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Attitude Exploration Using Factor Analysis Technique

MONIKA RAGHUVANSHI

Abstract

Attitude is a psychological variable that contains positive or negative evaluation about people or an environment. The growing generation possesses learning skills, so if positive attitude is inculcated at the right age, it might therefore become habitual. Students in the age group 14-20 years from the city of Bikaner, India, are the target population for this study. An inventory of 30 Likert-type scale statements was prepared in order to measure attitude towards the environment and matters related to conservation. The primary data is collected through a structured questionnaire, using cluster sampling technique and analyzed using the IBM SPSS 23 statistical tool. Factor analysis is used to reduce 30 variables to a smaller number of more identifiable groups of variables. Results show that students “need more regulation and voluntary participation to protect the environment”, “need conservation of water and electricity”, “are concerned for undue wastage of water”, “need visible actions to protect the environment”, “need strengthening of the public transport system”, “are a little bit ignorant about the consequences of global warming”, “want prevention of water pollution by industries”, “need changing of personal habits to protect the environment”, and “don’t have firsthand experience of global warming”. Analysis revealed that nine factors obtained could explain about 58.5% variance in the attitude of secondary school students towards the environment in the city of Bikaner, India. The remaining 39.6% variance is attributed to other elements not explained by this analysis. A global campaign for improvement in attitude about environmental issues and its utility in daily lives may boost positive youth attitudes, potentially impacting worldwide. A cross-disciplinary approach may be developed by teaching along with other related disciplines such as science, economics, and social studies etc.

Keywords: attitude, environment, youths, factor analysis technique.



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Introduction

Attitude is a psychometric analysis of an individual. Attitude is a psychological variable that contains positive or negative evaluation about people or an environment. Attitude is when a judgmental decision is taken by an individual's mind based on divine truth of their own perception. It may be cultivated from birth or from their upbringing, having taken on its own shape according to the individual's psyche. Attitude prepares the building blocks for initiative pillars of any foundation. Attitude gives a dampening or accelerating factor; proven at opposite ends of measurement scales with a burning spirit inside initiating anything or killing off any effort.

The growing generation possesses learning skills, so if positive attitude is inculcated at the right age, it might become habitual. If small changes are adopted with a little care for nature, either individually or collectively, sustainable growth can be achieved for future generation's survival.

The city of Bikaner, India, is situated on the fringes of the desert, making the environment a vital local issue for its residents. It also acts as a guide for future studies to check anomalies in the daily routines and practices that may have a minor impact on the individual, but noticeable impact on a broader scale for the sake of our future survival.

Wright and Klyn (1998) investigated the correlation between 'green' attitudes and 'green' consumption behaviors in 21 different countries, using data from the International Social Survey Program. They reported poor attitude-behavior correlations. The correlations varied considerably between countries, and were not significant at all in some countries.

Kaiser, Sybille, and Fuhrer (1999) studied environmental attitude as a powerful predictor of ecological behavior. They used a unified concept of attitude and a probabilistic measurement approach to overcome these shortcomings;

- Lack of a unified concept of attitude,
- Lack of measureable correspondence between general attitude and behavior,
- Lack of consideration of behavior constraints beyond people's control.

This study confirmed three measures as orthogonal dimensions by means of factor analysis;

- Environmental knowledge,
- Environmental values,
- Ecological behavior intention.

A structural equation model was used to confirm the proposed model: Environmental knowledge and environmental values explained 40% of the variance of ecological behavior intention which, in turn, predicted 75% of the variance of general ecological behavior.

