

# The nexus between sustainability dimensions and support for climate action: Perspectives of highway professionals in Ghana

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## ABSTRACT

The impact of climate change on sustainable development is felt across all areas of life, including transportation. The United Nations, however, reports that maximizing on the interlinkages between the 2030 Agenda and the Paris Agreement by leveraging climate action and SDG synergies, has the potential of achieving both agendas. Taking inspiration from the reported synergies and trade-offs, which exist between climate action and the delivery of the SDGs, this study explored the bidirectional relationships between climate action support and the level of importance attached to sustainability criteria by highway professionals in Ghana. Stated preference data was collected from 162 highway professionals in Ghana using a structured questionnaire. The study employed structural equation modelling approach for hypothesis testing. Six sustainability criteria were considered: economics, environment, technical aspects, project implementation, social equity and culture, and resource utilization. The results highlight the complex interplay between sustainability priorities and climate action support in highway development. Economic considerations and resource management practices emerged as key drivers of climate action support. Surprisingly, environmental, technical, social, and project management dimensions did not significantly influence climate action support. However, climate action support positively and significantly influenced attitudes towards all highway sustainability dimensions. This study addresses a major gap in the literature in terms of establishing bidirectional relationships between climate action support and sustainability perceptions, particularly in the field of highway infrastructural development. It also provides insights for regulatory and policy development in developing countries for sustainable highway infrastructure development. The bidirectional relationships imply the need for policies, which consider broader systems by prioritizing actions that target both ends of the relationship. This will promote collaboration across fields, leading to more comprehensive and long-term solutions. Moreover, this study contributes to the broader discussion on integrating climate action with sustainable development goals in the context of highway infrastructure.

## 1. Introduction

The impact of climate change is global, and it is negatively affecting lives and national economies, causing substantial current and future costs to individuals, communities, and nations. All areas of life, including transportation, feel its impact (Rawat et al., 2023). However, Wang et al. (2018) recognise sustainable transportation as a major driver for sustainable development. The 2030 Agenda for Sustainable Development mainstreams sustainable transport across several Sustainable Development Goals (SDGs) and targets. In both developed and developing countries, achieving sustainable transport in urban and rural

areas necessitates sustainable infrastructure development. Sustainable design, construction, operation and maintenance of roads and highways are essential for achieving sustainability in road and highway transport (Ibrahim and Shaker, 2019). This entails incorporating sustainability criteria into the various stages of infrastructure development by road and highway professionals.

In order to address climate change and its effects, SDG Goal 13 demands immediate action (United Nations, 2023a). The Global 2030 Sustainability Agenda recognises the critical role of climate action in achieving a wide range of Sustainable SDGs. It is evident from the literature that there is a strong synergy between climate action and other

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dimensions of sustainable development (United Nations, 2023b). The UN therefore encourages all stakeholders to take action towards reducing the impacts of climate change (United Nations, 2023a). This entails stakeholders', including transport professionals', support for climate change actions and policies at the individual and national levels. Climate action support from highway professionals would ensure robust design and construction that will yield transport infrastructures that are resilient to climate change.

Jones et al. (2022) divides support into two categories: stated and active support, with the former referring to positive attitudes towards protected areas and the latter to actual behaviour (e.g., responsible environmental behaviour when using the protected areas). The findings from several behavioural sciences clearly show that individual factors, including environmental concern, primarily determine the level of stated and active support for environmental policies (Ajzen, 1985; Stern et al., 1999). Several studies, for example (Helm et al., 2018; Liu et al., 2014; Zibenberg et al., 2018), have adopted the definition of environmental concern by Dunlap and Jones (2002) as "the degree to which people are aware of problems regarding the environment and support efforts to solve them and/or indicate a willingness to contribute personally to their solution." Furthermore, the literature demonstrates the normative and empirical interconnection between the commitments of the Paris Agreement and the 2030 Agenda, highlighting synergies between climate actions and most of the SDG's targets. Climate action is indivisible from the achievement of several economic, environmental, health, and social targets (Fuso Nerini et al., 2019). People who care about environmental issues, for example, are likely to support climate policies and actions due to the established interconnection between climate actions and sustainable development goals. It is, however, important to emphasize that few trade-offs exist between climate action and the delivery of the SDGs. Apart from the high cost of some climate actions in the short term, poorly designed climate policies could have negative effects. They may be economically and socially regressive, exacerbating inequality and poverty. Such issues may make it difficult for road and highway professionals to make decisions throughout the infrastructure's life cycle. Even when people consider climate change one of the most important threats facing our planet, climate action is challenging (Fuso Nerini et al., 2019).

Governments have found that public opinion shapes their actions and inaction on the issue of climate change (Fairbrother, 2022). The literature shows that perceptions have significant impacts on both individual and group behaviour and are therefore necessary to be considered in the formulation of climate change policies (Hagen et al., 2016; Kahan et al., 2011). It is not surprising that several studies have focused on investigating factors that determine climate action support among the public. Paloniemi and Vainio (2011) conducted an investigation into the ways that belief in climate change, post-materialist values, trust, and knowledge influence people's engagement in environmental action. Several studies e.g., (Bouman et al., 2020) have reported that biospheric, altruistic, egoistic, and hedonic values contribute to the support for climate action. Ding et al. (2011) conducted an assessment to determine whether perceptions of scientific agreement are associated with support for action to reduce climate change, and if so, to determine if this association is mediated by other climate change beliefs. McCright et al. (2013) confirmed the mediating role of climate change beliefs between perceived scientific agreement and climate action support. Bostrom et al. (2012) reported perceived societal and personal consequences of climate change, along with the perceived effectiveness of policy actions, to explain climate policy action support. Rhodes et al. (2017) conducted an exploration into citizen support for various types of climate policies. The authors found that attitudinal factors, such as values and general environmental concern, contextual factors, and institutional factors, influence climate action support. Additionally, having a sufficient understanding of climate change perceptions is very important when the goal is to generate sufficient public support for climate action.

Despite extensive research on public perceptions and attitudes towards climate action support, there is a notable gap in the literature regarding the specific relationship between highway professionals' perceptions and attitudes towards sustainability and their support for climate action. Numerous studies have explored the link between public perceptions and climate action support, but the unique perspectives of highway professionals – key stakeholders in infrastructure development – have been largely overlooked. This gap is particularly significant given the critical role that highway infrastructure plays in both contributing to and mitigating climate change. Furthermore, the potential bidirectional relationship between sustainability attitudes and climate action support among these professionals has not been adequately explored, especially in the context of developing countries. This study aims to address this gap by investigating the complex interplay between highway professionals' attitudes towards various sustainability dimensions and their support for climate action in Ghana. By focusing on this specific group of professionals and examining both directions of influence, this research provides valuable insights into how sustainability priorities and climate action support interact in the field of highway infrastructure development. Against this background, this study seeks to expand the argument by asking the question of whether such connections exist between highway professionals' level of support for climate action and the perceived importance of dimensions of sustainable development goals.

