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Development of The Climate Change Mitigation Practices Scale (CCMPS): An Exploratory Factor Analysis

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RESEARCH ARTICLE

Abstract
The issue of climate change is one of the most critical problems on a global scale, and an accurate understanding of the functions that people can perform to reduce the impact of this phenomenon is essential. The current paper created and validated a Climate Change Mitigation Practices Scale (CCMPS) via exploratory factor analysis. The data were obtained through 768 participants (384 Gen Z respondents aged 18-26 years and 384 Gen X respondents aged 46-62 years) residing in Quezon Province, Philippines. After factor extraction and rotation, two reliable factors were obtained in the final 19-item scale, i.e., Energy and Resource Conservation Practices and Active Environmental Engagement. Such factors include simple activities, like water and energy conservation, minimizing waste, and engaging in environmental activities. The CCMPS has adequate reliability with McDonald's omega measures of 0.836 and 0.776 on the two factors, respectively. This validated tool provides a useful tool to researchers and policymakers in evaluating climate change mitigation measures and creating specific interventions that can facilitate sustainable behaviors among individuals and communities. It is recommended that future studies use the CCMPS with diverse populations and environments.

Keywords: Climate Change Mitigation Practices Scale, CCMPS, Exploratory factor analysis

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1 INTRODUCTION

Climate change, which exists in a speeding trend, has far-reaching impacts on humanity in various spheres. Despite the fact that natural forces, the most significant of which are solar variability and volcanic eruptions, do influence weather systems, anthropogenic innovation and the blistering development of many industries have made human societies the main source of atmospheric disturbance. According to the National Aeronautics and Space Administration Vital Signs of the Planet (NASA, 2019), in March 2023, the levels of atmospheric carbon dioxide exceeded 420 parts per million (ppm), which is a relatively high base. Anthropogenic emissions of greenhouse gases are maintained at modern levels largely by the extraction and burning of fossil fuels, coal, oil, and natural gas. According to Pieter Tans, a senior scientist at the National Oceanic and Atmospheric Administration, "We are putting about 40 billion metric tons of CO2 pollution into the atmosphere annually" (NOAA, 2021). In the local context, the reports of the PAGASA show a remarkable increase in the mean temperature, about 0.648 C in total, or 0.0108C per year. At the same time, the hot days have multiplied, and the cold nights have decreased (PAGASA, 2023). Furthermore, there has been an increased intensity of tropical cyclones, i.e., those that have experienced constant winds that are greater than 150 kph have been on the rise, hence increasing the chances of more typhoons in that area. The rate at which tropical cyclones have passed through the Visayan region has significantly escalated in the past 30 years (PAGASA, 2023).

In addition to its immediate physical impact, climate change has a quantifiable effect on mental health. Most communities eventually recover after the occurrence of a natural disaster, but a small portion of them develop long-lasting psychological distress (Morganstein and Ursano, 2020). Major traumatic life events like bereavement, loss of property, and the overall destruction of a community can trigger major mental health pathology. Clayton (2020) proves that younger generations who live with these phenomena long enough experience increased anxiety levels related to climate change. The youth population is particularly vulnerable to climate-related disorders in the Philippine context, where, on average, 20 typhoons are observed annually, among which are post-traumatic stress disorder, depression, and anxiety (Simon et al., 2022).

Despite the fact that the prospect of adaptation to climate change may sound quite troubling, adaptation is, at least in the long term, inevitable (Berrang-Ford et al., 2011). The identification of this need may help in the development of efficient coping mechanisms with the resultant effects. This commitment is highlighted by the Department of Environment and Natural Resources (DENR) through the Intended Nationally Determined Contribution (INDC), which later became the Nationally Determined Contribution (NDC) under the Paris agreement, which comes with new goals every five years (Department of Environment and Natural Resources, 2016). Furthermore, the Climate Change Act of 2009 (Republic Act 9729) mandates climate change considerations in the making of government policy, thus creating the concept of frameworks like the National Framework Strategy on Climate Change (NFSCC) and the National Climate Change Action Plan (NCCAP) (Department of Environment and Natural Resources, 2016).

Furthermore, although policies and adaptation actions have increased, isolated actions such as unplugging household appliances are not enough actions to reduce the climate-related anxiety or significantly decrease greenhouse gas emissions. In their literature contribution, Morganstein and Ursano (2020) argues that some of the initial psychological strategies, such as the development of calm, strengthening of communal relations, the development of optimism, and hope, are essential defense mechanisms. It is therefore important that the community resilience involves the combination of pragmatic mitigation measures and psychological coping strategies.