Flamm (2006) analyzed the relations between environmental knowledge, environmental attitudes, and vehicle ownership/use. Hypotheses were tested concerning the bi-directional effects of environmental knowledge and environmental attitudes on each other and on the number of household vehicles, the fuel efficiency of household vehicles, estimated annual household mileage, and estimated annual household fuel consumption. These findings suggested that public education and social marketing campaigns focusing on the majority of Americans with pro-environmental attitudes, combined with policies to reduce barriers to

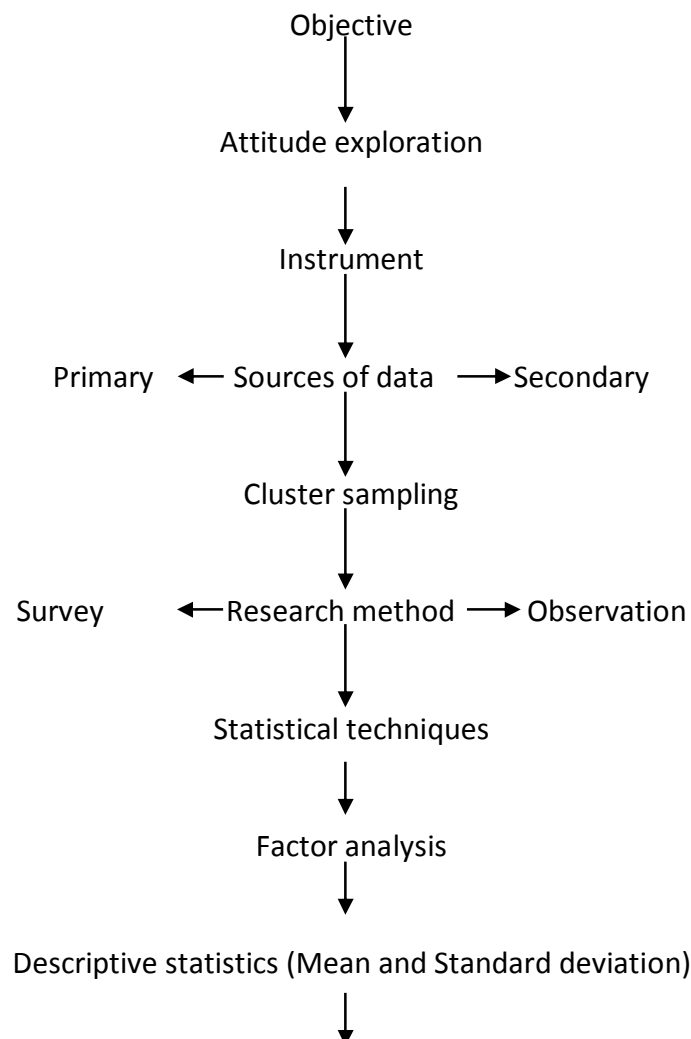
less resource-intensive vehicle ownership and use, could encourage greater demand for more fuel efficient vehicles and lower levels of vehicle ownership and miles driven. They also highlighted the research importance of effective survey design, appropriate measurement of latent variables, and the inclusion of knowledge and attitudinal variables in some travel and environmental behavior studies.

Eilam and Trop (2012) presented a compilation of results obtained from two studies that shed light on the relationship between influences on environmental attitudes and influences on environmental behavior. The results suggest that:

- Among adults, the strategies required for influencing attitudes are different from those required for influencing behaviors;
- The mechanisms for achieving influence among children are different from those among adults;
- Conventional educational approaches, such as behavior modification, can influence behavior more easily than they can influence attitudes.

The results provide grounds for questioning the prevailing belief that individual acquisition of responsible environmental behavior can drive changes on the global political scale.