## 2. Conceptual framework and hypothesis

Values have been reported in behavioural sciences as important for understanding complex societal and environmental behaviours. Values represents things that are considered important to individuals. Each person holds several values with varying degrees of importance. Previous studies show that individuals tend to rate all values at least as "somewhat important," and most values are rated at least as "very important" (Schwartz, 1992; Sagiv and Roccas, 2017). The importance an individual ascribes to specific values is relatively stable across situations (Schwartz, 1992). However, changes in personal values are possible (Schwartz, 2005; Schwartz et al., 2012), when they observe actions that are rewarding.

Schwartz's theory of human values Schwartz (1992) identifies ten broad categories of values, further grouped into four higher-order dimensions: Self-Enhancement, Self-Transcendence, Openness to Change, and Conservation. Relating this theory to the context of this study, the perceived importance of the sustainability criteria can be understood as reflections of the values of the highway professionals. Economic sustainability is driven by the pursuit of personal or collective gain and success reflecting Self-Enhancement (Achievement, Power). Environmental and social sustainability emphasize altruistic and egalitarian values, seeking to protect others and the environment reflecting Self-Transcendence (Universalism, Benevolence). Technical sustainability reflects Openness to Change (Stimulation, Self-Direction) as it focuses on creativity, exploration, and adaptability. Resource management and project implementation reflects Conservation (Security, Tradition) as it prioritizes stability, order, and long-term safety.

Values are desirable goals that motivate action (Sagiv and Roccas, 2021). Individuals are motivated to behave in ways that enable the expression of their values and the attainment of the goals underlying them (Sagiv and Roccas, 2021; Bardi and Schwartz, 2003). The relative importance of multiple values guides action. Values influence action when they are relevant in the context and important to the actor (Schwartz, 2012). Previous studies have shown that values relate to choice behaviour in real-life situations. In the study of Primc et al. (2021), the authors found that Schwartz's individually measured motivational types of values benevolence, universalism, self-direction are predictors of people's pro-environmental behaviour.

Typically, any action has implications for more than one value (Schwartz, 2012). Actions are guided by trade-offs among relevant, competing values. Some individuals, therefore, may recognise trade-offs

or synergies between the importance of sustainability dimensions and climate action. For example, some people might weigh economic benefits against environmental sustainability. In such cases, they might not support climate actions that require significant financial investment in the short term, regardless of the environmental benefits. However, an increase in their support for climate actions may lead to a reconsideration of their priorities (You et al., 2014) – either they balance their sustainability priorities or potentially shift towards more climate-friendly dimensions (Kaiser et al., 2023). This study investigates a bidirectional relationship between highway professionals' perceived importance of the highway sustainability dimensions and their support for climate action. In addition to the climate action support construct (CAS), six (6) highway sustainability dimensions (i.e., economics, environment, technical aspects, project implementation, social equity and culture, and resource utilization) are considered for the development of hypotheses. The remainder of this section sheds more light on the conceptual framework involving the various highway sustainability dimensions and the various hypotheses developed for further investigation.

### 2.1. Economic dimension

The importance of considering climate change implications in economic assessments of infrastructure projects cannot be overemphasized. Aligning economic interests with climate action can lead to more sustainable transportation investments (Ha et al., 2017; Locatelli et al., 2020). If individuals perceive that sustainable infrastructure investments can yield long-term economic benefits (e.g., reduced maintenance costs, job creation), they may be more inclined to support climate action that promotes sustainable and cost-efficient transportation solutions (Salon et al., 2014). However, when an individual places higher importance on economic issues of highway infrastructure development, it does not necessarily mean that the individual would support climate action (Fuso Nerini et al., 2019; IPCC, 2018; PEW Center, 2010). According to Drews and van den Bergh (2016), the public has the perception and belief that environmental and climate policies will negatively impact the economy. This perception usually results in lower climate policy support (O'Connor et al., 2002; Shwom et al., 2010).

In cases where climate actions are perceived as economically beneficial (e.g., creating green jobs, reducing long-term costs), individuals may increasingly prioritize environmental dimensions within sustainable infrastructure projects (Kaiser et al., 2023). Some individuals supporting climate action may be willing to accept higher short-term costs to achieve climate goals. Others may, however, prioritize long-term economic benefits and view sustainable infrastructure as cost-effective. Thus, we hypothesize that,

**H1a.** Perceived importance of economic dimension will significantly and positively influence climate action support.

**H1b.** Individuals who have support for climate actions will place higher importance on economic dimension.

### 2.2. Environmental dimension

Sustainable infrastructure practices, such as using green materials, energy-efficient designs, and emissions reduction measures, directly contribute to climate mitigation efforts. The literature highlights the role of environmental attitudes in advancing climate-friendly transportation projects (Richardson Moberg, 2024). Researchers have reported a close alignment between climate action support and a positive attitude towards environmentally friendly highway development (Rhodes et al., 2017; Salon et al., 2014). Similarly, individuals who are supportive of climate actions are more likely to have positive attitudes towards environmentally friendly highway development practices.

Thus, we hypothesize that,

**H2a.** Individuals who place higher importance on environmental dimension will have more support for climate actions.

**H2b.** Individuals who have support for climate actions will place higher importance on environmental dimension.

### 2.3. Technical dimension

In order to increase the resilience of road networks, there is a need for a standardised and well-described process for developing, revising, and subsequently implementing construction and design standards (Climate ADAPT, 2019; Toplis, 2015). Technical expertise and commitment to design and construction standards are essential for the successful execution of climate adaptation measures. Highway professionals who recognise the importance of, for example, the use of durable materials, adaptability and flexibility for the future, and technology in design and construction for sustainable highway development may support climate action (Chester and Allenby, 2019; Rattanachot et al., 2015; Shi, 2020). In the other direction, support for climate action is likely to translate into a strong commitment by highway professionals to technical indicators for sustainable highways. They are likely to advocate for climate-resilient design standards, materials, and construction methods with an understanding that technical excellence is crucial for designing and implementing infrastructure that can withstand the challenges posed by climate change.

