What matters for sustainability and climate change actions in developing countries: A stimulus–organism–behavior–consequence (SOBC) perspective

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Sustainable behaviors demand wielding communication strategies in social and political spheres for public understanding of scientific issues like climate change and the severe consequences of deteriorating environmental quality. Reliable information can improve public understanding of science and enhance public support for climate change actions at social and political levels. This study strives to examine the socio-political and psychological factors that affect climate change actions based on the stimulus-organism-behavior-consequences paradigm. This study further categorizes sustainable behavior into mitigation and adaptation strategies to capture behavioral consequences with the moderating effects of information literacy and a regulative environment. Empirical findings demonstrate interesting associations between socio-political and psychological factors. Significant effects were observed for environmental quality and belief in climate change in explaining pro-environmental behavior. This study reveals that people are more prone to mitigation than adaptation strategies to ensure sustainability and recommends better communication strategies to empower those already engaged in mitigating climate change and encourage those still struggling to adapt to climate change actions.

KEYWORDS

stimulus-organism-behavior-consequences (SOBC), political trust, environmental quality (EQ), environmental effectiveness, sustainable behavior, regulative environment

1 Introduction

The coping strategies for "Climate Change" conceptually comprise mitigation and adaptation. Climate change mitigation calls for reducing the causes of global warming leading to climate change. In contrast, adaptation indicates the impacts of climate change on society and the environment and involves a particular set of actions to reduce environmental vulnerability (Sussex and Study, 2006). The complexity of climate change, at both scientific and political levels, makes it challenging (Keren et al., 2021). It leads to controversies because it is tough to distinguish the differences over a short period as climate change trends are masked by normal variability (Asmi et al., 2022). Thus, individuals with substantial

environmental knowledge and concerns sometimes find translating these traits into sustainable actions challenging (Munerah et al., 2018). Public engagement in climate change actions is highly interesting as it generates positive behavioral outcomes with enhanced public effectiveness and beliefs to protect the environment (Sajjad et al., 2020). Critical policy input also has political implications, resulting in high or low political and institutional trust, which greatly encourages pro-social behaviors in most developing countries (Taniguchi & Marshall, 2018). Developing countries have devised institutional setups for climate change to implement strategies to sensitize the public to environmental issues on social and political platforms (Goldberg et al., 2022). However, they still require the gauging of sound communication strategies to get support in socio-political settings, i.e., political trust, risk perception, and knowledge, to encourage public environmental effectiveness and sustainable behavior with the aim of achieving national environmental goals.

With the increased prominence of global environmental challenges, more research focuses on the relationship between the natural environment, communication, and the public domain by incorporating topics such as risk communication, climate change framing, and environmental participation (Bødker and Neverla, 2012; Cox and Depoe, 2015). The influence of climate change communication has now expanded to social, cultural, and political spheres. Corner et al. (2010) emphasized the role of public communication required behavioral changes. Political and cultural settings are essential in shaping public perception of climate change as a socio-scientific issue with its related risks (Akerlof et al., 2013; Drummond et al., 2018). People are always dealing with risks, and the perception of those risks does not rely on facts or their impact, but framing them indicates the ultimate actions (Detenber et al., 2018). Climate change strategies focusing more on scientific evidence than communication framing produce limited outcomes as they deal with public ideology (Bain et al., 2012). The literature indicates that public engagement is critical in any national climate mitigation or adaptation strategy (Pike and Cara, 2010; Adelle 2015). Thus, it is required to provide the public with more climate change knowledge to comprehend the implications and consequences (Bord et al., 2000). Communicating the risks of a particular problem can increase stakeholder engagement for effective risk management (Boudet et al., 2014). Weber & Stern (2011) indicate that lack of understanding or concern is not a constraint for risk management decisions but the politics of climate change. Ryan & Ramirez (2016) find that political and social support for climate change policies is helpful for sustainable policy implementation. Information-based science advocacy has little impact on public climate concerns, whereas political mobilization can generate high levels of concern about climate change (Brulle et al., 2012). Carvalho, van Wessel, & Maeseele (2017) indicate that communication practices do not only help create the conditions for political engagement and engagement modes. Different political systems process the same scientific data on climate risks and propose different mitigation options. Hart & Nisbet (2012) indicate political partisanship as a boosting factor for positive political polarization on climate change. There is a need to know more about the social, environmental, psychological, and cognitive factors that influence scientific data's political processing and outcomes (Bernauer, 2013).

We argue that a heuristic model with political, environmental, and psychological factors can best explain the sustainable behavior of citizens in the context described above. The government must educate the public and promote climate change actions to achieve policy legitimacy and support. Drawing upon the above pro-environmental, political, and communication literature, we identify factors, i.e., environmental knowledge, political trust, environmental quality, environmental effectiveness, and belief in climate change, that influence sustainable behavior and translate sustainable behavior into mitigation and adaptation strategies. We also identify information literacy as a contextual factor that can moderate the effects of environmental effectiveness and belief in sustainable behavior. This study also proposes a supportive regulative environment as another moderating factor between sustainable behavior, mitigation, and adaptation strategies. These variables have not been integrated to analyze citizens' sustainable behaviors and support the government's climate change actions. The application of these variables in other contexts is well established by research, where they explain various sustainable, pro-social, and green behaviors with different theoretical frameworks. Thus, we integrate these variables into the stimulus-organism-behavioral-consequences (SOBC) framework to analyze the following research questions (RQ) empirically: (RQI) how environmental knowledge, political trust, and environmental quality stimulate environmental effectiveness and belief in climate change, and how these affect the sustainable behavior; (RQ2) how sustainable behavior affects mitigation and adaptation consequences.