Methodology



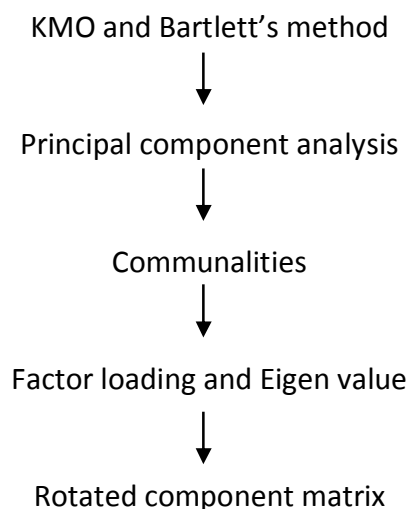


Figure 1. Overview of research methodology

- *Geographical area:* City of Bikaner, Rajasthan, India.
- *Target population:* Students aged 14 to 20 years. Targeted as deemed sufficiently mature to understand their responsibility towards the environment and they are the future dominant players in society.
- *Instrument:* An inventory of 30-point, Likert-type scale statements prepared to measure attitudes towards the environment and conservation related matters.
- *Data:* Primary data collected through a structured questionnaire. Secondary data collected from research papers of published journals.
- *Sampling:* Cluster sampling technique.
- *Statistical tool:* IBM SPSS 23
- *Statistical techniques:* Factor analysis refers to a variety of statistical techniques whose common objective is to represent a set of variables in terms of a smaller number of hypothetical variables (Stone, Lewis & Beck, 1994).

Findings

In this study, the objective of factor analysis is to reduce 30 variables to a smaller, more manageable number of more identifiable groups of variables. An inventory of 30 Likert-type scale statements was prepared in order to measure the attitude of school students towards the environment and conservation related matters. The respondents were asked to indicate their level of agreement or disagreement with each statement. The statements covered all major aspects pertaining to the environment such as air and water pollution, saving electricity, hydrocarbon fuel and water, tree plantation, plastic bags, green products etc.

Table 1 presents basic statistics such as mean and standard deviation of the measured responses for each statement.

Table 1. Descriptive statistics (Attitude)

#	Description	Mean	Standard deviation	Analysis N
1	Water wasted in washing	3.50	.746	518
2	Brushing teeth	3.64	.667	518
3	Taps turned off in public places	3.58	.682	518
4	Watering lawns	2.88	.866	518
5	Leaking flush valves	3.20	.788	518
6	Use of showers	2.48	1.073	518
7	Tap water filtered	3.51	.719	518
8	Old pipes	3.36	.748	518
9	Sewage treatment plants	3.39	.817	518
10	Rainwater harvesting	3.36	.778	518
11	Depleting water table	3.17	.787	518
12	Monitor use of pesticides	3.36	.732	518
13	Releasing untreated effluents	3.07	.974	518
14	LED streetlights	3.39	.791	518
15	Household LED lights	3.35	.789	518
16	Switch off when not in use	3.55	.772	518
17	Power ratings made mandatory	3.23	.780	518
18	Remove old vehicles	3.00	.935	518
19	Good public transport system	2.96	.875	518
20	More pollution checkpoints	3.44	.744	518
21	Gas connections checked	3.51	.666	518
22	Households each plant one tree	3.59	.697	518
23	Use both sides of paper	3.64	.663	518
24	Dump kitchen waste	3.59	.735	518
25	Ban plastic bags	3.57	.716	518
26	Carry cloth bag for shopping	3.59	.627	518
27	Paper instead of plastic cups	3.23	.880	518
28	Global warming not a threat	2.34	1.090	518
29	No global warming effect in Bikaner	2.55	.935	518
30	Should buy green products	3.25	.812	518

Source: SPSS Output (Data collected from fieldwork)

The responses were measured on a one to four scale; therefore, any mean value of greater than two indicates an agreement with the statement. It indicates that the respondents agree with these statements.

In this study the objective of factor analysis was to reduce 30 variables to a smaller number of more identifiable groups of variables. The first step in this test is to see whether or not the data generated from the fieldwork is suitable for factor analysis.

The KMO measure of sampling adequacy is an index used to examine the appropriateness of factor analysis. High values (between .5 and 1.0) indicate factor analysis

is appropriate in the given case. The Bartlett's test of Sphericity is used to examine the hypothesis that the variables are uncorrelated in the population. In other words, each variable correlates with itself but has no correlation with other variable (Malhotra, 2003). The hypothesis is examined by using Chi-square test.