We therefore hypothesize that,

**H3a.** Individuals who place higher importance on technical dimension will be more supportive of climate actions.

**H3b.** Individuals support for climate actions will place higher importance on technical dimension.

### 2.4. Project implementation and management dimension

Project risk assessment, criteria for contractor selection, and compliance with environmental requirements are some of the key indicators in highway project management and implementation (Ametepey et al., 2023; Sanchez et al., 2015). In an era where the words 'organic', 'sustainable', and 'ethical' are ubiquitous, Czinkota et al. (2014), as cited by Geach (2016), suggest that a company's failure to address the threat of climate change can pose a major threat to its reputation. Professionals who prioritize effective project management may recognise that climate regulations and requirements are becoming increasingly common in infrastructure development, and therefore, it is necessary to adhere to them for project success. They are likely to support climate action that ensures that projects meet these requirements. Further, those who support climate action are likely to have positive attitudes towards effective highway project management and implementation strategies (e.g., selection of competent contractors, compliance with project specifications, and environmental requirements). Based on these discussions, this study hypothesizes that,

**H4a.** Highway professionals who emphasize the importance of effective project implementation and management will be more supportive of climate actions.

**H4b.** Highway professionals who support climate actions will place higher importance on effective project implementation and management.

### 2.5. Social equity and culture dimension

Social equity is important for all populations in order to achieve sustainable responses to climate change (Erisken and Brown, 2011). Highway professionals who recognise the importance of social equity and culture in infrastructure development may have the understanding that certain communities are more vulnerable to climate change impacts

due to factors like socioeconomic status or location (Casillas and Kammen, 2012). Their positive attitudes towards social equity and culture can lead to strong support for climate actions that address the needs and vulnerabilities of these communities (Bostrom et al., 2012; Drews and van den Bergh, 2016). They may advocate for climate policies and infrastructure projects that protect culturally significant sites and practices while enhancing climate resilience. When highway professionals actively support climate action, they acknowledge the need to address the negative impacts of climate change on vulnerable and marginalized communities. They understand the importance of reducing disparities and ensuring equitable access to climate resilience measures (Fiack et al., 2021). Their support for climate action fosters a positive attitude towards social equity and cultural issues.

**H5a.** Highway professionals who emphasize the importance of social equity and culture dimension will be supportive of climate actions.

**H5b.** Highway professionals who have support for climate actions will emphasize on the importance of social equity and culture issues.

## 2.6. Resource utilization and management dimension

The urgency of adopting sustainable practices in resource utilization has never been greater, given the alarming rate at which the world's natural resources are depleting. Sustainable resource management is a multifaceted approach that involves responsible utilization and preservation of natural resources (Parvaiz, 2024). Adopting sustainable resource management practices, such as integrating supply chains, using local materials, material quality control, and using recycled construction materials in highway development, can significantly mitigate the adverse effects of climate change (Okogwu et al., 2023; Gálvez-Martos et al., 2018). Positive attitudes developed by highway professionals towards sustainable resource management practices are likely to translate into strong support for climate action, as they see the direct link between responsible resource utilization and management and mitigation of the environmental impact of highway projects (Bouman et al., 2021). Similarly, highway experts who support climate action align with the broader goals of reducing greenhouse gas emissions, conserving natural resources, and improving environmental sustainability, which require sustainable resource utilization and management practices. They may actively seek ways to reduce waste, promote recycling in highway design and construction, and, overall, preserve the environment.

**H6a.** Highway professionals who emphasize the importance of resource utilization and management dimension will be supportive of climate actions.

**H6b.** Highway professionals who have support for climate actions will emphasize on the importance of resource utilization and management dimension.

## 3. Methodology

### 3.1. Research design and measurement scales

This study focused on six sustainability criteria: economics, environmental, social equity and culture, technical, project implementation and management, resource utilization and management, and climate action support (CAS). First, we identified prospective indicators from the literature and other existing guidelines pertaining to highway sustainability and climate action (Appendix 1). The identified indicators were sent to six (6) highway construction professionals and three (3) experts in academia for them to evaluate their appropriateness and suggest additional indicators suitable for the Ghanaian context. A structured questionnaire was then developed to obtain information from the highway professionals for modelling. The questionnaire was structured into four main sections. Section A contained the purpose of the study and the written consent about confidentiality relating to data. Section B

focused on obtaining the demographic information of the highway experts. These included their level of affiliated organisation, education achieved, years of experience, and professional body membership. Section C of the questionnaire collected data about the indicators of the constructs representing the sustainability criteria (dimensions) for highway planning, design, construction, maintenance, and operations. In order to measure the sustainability constructs, the highway experts were asked to indicate the level of importance of each indicator in contributing to sustainable highway infrastructure development using the nominal scale, coding 1 as "least important," 2 as "moderately important," 3 as "important," 4 as "very important," and 5 as "extremely important," to measure the sustainability constructs. Higher scores for all the constructs indicate a higher perceived level of importance in sustainable highway infrastructure development. In order to measure climate action support (CAS) the highway experts were presented with measurement items, which required them to indicate their level of agreement or disagreement to statements pertaining to climate change mitigation and adaptation actions. For the climate action support construct, higher scores indicate a higher level of support for climate action. Table 1 (see supplementary material) illustrates the use of four items (EC1, EC2, EC3, and EC4) to measure the economic construct. Five items (i.e., ENV1, ENV2, ENV3, ENV4, and ENV5) measured environmental constructs. Six (6) items (i.e., T1, T2, T3, T4, T5, and T6) measured the technical construct. Similarly, six (6) items (i.e., PIM1, PIM2, PIM3, PIM4, PIM5, and PIM6) measured the project implementation and management construct. Finally, we measured climate action support (CAS) using eleven (11) items that involved mitigation and adaptation actions.

### 3.2. Data collection

Convenience sampling was used to obtain the total number of highway professionals registered under various professional bodies. This method was chosen because the list of registered professionals was readily available on the websites of the professional associations. The selection of participants for this research was guided by specific criteria, focusing on the qualifications and experience of individuals in road and highway planning, design, and construction within the Ghanaian context. Participants were supposed to be highway professionals including engineers, planners, surveyors, academics/research scientists, policymakers and contractors, with at least 5 years of experience. They were to be at the managerial or senior professional level such as senior engineers, department head, project managers and senior academics/research scientist. Purposive sampling method was employed to target key stakeholder organizations, and to ensure that participants of the survey had the necessary knowledge and experience to provide in-depth and valuable information on the development of sustainable highway infrastructure. The research was primarily conducted in Accra, where the headquarters of the various highway organizations are predominantly located.

Through consultation with experts, stakeholders, and review of membership lists from the Ghana Institution of Engineering (GhIE), Ghana Institution of Surveyors (GhIS), and Institution of Engineering and Technology-Ghana (IET-GH), a population of 400 highway professionals was identified who met the inclusion criteria (GhIE, 2023; GhIS, 2021; IET-GH, 2023). Given the manageable size of the identified population, a complete enumeration (census) approach was adopted to maximize response representation.

