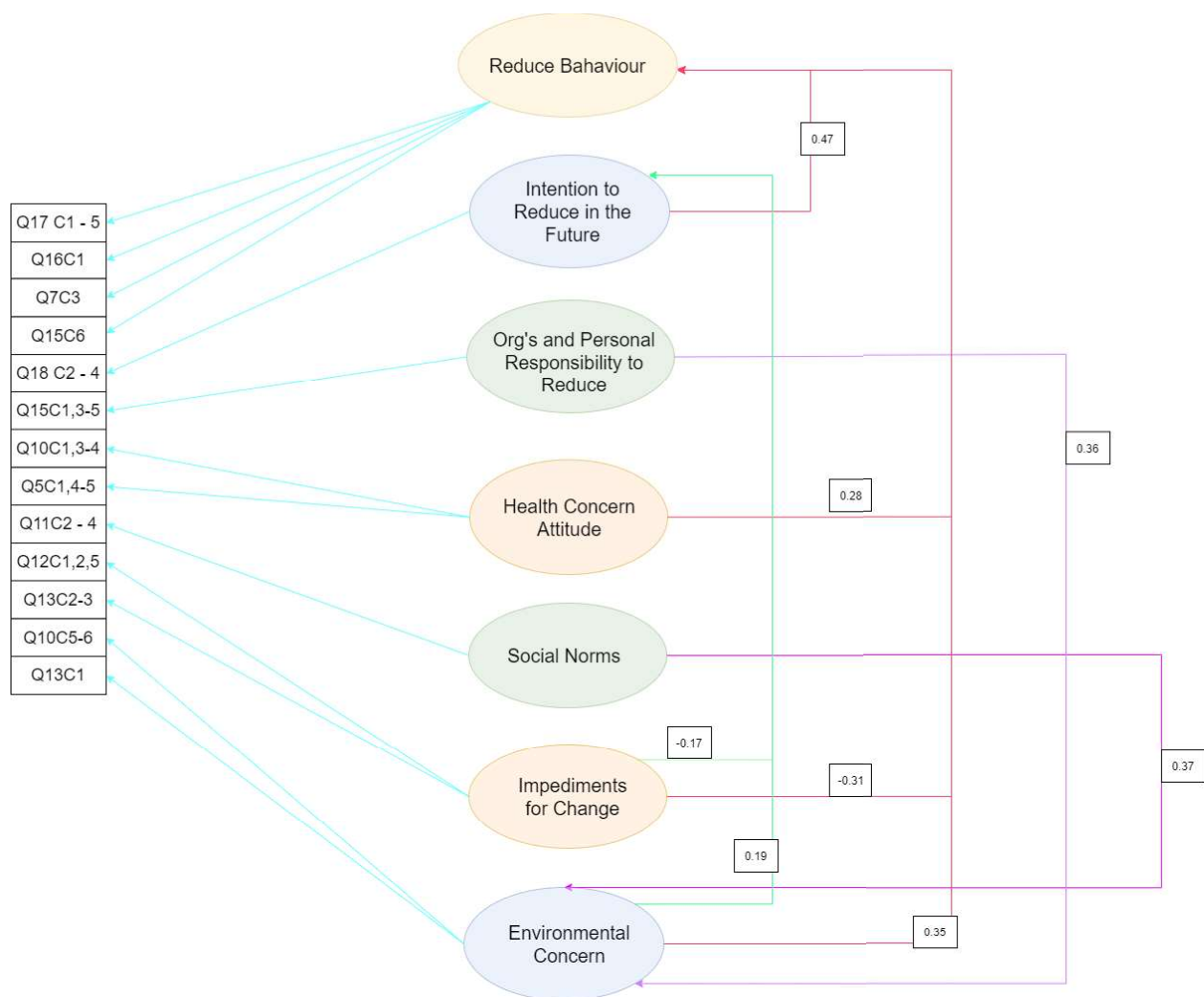
5. Research Question: What Factors influence Vietnam residents' Intentions and Behaviours to reduce plastic waste?

- **Q1:** Does health concern regarding plastic waste have a positive influence on the intention or Behaviour of consumers to reduce plastic waste?
- **Q2:** Does corporate, government, and personal accountability for reducing plastic waste have a direct impact on the behaviour or intention of consumers to reduce plastic waste?
- **Q3:** Does the concern of environmental plastic damage have a positive influence on the intention or behaviour of consumers to reduce plastic waste?
- **Q4:** Do social norms have a positive influence on the intention or behaviour of consumers to reduce plastic waste?
- **Q5:** Do impediments to reduce plastic waste have a negative influence on the behaviour or intention of consumers to reduce plastic waste?

6. Inference analysis and interpretation

We used EFA for analysis as we want to find out which latent factors most contribute to changing participant's plastic reduction behaviour. After analysis, we found 7 factors that are important contributors, and see a moderate correlation between these factors. We have compared various models considering a different number of factors. Refer to Model Comparisons (page 30) in the Appendix for more details.

7-Factor Model: Explanation & Insights⁸



⁸ Refer to Appendix: 7 Factor Model: Original R Output

Plastic reduction behaviour and intention to reduce in the future have the strongest connection with a correlation of 0.47. This could be a sign that once the participants are taking part in plastic reduction efforts, they are more likely to have the intention to keep trying to reduce plastic waste in the future. This is a significant pivotal point in our model as it could give a clue as to what needs to happen in order to change the long-term behaviour of participants.

After “Intention to Reduce,” the “Environmental Concern” factor is the highest correlated factor with “Reduction Behaviour” (0.35). Those who score high on environmental concern, also score high on plastic reduction practices such as refusing to use single-use plastic or nylon bags (Q17C1) and using life-long bags to avoid disposable plastic bags (Q17C2). This indicates that ecological concern does play an important role in influencing behaviour. By the same token, we ought to keep in mind, inconsistent results from other studies. A similar but more precise relationship was suggested in Carmi’s 2013 study, “Caring about tomorrow: future orientation, environmental attitudes and behaviours”. In this study, it was found that concern for the environment did yield environmentally friendly behaviours along with a future-oriented mindset to sacrifice for the environment but *only if the individual perceived personal gains from such sacrifices*.⁹ This is a limitation in our study as we did not separate if whether participants would sacrifice for the environment even when there was no immediate gratification for their efforts. Further research needs to be done to confirm if Carmi’s findings apply to residents in Vietnam. This will help policy makers know if their population genuinely cares more about their environment more than their personal gains, or if they care about the environment only if there are personal gains.

Interestingly, the Health Concern of the survey participants had a weak correlation with Behaviour, only 0.28. We expected that this would be higher than the environmental concern. Although many can relate anecdotally that sometimes individuals put the environment first rather than their health, further research needs to be done to be able to quantify and know why individuals have this set of priorities.

Impediments were the only negatively correlated factor directly with Behaviour with a moderate correlation of -0.31. This is logical and intuitive as the more impediments or disincentives to reduce single-use plastic, the less plastic reduction behaviour is expected. According to the participants, some of the impediments they faced were “very cheap and convenient” acquisition of these products (Q12C5), lack of knowledge about plastic waste (Q12C1), lack of alternative products (Q12C2), and lack of popularity within the participant’s society (Q12C4). A similar result was obtained in Pam Ellen’s 1994 study: those that felt that shopping for more environmentally friendly products were a sacrifice, there was a lower level of commitment to reducing their consumption of ecological products (Ellen, 1994).¹⁰

⁹ Nurit Carmi (2013) Caring about tomorrow: future orientation, environmental attitudes and behaviours, *Environmental Education Research*, 19:4, p. 430-444.

¹⁰ Ellen, Pam Scholder. "Do we know what we need to know? Objective and subjective knowledge effects on pro-ecological behaviours." *Journal of Business Research* 30, no. 1 (1994): 43-52.

“Organization and Personal Responsibility to Reduce” and “Social Norms” factors are indirectly connected to the “Reduction Behaviour” factor through the “Environmental Concern” factor. The social norm’s indirect relation to reduction behaviour is also attested in the study “An Investigation of Determinants of Recycling Consumer Behaviour” where it was also found that there are other factors in between social norms and recycling (Jackson & Olsen, 1993).¹¹ In this study, factors that came before recycling behaviour were personal benefits-vs-costs deliberations, social pressures, and personal values. In our study, our model indicates that the “Environmental Concern” factor goes first before reaching the “Reduction Behaviour” behaviour factor. This suggests that social norms regarding plastic reduction practices are not strong predictors of reduction behaviour and even less of intentions to keep reducing plastic waste in the future.

Additionally, the other factor that is indirectly connected to behaviour reduction is “Organization and Personal Responsibility to Reduce.” Correlation between “Organization and Personal Responsibility to Reduce” and “Environmental Concern” is one of the highest in the model (0.36). 95% of participants agreed that the individual consumer should take responsibility in the reduction of plastic waste efforts (Q15C5); 66% agreed that the government should also take responsibility (Q15C1), and 64% agreed that businesses such as supermarkets and convenient stalls should also take responsibility (Q15C3,4). These two factors, although not directly linked to behaviour, give us an indication as to some of the conditions that might help build environmental concern among survey participants – social norms, and more organizational and personal accountability for plastic reduction. In Dilkes-Hodgman's and Leela's 2019 study, “Public Attitudes Towards Plastics” found that 64% of their respondents hold business highly responsible for reducing plastic waste (Dilkes-Hodgman & Leela, 2019).¹² This number is very similar to our survey's findings. Additionally, these participants also scored high in their concern for the environment giving our model's relationship more validity.

In conclusion, many of our model's relationships have also been corroborated with other studies; however, one must keep in mind that the plastic reduction behaviour of people cannot be simplified to a basic model. It is extremely complicated as many more variables that we have not tested for in the survey also show an impact on people's overall concern and practice of plastic reduction behaviours. Some of the variables that have not been tested in this survey and which studies suggest that have an impact in reduction behaviours are outdoor-recreation time, participation in “ecological restoration work”, news consumption, environmental progressive documentary consumption. Although our model gives good indications of what variables affect present behaviour and future intention, further studies and more comprehensive studies need to be conducted to confirm and expand on our model's relationship with behaviour and intention.

¹¹ Anita L. Jackson, Janeen E. Olsen, Kent L. Granzin, and Alvin C. Burns (1993) , "An Investigation of Determinants of Recycling Consumer Behaviour", in NA - Advances in Consumer Research Volume 20, eds. Leigh McAlister and Michael L. Rothschild, Provo, UT : Association for Consumer Research, Pages: 481-487.

¹² Dilkes-Hoffman, Leela Sarena, Steven Pratt, Bronwyn Laycock, Peta Ashworth, and Paul Andrew Lant. "Public attitudes towards plastics." *Resources, Conservation and Recycling* 147 (2019): 227-235.

Multiple Linear Regression

Hypothesis Testing:

To prove our research questions, we consider the following Hypothesis:

H1- Health concerns and Intention/behaviour are associated.

H2- Government/business accountability and behaviour are associated.

H3- Behaviour and Environmental concerns are associated

H4-Social norms and intentions are associated

H5-Impediments and behaviour are associated

H6-Knowledge about plastic and intention are associated

To test our hypotheses, we use the Chi-square test. The summary of the Chi-Square test is given in the following table:

Hypotheses	p-value
Health concerns and Intention/behaviour are associated.	3.61e-05
Government/business accountability and behaviour are associated.	1.39e-11
Behaviour and Environmental concerns are associated	5.155e-15
Social norms and intentions are associated	0.0002836
Impediments and behaviour are associated	<2.2e-16
Knowledge regarding plastic and intention are associated	2.102e-06

The p-values of the Chi-Square test show that we can reject the null hypothesis. This infers that Health concern, Organization accountability, Environmental concerns, social norms, impediments, and knowledge regarding plastic are associated with an intention to reduce in the future and current plastic reduction behaviour. The people that are more concerned about the harmful effects of plastic on their health and environment are more likely to change their behaviour to reduce plastic in the future. Moreover, people follow their neighbourhood's social norms, and many places the responsibility of plastic reduction to the government and businesses. The individuals that have more knowledge about the harmful effects of plastic are more likely to change their intentions to reduce plastic waste.