The research questions are grounded in the SOBC framework. SOBC suits the context of this study as it presents an interactive effect among stimulus (S), organism (O), behavior (B), and consequences (C). The impact in SOBC starts from S and then flows to O, B, and C. We propose environmental knowledge, political trust, and environmental quality as stimuli, the micro and macro level factors that drive environmental effectiveness and belief in climate change, organismic factors in this study. These factors drive the sustainable behavior of partisans, leading to consequential actions of mitigation and adaptation strategies. The hypothesized relationships are tested using data from 1532 citizens from a developing region. To the best of our knowledge, this is the first study to employ the SOBC framework to track the effects of socio-political and psychological macro and micro factors on citizens' sustainable behavior and identify their behavior as mitigation or adaptation. Furthermore, the impact of some contextual factors is also incorporated to explain the climate change actions of citizens. Thus, the findings of this study may be helpful for political leaders, policymakers, and academicians, allowing them to better understand citizens' responses to socio-political, psychological, and environmental factors and determine the required climate change actions.

2 Theoretical development

The present study proposes a research model based on the SOBC paradigm. SOBC is an advanced form of stimulus-organism-response (SOR) model, grounded in Bandura's social learning theory, where particular factors in the environment (S) incite action from individuals (O), guiding their behavior (B) to

produce certain consequences (C) in that specific environment. This advancement on the previous cognitive-operant models allows for better environmental, cognitive, and behavioral analyses. Stimulus and consequences represent the environmental events, whereas organism and behavior are the processes linking these events. Consequences in SOBC represent past behavioral patterns. The reciprocal nature of environmental events enables us to analyze the interaction between environmental factors, personality traits, and behavior. This path is highly emphasized in climate change action models and social learning. Several studies have utilized the SOBC paradigm to capture the reciprocity of environmental events and behavioral processes in different contexts. For example, Talwar, et al. (2021) analyzed organic food buying behavior by incorporating SOBC, Yuan et al. (2017) utilized the SOBC model to highlight consumers' new media engagement, Chakraborty (2022) employed SOBC to examine buying intentions for Ayurveda products, and Dhir et al. (2021) used SOBC to explore consumer's green apparel buying behavior. Given its dynamic ability to capture various influences on behavior and consequences, particularly in sustainable contexts, we find SOBC a suitable theoretical lens for this study.

In connection with prior literature on pro-environmental behavior, which suggests that climate change beliefs and environmental effects are highly associated with personal knowledge and perception of institutions and the environment. The current study adopts eco-literacy (environmental knowledge), environmental quality, and trust in politics as stimulus (S); belief in climate change and environmental effectiveness represent organism (O); the sustainable behavioral intention is taken as behavior (B), and individual orientation toward climate change mitigation and adaptation as behavioral outcomes are represented as consequences (C). The effect of organisms on behavior and the influence of behavior on consequences is moderated by information literacy.

2.1 Stimulus

2.1.1 Environmental knowledge

Environmental knowledge represents a general knowledge of facts and concepts related to the natural environment and its relationship with its ecosystems (Sadiq et al., 2021). Individuals with high environmental knowledge show strong preferences for pro-environmental actions, as increased environmental knowledge positively and significantly impacts environmentally friendly behavior and intentions (Pan, Chou, Morrison, Lin and Huang, 2018). Lee et al. (2014) described a significant impact of environmental knowledge on green purchasing behavior. Climate change communication requires local knowledge, concerns of the targeted audience, values, and audience psychology to help the public mitigate and adapt to the impact of environmental hazards (Jarreau et al., 2017). Al Mamun et al. (2018) found that eco-literacy and self-efficacy are positive and significant factors in predicting respondents' green purchase attitudes. Increased environmental knowledge and concerns over climate change are undoubtedly creating new environmental ethics. Environmental knowledge and concerns are the most significant factors in determining consumers' green purchase intentions

(Kanchanapibul et al., 2014). Dhir et al. (2021) indicated that individuals with environmental knowledge more effectively translate their intentions into pro-environmental behavior. Climate change belief is highly influenced by climate change knowledge (Milfont et al., 2014). Environmental knowledge necessitates understanding the impact of individuals' activity on the ecosystem and their engagement in protecting it (Peña-Vinces et al., 2020). Thus, climate change concerns and environmental effectiveness appear to be outcomes of individuals' accumulated environmental knowledge, and we test this hypothesis in the case of partisans.

H1a: Environmental knowledge positively affects citizens' environmental effectiveness.

H1b: Environmental knowledge positively affects citizens' belief in climate change.

2.1.2 Political trust

Political trust in political science has been used to analyze the legitimacy of political institutions (van der Meer & Hakhverdian, 2017). The public generally supports institutions through their political trust based on their assessment of that institution's quality. The public tends to support high environmental taxes if they believe their politicians are trustworthy (Jagers et al., 2010). Mortoja & Yigitcanlar (2022) indicated the importance of political bias in explaining climate change beliefs. A lack of political trust causes public hostility toward environmental taxes. People are willing to pay environmental taxes when compensated by cuts in other taxes, but they don't believe the government will ensure those cuts (Fairbrother, 2017). The growing gap in trust dampens the public risk perception and their support for climate change mitigation and willingness to engage in adaptive strategies (Smith & Mayer, 2018). The severity of the issue calls for an in-depth analysis of the relationship between environmental concerns and trust in politics (Kentmen Cin, 2012). Low political trust and uncertainty in public engagement are influencing factors that can affect communal support for developing the common good (Pellizzone et al., 2017). Environmental protection requires political interventions that involve public engagement in certain environmental policies and necessitates public trust in government to strengthen political will (Peifer et al., 2016). Existing literature informs us that political trust, trust in institutions, and trust in government significantly impact individual effectiveness, climate change participation, willingness to pay, and green consumption (Kulin & Sevä, 2021). When people perceive a lack of personal control over the climate, they mostly prefer to support the messages from trustworthy sources (Tang et al., 2016). Thus, we argue that political trust encourages public confidence in institutions and positively affects environmental effectiveness and belief in climate change to adopt environmental behavior.