The questionnaire survey link, accompanied by a participant information sheet and research advertisement, was distributed via email to all 400 identified professionals. The target population comprised stakeholders across the Ghanaian highway industry, including professionals from private and government highway consultancy firms, highway construction companies, research and academic institutions, the Environmental Protection Agency, Ghana Standards Authority, Water Resources Commission, and the Forestry Commission. The survey

**Table 1**  
Convergent validity assessment.

Dimension	Indicator	Factor loading	CA	CR	AVE
CAS	<b>AD1:</b> I encourage the use of appropriate network data and hazard assessments by highway designers and planners with a focus on vulnerable communities for rapid recovery during disasters.	0.76			
	<b>AD2:</b> There is a need to develop education and training for road agencies and contractors in the areas of climate change adaptation and mitigation and the environment.	0.79			
	<b>AD3:</b> Managing stormwater locally through the use of natural vegetation to create sustainable drainage systems in the construction of highways and roads is a strategy really advocated for.	0.631			
	<b>M1:</b> I support road designs that harness local topography to reduce energy requirements during the construction phase.	0.669			
	<b>M2:</b> I suggest engineers and planners identify and incorporate the needs of vulnerable people and local communities at the planning stage to provide equal accessibility and meet the differentiated mobility needs of different users.	0.707			
	<b>M3:</b> I suggest the implementation of performance-based award criteria around material reuse, energy saving, or alternative energy use in road work contracts.	0.752	0.927	0.927	0.539
	<b>M4:</b> I think there is a need to incorporate emissions criteria in procurement and purchasing during highway projects.	0.761			
	<b>M5:</b> I support construction methods that support the social context of the project and how it is placed in the local environment.	0.838			
<b>M6:</b> Road authorities must ensure that plans and policies for mitigating climate change are applied and monitored during the highway construction phase.	0.757				
<b>M7:</b> I think it is important for road agencies to develop the skills and expertise to use design software that rapidly identifies the most energy-efficient route design from a number of otherwise equally viable alternatives.	0.786				
<b>M8:</b> When considering the greenhouse gas emissions from lighting, the amount (or number) of lights, the type of lights used, the	0.586				

**Table 1 (continued)**

Dimension	Indicator	Factor loading	CA	CR	AVE
ECON	wattage of the lamps (bulbs) used, and the operating hours of the lights all need to be considered.				
	<b>EC1:</b> Lifecycle costs	0.72	0.721	0.819	0.531
	<b>EC2:</b> Material costs	0.75			
	<b>EC3:</b> Construction time	0.7			
<b>EC4:</b> Maintenance and operation costs	0.744				
ENVRN	<b>EN1:</b> Dust control	0.6	0.765	0.810	0.519
	<b>EN2:</b> Environmentally friendly materials	0.668			
	<b>EN3:</b> Ecological functions drainage corridor	0.788			
PM	<b>EN4:</b> Environmental monitoring measures	0.805			
	<b>PM1:</b> Comply environmental requirements project specification	0.718			
	<b>PM2:</b> Sustainable policy and strategy	0.75			
	<b>PM3:</b> Meeting project duration	0.68	0.8	0.837	0.507
	<b>PM4:</b> Project risk assessment	0.757			
RM	<b>PM5:</b> Criteria for contractor prequalification	0.649			
	<b>RM1:</b> Supply chains	0.63	0.7	0.753	0.508
	<b>RM2:</b> Local materials	0.65			
<b>RM3:</b> Material quality control	0.84				
SC	<b>SC3:</b> Traffic congestion design operations	0.804			
	<b>SC4:</b> Traffic congestion construction	0.818	0.769	0.790	0.560
TECH	<b>SC5:</b> Public participation	0.604			
	<b>T1:</b> Durable materials	0.631	0.734	0.804	0.513
	<b>T3:</b> Climate change resilient designs	0.552			
	<b>T4:</b> Technology design construction	0.843			
	<b>T5:</b> Adaptability flexibility	0.8			

Note(s): CA: Cronbach's Alpha; CR: Composite Reliability; AVE: Average Variance Extracted.

garnered 162 completed responses, representing a 41 % response rate, which exceeds the typical response rates of 20–30 % observed in construction sector research (Assaad et al., 2020).

Prior to launching the main survey, a pilot study was conducted to evaluate the questionnaire's clarity, comprehensiveness, and completion time (Franz et al., 2022). The pilot study findings informed necessary modifications to enhance the questionnaire's effectiveness. Following data collection, the responses were extracted in CSV format and underwent systematic data cleaning and validation procedures to ensure data quality and reliability for subsequent analysis.

### 3.3. Method of data analysis

Descriptive statistics was initially performed to examine the demographic profile of the participants. In order to determine how the perceptions of highway professionals about the importance of the various sustainability criteria relate to their support for climate action, there was a need to develop a model that could establish such complex connections. As recommended by Anderson and Gerbing (1988), structural equation modelling (SEM), which is a two-step approach was used to analyse the data using SPSS AMOS version 25. SEM was used because of its extensive application in multivariate analysis in psychological and behavioural studies. The maximum likelihood estimation method was used to conduct a confirmatory factor analysis for developing the

measurement model and checking the reliability and validity of the measurement items (Hair et al., 2014). This study employed the maximum likelihood estimation method with an assumption that the data is continuous and multivariate normal (Rhemtulla et al., 2012). The second step involved the development of the structural model, which sought to investigate the hypotheses mentioned in the previous section, using the standardised regression coefficients and the *p*-values. The results of the modelling effort are presented in the subsequent subsections.

## 4. Results and discussions

### 4.1. Demographic profile

A total of 162 valid responses were imported into the Statistical Package for Social Sciences (SPSS) version 26 for the purpose of conducting the analysis. The majority (53 %) of the respondents were contractors, followed by those from road agencies (24 %), consultants (11 %), researchers/academia (8 %), and those from environmental agencies (4 %). The years of experience distribution of the respondents indicate that most (63 %) of the respondents have worked in Ghanaian highway industry for more than 10 years.

The majority (64 %) of the respondents are members of the Ghana Institution of Engineering. Further, 17 %, 6 %, and 4 % of the respondents are members of the Institution of Engineering and Technology, the Chartered Institute of Building—Ghana Chapter, and the Ghana Institution of Surveyors, respectively. The rest are either not members of any professional bodies, or part of other associations. This indicates that the data covers opinions from different professionals who come together to contribute to highway infrastructure development from varied perspectives in Ghana. The educational profile depicts respondents who are well educated, can read relatively well, and have a higher understanding of the questionnaire with no interpretation. Specifically, more than half (65 %) of the respondents have a master's degree or above. Only 2 % have a diploma, and the rest have a bachelor's degree.