We made various models with a different number of factors and compare results with Multiple Regression Analysis. The summary of regression is given in the following table:

	Number of factors	R-squared	Adj. R-Square	F-Statistics	AIC
Model1	6	0.3968	0.3844	31.97	995.91
Model2	7	0.3917	0.3784	29.51	1005.134
Model3	8	0.4007	0.3869	28.99	994.57
Model4	9	0.4056	0.3897	25.47	993.51

With the help of AIC and R-squared scores, we can get an insight about which model is better and by how much. Akaike Information Criterion (AIC) estimates the relative amount of information lost by the model, the less information of the model loses, the higher is the quality of the model. Whereas R-squared indicates the percentage of the variance in the response variable that is explained by independent variables. R-Squared determines how well the model fits the data.

The AIC and R-squared values show that model3 with 8 factors is most appropriate as it has the least AIC and larger R-Squared. Although AIC is less for model4, there is only a slight increase in R-squared, so it is not practical to choose one extra factor just to get an increase of 0.50 in R-squared value.

Initially, we run EFA on model3, we found a factor that was not very significant and just made our model complex; therefore, we finalized our model with 7 factors.

Stepwise Regression:

We applied stepwise regression on correlated variables of our dataset, and it gave us a model with important variables stated below.

We took initial model as follows:

$Q17M \sim Q1C2 + Q2C1 + Q3 + Q4 + Q5C1 + Q5C2 + Q5C3 + Q5C4 + Q5C5 + Q5C6 + Q5C7 + Q6 + Q7C1 + Q7C2 + Q7C3 + Q7C4 + Q8 + Q9 + Q10C1 + Q10C2 + Q10C3 + Q10C4 + Q10C5 + Q10C6 + Q10C7 + Q11C1 + Q11C2 + Q11C3 + Q11C4 + Q11C5 + Q12C1 + Q12C2 + Q12C3 + Q12C4 + Q12C5 + Q12C6 + Q13C1 + Q13C2 + Q13C3 + Q13C4 + Q13C5 + Q13C6 + Q14 + Q15C1 + Q15C2 + Q15C3 + Q15C4 + Q15C6 + Q15C5 + Q15C6 + Q16C1 + Q16C2 + Q16C3 + Q16C4 + Q16C5 + Q18C1 + Q18C2 + Q18C3 + Q18C4$

After Stepwise regression, we got the following model:

$Q17M \sim Q5C4 + Q5C5 + Q7C3 + Q10C1 + Q10C6 + Q11C2 + Q12C5 + Q13C2 + Q13C4 + Q15C1 + Q15C3 + Q15C6 + Q15C5 + Q16C1 + Q18C1$

The summary of the stepwise model is given below:

R-Squared	0.4308
Adj.R-Squared	0.4198
F(Anova)	39.5
Significance	<2.2e-16
AIC	898.03

R-Squared and significance level confirm that this model is good. The low significance level of F-statistics infers for the goodness-of-fit of the model.

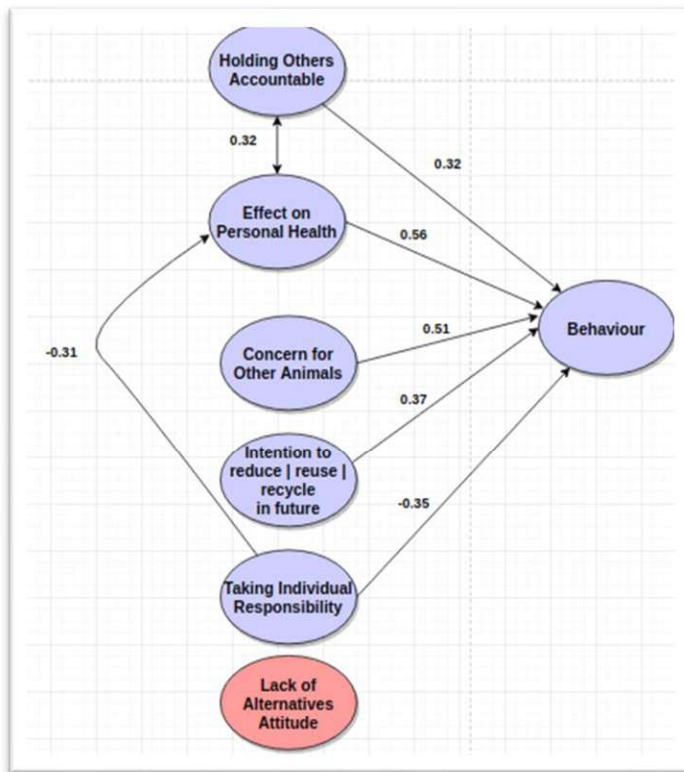
7. Demographic Comparisons

Data about the particular sector of the sample could be used to understand the psychology of the population in that category. This information could be very useful in designing targeted campaigns, which could make a mindful shift in plastic related behaviour.

So, we decided to take selective samples of the dataset, which only included females, males, individuals aged less than 40 and individuals age more than 40. The EFA was applied to those selective samples and the interpretation is as follows.

Using Gender Criterion

Females



Chi- Square Testing	p-value
Behaviour & Intention are correlated	0.00299
Behaviour & holding others accountable are not correlated	0.1799
Behaviour & effect on personal health are correlated	0.008496
Behaviour & concern for other animals are not correlated	0.8381
Behaviour & lack of alternative attitude are correlated	0.006997
Behaviour & taking individual responsibility are correlated	0.02349

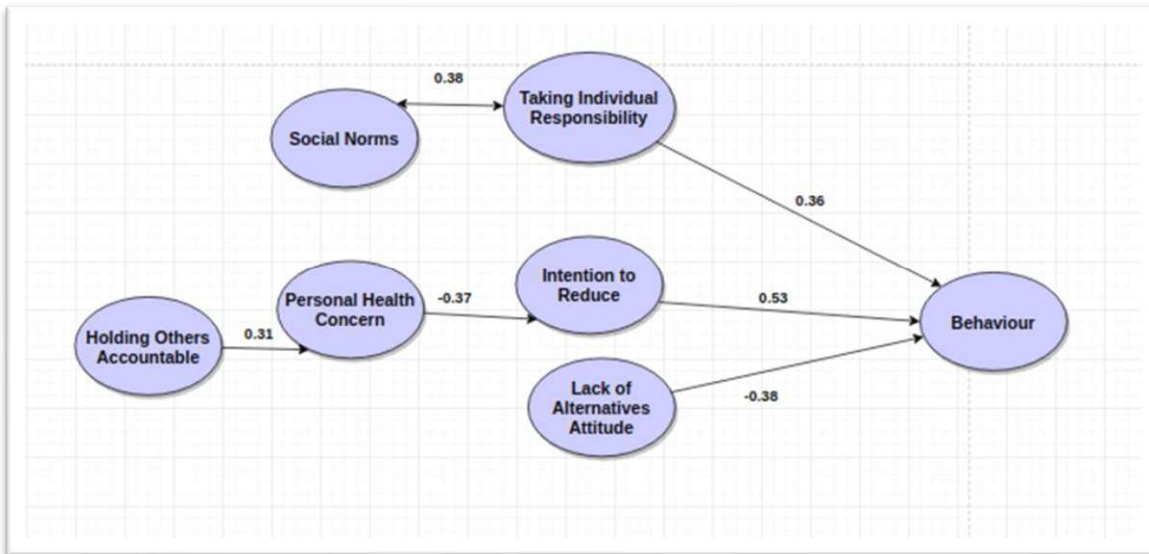
Interpretation

- Concern for biodiversity has a high correlation of 0.51 with behaviour.
- Individual responsibility was a negative correlation with personal health and behaviour, which means women in Vietnam believes she is not responsible to curb plastic menace. And this psychology is also proved by the positive correlation between holding others accountable and behaviour factors.

Goodness-of-Fit Indices

BIC	TLI	RMSEA
-575.07	0.792	0.067

Males



Interpretation

Chi-Square Testing	p-value
Behaviour & Intention are correlated	0.00549
Behaviour & Social Norms are not correlated	0.3428
Behaviour & Holding Others Accountable are correlated	0.00149
Behaviour & Personal Health Concern are not correlated	0.06197
Behaviour & lack of alternative attitude are not correlated	0.8916
Behaviour & taking individual responsibility, are not correlated	0.1589

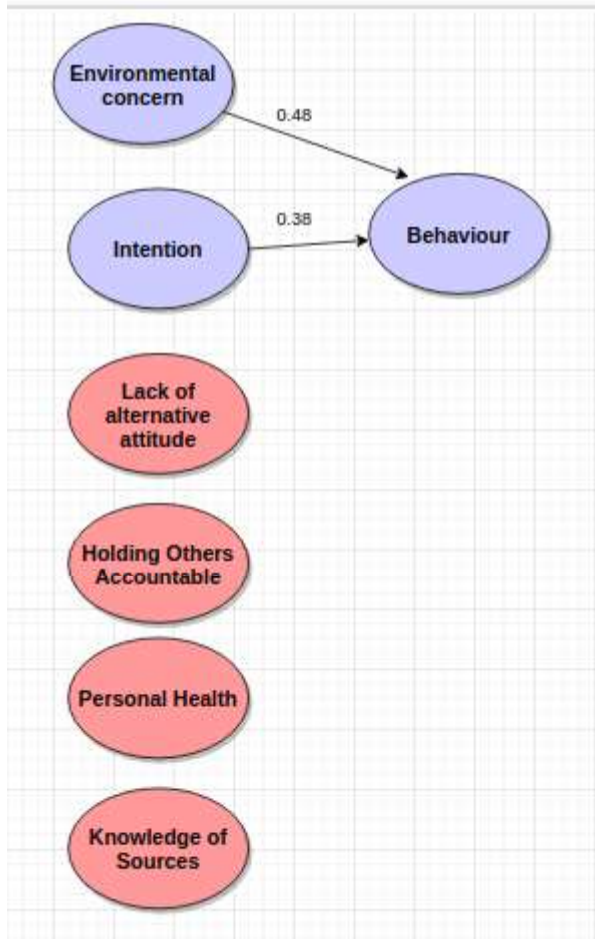
- For males, the latent variable to taking individual responsibility loads positively on behaviour which could be interrupted as males have a psychology of taking charge and get influenced by social norms.
- Also, personal health concern is negatively correlated to intention to a level of 0.37, this means the odds of persuading a male to reduce plastic waste is very less with a marketing campaign on personal health.
- They have depicted a lack of alternative attitude negatively on behaviour, which kind of makes sense since generally males think since there is no alternative.