H2a: Political trust positively affects citizens' environmental effectiveness.

H2b: Political trust positively affects citizens' belief in climate change.

2.1.3 Environmental quality

Environmental quality indicators, i.e., air, water, and land pollution, overexploitation of natural resources, deforestation, loss of biodiversity, and climate change, affect human welfare (Ibrahiem

& Hanafy, 2021) and concern vital elements for environmental quality. While analyzing the association between air quality and personal wellbeing in Europe, Ferreira et al. (2013) revealed a significant negative impact of SO^2 concentrations on life satisfaction. Environmental quality significantly describes subjective wellbeing, and providing better air quality and protecting the individual's health are listed as one of the governments' key global concerns (Giovanis & Ozdamar, 2018). High local air pollution and noise levels negatively affect subjective wellbeing (Rehdanz & Maddison, 2008). Life satisfaction is higher in areas where urban lands are used as accessible green areas and parks than in urban areas where land has been abandoned (Krekel et al., 2016). Zhang et al. (2017) reported a significant effect of air pollution on happiness. Deteriorating air quality positively reduces subjective happiness and increases depression. People's perception of their social and economic statuses positively relates to environmental concerns (Sulemana et al., 2016). People receive climate change information from multiple sources, i.e., scientific, political, media, and personal experiences (Davydova et al., 2018), affecting their risk perception regarding environmental quality. Better environmental quality also indicates that governments are concerned with tackling and eradicating hazardous effects of human activities and industrialization (Taniguchi & Marshall, 2018). Thus, we hypothesize the impact of environmental quality on citizens' beliefs and effectiveness.

H3a: Environmental quality positively affects citizens' environmental effectiveness.

H3b: Environmental quality positively affects citizens' belief in climate change.

2.2 Organism

2.2.1 Environmental effectiveness

Environmental effectiveness is the belief in one's own ability and confidence to take actions that can positively affect the environment. It is strongly related to green behavior (Ghvanidze et al., 2016). Perceived ability to execute an action or plan directly affects pro-environmental behavior, regardless of the cost and time required to do so (Ertz et al., 2016). Individuals with higher self-efficacy levels in mitigating global warming tend to find more information for possible mitigation measures (Huang, 2016). Quantitative studies indicate that individuals who have no control over environmental issues or lack self-efficacy demonstrate low pro-environmental or environmentally friendly behavior (Tam & Chan, 2017). Evidence indicates that environmental concerns are not necessarily being transformed into environmentally friendly behavior (Dong et al., 2018), indicating the facilitating role of self-control in transforming environmental concerns into green behavior (Tam & Chan, 2018). There is a weak connection between environmental concerns and pro-environmental behavior in societies with high distrust, helplessness, and belief in external control (Tam & Chan, 2017). Individual self-efficacy is reported as an important motivational tool and psychological resource through which individuals' pro-environmental behavior can be explained (Coelho et al., 2017). Self-efficacy appears to be the strong predictor of an individual involved in an activity that requires significant personal effort (Tabernero et al., 2015).

H4: Perceived environmental effectiveness positively affects citizens' pro-environmental behavior.

2.2.2 Belief in climate change

Belief polarization happens when two persons develop opposite beliefs in response to the same evidence. The reaction, due to this polarization, is expected to be irrational, which could disrupt "normatively optimal responding" (Cook & Lewandowsky, 2016). The respondents with substantial climate change knowledge are those who accept that climate change is happening (Guy et al., 2014). People near the coastal level strongly believe in climate change and support emission control policies. Research has found that belief in climate change is vital for risk appraisal and can lead to pro-environmental actions (Mase et al., 2017). Belief in climate change is associated with high engagement in climate change actions among forest owners (Vainio & Paloniemi, 2013). On the other hand, the belief that climate change is not happening and that humans play no role in it has been related to environmental indifference and hinders individuals from taking climate change actions (Scannell & Gifford, 2013). Thus we propose that belief in climate change can lead to pro-environmental behavior, and we hypothesize around this.

H5: Belief in climate change positively affects the citizens' pro-environmental behavior.

2.3 Behavioral responses

Pro-environmental behavior, also indicated as "ecological behavior," "environmentally friendly behavior," "green behavior," or "sustainable behavior," represents a range of behavioral responses that are considered beneficial to the environment, i.e., green purchase, circular behavior, adoption of renewable energy, water conservation, adoption of sustainable traveling modes to reduce pollution, etc. (Wang & Yao, 2020). Pro-environmental behavior is a response that intentionally minimizes the negative impact of individual actions on the environment (Davis et al., 2020). Whitmarsh (2009) described pro-environmental behavior as individuals' moral obligation when they believe their actions can effectively protect the environment. Pro-environmental actions require individuals to be internally motivated, and they usually require extra effort to overcome social, psychological, and cognitive barriers (Y. Zhang et al., 2020). Existing literature indicates many psychological, social, political, and cognitive factors that can affect pro-environmental behavior.

The coping strategies for climate change conceptually comprise mitigation and adaptation initiatives. Mitigation refers to eradicating climate change causes, whereas adaptation refers to the impacts of climate change on society and involves particular actions (Sussex and Study, 2006). Consumer knowledge and commitment to green purchasing play an important role in behaving in an environmentally friendly manner (Maniatis, 2016). As the Kantian imperative indicates, green behavior is an effect of being responsible, which classifies the individual's behavior into two specific categories: green or gray. Individuals with strong green attitudes are more likely to display green behavior (Cerda Planas, 2018). Environment preservation has encouraged sustainable or altering consumption patterns and has become a

priority on the international public administration list (Mascarello et al., 2014). The development of climate change mitigation policy and its implementation is highly dependent on public climate change knowledge and the perceived risk of climate change. Various factors significantly affect climate change mitigation and adaptation initiatives, e.g., attitude, environmental concern, social values, literacy rate, identity, and income (Dong et al., 2018). Implementing climate change actions involves targeted communication of consequences related to climate change and the climate science determining these changes (Hahn et al., 2016).