With the increasing impacts of climate change, it is important to have a stringent knowledge of the mitigation activities that people engage in. Despite the fact that current research focuses on a wide variety of behavioral areas, no single, empirically validated tool exists to measure the practices of this nature. The paper fills this gap by suggesting and confirming the Climate Change Mitigation Practices Scale (CCMPS) using exploratory factor analysis. The CCMPS was formulated to empower researchers, policymakers, and community stakeholders to identify and promote pro-environmental behaviors leading to the achievement of sustainability goals and mental health.

2 METHODOLOGY

2.1 Research Method

The research employed a mixed-methods approach using a sequential exploratory research design. This design has a two-phase approach that begins with qualitative data collection and analysis, and is then followed by the utilization of quantitative data in the generation phase of the items. This design is essentially useful when the researcher needs to explore a particular phenomenon or if a researcher needs to develop an instrument before quantitative analysis can be conducted (Creswell and Clark, 2017). Sequential exploratory research design is useful for exploratory factor analysis (EFA) because the qualitative phase can help identify relevant factors or constructs that may not have been initially evident before generating items for a scale. By exploring the phenomenon through qualitative methods first, researchers can gain insights into the underlying dimensions or themes, which can then be used to develop or refine the quantitative instrument used for EFA.

2.2 Respondents

A multi-stage cluster sampling method (Thomas, 2023) was applied in some regions in Quezon Province in the Philippines: Real, Infanta, General Nakar (commonly known as REINA), and Lucena City. Barangays were grouped into clusters, and random sampling was done on the clusters, and the random sampling inside the selected barangay was done to ensure that the sampling represents all the domains of the study thoroughly.

A total of 768 respondents were used to complete the survey; these were a balanced sample of 384 males and 384 females. The participants were stratified into two birth-cohort groups, namely Generation Z (18-26 years old, 50%) and Generation X (46-62 years old, 50%). These birth-cohort groups were chosen as the previous studies have shown that younger cohorts experience more climate anxiety (Clayton, 2020; Simon et al., 2022), and Generation X is an older generation whose behaviors and attitudes can be different. The comparison aims at identifying possible generation-related differences in the climate-change mitigation behavior.

2.3 Research Instruments

To develop the items of the instrument, the researcher conducted interviews with 50 residents. Most of them were interviewed from the REINA area (30 residents), and the rest came from Lucena City (20 residents). These respondents are not included in the final respondents for factor analysis. The respondents met the inclusion criteria of the sample, i.e., half of each group must be from Generation X and the other must be from Generation Z. The purpose of the interviews was the development and norming procedure of the research instrument. After collecting the data by conducting the interviews, a closed-ended instrument was developed comprising 19 items related to different behaviors on climate change mitigation with a five-point Likert scale, with 1 denoting "Never" and 5 denoting "Always".

2.4 Data Gathering Procedures

Prior to the actual data collection for factor analysis, the respondents were informed of the study's objectives and were reminded of the importance of their involvement. The researchers made sure that the participants understood their rights and helped them gently if necessary during the completion of the questionnaire, and provided further explanation if needed. The researchers read the questions to respondents who needed assistance filling out forms as they asked them for their proper response to the item. When respondents had finished responding to the questionnaire, the researchers highlighted once more that they could discontinue their involvement at any time. The researchers then made sure that only they, their research adviser, and a small number of panels would be knowledgeable of their responses. Following the completion of the survey by the required number of respondents, the information was gathered, totaled, and examined by the researchers. Finally, a statistician was recruited to help guarantee that the data were correctly examined and understood.

2.5 Statistical Treatment of Data

The first step in the utilization of exploratory factor analysis (EFA) was to screen the data for missing values, outliers, and violations of assumptions such as normality, linearity, and absence of multicollinearity (Tabachnick and Fidell, 2013). Next, the factorability of the correlation matrix was examined using Bartlett's test of sphericity and the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (Field, 2013). The number of factors to retain was then determined through methods like the Kaiser criterion, scree plot, or parallel analysis (Hayton et al., 2004). Principal axis factoring or maximum likelihood estimation were preferred extraction methods over principal components analysis (Fabrigar et al., 1999).