Goodness-of-Fit Indices

BIC	TLI	RMSEA
-1505.24	0.921	0.037

Using Age Criterion

Individuals less than age 40:



Chi-Square Testing	p-value
Behaviour & Intention are correlated	0.002999
Behaviour & Holding other people accountable are not correlated	0.05447
Behaviour & Lack of alternative attitude are not correlated	0.4678
Behaviour & Environment Concern are correlated	0.007496
Behaviour & Personal Health are correlated	0.007496
Behaviour & Knowledge of Sources are not correlated	0.1039

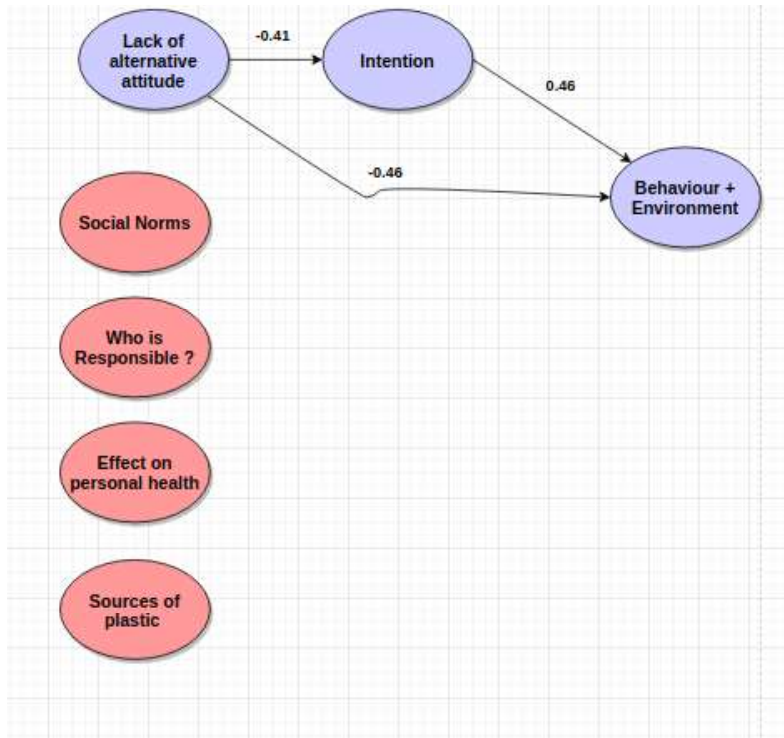
Interpretation

- We tried to show only the significant correlations in this plot, detailed plot is in the appendix.
- Interestingly for younger people, the only latent variable which leads to the behaviour was environmental concerns, these were from question 10C6 and 10C5 which were plastic can kill animals due to ingestion and plastic can destroy habitats.

Goodness-of-Fit Indices

BIC	TLI	RMSEA
9597.13	0.064	0.257

Individuals greater than 40 years of age:



Chi-Square Testing Hypothesis	p-value
Behaviour & Intention are correlated	0.002999
Behaviour & Social Norms are not correlated	0.05447
Behaviour & Responsibility are not correlated	0.4678
Behaviour & Lack of Alternative Attitude are correlated	0.007496
Behaviour & Personal Health are not correlated	0.007496
Behaviour & Knowledge of Sources are not correlated	0.1039

Interpretation

- We have only displayed the most significant correlations; the detailed model is attached in the appendix.
- For individuals of age group 40 and above intention is highly correlated to behaviour.
- But mostly they are having a lack of alternative attitude, and this is expected out of it.

Goodness-of-Fit Indices

BIC	TLI	RMSEA
1114.08	0.217	0.242

8. Suggestions

1. **Improve survey.** For a better Factor Analysis model, the survey questions need to improve the following:

- a. **More specific questions.** For example, Q3: “Do you know how many types of plastics?” This question is prone to misleading interpretations as it gives the participant too much trust to know specific types of plastics. This survey was intended for the general population, not for post-graduate chemistry students who would certainly know different compounds that would make different types of plastics. Additionally, the options are only 2,4,7, and No idea. The options do not leave room for if the participant only knows one type of plastic.

The same principle of giving too much trust to know what the participant knows what he/she is talking about repeats throughout the survey (i.e. Q4, Q6, Q8, Q9, etc.).

- b. **Improve grammar and avoid a lack of clarity.** Many of the questions are awkwardly and poorly worded. For example, Q10C2: “Plastics can affect my health because **microplastics might be existed** in cosmetics or domestic appliances” should be “Plastics can affect my health because **microplastics might exist** in cosmetics or domestic appliances.”

Also, in question Q12: “According to you, what is the difficulty in reducing plastics”, choice 5: “Very cheap and convenient” is a very general statement. This can be solved by making it a full sentence such as “Single-use plastic products are very cheap to obtain and convenient to use.”

As a final example, Education has the option “Schools.” It is unclear as to what that is supposed to mean. More options should be added to avoid a lack of clarity, such as Elementary School, Junior High School, High School, Undergraduate Degree, etc.

- c. **Target and design the survey for a specific audience.** The wording choice and concepts introduced in many of the survey questions are targeted to people that are proficient and literate in the English language. These types of wordings are not appropriate for the youngest of participants or even for some blue-collar workers as they might have a lesser education level than their white-collar colleagues. For example, words and concepts like “microplastic”, “aesthetics”, “economic values”, and “cosmetic and domestic appliances” are niche concepts that are understood only by those with higher education or literacy. The questions should talk naturally to the audience and should not interfere with their focus in providing an accurate answer to the survey questions.

- d. **Avoid binary questions.** Factor Analysis performs better when all its variables are continuous. Many of the questions in the survey had to be binary, or categorical (“can select multiple-choice” type-questions). A solution to this is to design the questions so that they might be on a Likert-scale or ask for quantitative answers (for example, “In the past 2 days, how many times did you refuse single-use plastic bags?”). In addition to the questions being relevant to the audience, these types of questions will increase the chance to create stronger correlations between items and therefore build better latent variables that capture a larger commonality.

9. Limitations

When considering the applicability of the model to the general population of Vietnam residents, one should keep in mind the following:

- **The gender ratio is highly unbalanced.** Currently, the ratio between Male and Female participants is 1:3. This creates a bias toward Female answers, and it is not proportionate with the actual Vietnamese population. As of 2020, Male and Female ratio in the population is close to being equally distributed in age and gender.¹³ Further research needs to be done to males to balance the proportion of gender ratios.
- **Response Bias.** In Questions regarding social norms and consumer intention, we should consider that participants might not give an honest response due to social pressure, or fear that they might be not “righteous” for not desiring to have sustainable environmental desires.
- **The survey does not take into consideration whether the participant lives in a rural or urban area.** Lifestyle can differ greatly and therefore different solutions might be needed. For example, a person living in the city might frequently and improperly dispose of single plastic food containers from restaurant take-out, but a person living in the country might burn all their garbage because of no proper waste collection or disposal systems. These challenges will need different approaches.

10. Conclusion

Even though our study did not generate a model with strongly correlated factors, many of the factor’s relationships were also found in several peer-reviewed studies: Impediments to plastic reduction does indeed have a negative effect with plastic reduction behaviour (Ellen, 1994); Social Norms do not directly influence reduction behaviour (Jackson & Olsen, 1993), and that the public does expect the government and businesses to take responsibility to reduce plastic waste (Dilkes-

¹³ "Vietnam — The World Factbook - Central Intelligence Agency". 2020. *Cia.Gov*.
<https://www.cia.gov/library/publications/the-world-factbook/geos/vm.html>.

Hoddman & Leela, 2019). Therefore, the model does have some degree of validity. On the other hand, we have learned that further research needs to be done to address the following points:

- Do our participants who currently practice plastic reduction behaviours do so because they are truly concerned for the environment or because there is a personal benefit which if it was not there, they would still be concerned for the environment but not practice plastic reduction behaviour?¹⁴ This can affect policymakers discern if they have an “egocentrism” challenge in their society, or if they need to inculcate environmental concern in their residents, and consequently, that concern will take care of the changing their present and future plastic reduction behaviours.
- If the model suggests that those that presently practicing plastic reduction behaviours are more likely to have the intention to keep doing so in the future, further research needs to be done to confirm that those who sincerely have the intention to reduce in the future, actually do so. In a study also measuring behaviour and intention of pro-environmental behaviours, a similar correlation coefficient was found in their behaviour-intention relationship (0.45); however, when it was verified if participants did act on their intention, the actual action rate was only 20% (Gifford & Andreas, 2014).¹⁵ This an important verification because this will determine if the factors of this model actually inference correctly the long-term behaviour of participants.
- The survey needs to expand on one of the most logical relationships of the model: impediments to reducing plastic and reduction behaviour. In Braganza’s 2017 study, he found that in Quezon City, Philippines, a common reason why people did not reduce their single-use plastic item consumption where simple reasons that were not included in the survey: laziness to use and forgetfulness to use reusable plastic items.¹⁶ If these findings are also applicable to residents in Vietnam, these can influence any future campaigns or policies to help the population change their plastic reduction behaviours, presently and in the long term.

These questions remain unanswered and further investigation is required.

¹⁴ Refer to Carmi’s 2013 study, “Caring about tomorrow: future orientation, environmental attitudes and behaviours”

¹⁵ Gifford, Robert, and Andreas Nilsson. "Personal and social factors that influence pro - environmental concern and behaviour: A review." *International Journal of Psychology* 49, no. 3 (2014): 141-157.

¹⁶ Braganza, Patricza Andrhea T. 2017. “Assessment of the Implementation of the Plastic Bag Reduction Ordinance in Quezon City (2012-2016).” *Philippine Journal of Public Administration* 61: 20-42.

11. Appendix:

11.1 Descriptive Analysis Tables:

Attitude Table:

Attitude and Perception		Likert scale: 4 (Very Concerned), 3 (Concerned a bit), 2 (Not concerned) and 1 (No idea)					
Latent Factor	Question	Min	Max	Mean	Standard Deviation	Findings	Commentary
Health Concern	10.1 Plastic can affect my health through ingestion	1	4	3.67	0.50	Very Concerned: 68% Concerned a bit: 31% Not concerned: 0.8% No idea: 0.2%	Residents of Vietnam are aware of and concerned about the dangers of plastic in their environment. Awareness of the dangers of plastic pollution is an important step to long-term sustainable change.
	10.2 Plastics can affect my health because microplastic might be existed in the air or due to plastic burning	1	4	3.70	0.50	Very Concerned: 72% Concerned a bit: 26% Not concerned: 2% No idea: 1%	
	10.3 Plastics can affect my health because microplastic can exist in cosmetics or domestic appliances	1	4	3.51	0.61	Very Concerned: 56% Concerned a bit: 38% Not concerned: 5% No idea: 1%	
	10.4 Plastics can affect my health because microplastic can exist in my clothes	1	4	3.26	0.75	Very Concerned: 43% Concerned a bit: 41% Not concerned: 14% No idea: 2%	
Environmental Concern	10.5 Plastics can kill animals due to ingestion or entanglement with plastic wastes	1	4	3.67	0.52	Very Concerned: 69% Concerned a bit: 29% Not concerned: 1% No idea: 1%	Vietnam residents show much concern regarding the negative impact plastic is having on their wildlife and local natural habitats.
	10.6 Plastics can damage the natural habitats of living creatures	1	4	3.74	0.44	Very Concerned: 74% Concerned a bit: 25% Not concerned: 1% No idea: NIL	
	10.7 Plastics can reduce the aesthetic and economic values of the environment	1	4	3.61	0.54	Very Concerned: 63% Concerned a bit: 34% Not concerned: 2% No idea: 1%	

Social Norms Table:

SOCIAL NORMS AFFECTING PLASTIC CHANGING INTENTION AND BEHAVIOURS			Likert Scale: 1 (Agree), 2 (Neutral), and 3 (Disagree)				
Latent Factor	Question	Min	Max	Mean	Standard Deviation	Findings	Commentary
	11.1 If my colleagues or friends reduce plastics, I might follow suit	1	3	2.96	0.21	Agree: 97% Neutral: 3% Disagree: 1%	Respondents showed a willingness to change if their social circles and influential organizations demonstrated a positive example and requirements regarding the plastic reduction.
	11.2 If my neighbourhoods use alternatives to plastics, I might follow suit	1	3	2.93	0.27	Agree: 93% Neutral: 6% Disagree: 1%	
	11.3 If my family members reduce single used plastics, I might follow suit	1	3	2.99 +	1.12	Agree: 98.5% Neutral: 1.5% Disagree: 0	
	11.4 If the shops which I visit, have alternatives to plastics, I will shift to use such alternatives	1	3	2.97	0.17	Agree: 97% Neutral: 3% Disagree: 0	
	11.5 If my workplace or schools set regulations on reducing plastics, I will follow the rule	1	3	2.98	0.14	Agree: 98% Neutral: 2% Disagree: 0	