H6a: Sustainable behavior positively affects citizens' participation in mitigation strategies.

H6b: Sustainable behavior positively affects citizens' participation in adaptation strategies.

2.4 Moderating effect of information literacy and regulative environment

Information literacy refers to an individual's ability to classify information for problem-solving and to recognize its purpose for evaluation (American Library Association, 1998). This suggests that classifying the need for information prompts behavioral change in individuals by encouraging them to comprehend and identify newly received information and help the individual trace it with prior knowledge or a lack of knowledge, leading to its adoption as habit (SCONUL, 2016; Lumen, 2018). There is strong evidence that information positively affects climate change actions, but the mechanism that explains the effect of information on these actions is not addressed properly (Dong et al., 2018). If consumers are provided with more information on climate change and environmental issues, the increased information significantly affects their purchasing behavior (Gleim et al., 2013). As attitudes are shaped by individual beliefs and knowledge, providing more information in advertisements on energy-saving characteristics could help customers develop a positive attitude toward these appliances (Ha & Janda, 2012).

H7a: Information literacy positively moderates the effect of perceived environmental effectiveness while defining sustainable behavior among citizens.

H7b: Information literacy positively moderates the effect of belief in climate change while defining sustainable behavior among citizens.

The institutional environment is highly recognized in implementing climate change mitigation and adaptation strategies, particularly for forest management. Still, there is a dearth of research, including institutional factors, studying adaptation strategies (Bouriaud et al., 2015). Environmental degradation caused by climate change negatively affects social, economic, and development indicators, as indicated by research on environmental impact, and suggests various mitigation and adaptation strategies. The effectiveness of a country's climate change mitigation or adaptation policy is determined by the public support they get for coping with the threats or opportunities posed by climate change (Taylor et al., 2017). Psychologists and climate change communicators emphasize information for effective communication (Jarreau et al., 2017). The perceived certainty of the message predicts whether the climate change action involves knowledge of climate change

(Lombardi et al., 2014). Information undoubtedly improves individuals' ability to mitigate or adapt to climate change as it increases their risk perception. A positive association exists between information and climate action, whereby information moderates the relationship (Dong et al., 2018). Evidence indicates that environmental concerns are not necessarily transformed into environmentally friendly behavior. Some intermediates facilitate the relationship between environmental problems and their transition into green behavior (Tam & Chan, 2018).

H8a: Supportive regulative environment positively moderates the effect of sustainable behavior while defining citizens' participation in mitigation strategies.

H8b: Supportive regulative environment positively moderates the effect of sustainable behavior while defining citizens' participation in adaptation strategies.

3 Methodology

The structured questionnaire is preferred when addressing and understanding attitude-related factors (Tourangeauet al., 2000). The Likert scale was adopted in a quantitative survey, as it allows respondents to map their perception and socio-psychological understanding of the scenario. The construct of the 7 Likert scale was adopted in the current research. Specifically, 1 was "Highly Disagreed" (not supporting) to the expression classified, and 7 was considered "Highly Agreed" (most likable expression). The adapted sources were revisited while designing the questionnaire. Each construct's related questions were adapted, customized, and re-evaluated to understand the validity and credibility concerns of the proposed construct and its adapted version (for the current study).

The respondents' political views and geographic spectrum diversity were considered the prime concern while collecting data. Initially, the electronic version of the questionnaire was circulated to the potential respondents (approximately 3500) through the electronic channels of the political parties' platforms and open discussion blogs over social media and the web. However, the received respondents' count was noted as 1943 in total; therefore, a response rate of approximately 55% was recorded after excluding the incomplete response sets. The acceptable count of 1532 responses was taken into further consideration for the data analysis in the current study. In other words, the response percentage of 43.77 was a considerable response count.

4 Findings and analysis

This study found that more than 57% of the population were men, indicating that men account for the more active population segment in the country's economic and socio-political development. Moreover, almost 80% of the respondents were younger than 35.

Regardless of the model design, arrangement, and re-formulation, the Exploratory Factor Analysis (EFA) helps us to understand the constructs' validity and reliability concerns. At the beginning of the EFA, the KMO test was usually conducted to examine the collected sample's capability to behave in terms of the model. In other words, KMO addresses the common variance from

each noticeable construct observed while working as an overall model (Cerny & Kaiser, 1977). From the EFA's results in the current research, the KMO value of .921 was recorded, highlighting the sample's significant ability to work as a model. The sample's acceptability as a respectable sample demands symmetry/homogeneity in the data trends and was examined by Bartlett's test and recorded as 0.00. This concluded that the sample was acceptable for further EFA and Confirmatory Factor Analysis (CFA).

To examine internal reliability, Cronbach Alpha (α) is usually measured, in statistical terms, its cutoff value is .70 (Saunders et al., 2009). A higher Cronbach's alpha value represents the constructs' healthy internal reliability. In the current scenario, Cronbach's alpha was within the range of .980, and .904 was observed. Moreover, the Composite Reliability (CR) is also labeled as McDonald's coefficient and collects the sum of variance and co-variance in the composite fashion for each construct. The composite value examines the loadings of each item within the construct.

Moreover, the Composite Reliability (CR) is preferred to be above 0.70 (Fornell & Larcker, 1981). Composite reliability between the range of .956 and .859 was observed in the present scenario. The measurement errors usually hold significant value while examining constructs' internal reliability and divergent validity. The 'Average Variance Extracted' (AVE) is usually defined as the outcome of squared loadings (standardized), the collective sum of error (variance). In statistical terms, it deals with the loadings computed during factor analysis and helps to measure convergent and divergent reliability.

Furthermore, most statisticians recommend a lower cutoff value of .50 (Hair et al., 2014). In the current study, the range of AVE was observed between .812 and .580. Table 1 holds all composite reliability values, Cronbach alpha, and average variance extracted and satisfies the recommended value.