To improve interpretability, the factors were rotated using oblique (promax) rotations, regardless of whether the factors are assumed to be uncorrelated or correlated, respectively (Tabachnick and Fidell, 2013). The factor loadings, representing the correlations between variables and factors, were then examined to interpret the meaning of the factors, with loadings greater than 0.3 or 0.4 typically considered significant (Stevens, 2009). As needed, factor scores were computed for each participant to represent their standing on the extracted factors, which can be used in subsequent analysis (Distefano et al., 2009).

Based on the initial results, the researcher specified the model by removing problematic variables, extracting additional factors, or modifying the rotation method (Worthington and Whittaker, 2006). EFA is an iterative process, and the researcher revisits the earlier steps based on the results obtained.

2.6 Ethical Consideration

The study began with informed consent procurement from all the participants, highlighting the research's objectives clearly, data collection methods, and the participants' right to withdraw from the study without any consequences. It is noteworthy to say that the research adhered to the principle of anonymity and confidentiality by cross-checking or de-identifying all personal data, which was given unique participant codes. The use of password-protected devices and encrypted storage, as well as restricted access to authorized personnel, was the measure this study took to extend strict data security. Ethical guidelines were developed to minimize potential harm to subjects, especially concerning studies on the issues of climate change in the typhoon-hit areas of REINA, who were affected in 2004, ensuring questions are carefully worded and help is provided to those affected by the study. Research involved provisions for safe and proper keeping of data, as well as a time limit for proper storage and secure disposal upon completion of the project.

There was transparency throughout the research process right from the start. This was evident in the open communication on the purpose and methodology of the research, as well as the accurate and honest reporting of the findings. Participants were asked for signed consent forms if their data was going to be published, so as to ensure that they fully understood what the consequences of publishing were. Moreover, the research will be sensitive to cultural aspects, taking into account the specific cultural norms and values in the Philippines, particularly with regard to the mitigation of climate change issues. Eventually, to avoid a participant's privacy breach, the strictest ethical rules are followed when publicizing research. This coherent ethical process was the backbone of the research and ensured that the study conducted responsible and ethical quantitative research while respecting the Data Privacy Act of 2012 (Republic Act 10173) and international ethical standards and the privacy and rights of the study participants. Moreover, this paper was approved by the Ethics Review Board of the Southern Luzon State University.

3 RESULTS AND DISCUSSIONS

Table 1 shows the result of the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy for each of the items of the scale. Based on the provided output in the table, the overall value of 0.849 indicates that the sample size was adequate for factor analysis (n = 768). A KMO value between 0.8 and 0.9 is considered "great" according to Kaiser (1974) criteria, suggesting that the data meet the necessary requirements and assumptions for factor analysis (Hutcheson and Sofroniou, 1999).

Table 1. KMO Measure of Sampling Adequacy

	MSA
1. I use alternative sources of energy such as solar/wind energy.	0.824
2. I join environmental activities like coastal clean ups and/or tree planting.	0.773
3. I monitor my usage of electricity.	0.841
4. I make sure/ prefer that the products I use are produced by companies who care for the environment.	0.811
5. I read information related to climate change.	0.79
6. I follow environmental laws in my municipality. Example: Avoiding using single-use plastics.	0.934
7. I monitor my usage of water.	0.822
8. I grow my own food in my garden.	0.797
9. I do not buy things that are not needed because I am aware of the effects of overconsumption	0.893
10. I recycle things whether non-biodegradable for pots, water containers, and wrapping materials or biodegradable for fertilizers.	0.847
11. I turn-off the faucet when not in use such as while brushing my teeth, shaving beards, etc.	0.838
12. I reuse things for another purpose.	0.874
13. I prefer to walk if it is just a short distance to help regulate the oil resources.	0.907
14. I don't waste food.	0.892
15. I plant trees that shade my house, to reduce our air conditioning use.	0.807
16. I get involved in forest restoration projects.	0.781
17. I turn-off the lights when not in use.	0.84
18. When it's time to replace appliances, I buy the most energy-efficient ones.	0.937
19. I watch environmental shows.	0.878
Overall	**0.849**

The individual KMO values for each item range from 0.773 to 0.937, with most items falling within the "great" or "meritorious" range (MSA = 0.8 to 0.9). This indicates that the data for these items is well-suited for factor analysis. However, there are few items, such as "I join environmental activities like coastal clean ups and/or tree planting" (MSA = 0.773) and "I get involved in forest restoration projects" (MSA = 0.781), have slightly lower KMO values, which could suggest that these items may not be as well-suited for factor analysis as the other items. It is worth noting that the KMO statistic is a measure of sampling adequacy and does not directly indicate the validity or reliability of the factor structure itself. Henceforth, an additional analysis coefficient, such as factor loadings, communalities, and model fit indices, should be examined to evaluate the overall factor structure and the relationships between the items and the underlying factors (Pett et al., 2003). In summary, the KMO values suggest that the overall sample size and data are adequate for conducting factor analysis.