### 4.2. Measurement model (CFA)

The result of the CFA is the measurement model, which defines how measured items (indicators) and constructs (latent dimensions) are related to each other. It provides the link between scores on the measured items and the underlying constructs they are designed to measure (Byrne, 2010), and among the constructs (i.e., Perceived Importance of Economics, Environmental, Technical, Project Implementation and Management, Social Equity and Culture, Resource Utilization and Management, and Climate Action Support). Altogether, 75 parameters were estimated, consisting of 24 regression weights, 8 covariances, and 16 variances. In addition, the number of measured and latent dimension variables was 34 and 7, respectively.

There was a need for respecification since the modification indices (MI) values greater than 15, indicated high covariances (significant at *p*-values < 0.001) between the error terms of some measured indicators of various latent dimensions. Covariance was therefore introduced between the error terms of the measurement indicators: T1 and T4; PM1 and PM4; PM2 and PM5; AD3 and M7; AD3 and M8; M3 and M7; and M5 and M6. In addition, this study considered a factor loading of 0.5 as the minimum value to retain an indicator in the model. Based on the aforementioned issues, some of the items were removed from the model to improve the overall fit of the model. The environmental dimension, which initially had five items, was left with four items. Two items were removed from the initial six items in the technical dimension. An item was also removed from both social equity and culture criteria and the resource utilization and management criteria constructs. The remaining measurement items for each sustainability dimension are as presented in Table 1.

After the re-specifications, the measurement model obtained exhibited an acceptable goodness of fit. Jenatabadi and Ismail (2014)

suggested that there should be a minimum of four tests that are acceptable for the model fit. The loadings of all items on their respective dimensions were statistically significant (*p*-value < 0.001) given C.R. > 1.96 as shown in Table 1. The performance indices of the measurement model were found to be in acceptable ranges. The model fit indices are as follows: Chi-square/degree of freedom (CMIN/DF) = 1.790; comparative fit index (CFI) = 0.963; adjusted goodness of fit index (AGFI) = 0.906; normed fit index (NFI) = 0.802; root mean square error of approximation (RMSEA) = 0.070. The convergent and discriminant validity were assessed to check the construct validity. The model was considered to have no convergent validity issues if the constructs had an average variance extracted (AVE) above 0.5. On the other hand, the square root values of their AVEs are expected to be greater than their individual and inter-construct correlation values in order to have no discriminant validity issues (Fornell and Larcker, 1981). The reliability of each construct was evaluated through the Cronbach's alpha value and confirmed by the composite reliability, both of which are expected to be above 0.7. Table 1 displays the results of convergent validity and reliability. The Cronbach's alpha values and composite reliability were all found to be above 0.7, indicating that the constructs are all reliable. Furthermore, the constructs' AVEs, as shown in Table 1, are all above the threshold of 0.5, indicating that the model has no convergent validity issues. Table 2 shows the inter-construct correlation matrix used for assessing the discriminant validity. For each construct, the square root of AVEs presented in the diagonal (and boldface) was compared with the highest inter-construct correlation in the correlation matrix (Malhotra and Sharma, 2023). The result reveals no concerns about the model's discriminant validity. This facilitated the development of the structural model. The next subsection presents the results of the structural model.

### 4.3. Structural models for hypothesis testing

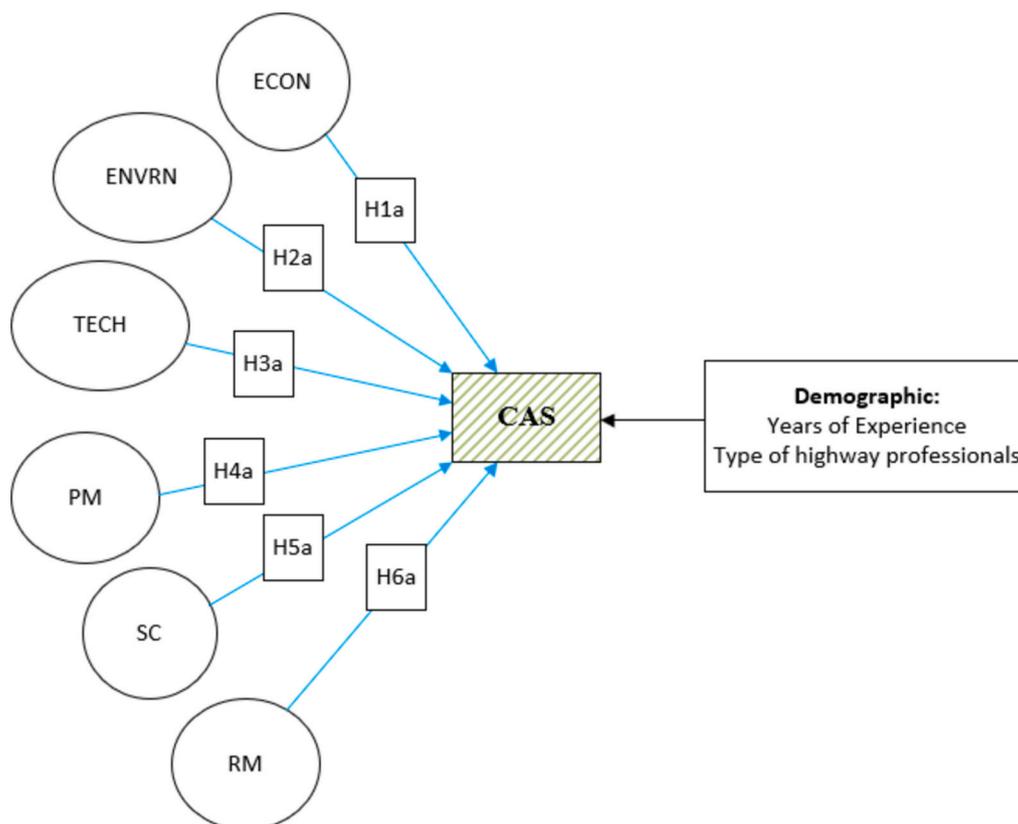
This section presents the results of two structural models that sought to explore the relationship between the perceived level of importance of the sustainability dimensions and support for climate action. Model 1 examines the hypothesis that the perceived importance of all sustainable highway dimensions among highway professionals significantly and positively influences their support for climate action. On the other hand, the second model (Model 2) tests the hypotheses that the highway professionals' level of support for climate actions will significantly and positively determine their perceived level of importance of the sustainable highway dimensions.