Perceived Behaviour Control (PCB) Table:

PERCEIVED BEHAVIOUR CONTROL OVER PLASTIC BEHAVIOUR INTENTION AND BEHAVIOURAL CHANGE		Multiple-choice questions				
Latent Factor	Question	Median	Mean	Standard Deviation	Findings	Commentary
	12. According to you, what is the difficulty in reducing plastics? (can select multiple choices)					High mean suggests that most of the participants suggest that lack of alternative and very cheap and

	<input type="checkbox"/> Lack of knowledge or attitude on the impacts of plastic wastes (1) <input type="checkbox"/> Lack of alternatives (2) <input type="checkbox"/> The power of habit (3) <input type="checkbox"/> The popularity of using by the society (4) <input type="checkbox"/> Very cheap and convenient (5) <input type="checkbox"/> Don't know (6)	3 4 4 3 4 3	3.28 3.72 3.91 3.03 3.99 3.12	1.73 1.58 1.67 1.55 1.66 1.85	24.64% 9.7% 11.13% 19.66% 8.41% 26.42%	convenience are 2 things most of the people agree on.
	13. If you change in reducing plastic consumption and disposal, which are the main reasons for changing? <input type="checkbox"/> Regulations at my workplace/ schools (1) <input type="checkbox"/> My pro-environmental consciousness (2) <input type="checkbox"/> My health consciousness (3) <input type="checkbox"/> The popularity of using by people around me (4) <input type="checkbox"/> I have conditions to change (5) <input type="checkbox"/> Don't know (6)	1 1 1 0 0 0	0.52 0.86 0.90 0.25 0.47 0.01	0.50 0.35 0.30 0.43 0.50 0.08	51.54% 85.90% 90.04% 25.11% 46.94% 0.71%	90% of the participants believed health was their main reason to reduce plastic consumption. And 85% believed for environmental reasons.
	14. Do you support the ban of single used plastics/nylon bags?	3	2.73	0.52	Agree: 77% Neutral: 20% Disagree: 3%	77% of respondents were in support of single ban use of plastic.
	15. Do you think that the responsibility of the reduction of plastic wastes and nylon bags is belonged to? <input type="checkbox"/> The Government (1) <input type="checkbox"/> Functional agencies (2) <input type="checkbox"/> The service providers (supermarkets, convenient stalls, markets, vendors, etc) (3) <input type="checkbox"/> Manufacturers (4) <input type="checkbox"/> Individual consumer (5) <input type="checkbox"/> Don't know (6)	1 1 1 1 1 0	0.66 0.51 0.64 0.60 0.95 0.05	0.47 0.50 0.48 0.49 0.22 0.21	65.87% 51.42% 63.86% 60.18% 95.02% 4.73%	95% of the participants answered that it was an individual's responsibility to curb plastic waste, and 60% also believe that it's the Government's and service providers duty as well.

PLASTIC - RELATED BEHAVIOURS		Likert Scale: Frequently (4), Sometimes (3), Rarely (2) and No (1)					
Latent Factor	Question 17 How often you can limit the impact of plastic waste on the environment?	Min	Max	Mean	Standard Deviation	Findings	Commentary
	17.1 Refuse to use single-used plastics, nylon bags because of	1	3	3.13	0.71	Sometimes: 49.40% Frequently: 32.10%	High mean value and the low standard deviation is

	concerns about the plastic risk to health						observed. Hence a similar response between all candidates. This table shows the pre-existing behaviour of our participants towards plastic
	17.2 Refuse to use single-used plastics, nylon bags because of concerns about the plastic risk to the environment	1	3	3.11	0.74	Sometimes: 47.63% Frequently: 32.64%	
	17.3 Use life-long bags to avoid disposable plastic bags	1	3	3.26	0.79	Sometimes: 36.25% Frequently: 45.61%	
	17.4 Reducing the amount of plastic used	1	3	3.18	0.76	Sometimes: 45.14% Frequently: 37.44%	
	17.5 Encourage people around to minimize the discharge of plastic waste into the environment	1	3	2.90	0.93	Sometimes: 37.91% Frequently: 30.45%	

INTENTIONS TO CHANGE BEHAVIOURS		Likert Scale: From total disagreed (1) to total agreed (5); N/A: No idea				
Latent Factor	Question	Min	Max	Mean	Standard Deviation	Findings
	18 With the following band score, please indicate your level of agreement to the following statements					
	18.1 think I will reduce plastic wastes in the upcoming time	1	5	3.53	1.58	As we can see, the results show that people are ready to change behaviours but high standard deviation (greater > 1), suggest mixed emotions in the sample)
	18.2 will try to reuse plastic-related items	1	5	3.53	1.60	
	18.3 Use life-long bags to avoid disposable plastic bags	1	5	3.56	1.58	
	18.4 Reducing the amount of plastic used	1	5	3.64	1.67	

11.2 Running Factor Analysis & Evaluating Different Models

Factor Analysis is a statistical dimension reduction technique whereby one can deduct, through proper interpretation, unobserved variables hidden underneath the data. Dimension reduction techniques require the data to be correlated. To meet this requirement, only items that have a correlation greater than $|0.3|$ remain for further analysis. We then test the data before and after appropriateness for Factor Analysis. See Table 1.1 and 1.2.

Table 1.1

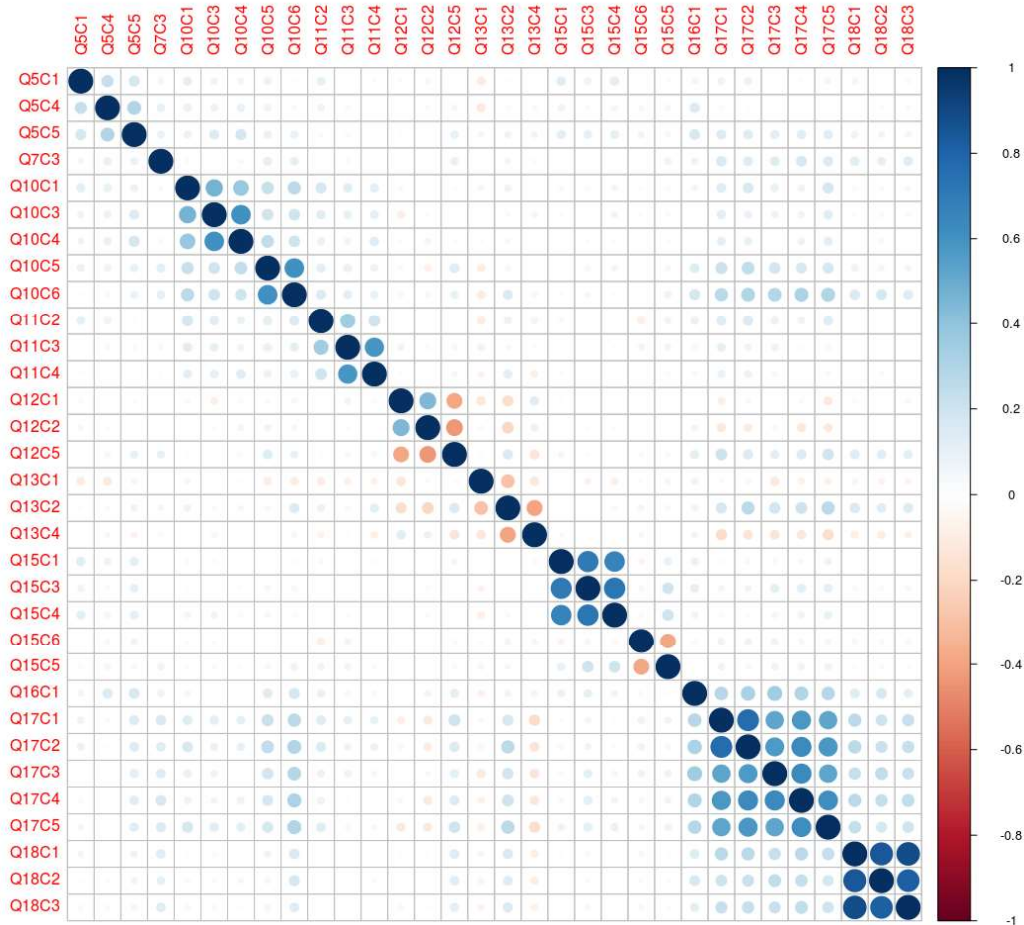


Table 1.2

Data's Appropriateness for Factor Analysis		
Raw Data	KMO coefficient: 0.5	Significance of Barlett's Test: 0.000
Correlated Data	KMO coefficient: 0.76	Significance of Barlett's Test: 0.000

Choosing a Factor Analysis model requires a balance between easiness of interpretation, favourable statistical metrics, and practicality in real life. Below are the factors that influenced the choice of a 7-factor model:

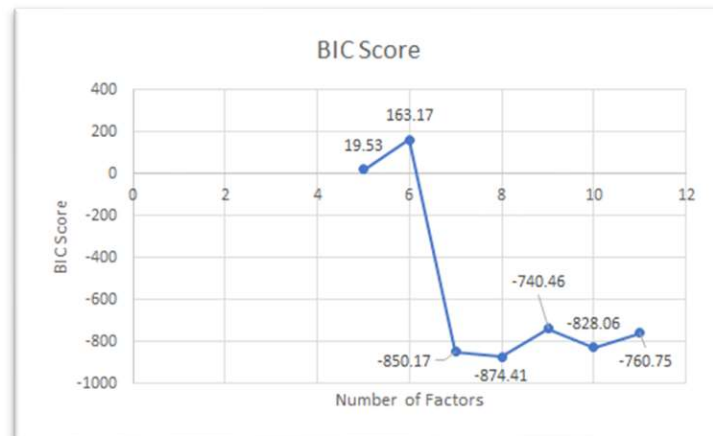
- I. Factors wanted to be tested out of our questions, in addition to the behaviour and intention factor:
 1. Q1: Concern for Health
 2. Q2: Personal accountability
 3. Q3: Concern of environmental damage
 4. Q4: Social influence
 5. Q5: Impediments

II. PCA Comparative Result

	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10	PC11	PC12
Standard deviation	2.2290	1.64392	1.5636	1.41732	1.34372	1.28862	1.19814	1.16417	1.08754	1.08184	1.01428	0.96532
Proportion of Variance	0.1553	0.08445	0.0764	0.06277	0.05642	0.05189	0.04486	0.04235	0.03696	0.03657	0.03215	0.02912
Cumulative Proportion	0.1553	0.23972	0.3161	0.37889	0.43532	0.48721	0.53207	0.57442	0.61138	0.64796	0.68010	0.70922
	PC13	PC14	PC15	PC16	PC17	PC18	PC19	PC20	PC21	PC22	PC23	
Standard deviation	0.95046	0.90254	0.85097	0.81964	0.78404	0.78206	0.76791	0.74090	0.7288	0.69033	0.62942	
Proportion of Variance	0.02823	0.02546	0.02263	0.02099	0.01921	0.01911	0.01843	0.01715	0.0166	0.01489	0.01238	
Cumulative Proportion	0.73746	0.76291	0.78554	0.80653	0.82574	0.84486	0.86329	0.88044	0.8970	0.91193	0.92431	
	PC24	PC25	PC26	PC27	PC28	PC29	PC30	PC31	PC32			
Standard deviation	0.61878	0.6119	0.58561	0.55456	0.53093	0.50186	0.45334	0.4156	0.3199			
Proportion of Variance	0.01197	0.0117	0.01072	0.00961	0.00881	0.00787	0.00642	0.0054	0.0032			
Cumulative Proportion	0.93627	0.9480	0.95869	0.96830	0.97711	0.98498	0.99140	0.9968	1.0000			

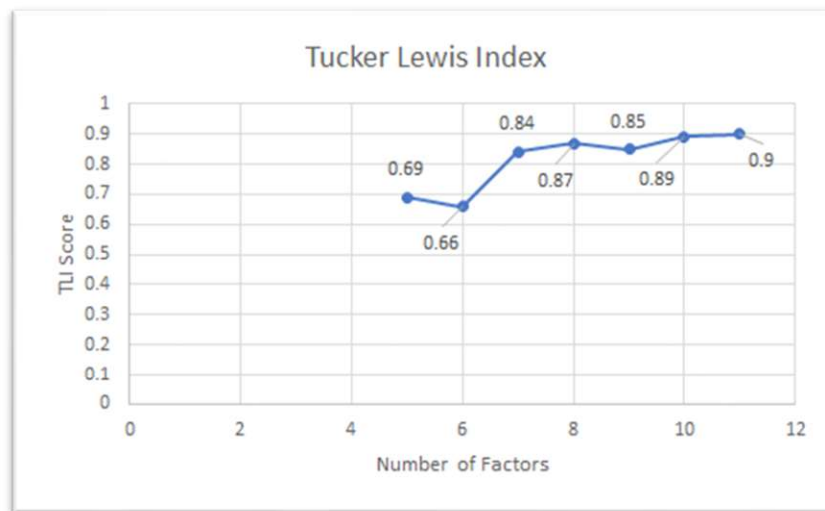
In PCA, one indicator of how many factors would make a good model is the number of principal components with standard deviations higher than 1. In terms of Factor Analysis, this PCA output can help indicate the optimal number of factors as well to be included in the FA model. Our PCA output showed that out of 32 Principal Components, the eleven first had a standard deviation higher than 1. Our team took this as an indication to stay under 11 factors.