The next phase in statistical analysis was to examine the external reliability of the constructs. In other words, it helps to define that each of the constructs proposed is statistically different and holds distinct characteristics (Campbell & Fiske, 1959). Moreover, each variable's AVE's square root value is mentioned in the diagonal of the correlation matrix. The result concludes the supportive findings, as shown in Table 2. In statistical terms, zero issues about divergent reliability were observed in the current research. Furthermore, none of the multi-collinearity was observed, as all VIFs were observed within the continuum of 2.02–1.21. The structural model returned acceptable goodness-of-fit indices as presented in Table 3.

4.1 Hypotheses testing

While examining the overall role of eco-literacy, the influence of eco-literacy over environmental effectiveness and belief in climate change was measured. Specifically, in the case of H1(a), eco-literacy was observed to strongly influence perceived environmental effectiveness in the case of examining citizens' climate change mitigation and adoption behavior (β = 0.248, p ≤ 0.001). In contrast, its power to define perceived belief in climate change was slightly low but strongly significant. Statistically, H1(b) was observed to be holding β = 0.170 and p ≤ 0.001 as shown in Table 4.

While examining the proposed hypotheses highlighting the role of political trust, the effect was observed to be stronger for environmental effectiveness. Statistically, it was noted as β = 0.266 and p ≤ 0.001. However, political trust holds comparatively less explanatory power to define citizens' perceived belief in climate change. Statistically, H2(b) was observed to be holding β = 0.170 and p ≤ 0.001. Environmental quality is predicted to influence citizens' perceived environmental effectiveness and belief in climate change. Statistically, the explanatory power of environmental quality significantly influences citizens' perceived environmental effectiveness while mapping their sustainable behavior. Statistically, it is noted as H3(a): β = 0.288 and p ≤ 0.001. Interestingly, among all three exogenous factors, while defining citizens' belief in climate change, perceived environmental quality was observed to be the strongest construct. Statistically, it is stated as H3(b): β = 0.310 and p ≤ 0.001. The role of sustainable behavior was observed very strategically in the current study, while defining pro-environment behavior, the perceived environmental effectiveness was found to be a significant contributor in explaining pro-environment behavior. Statistically, it was stated as H4: β = 0.179 and p ≤ 0.001. Belief in climate change is the most significant path in explaining citizens' sustainable behavior. Statistically, it was stated as H5: β = 0.591 and p ≤ 0.001. In other words, it can be stated that belief in climate change had the strongest impact while defining pro-environment behavior in the current study. Moreover, while defining climate change mitigation intentions among citizens through sustainable behavior, a strong significant relationship was observed (H6: β = 0.275 and p ≤ 0.001)compared to its ability to explain climate change adoption intentions (H7: β = 0.195 and p ≤ 0.001), as shown in Figure 1 and Table 5.

These findings conclude that low information literacy dampens the positive relationship between environmental effectiveness and sustainable behavior (H8a: β = −0.065). The presence of low information literacy dampens the positive relationship between belief in climate change and sustainable behavior (H8b: β = −0.095).

The presence of an unsupportive regulative environment dampens the positive relationship between sustainable behavior and climate change mitigation (H9a: β = −0.228). The presence of a low regulative environment dampens the positive relationship between sustainable behavior and climate change mitigation (H9b: β = −.135).

5 Discussion

This study demonstrates interesting associations between socio-political and cognitive factors to comprehend citizens' sustainable behavior and their engagement in climate change, e.g., mitigation and adaptation. Empirical findings suggest that all the exogenous variables significantly explain belief in climate change and environmental effectiveness. In explaining belief in Climate Change, environmental quality was observed as the most significant variable, followed by eco-literacy and political trust, respectively. In the case of environmental effectiveness, the explaining power of environmental quality has been observed to be the highest, followed by political trust and eco-literacy. While explaining sustainable behavior, a significant association has been

TABLE 1 Descriptive collected from the research sample (Size: 1532).

Citizen's characteristics (sample)		Associated political party				Count
		PTI (638)	PPP (402)	PML(N) (480)	Others (12)	Total 1532
Gender	Men	379	230	270	7	887
	Women	259	172	210	5	645
Age Group	Under 25	258	149	218	7	632
	25–35	264	132	185	5	586
	Above 35	116	121	77	0	314
Resident	Urban	431	214	259	3	907
	Rural	207	188	221	9	625
I mostly follow government climate change campaigns through	Television	136	103	124	8	371
	Newspaper	81	83	97	4	265
	SNS (Electronic Media)	263	102	113	0	478
	Local interaction	158	114	146	0	418
In the case of Climate Change, the most important factor is	Urbanization	167	121	153	2	443
	Transportation	189	76	112	3	380
	Waste	128	89	67	4	288
	Industry	154	116	148	3	421
Who is more responsible for tackling Climate Change	NGOs	40	21	28	0	89
	Government	178	163	131	2	474
	Citizens	123	134	186	5	448
	All of above	297	84	135	5	521

observed between belief in climate change and environmental effectiveness. The strongest effect was observed for belief in climate change. In distinguishing between the consequences of sustainability, i.e., mitigation and adaptation, this study indicates that citizens are more prone to participate in mitigation strategies than in adaptation strategies.