#### 4.3.1. Influence of perceived importance of sustainability dimensions on climate action support (Model 1)

Fig. 1 and Table 3 present the results of Model 1, which highlight the relationship between the perceived importance of sustainability dimensions and climate action support. Unstandardised coefficients, C.R. values, and *p*-values are shown in Table 3, whereas Fig. 1 presents the standardised coefficients. The results show that only two of the independent variables in the model significantly and positively influence the dependent variable (i.e., climate action support), with all other variables remaining constant while accounting for years of experience and the type of highway professional. The paths with significant relationships are coloured "blue" in Fig. 1, and they are: ECON → CAS ( $\beta = 0.159$ ; *p*-value = 0.016), and RM → CAS ( $\beta = 0.429$ ; *p*-value = 0.02). These findings validate the hypotheses H1a and H6a. This implies that highway professionals who place higher importance on the economic dimension will have more support for climate action; all other factors are held constant. Specifically, the results suggest that highway professionals who place much emphasis on reducing life cycle costs, material costs, construction time, and maintenance and operation costs are likely to support climate action. This association may suggest that these professionals view climate action as beneficial, possibly anticipating favourable economic consequences. Highway professionals may

**Table 2**  
Discriminant validity assessment.

Dimension	MSV	MaxR(H)	PM	ECON	ENVRN	TECH	CAS	RM	SC
PM	0.504	0.841	<b>0.712</b>						
ECON	0.340	0.820	0.566	<b>0.729</b>					
ENVRN	0.504	0.829	0.710	0.407	<b>0.720</b>				
TECH	0.500	0.842	0.702	0.396	0.650	<b>0.717</b>			
CAS	0.449	0.933	0.613	0.462	0.519	0.561	<b>0.734</b>		
RM	0.504	0.791	0.709	0.583	0.613	0.707	0.670	<b>0.713</b>	
SC	0.504	0.816	0.689	0.518	0.673	0.671	0.498	0.710	<b>0.748</b>



**Fig. 1.** Conceptual framework path diagram sustainability dimension to climate action support.

**Table 3**  
Model output for hypotheses testing (Model 1).

Endogenous variable		Exogenous variable	B	S.E.	C.R.	P	Findings on hypothesis
CAS	<—	SC	-0.238	0.169	-1.408	0.159	H5a: Rejected
CAS	<—	ECON	0.159	0.066	2.403	0.016	H1a: Supported
CAS	<—	TECH	0.055	0.104	0.526	0.599	H3a: Rejected
CAS	<—	PM	0.186	0.153	1.214	0.225	H4a: Rejected
CAS	<—	ENVRN	0.064	0.098	0.657	0.511	H2a: Rejected
CAS	<—	Stakeholders	0.018	0.03	0.587	0.558	n/a
CAS	<—	Experience	-0.026	0.028	-0.911	0.362	n/a
CAS	<—	RM	0.429	0.185	2.32	0.02	H6a: Supported

anticipate financial benefits from climate actions, which could include savings in cost from energy-saving techniques, lower maintenance expenses from climate-resilient infrastructure, and perhaps even getting access to incentives or funding linked to environmentally friendly and sustainable activities (Cimato and Mullan, 2010). The anticipated economic benefits of the climate actions will eventually promote climate action support among highway professionals (Bergquist et al., 2020; Stokes and Warshaw, 2017). This means that climate policies that eventually increase, for example, the total life cycle cost, construction

time, and maintenance costs are not likely to be supported by highway professionals. This finding is consistent with the literature that suggests that economic factors play a significant role in shaping public support for climate action. For instance, Simon (2023), Tobler et al. (2012), and Bemelmans-Videc et al. (2011) opined that policies that imply more direct monetary costs tend to be less supported. Similarly, Bergquist et al. (2020) mentioned in their study that including economic policies unambiguously expands support for bundled climate policies.

The resource utilization and management dimensions include factors

like supply chain management, local material consumption, and quality control of the materials. These have a crucial role in deciding how effectively and sustainably resources are used in highway construction projects. The model indicates that highway professionals who emphasize the importance of resource utilization and management dimensions are also inclined to endorse actions aimed at mitigating and/or adapting to climate change. The increasing constraints on the environment and resources are now contributing to the mainstream trend of sustainable development to promote efficient resource management practices (Ali et al., 2021; Wang et al., 2022). This finding indicates the need to explicitly address climate change in management plans in order to protect biodiversity and natural resources for future generations (Cross et al., 2012; Lawler et al., 2010). Effective resource utilization and management practices promote climate-friendly behaviour (Cross et al., 2012). For example, using locally produced materials can reduce transport-related emissions, and effective supply chain management can reduce environmental impacts.

The dimensions SC, TECH, PM, and ENVRN are surprisingly not significant in predicting CAS, as shown in Table 3 and Fig. 1. As such, hypotheses H2a, H3a, H4a, and H5a were not validated. This means that the level of climate action support of highway professionals is not significantly determined by the level of importance they assign to social equity and culture dimensions, technical dimensions, project implementation and management dimensions, and environmental dimensions. These results are not as we expected because, for example, climate change is actually seen globally as an extension of other social concerns (Williams and Schaefer, 2013), and has been viewed globally as one of several inter-linked crises that exacerbate poverty, inequality, and social vulnerability (Brulle and Pellow, 2006; Mohai et al., 2009). Further, climate actions have been reported to improve global health outcomes by reducing local pollution in cities. For these reasons, highway professionals who place much importance on the safety and health of workers, reduction of traffic congestion during construction and operation, and safety risk assessment and mitigation were expected to support climate action. Contrary to the results of Model 1, Bergquist et al. (2020) reported that the inclusion of social policies in a bundled climate policy increased support significantly. From another angle, the results could mean that highway professionals might perceive potential trade-offs between social equity considerations and climate action. For example, certain climate mitigation and adaptation measures, if not properly designed, may be perceived to have negative social impacts, and this perception could reduce the overall support for climate action within the social equity and culture dimensions (Eriksen et al., 2021; Fuso Nerini et al., 2019; Sovacool, 2018). In addition, individuals who place high importance on their cultural heritage might not support climate projects that negatively and significantly affect culture.

Similarly, the insignificant role of the importance of the environmental dimension is inconsistent with the many studies that have reported that high levels of environmental attitudes and concerns tend to promote support for climate action (Chen et al., 2011; Colvin and Jotzo, 2021; Hornsey and Fielding, 2020; Prati et al., 2017). On the other hand, there can be only a weak link between concerns about environmental problems and support for potential solutions (Fairbrother, 2022). The finding of this study corroborates the assertions made by other studies (e.g., Kollmuss and Agyeman, 2002; Tam and Chan, 2018; and Gifford and Nilsson, 2014) that environmental concerns may not always translate into support for environmental solutions in societies with constraints in economic resources (e.g., time, money, and enabling facilities). There are therefore competing priorities, whereby other issues are perceived as more pressing. Further, some professionals might perceive climate change to be too distant (i.e., a problem affecting faraway regions or future generations) (Duncan et al., 2024; Leiserowitz et al., 2021; Loy and Spence, 2020), reducing their motivation to support climate actions. Environmental fatalism could also be a contributing factor for this insignificant relationship (Pajardi et al., 2020). When individuals believe that the degradation of the environment is

inevitable, their motivation to support climate actions reduces.