III. Bayesian information criterion (BIC)



The Bayesian Information Criterion (BIC) score penalizes a model for added complexity¹⁷; therefore, the best model according to this score is the one with the lowest score. Several different models were tested using different factor numbers. As shown in the graph above, the lowest BIC score was at 8 factors; however, notice that the difference between the 7 and 8-factor model was only a difference of around 24 points. This is not a significant amount and since there needs to be a balance between, easiness of interpretation and favourable statistical metrics, the BIC score for the 7-factor model is considered “better value” as adding one more factor for 24 points is not worth the added interpretation complexity.

IV. Tucker Lewis Index of Factoring Reliability



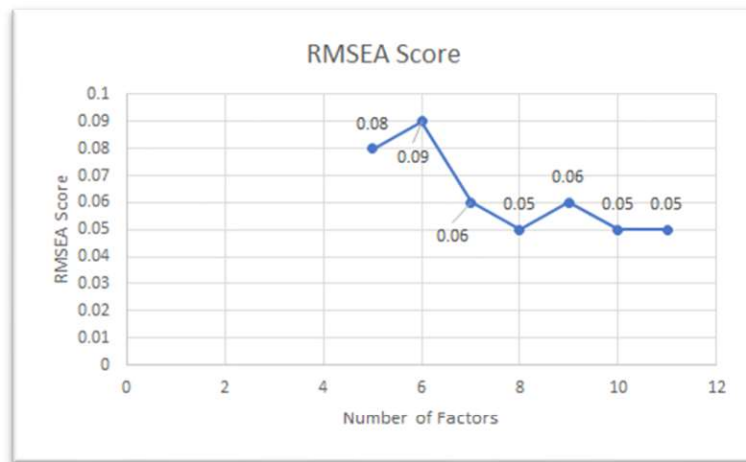
The Tucker Lewis Index (TLI) or Non-Normed Fit Index measures the goodness of fit of a model.¹⁸ It is recommended that a model be close to 0.9 or above. As shown in the graph above, the 11-factor model reached a TLI score of 0.9; however, the complexity of an 11-factor model is not practical in real life.¹⁹ We notice the biggest jump (0.18 difference) between 6 factors and 7 factors, therefore we take that leap as an indication that our 7-factor model is a good balance between the TLI and easiness of interpretation.

¹⁷ “Penalizing Likelihood with a BIC Score”, David Gifford, March 20, 2017, *Mit6874.Github.Io*. https://mit6874.github.io/assets/BIC_Scores.pdf.

¹⁸ Hooper, Daire & Coughlan, Joseph & Mullen, Michael. (2007). Structural Equation Modeling: Guidelines for Determining Model Fit. *The Electronic Journal of Business Research Methods*. 6.

¹⁹ See “Model Comparisons” Section

V. Root Mean Square Error of Approximation (RMSEA)



RMSEA is another measure to evaluate a model's goodness-of-fit. A fine score is between 0.05 and 0.08 while an excellent score is below 0.05.²⁰ Out of the models we tested, the 8,10, and 11-factor models have the lowest scores. The second-lowest scores are by the 7 and 9-factor model. According to the RMSEA scores, the best model would be the 8-factor model since it is the intersect between lowest score and lower number of factors; however, we have seen²¹ that the 8-factor model is not practical and is hard to interpret, therefore we go with the second option, the 7-factor model.

11.3 Summary of the Model

The 7 and 8-factor models have remarkably similar scores. Statistically, the 8-factor model slightly beats the 7-factor model. The 8-factor model has a BIC score of -874.41 and the 7-factor model has a score of -850.17. The BIC suggests that the better model has the lowest score, hence the 8-factor model. For the TLI score, good models should be close or ideally higher than 0.9. The 8-factor model receives a TLI score of 0.87, while the 7-factor model receives a score of 0.84. The Root Mean Square Error of Approximation Score (RMSEA) was 0.05 for the 8-factor model and 0.06 for the 7-factor model.

Choosing the best model means balancing between statistical metrics, reality, and easiness of interpretation. Therefore the 7-factor model is chosen. The slight difference in statistical score, do not justify adding another factor to our model.

²⁰ Hooper, Daire & Coughlan, Joseph & Mullen, Michael. (2007). Structural Equation Modeling: Guidelines for Determining Model Fit. The Electronic Journal of Business Research Methods. 6.

²¹ See "Model Comparisons" Section

11.4 Model Comparisons

Following is a comparison of the different models that tried to see their positive and negative aspects. Once the determination was set to build a 7-factor model, the minimum Chi-Square factoring method and Promax rotation were chosen as these gave us the most insightful interactions between factors and best statistical metrics.

6-Factor Model

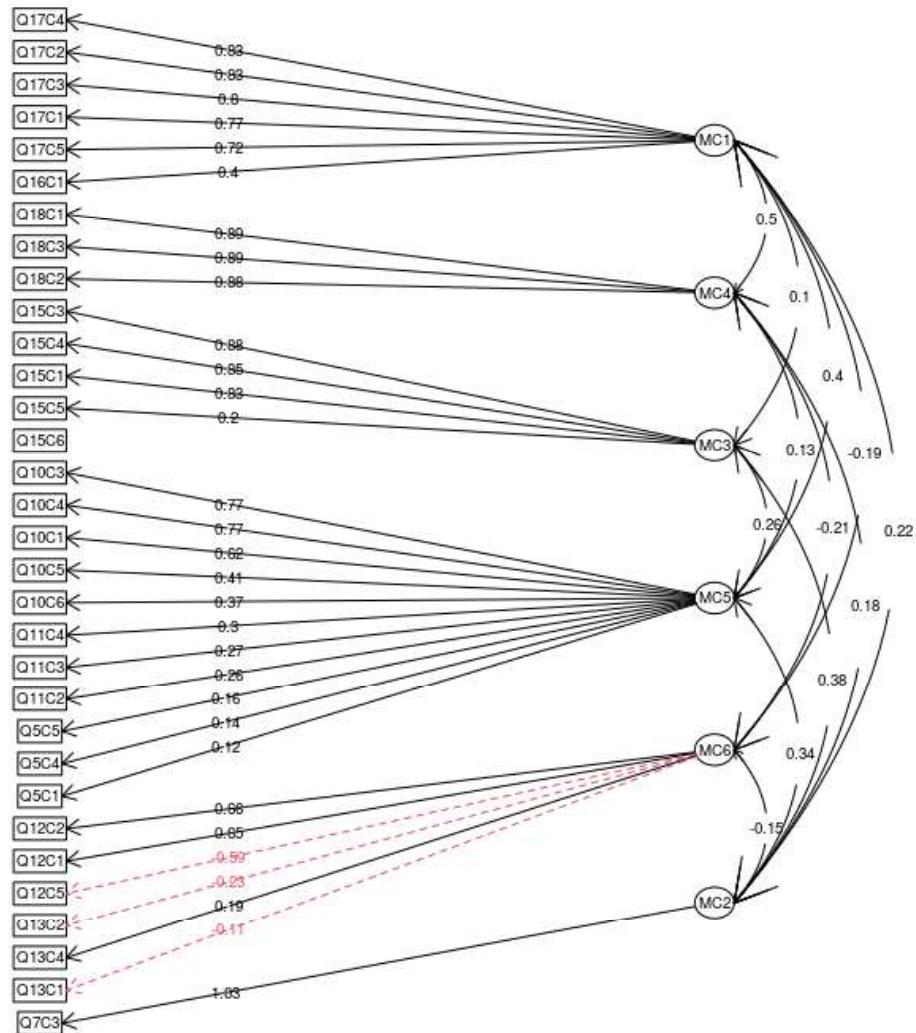
Item Q15C6 does not cling unto any factor even when the correlation cut-off score is set to a low score of 0.1.

The following factor MC5 incorporate the topics:

- Health & Environmental Concern (Q10)
- Social Norms (Q11)
- Knowledge about plastic pollution (Q5)

These combinations of topics are hard and not practical to interpret.

Factor MC2 is not very significant as only one item (regarding knowledge) clings unto it.



Tucker Lewis Index	0.661	The model is not above 0.9; the model has a weak TLI score.
RMSEA Index	0.086	The model is above 0.08; the model does not have a good fit.
BIC	163.17	The score is far above the -850 score given by the 7-factor model.
Cumulative Variance	0.37	Very low variance captured.