Table 2. KMO and Bartlett's Test^a

1	Kaiser-Meyer-Olkin Measure of Sampling Adequacy	.897
2	Bartlett's test of Sphericity: Approx. Chi-square	4034.138
3	Degree of freedom	435
4	Significance	.000

Based on correlations

The KMO value in this analysis is 0.897, indicating that the sample size is adequate and factor analysis is suitable for the given data. The significance value for the Bartlett's test is 0.00, suggesting rejection of the hypothesis. This means that the variables are correlated, hence factor analysis is an appropriate test in this situation.

The amount of variance a variable shares with all the other variables being considered is explained by communality. This is also the proportion of variance explained by the common factors. The variables having low communality don't combine with other variables. Rescaling is performed by the software using a set of agglomerations for normalization of data collected from a large population in order to minimize the effect of extreme responses. The SPSS output for communalities is given in Table 3.

Table 3. Communalities

		Raw		Rescaled	
		Initial	Extraction	Initial	Extraction
1	Water wasted in washing	.556	.236	1.000	.424
2	Brushing teeth	.445	.223	1.000	.502
3	Taps turned off in public places	.465	.258	1.000	.555
4	Watering lawns	.751	.547	1.000	.729
5	Leaking flush valves	.621	.248	1.000	.399
6	Use of showers	1.152	1.100	1.000	.955
7	Tap water filtered	.517	.225	1.000	.435
8	Old pipes	.560	.280	1.000	.500
9	Sewage treatment plants	.668	.407	1.000	.610
10	Rainwater harvesting	.605	.249	1.000	.412
11	Depleting water table	.620	.262	1.000	.423
12	Monitor use of pesticides	.536	.221	1.000	.412
13	Releasing untreated effluents	.949	.803	1.000	.846
14	LED streetlights	.626	.317	1.000	.506
15	Households LED lights	.623	.265	1.000	.425
16	Switch off when not in use	.596	.223	1.000	.374
17	Power ratings made mandatory	.608	.300	1.000	.493
18	Remove old vehicles	.874	.725	1.000	.830
19	Good public transport system	.766	.573	1.000	.748
20	More pollution checkpoints	.553	.252	1.000	.455

21	Gas connections checked	.444	.235	1.000	.531
22	Households each plant one tree	.486	.266	1.000	.547
23	Use both sides of paper	.439	.274	1.000	.623
24	Dump kitchen waste	.540	.283	1.000	.525
25	Ban plastic bags	.513	.186	1.000	.363
26	Carry cloth bag for shopping	.393	.165	1.000	.419
27	Paper in place of plastic cups	.775	.367	1.000	.473
28	Global warming not a threat	1.187	1.097	1.000	.924
29	No global warming effect in Bikaner	.874	.822	1.000	.940
30	Should buy green products	.659	.310	1.000	.470

Extraction Method: Principal Component Analysis

Variables having low communality (less than 0.5) do not combine with other variables, resulting in unusually high number of factors in the output of analysis. Table 3 has at least 14 such variables whose communality score is less than 0.5. This is the reason that nine different factors are seen, even in the most optimized situation.

Factor loadings represent the degree of correlation between the particular variable and the factor. Factor loadings represent the importance of the factor and rotation is performed to bring to light to relationships not previously seen. Varimax rotation method helps in minimizing the number of factors.

An Eigen value is the sum of squared factor loadings for a particular factor. A common criterion for selecting the number of factors to be extracted from analysis is generally based on the strength of Eigen values. If the Eigen Value (λ) > or equal to 1, the factor is considered as being significant.

The percentage of variance explained is a summary measure indicating how much of the total original variance of all the variables is represented by the factor. All factors taken together provide total explanation for a particular phenomenon.