Table 2 shows the factor loading for each item. Factor 1 appears to represent "Energy and Resource Conservation Practices." The items loading highly on this factor (e.g., items 14, 3, 11, 9, 17, 7, 13, 18, 6, and 12) reflect behaviors aimed at waste reduction, resource conservation, such as water and electricity, and promoting sustainable consumption practices. These behaviors align with the principles of environmental sustainability and responsible resource utilization (Steg and Vlek, 2009).

Table 2. **Factor Loadings (Factor 1)**

	Factor		
	1	2	Uniqueness
14. I don't waste food.	0.665		0.617
3. I monitor my usage of electricity.	0.633		0.585
11. I turn-off the faucet when not in use such as while brushing my teeth, shaving beards, etc.	0.629		0.674
9. I do not buy things that are not needed because I am aware of the effects of overconsumption.	0.615		0.612
17. I turn-off the lights when not in use.	0.581		0.709
7. I monitor my usage of water.	0.57		0.66
13. I prefer to walk if it is just a short distance to help regulate the oil resources.	0.559		0.707
18. When it's time to replace appliances, I buy the most energy-efficient ones.	0.531		0.644
6. I follow environmental laws in my municipality. Example: Avoiding using single-use plastics.	0.531		0.67
12. I reuse things for another purpose.	0.406		0.63

Factor 2, on the other hand, seems to capture "Active Environmental Engagement." The items that load strongly on this factor (e.g., items 16, 2, 15, 5, 19, 8, and 10) reflect active participation in environmental activities, such as forest restoration projects, coastal clean-ups, tree planting activities, and acquiring knowledge about serious environmental issues. These behaviors demonstrate a proactive approach to environmental protection and a willingness to engage in efforts that promote environmental awareness and conservation (Fielding and Head, 2012).

Table 3. **Factor Loadings (Factor 2)**

	Factor		
	1	2	Uniqueness
16. I get involved in forest restoration projects.		0.776	0.513
2. I join environmental activities like coastal cleanups and/or tree planting.		0.712	0.596
15. I plant trees that shade my house, to reduce our air conditioning use.		0.637	0.605
5. I read information related to climate change.		0.529	0.748
19. I watch environmental shows.		0.471	0.665
8. I grow my own food in my garden.		0.451	0.721
10. I recycle things whether non-biodegradable for pots, water containers, and wrapping materials or biodegradable for fertilizers.		0.411	0.699
4. I make sure/ prefer that the products I use are produced by companies who care for the environment.		0.38	0.848
1. I use alternative sources of energy such as solar/wind energy.		0.321	0.893

The emergence of these two distinct factors is consistent with the multidimensional nature of environmental behavior, as suggested by various theoretical frameworks (Kollmuss and Agyeman, 2002). The distinction between sustainable consumption behaviors and environmental engagement behaviors clearly aligns with the categorization proposed by Stern (2000), who differentiated between "environmentally significant consumer behavior" and "environmental citizenship behavior."

Nevertheless, others, like “I use alternative sources of energy like solar/wind energy” and “I make sure/ prefer that the products I use are produced by companies who care for the environment,” had greater uniqueness values. It implies that a bigger part of their variance cannot be explained by the key factors that have been extracted. This could be because the use of alternative energy sources could be more reliant on other external factors (e.g., access to technology, financial ability) than it is on daily personal decisions, thus diluting its relationship with other personal conservation behaviors (Markle, 2013). On the same note, the option of products of environmentally conscious companies could be based on availability or marketability instead of regular practices such as water or electricity conservation. It is not atypical to find such results. As an example, Whitmarsh and O’Neill (2010) observed that certain green consumer behaviors, such as purchasing eco-friendly products, may portray identity or brand perception instead of direct day-to-day conservation behavior. A high level of uniqueness of these items implies that they may appeal to other dimensions of environmental behavior that are desirable but only weakly related to the regular consumption and participation patterns.