Furthermore, the highway professionals' support for climate action was found to be not significantly influenced by the project management or technical aspects. This could be attributed to the probable existence of perceived trade-offs between climate action and certain project management and technical practices. For instance, it is possible for environmentally friendly practices to compete significantly with project duration or efficiency-focused construction methods, which could weaken support for overall climate action. Similarly, highway professionals may have the perception that specific climate-resilient design could interfere with project budgets or schedules, which would lessen the focus on the technical aspect of climate action. Others may not fully understand how technical or project management sustainability contributes to climate resilience (Silvius and Schipper, 2014), reducing their inclination to support the action.

Generally, the insignificant relationships reflect issues of value-action gap (Essiz et al., 2023), which is defined as the inconsistency between people's reported concerns about key environmental, social, economic or ethical concerns and the lifestyle or purchasing decisions that they make in practice (AFRY, 2022; Franco and Ghisetti, 2022). Relating it to this study, the highway professional might acknowledge the importance of the sustainability criteria but may not feel motivated to support climate action. This as explained previously, could be the result of a number of factors including individuals having competing values that support different actions; lack of trust that acting in accordance with values will be effective; practical barriers (e.g., cost, time, access); environmental fatalism; among others.

Cognitive dissonance could also be at play when the highway professionals do not see the relevance of supporting climate action, although they prioritize the sustainability criteria (Weder et al., 2020; Bentler et al., 2023). For example, highway professionals who believe in promoting environmental sustainability by integrating eco-friendly materials and green infrastructure may end up approving the use of conventional, less sustainable materials or skips sustainability features altogether, due to financial constraints or pressure from stakeholders like politicians. Deciding to prioritize cost-efficiency, fully aware of its contradictions from their personal and professional commitment to sustainability, creates dissonance inside the mind of the highway professionals. To compensate for their "bad" decision, they might rationalize the decision by telling themselves that the project's main goal is transportation efficiency, and sustainability can be addressed in future upgrades.

#### 4.3.2. Influence of climate action support on perceived importance of sustainability dimensions (Model 2)

The results of Model 2 are presented in Fig. 2 and Table 4. Similar to Model 1, unstandardized coefficients, C.R. values, and *p*-values are presented in Table 4. Fig. 2 presents the standardised coefficients, with the path forming significant relationships ( $p < 0.05$ ) coloured "blue." Unlike Model 1, all path coefficients, as shown in Fig. 2 and Table 4, are found to be significant ( $p < 0.05$ ). The independent variable (i.e., climate action support) significantly and positively influences all the dependent variables, with all other variables held constant while accounting for years of experience and the type of highway professional. In other words, the dimensions ECON, RM, SC, TECH, PM, and ENVRN are all significantly and positively predicted by CAS. These findings mean that hypotheses H1b, H2b, H3b, H4b, H5a, and H6a were validated.

The positive relationship between climate action support and the economic dimension indicates that as highway professionals become more supportive of climate action, they tend to be more inclined to prioritize economic factors. This finding implies that highway professionals recognise the interconnectedness of climate action and economic dimension (reflected in the consideration of reduced material cost, life cycle cost, construction time, and maintenance and operation cost) in achieving broader sustainable development goals.

Furthermore, the study suggests that highway professionals who

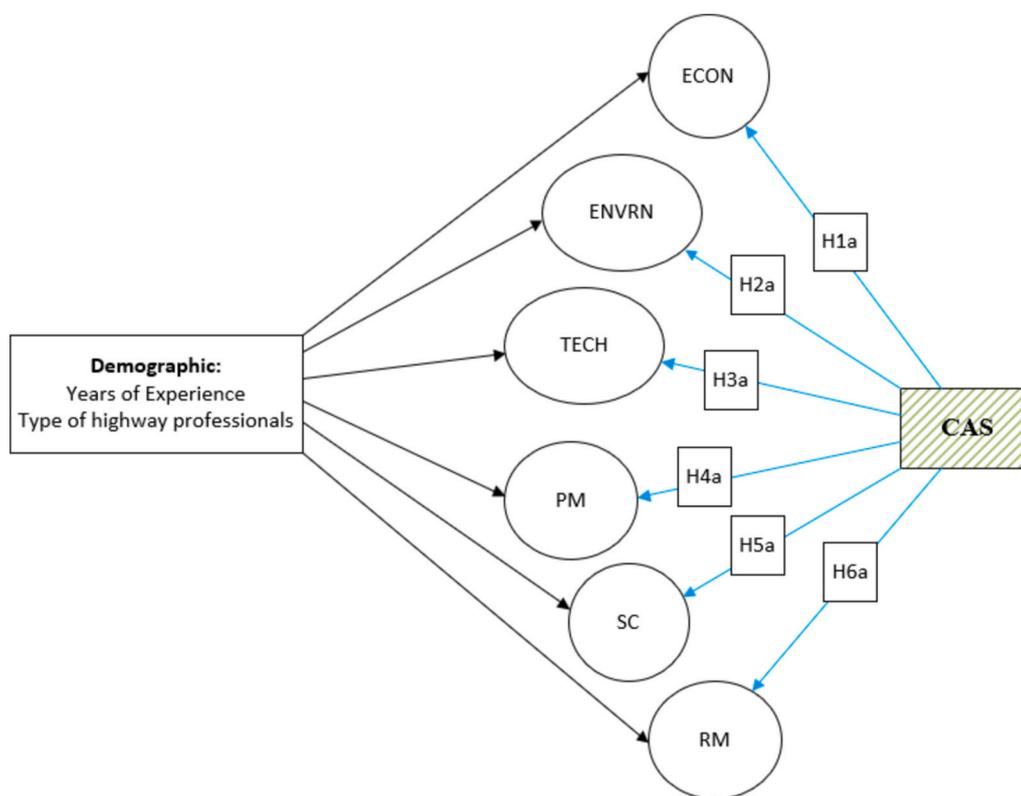


Fig. 2. Conceptual framework path diagram climate action support to sustainability dimension.

Table 4  
Model output for hypotheses testing (Model 2).