Table 4. Total Variance Explained

	Initial Eigen values ^a			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.187	21.579	21.579	4.187	21.579	21.579	2.133	10.992	10.992
2	1.674	8.630	30.209	1.674	8.630	30.209	1.679	8.652	19.643
3	1.193	6.147	36.356	1.193	6.147	36.356	1.457	7.510	27.154
4	1.001	5.161	41.518	1.001	5.161	41.518	1.119	5.769	32.922
5	.867	4.468	45.986	.867	4.468	45.986	.988	5.093	38.016
6	.758	3.906	49.892	.758	3.906	49.892	1.251	6.445	44.461
7	.730	3.762	53.654	.730	3.762	53.654	.972	5.009	49.470
8	.655	3.375	57.029	.655	3.375	57.029	1.200	6.183	55.653
9	.654	3.373	60.402	.654	3.373	60.402	.921	4.749	60.402
10	.626	3.227	63.629						
11	.602	3.105	66.734						

12	.555	2.860	69.593						
13	.545	2.808	72.402						
14	.492	2.534	74.936						
15	.457	2.353	77.289						
16	.444	2.289	79.578						
17	.429	2.211	81.789						
18	.382	1.971	83.760						
19	.365	1.881	85.641						
20	.361	1.860	87.501						
21	.335	1.726	89.227						
22	.304	1.568	90.795						
23	.281	1.450	92.245						
24	.269	1.388	93.632						
25	.254	1.307	94.939						
26	.242	1.246	96.186						
27	.214	1.104	97.289						
28	.198	1.022	98.311						
29	.179	.920	99.231						
30	.149	.769	100.000						

The nine factors extracted from the data using the Principal component analysis approach explain about 60% variance in the attitude of school students towards the environment. The Eigen values for the factors five, seven, and nine are approximately equal to one; therefore, we have included them in the number of factors extracted.

Rotated factors

The factor matrix contains the coefficients of variables in terms of factors. These coefficients, known as factor loadings, represent the correlations between factors and variables. A coefficient with a large absolute value indicates that the factor and the variable are closely related. The coefficients of the factor matrix are used to interpret the factors.

Rotation redistributes the variance explained by the individual factors hence it may result in identification of different factors. The most commonly used method of rotation is the Varimax rotation. This is an orthogonal method that minimizes the number of variables with high loadings on a single variable, thereby enhancing the interpretability of the factor (Malhotra, 2003, p. 595). The rotated component matrix with factor loadings is shown in Table 5:

Table 5. Rotated Component Matrix

Factor		Rescaled								
		Component								
		1	2	3	4	5	6	7	8	9
1	Water wasted in washing	.274	.128	.493			-.236	-.122		
2	Brushing teeth	.350	.166	.516		.140	-.185	-.130		.118
3	Taps turned off in public places	.332	.209	.557	-.123	.203	-.154			
4	Watering lawns			.707	.221	-.233	.275		.162	
5	Leaking flush valves	.149		.584		.108				
6	Use of showers								.966	
7	Tap water filtered	.301	.368	.398			.139	.110		
8	Old pipes		.659	.189				.115		
9	Sewage treatment plants	.114	.755					.103		
10	Rainwater harvesting	.217	.476	.288		.210				
11	Depleting water table	.168	.402	.225				.368	-.181	
12	Monitor use of pesticides	.337	.447			.257	.123			
13	Releasing untreated effluents	.234	.167			.181		.847		
14	LED streetlights	.247	.554		.217		-.146		.214	.137
15	Households LED lights	.318	.447		.126	.204			.193	.156
16	Switch off when not in use	.400	.351	.140		.205	-.140			
17	Power ratings made mandatory	.425	.324	.176	.181	.344		-.136		
18	Remove old vehicles	.193			.869		.106			
19	Good public transport system		.152	.111		.794	.139	.229		
20	More pollution checkpoints	.565	.125		.171	.164		.226		
21	Gas connections checked	.658	.229	.113	.107					
22	Households each plant one tree	.706	.108	.161						
23	Use both sides of paper	.737	.189	.166				.101		
24	Dump kitchen waste	.685		.141			.131			