8-Factor Model

The following factor MC8 incorporate the topics:

- Perceived Behavioural Control (Q₁₃)
- Plastic Reduction Behaviour (Q₁₆ & Q₁₇)

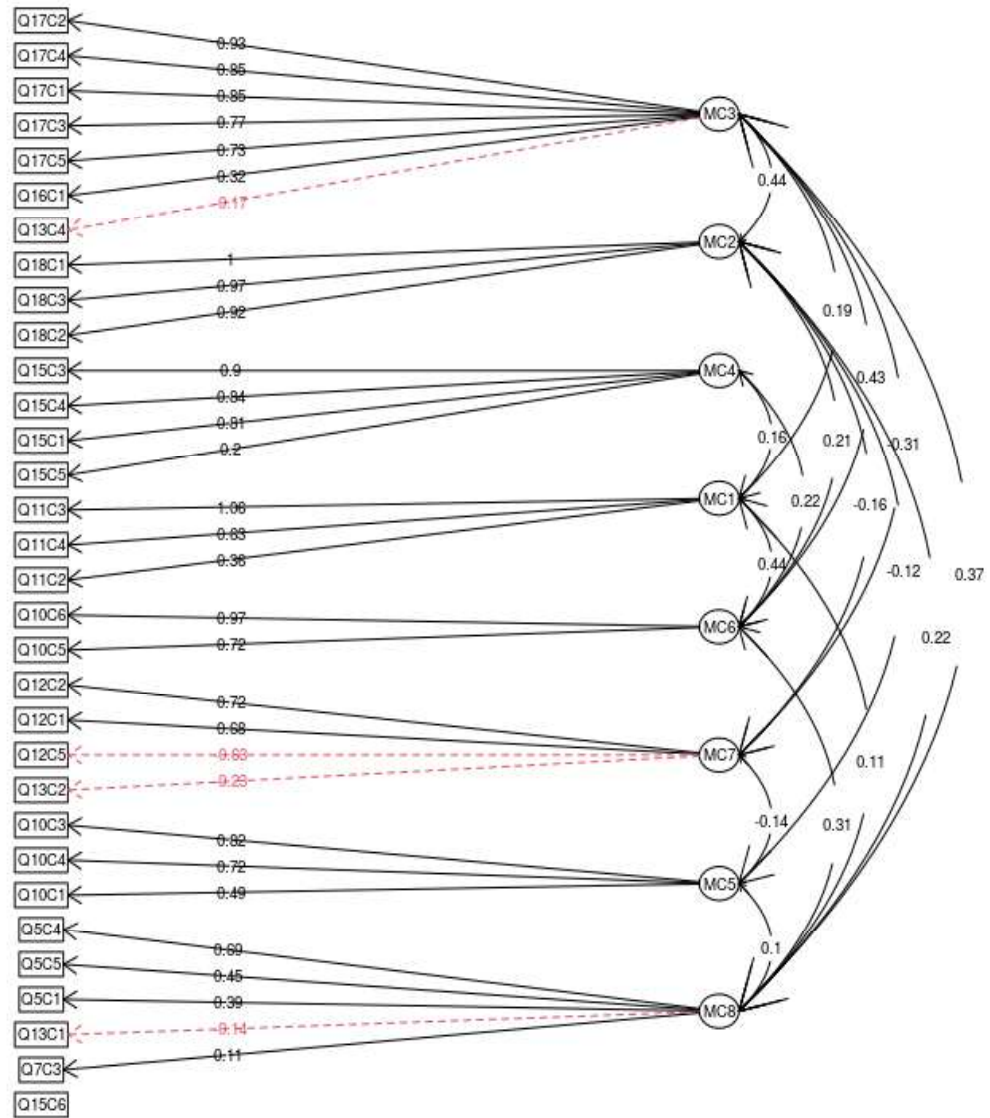
These combinations of topics are hard and not practical to interpret.

The following factor MC8 incorporate the topics:

- Perceived Behavioural Control (Q₁₃)
- Knowledge about plastic pollution (Q₅ & Q₇)

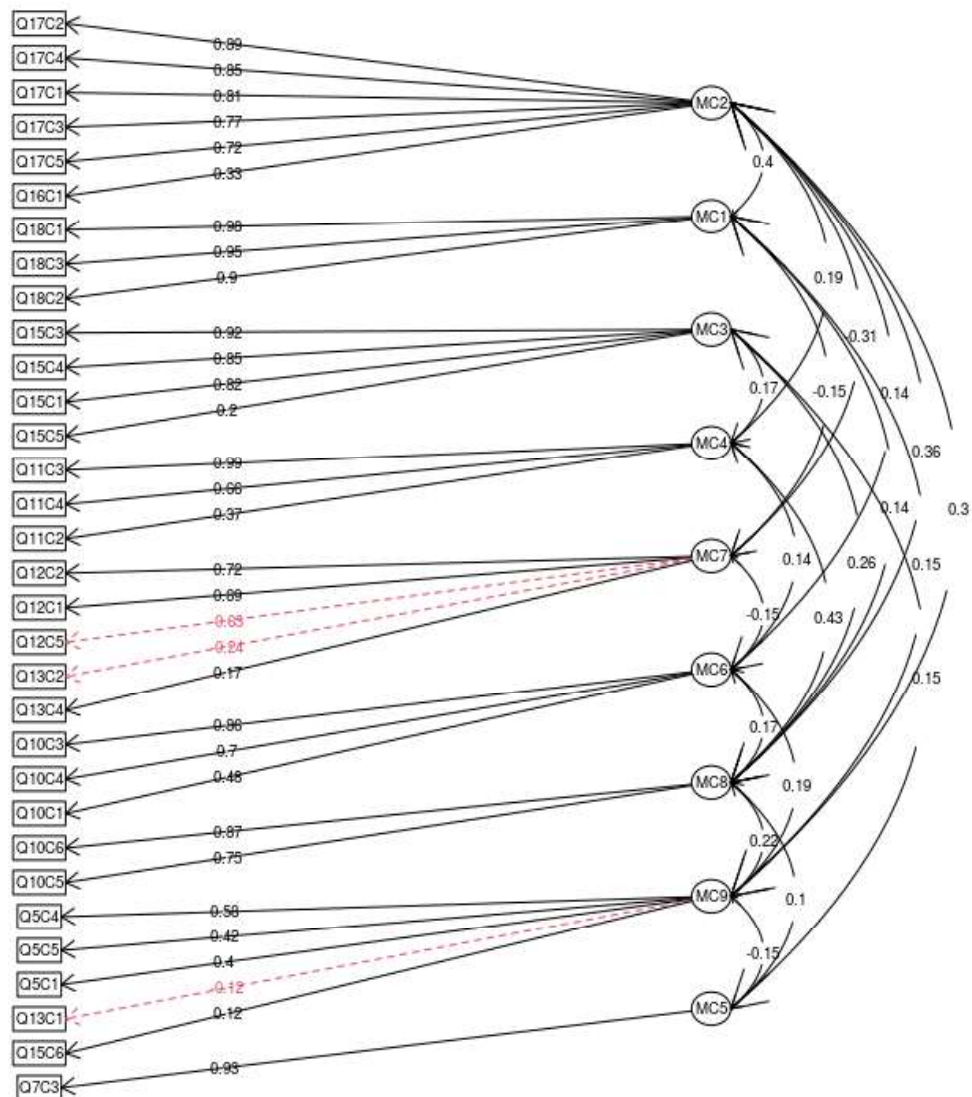
These combinations of topics are hard and not practical to interpret.

Item Q₁₅C₆ does not cling unto any factor even when the correlation cut-off score is set to a low score of 0.1.



Tucker Lewis Index	0.866	The model is close to 0.9 TLI score.
RMSEA Index	0.054	The model is close to 0.05; the model has a good fit.
BIC	-874	The score is only 24 points away from the -850 score given by the 7-factor model. This difference is not worth the addition of an additional latent variable.
Cumulative Variance	0.46	Low variance captured.

9-Factor Model



All the items nicely cling unto most of the 9 factors; however, the 9-factor model has many relationships and it is hard to interpret and impractical in real life.

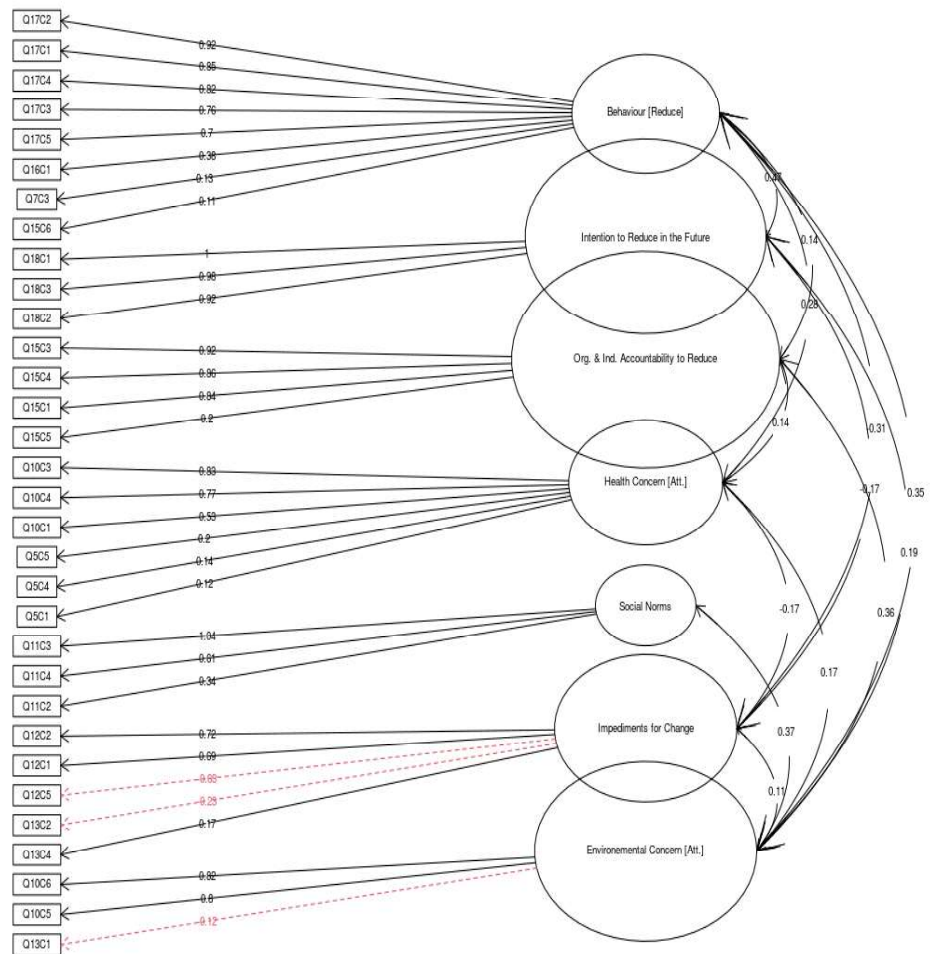
Item Q7C3 clings only to one factor. This is not ideal.

Tucker Lewis Index	0.853	The model is close to 0.9 TLI score.
RMSEA Index	0.057	The model is close to 0.05; the model has a good fit.
BIC	-740	BIC score has gone up significantly relative to the 7 and 8-factor models. This indicates an increase of complexity in the model.
Cumulative Variance	0.48	Low variance captured.

Note on 10+ Factor Models: After analyzing models with 10 factors or more, we conclude that the balance between easiness of interpretation and favourable statistical metrics are not close to reaching a balance. Therefore, for this report, it suffices to mention that a good statistical and practical balance is achieved between the 6 and 9-factor model. Next is our chosen model.

7-Factor Model: Our Chosen Model

All the items nicely cling to a factor; the factors are linked to a reasonable number of items; factors are the most interpretable and practical. These conditions are ideal for the chosen model.



Tucker Lewis Index	0.846	The model is close to 0.9 TLI score; this is a good score. An excellent score would be higher than 0.9.
RMSEA Index	0.058	The model is close to 0.05; the model is considered to have a good fit.
BIC	-850	BIC is only 24 points away from the lowest score (8-factor model: -870). The difference is not significant and shows that this is the best value model for balancing statistical metrics and easiness of interpretation is the 7-factor model.
Cumulative Variance	0.44	Low variance captured. An ideal model would capture at least 60% with 7 factors.