Interestingly, the results for information literacy and regulative environment do not support the hypotheses and reveal that (low) information literacy dampens the positive relationship between belief, effectiveness, and sustainable behavior and the lack of a supportive regulative environment dampens public participation in mitigation and adaptation strategies as consequences of sustainable responses to Climate Change. From the viewpoint of the SOBC framework, macro and micro environmental factors, i.e., socio-psychological and political, when stimulating the individual organismic characteristics, yield the response and resultant outcomes. Environmental factors influence the cognitive organism of individuals with different magnitudes. Environmental knowledge and quality hold significant explanatory power in explaining belief in climate change, whereas political trust holds little explanatory power. On the other hand, political trust was the second most significant factor in explaining environmental effectiveness. All the external stimulus factors explain the environmental effectiveness, but environmental quality's impact remains the highest. The factors in an organism, like belief and

effectiveness, shape the behavioral response, which further explains respondents' behavioral consequences in the external environment. These environmental consequences thereby explain the natural environment where citizens opt for mitigation or adaptation. The decision depends on institutional support provided to comprehend the impact of climatic stressors and acquire the required information to shape behavior.

Knowledge, political trust, and environmental quality affect the respondent's climate change belief, enhancing the comprehension of protective measures by enhancing their effectiveness. Environmental knowledge enables the collection of knowledge required to realize socio-scientific issues, e.g., climate change. Environmental quality concerns can be seen as public risk perception, as it is necessary to remember the impact of climate change on social and economic settings. The overlapping of these macro and micro environmental factors with belief in climate change and environmental effectiveness endorses citizen behavior aimed toward preserving the environment. From the argument that both the consequences of human behavior and the environment are reciprocal, if respondents believe and feel their climate change actions are effective, they will be more likely to behave in an environmentally friendly manner. This will also be reciprocated by the natural environment in the form of a better ecological system and will encourage political institutions to empower people with

TABLE 2 Exploratory Factor Analysis of the collected sample.

Variable(s)	Items	Loadings (FL)	Cronbach α	Comp. Rel	AVE
Environmental Quality (EQ)	EQ1	.880	.957	.921	.745
	EQ2	.863			
	EQ3	.858			
	EQ4	.851			
Trust in Politics (TP)	TP1	.916	.978	.956	.812
	TP2	.915			
	TP3	.905			
	TP4	.898			
	TP5	.871			
Eco-Literacy (EL)	EL1	.905	.980	.955	.808
	EL2	.904			
	EL3	.898			
	EL4	.898			
	EL5	.890			
Belief in Climate Change (BCC)	BCC1	.827	.935	.859	.669
	BCC2	.815			
	BCC3	.813			
Regulative Environment (RE)	RE1	.925	.966	.933	.777
	RE2	.877			
	RE3	.872			
	RE4	.851			
Pro-Environment Behavior (PEB)	PEB1	.883	.980	.912	.777
	PEB2	.881			
	PEB3	.880			
Climate Change Adaption (CCA)	CCA1	.876	.914	.899	.748
	CCA2	.873			
	CCA3	.845			
Climate Change Mitigation (CCM)	CCM1	.847	.922	.864	.679
	CCM2	.825			
	CCM3	.799			
Information Literacy (IL)	IL1	.847	.955	.906	.707
	IL2	.847			
	IL3	.841			
	IL4	.829			
Environmental Effectiveness (EE)	EE1	.787	.904	.805	.580
	EE2	.750			
	EE3	.747			

Note: FL, factor loadings; Comp. Rel, composite reliability; Avg. Vari. Ext, Average Variance Extracted.

TABLE 3 Model confirmation.

Indices to measure Fitness	Cutoff value	Confirmatory (CFA)	Model (proposed)
CMIN		1649.029	1622.795
Degree of Freedom		331	334
CMIN/df	Less than 5.0 Hair et al., (2014)	4.982	4.859
GFI	Above 0.90 Hu & Bentler, (1999)	.935	.935
AGFI	Above 0.80 Bélanger & Carter, (2009)	.908	.909
CFI	Above 0.95 Hu & Bentler, (1999)	.979	.980
RMSEA	Below 0.8 Hooper et al., (2008)	.051	.050
NFI	Above 0.95 Hu & Bentler, (1999)	.974	.975
TLI	Above 0.95 Hu & Bentler, (1999)	.973	.974
IFI	Above 0.95 Hu & Bentler, (1999)	.979	.980

TABLE 4 External reliability testing.

Constructs	M(SD)	EQ	PT	EK	EE	BCC	PEB	CCA	CCM	IL	RE
Environmental Quality	5.38(1.34)	.863									
Political Trust	4.27(1.58)	.314	.901								
Environmental Knowledge	4.62(1.43)	.298	.459	.898							
Environmental Effectiveness	4.40(1.50)	.432	.430	.419	.881						
Belief in Climate Change	5.48(1.25)	.451	.288	.294	.470	.817					
Pro-Environment Behavior	5.14(1.45)	.401	.232	.293	.289	.448	.881				
Climate Change Adaption	5.30(0.98)	.265	.055	.125	.073	.435	.430	.864			
Climate Change Mitigation	4.96(1.26)	.319	.365	.419	.348	.515	.419	.342	.824		
Information Literacy	5.03(1.20)	.483	.361	.277	.360	.522	.405	.392	.469	.840	
Regulative Environment	5.24(1.39)	.546	.351	.345	.417	.470	.555	.360	.470	.555	.761

more knowledge and belief. These findings are in line with Abid, Schneider, & Scheffran (2016); W. Ullah H. et al (2018); Salman et al. (2018); Furnham & Robinson (2022); and Bacha, Nafees, Hayat, Nawab, & Khan (2018). Although people are highly concerned about environmental quality and possess Climate Change knowledge, they still need to be educated and provided with more information to enhance their beliefs. High levels of concern and knowledge result from their experience of weather variability, but translating this into belief and sustainable behavior requires interventions. Communication between stakeholders should be integral to Climate Change adaptation strategies.

The low explanatory power of environmental knowledge indicates that individuals cannot update their prior knowledge with the newly received information. It can be said that the information being delivered to the individual does not match existing knowledge. The gap is understandable, but the factors behind the low explanatory power of knowledge and higher explanatory power of risk remain unclear. This could be explained from the socio-ecological framework, where the effect of the natural environment and risk perception boost the credibility of climate change messages from institutions.