Based on the inter-factor correlation matrix presented in Table 4, the moderate positive correlation of 0.520 between the two factors suggests that they are related but distinct constructs. This finding supports the previous study suggesting that pro-environmental behavior can be conceptualized as a multidimensional construct encompassing various aspects (Stern, 2000; Steg and Vlek, 2009).

Table 4. **Inter-Factor Correlations**

	Factor 1: Energy and Resource Conservation Practices	Factor 2: Active Environmental Engagement
Factor 1: Energy and Resource Conservation Practices	—	0.52
Factor 2: Active Environmental Engagement		—

"Energy and Resource Conservation Practices" refers to the collection of the group’s shared set of behaviors that is meant to conserve energy and natural resources. This seems to be the factor that encompasses such actions as lowering household energy usage, recycling, reusing, and reducing waste, which have been accepted as very important components of environmentally responsible behavior (Markle, 2013; Whitmarsh and O’Neill, 2010). On the other hand, the "Active Environmental Engagement" point shows a bearer of more proactive, active, and participatory features of pro-environmental behavior. This factor may include the performance of such activities as volunteer work at environmental organizations, joining in community-based environmental projects, and actively promoting environmental causes (Fielding and Head, 2012; Stern, 2000. The fact that the two factors extracted are moderately correlated suggests that the people who are involved in energy conservation and resource saving practices are also likely to be involved in activities of environmental engagement, and vice versa. Nevertheless, the specific nature of these reasons implies that they are connected but to some extent also separate areas of pro-environmental behavior (Steg and Vlek, 2009; Vicente-Molina et al., 2013). Such research findings provide essential information on the multidimensional nature of pro-environmental behavior and demonstrate that there is a need to consider both the conservation-oriented actions and the active environmental participation while studying and promoting sustainable trends (Steg and Vlek, 2009; Vicente-Molina et al., 2013).

Table 5 shows the reliability statistics for the scale between the factors. The first factor, labelled as "Energy and Resource Conservation Practices," has a mean score of 4.31 on a scale of 1-5, with a standard deviation of 0.619. The McDonald’s omega (ω) value of the factor of 0.836 can be interpreted as a good level of internal consistency of items included in this factor (Raykov and Marcoulides, 2011). The McDonald’s omega is a good measure of internal consistency of items that takes into account the factor loadings and the relationships between the items (Raykov and Marcoulides, 2011). A value above 0.7 is generally considered acceptable, and a value above 0.8 is considered a good item (Vieira, 2011).

Table 5. Scale Reliability Statistics

	Mean	SD	McDonald's
Factor 1: Energy and Resource Conservation Practices	4.31	0.619	0.836
Factor 2: Active Environmental Engagement	3.14	0.768	0.776

Factor 2, labeled as "Active Environmental Engagement," on the other hand, has a lower mean score of 3.14 and a higher standard deviation of 0.768. This factor has a McDonald's omega of 0.776, which can be considered within an acceptable level of internal consistency of items (Vieira, 2011). These results suggest that the factor structure identified through the exploratory factor analysis showed acceptable evidence of internal consistency.

4 CONCLUSION AND RECOMMENDATIONS

Exploratory factor analysis revealed two unique factors as the basis of climate change mitigation practices, i.e., Energy and Resource Conservation Practices and Active Environmental Engagement, which define the multidimensional nature of pro-environmental behaviour. The Climate Change Mitigation Practices Scale (CCMPS) is thereby a useful tool in the assessment of environmental literacy in educational facilities, community climate action planning in local government units, intervention measurement in environmental NGOs, and employee engagement measurement in corporate sustainability programs. The next steps in research should focus on the confirmation of the factor analysis using independent samples, measurement invariance across demographic groups, predictive validity using longitudinal monitoring of behavior, intervention sensitivity in randomized trials, and normative data in diverse populations. It is also recommended that researchers examine the connection between the factors of the CCMPS and other psychological constructs (environmental self-efficacy, climate risk perception, environmental values) through structural equation modeling, shorten the scale to use in large-scale studies, and cross-culturally validate the scale, especially in developing countries with comparable climate vulnerabilities, and eventually help in the development of evidence-based policies and specific environmental education programs.

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