7 Factor Model – Original R Output

```

Factor Analysis using method = minchi
Call: fa(r = data, nfactors = 7, rotate = "promax", fm = "minchi")
Standardized loadings (pattern matrix) based upon correlation matrix

```

	item	MC3	MC2	MC4	MC5	MC1	MC6	MC7	h2	u2	com
Q17C2	26	0.92							0.736	0.2635	1.0
Q17C1	25	0.85							0.657	0.3426	1.0
Q17C4	28	0.82							0.606	0.3943	1.0
Q17C3	27	0.76							0.512	0.4878	1.1
Q17C5	29	0.70							0.511	0.4889	1.0
Q16C1	24	0.38							0.162	0.8382	1.2
Q7C3	4								0.048	0.9516	2.7
Q15C6	22								0.023	0.9765	3.3
Q18C1	30		1.00						0.922	0.0780	1.0
Q18C3	32		0.98						0.858	0.1418	1.0
Q18C2	31		0.92						0.784	0.2160	1.0
Q15C3	20			0.92					0.779	0.2212	1.0
Q15C4	21			0.86					0.685	0.3154	1.1
Q15C1	19			0.84					0.643	0.3569	1.1
Q15C5	23								0.059	0.9411	1.6
Q10C3	6				0.83				0.648	0.3524	1.1
Q10C4	7				0.77				0.559	0.4413	1.2
Q10C1	5				0.53				0.327	0.6733	1.3
Q5C5	3								0.082	0.9184	2.1
Q5C4	2								0.028	0.9721	1.7
Q5C1	1								0.035	0.9654	2.2
Q11C3	11					1.04			0.992	0.0085	1.0
Q11C4	12					0.61			0.350	0.6504	1.1
Q11C2	10					0.34			0.151	0.8490	1.4
Q12C2	14						0.72		0.474	0.5260	1.1
Q12C1	13						0.69		0.435	0.5655	1.1
Q12C5	15						-0.63		0.393	0.6067	1.1
Q13C2	17						-0.23		0.144	0.8557	2.3
Q13C4	18								0.078	0.9216	2.3
Q10C6	9							0.82	0.643	0.3567	1.2
Q10C5	8							0.80	0.570	0.4303	1.3
Q13C1	16								0.041	0.9592	3.0

	MC3	MC2	MC4	MC5	MC1	MC6	MC7
SS loadings	3.33	2.60	2.21	1.68	1.55	1.42	1.14
Proportion Var	0.10	0.08	0.07	0.05	0.05	0.04	0.04
Cumulative Var	0.10	0.19	0.25	0.31	0.36	0.40	0.44
Proportion Explained	0.24	0.19	0.16	0.12	0.11	0.10	0.08
Cumulative Proportion	0.24	0.43	0.58	0.70	0.82	0.92	1.00

With factor correlations of

	MC3	MC2	MC4	MC5	MC1	MC6	MC7
MC3	1.00	0.47	0.14	0.28	0.10	-0.31	0.35
MC2	0.47	1.00	0.05	0.03	-0.02	-0.17	0.19
MC4	0.14	0.05	1.00	0.14	0.09	0.06	0.36
MC5	0.28	0.03	0.14	1.00	-0.01	-0.17	0.17
MC1	0.10	-0.02	0.09	-0.01	1.00	0.09	0.37
MC6	-0.31	-0.17	0.06	-0.17	0.09	1.00	0.11
MC7	0.35	0.19	0.36	0.17	0.37	0.11	1.00

Mean item complexity = 1.5
Test of the hypothesis that 7 factors are sufficient.

The degrees of freedom for the null model are 496 and the objective function was 11.65 with Chi Square of 9689.13
The degrees of freedom for the model are 293 and the objective function was 1.36

The root mean square of the residuals (RMSR) is 0.04
The df corrected root mean square of the residuals is 0.05

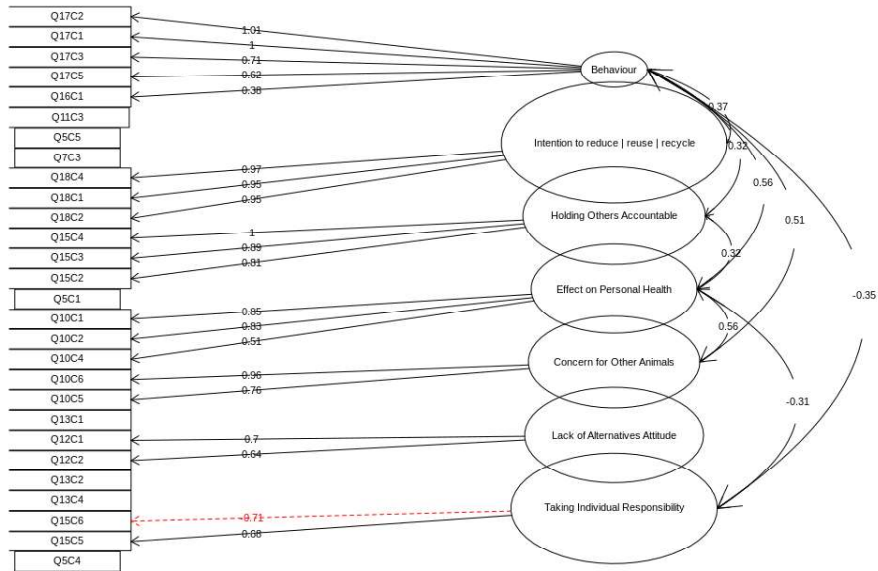
The harmonic number of observations is 844 with the empirical chi square 1231.36 with prob < 3.9e-115
The total number of observations was 844 with Likelihood Chi Square = 1124.11 with prob < 1.4e-97

Tucker Lewis Index of factoring reliability = 0.846
RMSEA index = 0.058 and the 90 % confidence intervals are 0.054 0.062
BIC = -850.17
Fit based upon off diagonal values = 0.95
Measures of factor score adequacy

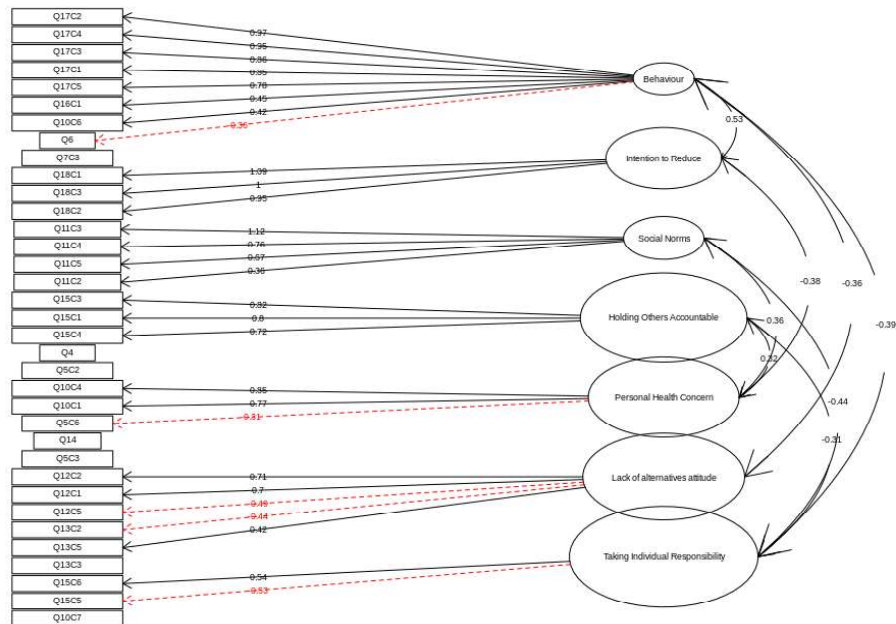
	MC3	MC2	MC4	MC5	MC1	MC6	MC7
Correlation of (regression) scores with factors	0.95	0.98	0.94	0.89	0.99	0.85	0.87
Multiple R square of scores with factors	0.91	0.96	0.88	0.80	0.99	0.72	0.76
Minimum correlation of possible factor scores	0.81	0.92	0.76	0.60	0.98	0.44	0.52