These findings are in line with Sajid Amin Javed and Shabana Kishwar, (2015); Hasan & Akhter (2011); Khan, Hasan, & Khan (2019); and Maryam (2014). This study suggests the government's proactive role in encouraging Climate Change actions through media, groups, and official information sharing at societal and individual levels as low-level skepticism on Climate Change has been observed. The government should play a significant role in reducing greenhouse gas emissions by introducing and implementing strict emission laws to reduce skepticism further. Media has been identified as an effective source of information by the public. The government should devise strategies and campaigns, utilizing this potential source to spread official climate change information and using media to sensitize the public to climate change issues. As indicated by this study, the public considers institutions as credible sources of information regarding climate change. The institutions are responsible for demonstrating a strong consensus on climate change and delivering strong messages to eliminate its consequences. The official information should be loaded with local elements and should enable individuals to build on their existing knowledge easily.

TABLE 5 Path analysis for the proposed model.

	Hypotheses	Significance	Finding
H1(a)	EL+→EE+	.248***	Supported
H1(b)	EL+→BCC+	.170***	Supported
H2(a)	PT+→EE+	.266***	Supported
H2(b)	PT+→BCC+	.144***	Supported
H3(a)	EQ+→EE+	.288***	Supported
H3(b)	EQ+→BCC+	.310***	Supported
H4	EE+→PEB+	.179***	Supported
H5	BCC+→PEB+	.591***	Supported
H6	PEB+ →CCM+	.275***	Supported
H7	PEB+ →CCA+	.195***	Supported
H8(a)	EE*IL→PEB	−.065*	Not Supported
H8(b)	BCC*IL→PEB	−.095*	Not Supported
H9(a)	PEB* RE →CCM	−.228**	Not Supported
H9(b)	PEB* RE →CCA	−.135***	Not Supported

***, $p \leq 0.001$, **, $p \leq 0.01$, *, $p \leq 0.05$

As a public policy outcome, more support for mitigation indicates less information on adaptive actions. People think the natural environment can only be protected if resources are not exploited; furthermore, people are more willing to give up their existing lifestyle habits than to replace them with more environmentally friendly alternatives. This implicates two important challenges. First, the respondents possess low levels of information literacy or are not provided with the appropriate information on adaptive techniques or measures. Secondly, they feel helpless in identifying the right climate change action in the current regulative environment. Thus, they possess adequate knowledge, have experienced the effects of climate change, and believe that climate change is happening, but still, there is

no available public provision of adequate adaptive measures. This could be determined as eco-anxiety, a situation in which individuals feel helpless and stressed in the face of any climatic stressor. This indicates the role of institutions in facilitating people's understanding of available alternatives and adaptation actions through legislation or collaboration. These findings are in line with Syed Amir, et al. (2016); S. Ali et al. (2017); H. Ullah W. et al (2018); Fahad & Wang (2018); Iqbal et al. (2016); A. Ali & Erenstein (2017); and Lohano (2018). Rosenthal (2022) public intentions to engage with the information that they found aligned with their experience. This study recommends more education, access to Climate Change advisory services, and more information on Climate Change adaptation to ensure sustainability. This demands that the government play a significant role in providing information on Climate Change, particularly in areas with temperature variability to handle Climate Change and its resultant effects. Intervention strategies should focus on increasing citizen endowments and supporting the poor. This study suggests investing more in education and providing more government-backed information along with Climate Change advisory services for risk management. Government interventions must support adaptation by providing input, information, and related services. This study suggests the government must play an active role in promoting effective interventions to enhance the adaptation capacity of citizens. This study further recommends that government should involve different stakeholders to develop and implement effective Climate Change mitigation and adaptation policies.

5.1 Theoretical implications

This study presents various theoretical contributions that can be utilized to improve the understanding of sustainable behavior. First, to the best of our knowledge, this study is a pioneer in incorporating SOBC to explain sustainable behavior, specifically in the environmental context. The current study's findings are distinct from others focused on green consumption or intentions. Second, in the continuity of sustainable behavior, the current initiative explains behavior regarding mitigation
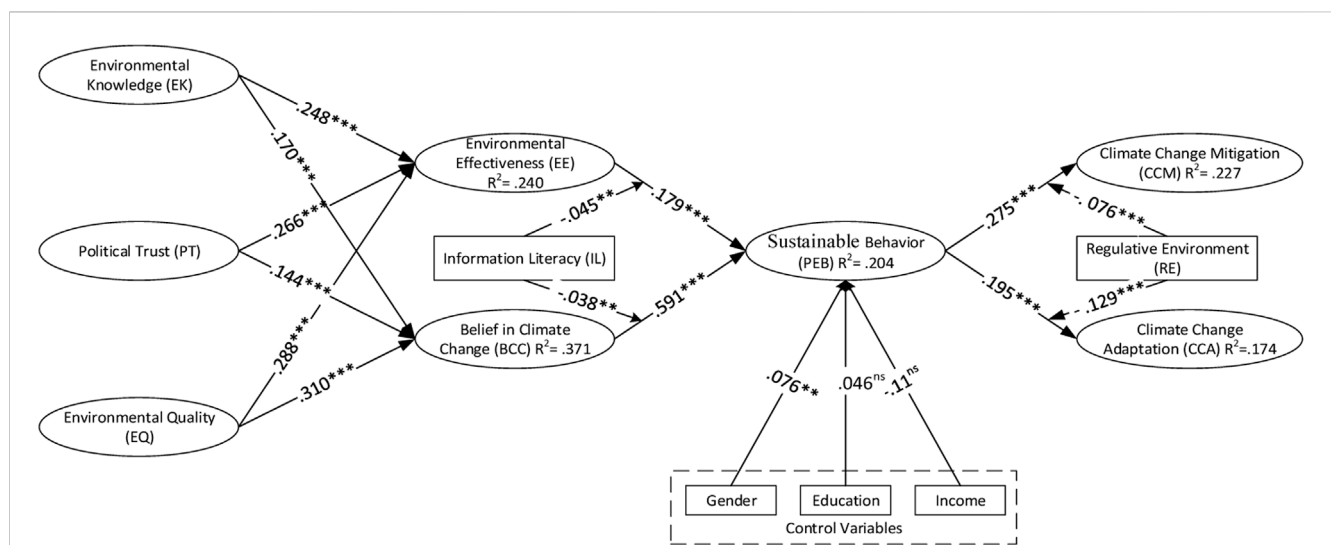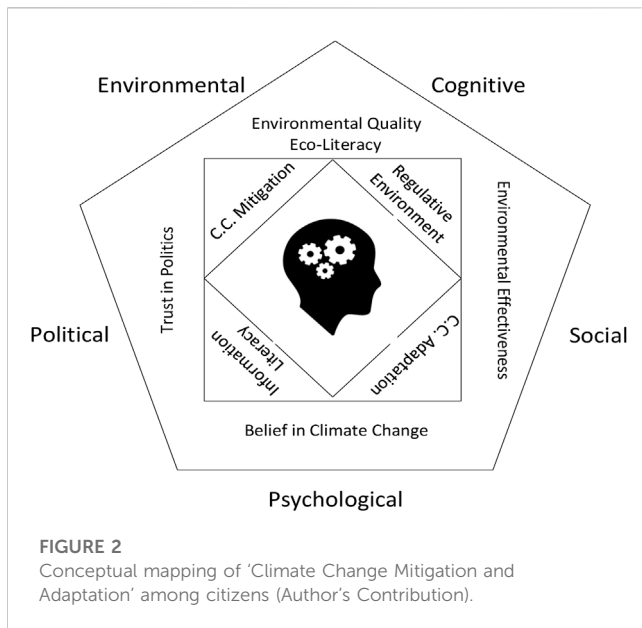