Factor		Rescaled								
		Component								
		1	2	3	4	5	6	7	8	9
25	Ban plastic bags	.513		.176	.123	.170				
26	Carry cloth bag for shopping	.535	.193	.212	.203					
27	Paper in place of plastic cups	.182		.384	.383	.224	-.151	.225		.136
28	Global warming not a threat					.161	.907			.215
29	No global warming effect of in Bikaner				.117		.182			.940
30	Should buy green products	.155	.100	.209	.485	.370		-.134		

Extraction Method: Principal Component Analysis

Rotation Method: Varimax with Kaiser Normalization

It can be easily noticed from Table 5 that the first factor is loaded on nine attitudinal variables, including: More checkpoints for monitoring vehicle pollution (.565), Domestic gas connections checked for leakage (.658), Each household should plant a tree (.706), Use both sides of a paper for writing (.737), Kitchen waste dumped at proper place (.685), Plastic carrier bags banned (.513), Cloth bags used for shopping (.535), Switch off lights and fans when not used (.400), and Power saving ratings made compulsory for all electric appliances (.425). These variables may together be clubbed together under one factor as “Need for more regulation and voluntary participation”. This first factor represents 10.99% variance in the attitudinal make-up towards the environment among secondary school students.

The second factor is loaded on seven variables namely: Old pipes replaced to stop wastage of water (.659), Sewage treatment plant for recycling water (.755), Rainwater harvesting made compulsory (.479), Water table in the area depleting (.402), Use of pesticides monitored to avoid groundwater contamination (.447), Street lights changed to LED to reduce electricity consumption (.554), and Households should use only LED lighting (.447). Based on the common attributes of these seven variables, this factor may be labelled as “Conservation of water and electricity”. This factor explains about 8.65% variance in the attitude of school children.

The third factor is loaded on six variables namely: Too much water is wasted washing clothes (.493), Taps should be turned off while brushing teeth (.516), Taps in public places should be turned off when not in use (.731), People waste too much water in watering lawns (.707), Lots of water is wasted due to leaking flush valves (.584), and Tap water should be filtered to make it potable (.398). Based on common properties of the six attributes, this factor may be named as “Concern for undue wastage of water”. This third factor explains about 7.5% variance in the attitude towards the environment.

The fourth factor is loaded on three variables identified as: Old vehicles taken off the road (.869), Paper cups used instead of plastic cups for serving tea and beverages (.383), and People should buy green products, even if a bit more expensive (.485). This factor is named

as “Need for visible action to protect the environment”. This factor explains about 5.77% variance.

The fifth factor is heavily loaded on just one variable; Public transport system should be strengthened to reduce air pollution (.794). This variable does not readily combine with any other variable, and singularly explains about 5.1% variance in the attitude of school students towards the environment, therefore we cannot ignore it. This factor is named as “Need for strengthening the public transport system”.

The sixth factor is again heavily loaded on a single variable, which has somewhat negative connotations for attitude towards the environment. The variable is: Global warming is not a threat to our lives (.907). It explains about 6.45% variance in the attitude, and may be termed as “Ignorance about the consequences of global warming”.

The seventh factor is loaded on a single variable which also does not combine with other variables. The variable stated as: Industries should not be allowed to release untreated effluents into rivers and other water bodies, has a factor loading of 0.847. This factor is named as “Preventing water pollution by industries”, and explains about 5.00% of the variance.

The eighth factor is also loaded heavily on a single variable: Use of shower for washing may save water (.966). It explains about 6.2% variance. This factor is named as “Need for changing personal habits to protect environment”.

The last factor is again loaded on a single unique variable which did not combine even with a similar variable (global warming is not a threat) to form a common factor. The variable is: There is no effect of global warming in Bikaner (.94). This factor is named as “No firsthand experience of global warming”. This factor explains about 4.75% variance.