11.5 Demographic Analysis

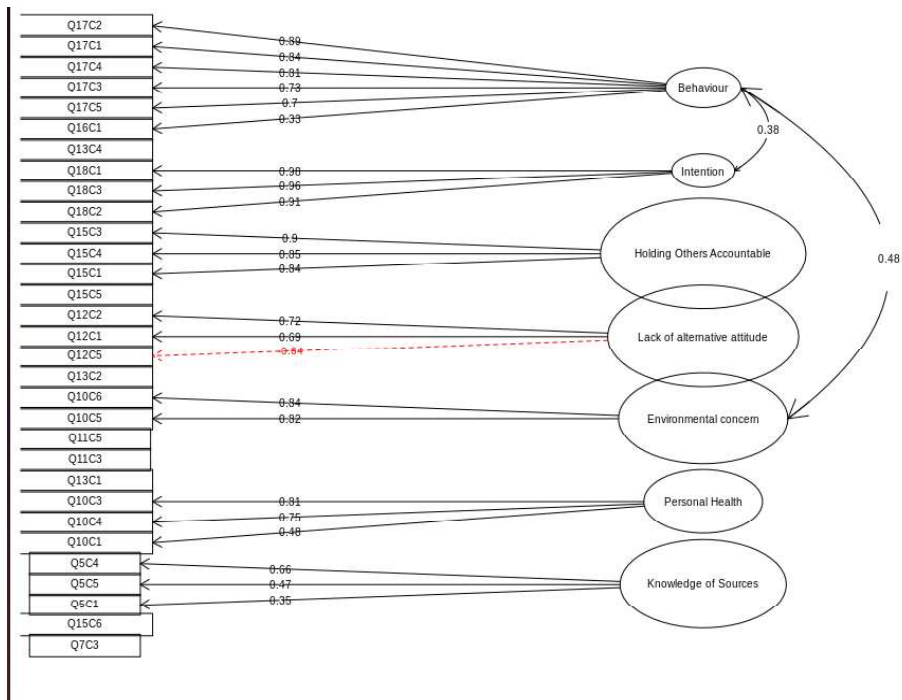
Females



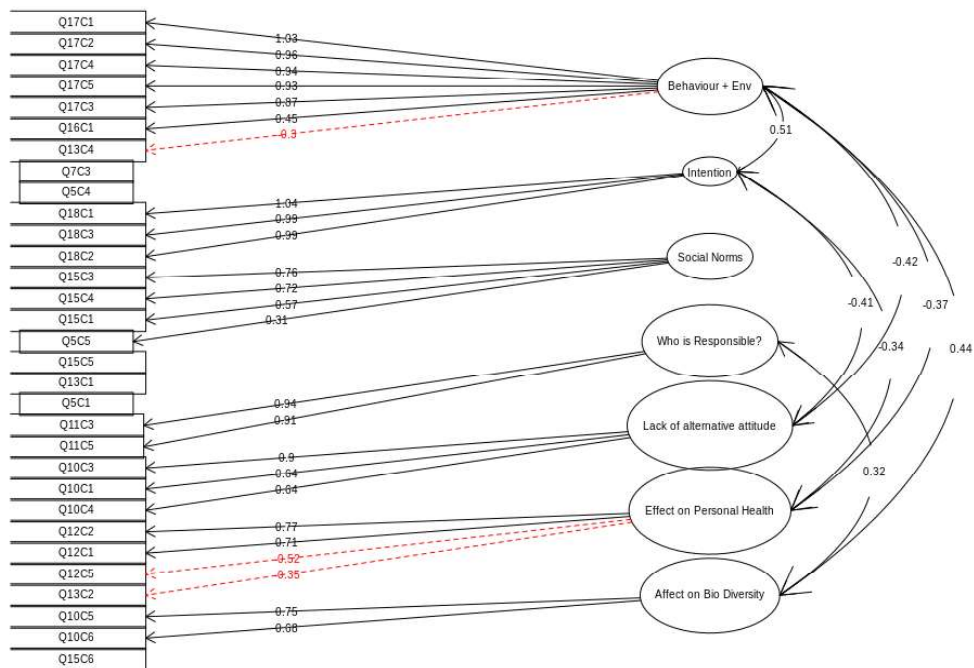
Males



Individual with age less than 40

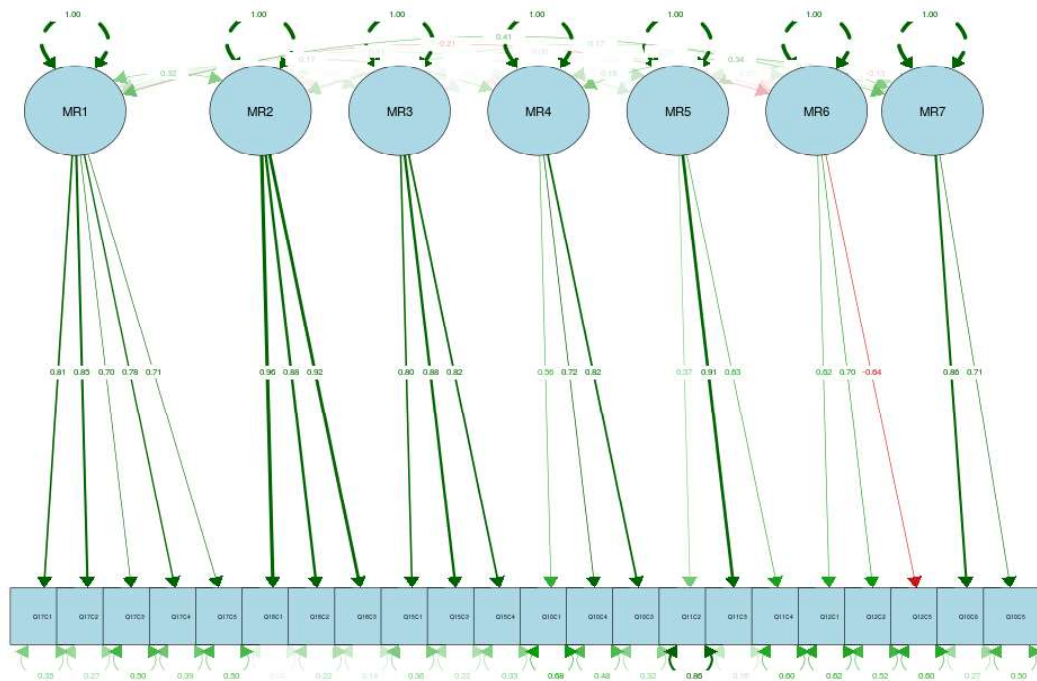


Individual with age greater than 40



11.6 CFA (Confirmatory Factor Analysis)

CFA is a technique used to verify the factor structure of a set of observed variables (Suhr, Diana, 2006). CFA allows the researcher to test the hypothesis that the relationship between the observed variables and their underlying latent variables exist.



User Model versus Baseline Model:

Comparative Fit Index (CFI)	0.964
Tucker-Lewis Index (TLI)	0.955

Root Mean Square Error of Approximation:

RMSEA	0.043
90 Percent confidence interval - lower	0.039
90 Percent confidence interval - upper	0.048
P-value RMSEA <= 0.05	0.989

Latent Variables:

	Estimate	Std. Error	z-value	P(> z)	Std.lv	Std.all
MR1 =~						
Q17C1	0.577	0.021	27.038	0.000	0.577	0.808
Q17C2	0.636	0.022	29.407	0.000	0.636	0.854
Q17C3	0.557	0.025	22.304	0.000	0.557	0.705
Q17C4	0.590	0.023	25.570	0.000	0.590	0.780
Q17C5	0.658	0.029	22.440	0.000	0.658	0.707
MR2 =~						
Q18C1	1.517	0.041	37.389	0.000	1.517	0.961
Q18C2	1.415	0.044	32.413	0.000	1.415	0.883
Q18C3	1.461	0.042	34.970	0.000	1.461	0.925
MR3 =~						
Q15C1	0.381	0.014	26.588	0.000	0.381	0.803
Q15C3	0.423	0.014	30.128	0.000	0.423	0.881
Q15C4	0.402	0.015	27.393	0.000	0.402	0.821
MR4 =~						
Q10C1	0.281	0.018	15.580	0.000	0.281	0.563
Q10C4	0.539	0.027	20.315	0.000	0.539	0.719
Q10C3	0.499	0.022	22.902	0.000	0.499	0.824
MR5 =~						
Q11C2	0.099	0.010	9.888	0.000	0.099	0.373
Q11C3	0.108	0.006	17.589	0.000	0.108	0.915
Q11C4	0.105	0.007	14.712	0.000	0.105	0.634
MR6 =~						
Q12C1	1.073	0.068	15.700	0.000	1.073	0.620
Q12C2	1.100	0.065	17.040	0.000	1.100	0.695
Q12C5	-1.056	0.068	-15.642	0.000	-1.056	-0.635
MR7 =~						
Q10C6	0.381	0.020	19.520	0.000	0.381	0.857
Q10C5	0.368	0.021	17.168	0.000	0.368	0.705

All of these variables are significant. P-value is less than 0.05, also the CFI and TLI index values were greater than 0.95.

11.7 Questionnaire regarding the survey

A. DEMOGRAPHIC INFORMATION

Education <input type="checkbox"/> Schools (1) <input type="checkbox"/> Graduate (2) <input type="checkbox"/> Post-graduate (3)	Occupation <input type="checkbox"/> Student (1) <input type="checkbox"/> White collar workers (2) <input type="checkbox"/> Blue collar workers (3) <input type="checkbox"/> Other (4)	Monthly average income.....
Gender <input type="checkbox"/> Male (1) <input type="checkbox"/> Female (2)		Age:.....

A. KNOWLEGDE

Q1. Do you know which is conventional plastic made from?	<input type="checkbox"/> Rubber (1) <input type="checkbox"/> Fossil fuel (2) <input type="checkbox"/> Paper (3) <input type="checkbox"/> Food (4) <input type="checkbox"/> No idea (5)
Q2. Do you know which is single used plastic item in the following stuffs?	<input type="checkbox"/> Plastic Straw (1) <input type="checkbox"/> Water supply tube (2) <input type="checkbox"/> Kid toys (hard plastic) (3) <input type="checkbox"/> No idea (4)
Q3. Do you know how many types of plastics?	<input type="checkbox"/> 2 <input type="checkbox"/> 4 <input type="checkbox"/> 7 <input type="checkbox"/> No idea
Q4. Do you know any of plastic wastes' impacts over human health?	<input type="checkbox"/> I know. <input type="checkbox"/> I don't know
Q5. Where do you think sources of plastics impacting health may come from? (can select multiple choice)	<input type="checkbox"/> In drinking water (1) <input type="checkbox"/> In food (2) <input type="checkbox"/> In the air (3) <input type="checkbox"/> In soil (4) <input type="checkbox"/> In cloths (5) <input type="checkbox"/> In domestic stuffs, cosmetics (6) <input type="checkbox"/> Sea salt (7) <input type="checkbox"/> No idea (8)
Q6. Do you know plastic wastes' impacts over the environment?	<input type="checkbox"/> I know (1) <input type="checkbox"/> I don't know (2)
Q7. Do you know what happen with the most of the plastics after you dispose plastic waste?	<input type="checkbox"/> Recycled (1) <input type="checkbox"/> Dumped at landfill site (2) <input type="checkbox"/> Litter to the environment (3) <input type="checkbox"/> No idea (4)
Q8. Where is the position of Vietnam in the list of countries disposing plastic wastes to the marine?	<input type="checkbox"/> Top 5 <input type="checkbox"/> Top 10 <input type="checkbox"/> Top 50 <input type="checkbox"/> No idea
Q9. Do you know any regulations on plastics reduction at your community/ workplace/school?	<input type="checkbox"/> Yes <input type="checkbox"/> No

B. ATTITUDE AND PERCEPTION

Q10. How do you concern in these situations?	Very Concerned	Concerned a bit	Not concerned	No idea
1. <i>Plastics can affect my health through ingestion</i>	1	2	3	4
2. <i>Plastics can affect my health because microplastic might be existed in the air or due to plastic burning</i>	1	2	3	4
3. <i>Plastics can affect my health because microplastic can be existed in cosmetics or domestic appliances</i>	1	2	3	4
4. <i>Plastics can affect my health because microplastic can be existed in my clothes</i>	1	2	3	4
5. <i>Plastics can kill animals due to ingestion or entanglement with plastic wastes</i>	1	2	3	4
6. <i>Plastics can damage the natural habitats of living creatures</i>	1	2	3	4
7. <i>Plastics can reduce the aesthetic and economic values of the environment</i>	1	2	3	4

C. SOCIAL NORMS AFFECTING PLASTIC CHANGING INTENTION AND BEHAVIORS

Q11. Do you agree or disagree with the following statements	Agree	Neural	Disagree
1. <i>If my colleagues or friends reduce plastics, I might follow suite</i>	1	2	3
2. <i>If my neighbourhoods use alternatives to plastics, I might follow suite</i>	1	2	3
3. <i>If my family members reduce single used plastics, I might follow suite</i>	1	2	3
4. <i>If the shops which I visit to, have alternatives to plastics, I will shift to use such alternatives</i>	1	2	3
5. <i>If my workplace or schools set regulations on reducing plastics, I will follow the rule</i>	1	2	3

D. PERCEIVED BEHAVIOR CONTROL OVER PLASTIC BEHAVIOR INTENTION AND BEHAVIORAL CHANGE

Q12. <i>According to you, what is the difficulty in reducing plastics? (can select multiple choices)</i>	<input type="checkbox"/> Lack of knowledge or attitude on impacts of plastic wastes (1) <input type="checkbox"/> Lack of alternatives (2) <input type="checkbox"/> The power of habit (3) <input type="checkbox"/> The popularity of using by the society (4) <input type="checkbox"/> Very cheap and convenient (5) <input type="checkbox"/> Don't know (6)
Q13. <i>If you change in reducing plastic consumption and disposal, which are the main reasons for changing? (select the most 3 appropriate choices)</i>	<input type="checkbox"/> Regulations at my workplace/ schools (1) <input type="checkbox"/> My pro-environmental consciousness (2) <input type="checkbox"/> My health consciousness (3) <input type="checkbox"/> The popularity of using by people around me (4)

	<input type="checkbox"/> I have conditions to change (5) <input type="checkbox"/> Don't know (6)
Q14. Do you support for the ban of single used plastics/nylon bags?	<input type="checkbox"/> Supportive (1) <input type="checkbox"/> Neutral (2) <input type="checkbox"/> Not supportive (3)
Q15. Do you think that the responsibility of reduction of plastic wastes and nylon bags is belonged to? (can select multiple choices)	<input type="checkbox"/> The Government (1) <input type="checkbox"/> Functional agencies (Environmental companies) (2) <input type="checkbox"/> The service providers (supermarkets, convenient stalls, markets, vendors, etc) (3) <input type="checkbox"/> Manufacturers (4) <input type="checkbox"/> Individual consumer (5) <input type="checkbox"/> Don't know (6)

E. PLASTIC - RELATED BEHAVIORS

Q16. Typically, how do you deal with plastic related items (bags, containers, etc)? (can select multiple choices)	<input type="checkbox"/> Reuse for shopping (1) <input type="checkbox"/> Reuse for storing wastes (2) <input type="checkbox"/> Store it for other purposes (3) <input type="checkbox"/> Dispose it (4) <input type="checkbox"/> Burn it (5)			
Q17. How often you can limit the impact of plastic waste on the environment	Frequently	Sometimes	Rarely	No
1. Refuse to use single-used plastics, nylon bags because of concerns about plastic risk to health	1	2	3	4
2. Refuse to use single-used plastics, nylon bags because of concerns about plastic risk to environment	1	2	3	4
3. Use life-long bags to avoid disposable plastic bags	1	2	3	4
4. Reducing the amount of plastic used (eg, collecting for selling for recycling plastic products)	1	2	3	4
5. Encourage people around to minimize the discharge of plastic waste into the environment	1	2	3	4

F. INTENTIONS TO CHANGE BEHAVIORS

Q18. With the following bandscore, please indicate your level of agreement to the following statements (From total disagreed (1) to total agreed (5); N/A: No idea)						
1. I think I will reduce plastic wastes in the upcoming time	N/A	1	2	3	4	5
2. I will try to reuse plastic-related items	N/A	1	2	3	4	5
3. I will try to reduce single-used plastics (bags, containers, straws, etc)	N/A	1	2	3	4	5
4. I will opt for environmental friendly packaging materials	N/A	1	2	3	4	5
5. If possible, I will buy tumbler or any kind of reusable things instead of plastics when going out?	N/A	1	2	3	4	5