FIGURE 1
Graphical representation of the examined empirical model for the current study.

FIGURE 2
Conceptual mapping of 'Climate Change Mitigation and Adaptation' among citizens (Author's Contribution).

and adaptation. It is very important to understand the mindful disposition of individuals in adopting climate change actions based on their sustainable behavior. Thirdly, this study incorporates unique factors in the SOBC framework, i.e., political trust, environmental quality, and environmental effectiveness, which explain the sustainable behavior of citizens more comprehensively. These socio-ecological factors remain underutilized in explaining individuals' sustainable behaviors. Lastly, this study analyzes the moderating role of information literacy and regulative environment in explaining the behavioral responses of individuals. These factors enhance our understanding of the interplay between cognitive factors and behavioral outcomes.

6 Conclusion

This study applies the SOBC framework to analyze the impact of macro and micro socio-political, psychological, and cognitive environmental factors on sustainable behavioral outcomes. This study identifies environmental quality and belief in climate change as the most influential factors in explaining sustainable behavior, where citizens are found to be more prone to participate in mitigation strategies as the consequential effect. This study recommends the path from environmental quality to belief, sustainable behavior, and ultimately, to mitigation. This study indicates that better communication practices help to create the conditions for political engagement and embrace the modes of such engagement. The political and social support for climate change policies is helpful for sustainable policy implementation. Climate change communication should facilitate individuals already involved in climate change actions to respond effectively and motivate those who feel helpless to perform these actions. These communication practices are helpful in the transformation of action plans by the government and public into more effective and climate-friendly behavioral outcomes. The findings and discussion of the current study can be understood using the below Figure 2. The diagram presents the socio-political, psychological, and environmental understanding of socio-scientific issues, i.e., Climate change. The outermost sphere reflects an individual's society's

environmental, economic, political, social, and psychological conditions, which gives a basic comprehension of their changing environment, economic resources, political culture, and socio-psychological interpretation of these climatic changes.

The inner space is the factor that is necessary to translate the outer sphere indicators into required actions. Belief stands strong, as identified by the current study, but if eliminated, can create space or a black box to convert environmental knowledge, environmental quality, and political trust into sustainable behavior. Then comes environmental effectiveness, which can cause skepticism and a lack of control in improving environmental quality and engagement in promoting sustainable actions. Environmental quality and knowledge are necessary to stimulate climate change belief and encourage citizens to perform climate change actions. High political trust is necessary to boost climate change belief and citizens' effectiveness, but if eliminated, can create political space that could harm the social contract between state and citizens by causing changes in the outer sphere and climate change actions in the inner sphere. Within the inner sphere of climate change actions concerning mitigation and adaptation, information literacy and regulative environment are equally important as they affect these actions by changing the interaction between climate change belief, source credibility, and sustainable behavior.

6.1 Limitations

This study highlights the relationship between socio-political, psychological, and cognitive factors in shaping sustainable behavior. The current study and its contributions have some limitations and future directions, as revealed here. This study analyzes citizens' climate change perception and its effects on sustainable behavior, with primary data collected from a developing region. The interaction between these variables and sustainable behaviors, particularly political trust, should be examined with a longitudinal study to capture the effect of pre- and post-election campaigns and actions. This study uses particular psychological, political, and environmental factors to analyze sustainable behavior. Still, the other contextual factors should also be analyzed, i.e., social trust, institutional quality, and post-materialistic values. Future studies could extend the model by checking the mediation role of climate change belief and environmental effectiveness with the first-level variables defined in this study to explain sustainable behavior.

Data availability statement

The raw data supporting the conclusion of this article will be made available by the authors, without undue reservation.

Ethics statement

Ethical review and approval was not required for this study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the participants was not required to participate in this study in accordance with the national legislation and the institutional requirements.

Author contributions

MA sketch the idea and development model and was involved in the writeup. FA performed the analysis and paper writeup. RZ writes the conclusion and improves the quality. All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication. FT revised the manuscript. RL revised the methods part and editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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