Conclusion

The following are the most important components of secondary school students' attitudes towards the environment:

- Need for more regulation and voluntary participation to protect the environment
- Conservation of water and electricity
- Concern for undue wastage of water
- Need for visible action to protect the environment
- Need for strengthening the public transport system
- Little bit ignorant about the consequences of global warming
- Preventing water pollution by industries
- Need for changing personal habits to protect the environment
- No firsthand experience of global warming

With the help of these nine factors, this analysis could explain about 58.5% variance in the attitude of secondary school students towards the environment in the city of Bikaner. The remaining 39.6% variance is attributed to other elements not explained by this analysis.

Attitude is a wide-area of study and not exactly measureable; however, predictions can be made to reach some conclusions. The same has been done within this current study, which shows that: “Students need more regulation and voluntary participation to protect the environment”, “need conservation of water and electricity on second priority”, and

“have concerns for undue wastage of water”. The instrument developed in this study is original, and therefore may not match any previous studies. However, this instrument has been developed taking into account demographic factors into consideration, and therefore may act as guide for future studies.

A global campaign for the improvement in attitudes about environmental issues and its utility in daily lives may boost positive youth attitudes, impacting worldwide. Emphasis on such programs may be regional or even global in order for results to permeate into daily life. Programs may be voluntary, encouraged with money saving approaches, or amendments made to survival theory; whichever is suitable case-wise.

Schools play a major role in shaping of youth attitudes; hence initiatives can be inculcated through schools in the form of assignments or activities. Cross-disciplinary approaches may be utilized in which the attitudes about environmental issues may be developed by teaching along with other related disciplines such as science, economics, social studies etc. In view of the findings of this research, the following recommendations are made:

- This research could be extended to other age-groups (not just secondary school students).
- The effectiveness of environmental programs could be assessed. Programs such as “routine life education”, “life skills education” etc. could be organized and assessed.
- The instrument developed in the current study is comprised of general environmental issues. In order to refine the instrument, further studies could be conducted that address other environmental problem areas.

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Appendix

Questionnaire on Attitude

Indicate your level of agreement or disagreement with the following statements by ticking the appropriate box. (1) means completely disagree, (2) disagree, (3) agree, and (4) fully agree.

		1	2	3	4
1	Water should not be wasted while washing clothes or taking a bath				
2	When you brush your teeth, the tap should not be left open				
3	Water taps in public places should remain turned off when not in use				
4	People waste too much water in watering lawns and gardens				
5	Leaking flush valves in toilets at home waste lots of water				
6	Use of a shower instead on a bath saves water				
7	Tap water should be filtered at home to make it fit for drinking				
8	Old pipes for municipal water supply should be replaced to avoid leakage				
9	A sewage treatment plant is essential for Bikaner				
10	Rainwater harvesting should be compulsory for all commercial and institutional buildings				
11	The water table in the Bikaner region is depleting fast due to overuse of groundwater				
12	The government should monitor the use of pesticides in agriculture				
13	Industries should not be allowed to release untreated effluent into rivers and water bodies				
14	Streetlights should be replaced by LED lights to save electricity				
15	Households should use LED lights only				
16	Fans/ lights/ AC should be switched off when not in use				
17	Power consumption ratings should be made mandatory for all domestic appliances				
18	Old vehicles should be removed from the roads of the city				
19	A good public transport system may discourage the use of private vehicles				
20	More pollution control checkpoints for vehicles should be set in the town				
21	All gas connections in the town should be checked regularly for leakage				
22	Every household in the town should plant at least one tree				
23	We should use both sides of paper to save trees				
24	We should dump kitchen waste and garbage in dustbins only				
25	Use of plastic carrier bags should be banned in the town				
26	You would carry a jute or cloth bag while going shopping				
27	Disposable paper cups should be used in place of plastic cups				
28	Global warming is not a real threat for India in the near future				
29	Bikaner city has so far not experienced any effect of global warming				
30	You would buy green (environment friendly) products even if they are slightly more expensive				