Endogenous variable		Exogenous variable	B	S.E.	C.R.	P	Findings on hypothesis
RM	<←	CAS	1.002	0.157	6.389	***	H1b: Supported
SC	<←	CAS	0.684	0.139	4.928	***	H2b: Supported
ECON	<←	CAS	0.728	0.157	4.648	***	H3b: Supported
ENVRN	<←	CAS	0.936	0.165	5.692	***	H4b: Supported
TECH	<←	CAS	1.017	0.156	6.522	***	H5b: Supported
PM	<←	CAS	0.987	0.16	6.187	***	H6b: Supported
RM	<←	Stakeholders	-0.033	0.043	-0.77	0.441	n/a
SC	<←	Stakeholders	0.05	0.04	1.26	0.208	n/a
ECON	<←	Stakeholders	0.074	0.055	1.34	0.18	n/a
ENVRN	<←	Stakeholders	0.073	0.053	1.372	0.17	n/a
TECH	<←	Stakeholders	-0.016	0.048	-0.343	0.731	n/a
RM	<←	Experience	0.044	0.04	1.093	0.274	n/a
SC	<←	Experience	0.079	0.038	2.108	0.035	n/a
TECH	<←	Experience	0.11	0.045	2.464	0.014	n/a
PM	<←	Experience	0.077	0.039	1.982	0.047	n/a
ENVRN	<←	Experience	0.082	0.05	1.651	0.099	n/a
ECON	<←	Experience	0.188	0.053	3.526	***	n/a
PM	<←	Stakeholders	0.063	0.041	1.524	0.127	n/a

support climate action are more inclined to adopt practices that improve resource utilization and management in highway infrastructure development (Watson et al., 2012). This alignment is an indication that climate action support extends beyond environmental concerns to influence decisions related to material sourcing, quality control, and management (Y. Wang et al., 2022). The use of local materials is most often associated with a reduced impact on the environment due to lower transport-related emissions. Contributing to climate mitigation efforts, highway professionals may recognise the value of sourcing materials locally to minimise the carbon footprint associated with transportation. Effective supply chain management is important for making infrastructure projects resilient and flexible (Thacker et al., 2021). The highway professionals who support climate action may have understood how important it is to have resilient supply chains in case of climate-

related uncertainties, like bad weather or problems getting materials. The level of support for climate action significantly influenced the social equity and culture dimensions, as expected. One possible reason is that highway professionals may have noticed an overlap between the objectives of social equity and climate action (Fiack et al., 2021; Swanson, 2021). For instance, efforts to reduce congestion during construction or enhance worker safety can have both climate mitigation and social benefits. The results further suggest that highway professionals who support climate action prioritize public involvement in highway infrastructure project decision-making processes to uphold social equity and consider diverse opinions. This is consistent with most of the climate action initiatives, which often emphasize the importance of engaging communities and public participation at every stage of the projects (Chitsa et al., 2022; Hügel and Davies, 2020).

The positive and significant influence of climate action support on the technical dimension could be the reason that highway professionals who express greater support for climate action are likely to acknowledge that there is a need for highway infrastructure that can withstand climate change effects. This entails utilising durable materials and integrating climate-resilient design to guarantee the longevity and functionality of infrastructure in the face of changing environmental conditions (OECD, 2018). Secondly, climate-conscious professionals may put much emphasis on the need for innovative technologies and advancements in construction and design (Thacker et al., 2021). This involves the use of state-of-the-art materials and techniques that promote climate resilience while enhancing the overall technical performance.

Moreover, project management was found to be significantly influenced by climate action support. Highway professionals who support climate action are likely to adopt project management practices that ensure compliance with environmentally focused regulations and standards, thereby driving the incorporation of environmental considerations into project planning and execution (Williams and Schaefer, 2013). Additionally, they are likely to advocate for sustainable policies and strategies that align with climate goals. These policies will guide project management decisions, ensuring that climate issues are considered throughout the project's life cycle.

Finally, Model 2 revealed that climate action support has a positive and significant impact on the level of importance that highway professionals place on the environmental dimension. Support for climate action often correlates with adherence to environmental regulations and standards, as predicted by Vezirgiannidou (2009). Highway professionals with support for climate action are therefore likely to commit to practices that promote biodiversity, habitat preservation, and ecosystem services. Climate action goals require integrating ecological considerations into drainage corridors, which contributes to overall environmental sustainability.

#### 4.4. Study contributions

This research makes several important contributions. This work is the only study to date in the field of climate change to investigate how perceived importance of highway sustainability criteria relate with climate action support. The effort of examining bidirectional relationships between climate action support and perceived importance of highway sustainability criteria provides a more comprehensive picture of the dynamics at play. It extends the theoretical understanding of climate action support from the perspective of the crucial yet less studied group of highway professionals. By focusing on Ghana, the study offers valuable context-specific insights into sustainability and climate action in developing countries, addressing a significant gap in the literature.

The findings have important implications for policy and practice. They suggest that policies aligning with economic factors and resource utilization with climate goals may be particularly effective in promoting climate action support. For industry professionals and organizations, the research highlights the values of highway professionals in terms of sustainability criteria, which independently drive support for climate action. This also serve as a valuable information for policy makers about the specific sustainability criteria, which should be bundled with climate policies to successfully promote climate action support among highway professionals.

This study contributes to a more in-depth understanding of the factors driving climate action support among highway professionals and the potential for climate initiatives to influence broader sustainability values of highway professionals. As the global community continues to grapple with the challenges of climate change, these insights offer a valuable foundation for developing effective strategies to promote sustainable and climate-resilient highway infrastructure in developing countries. While acknowledging the limitations of this study, future

research can build upon these findings, further exploring the complex dynamics between sustainability, climate action, and infrastructure development in diverse contexts.

## 5. Conclusion and recommendations

### 5.1. Conclusion

This study unveils the complex interplay between highway professionals' perceptions towards the importance of sustainability criteria and their support for climate action in Ghana, offering valuable insights for both academic understanding and practical policy implementation. Through structural equation modelling, we uncovered significant relationships that challenge existing assumptions and provide an in-depth perspective on climate action support in the context of highway infrastructure development. Our findings reveal that economic factors and resource utilization are key drivers of climate action support among highway professionals. Value-action gap phenomenon was found as environmental, technical, social, and project management dimensions surprisingly did not show significant influence on climate action support. This highlights the importance of aligning climate initiatives with economic considerations and efficient resource management practices to reduce value-action gap. Moreover, we found that climate action support positively influences the perceived importance of all sustainability dimensions, suggesting a potential cycle between climate action and broader sustainability attitudes. We conclude that perceived importance of economic sustainability criteria and support for climate action reinforces each other through the bidirectional relationship. The same can be said about resource utilization criteria. On the other hand, a unidirectional relationship exists between support for climate action and perceived importance of environmental, technical, social, and project management sustainability criteria.

### 5.2. Recommendations

Based on the conclusion, this section presents the recommendations in terms of practical implications, and limitations and areas for future studies.

#### 5.2.1. Practical implications

The findings of this study suggest the need for a comprehensive approach to enhance climate action support and sustainability in highway infrastructure development in developing countries. Firstly, the bidirectional relationships between perceived importance of economic or resource utilization criteria and climate action support create a reinforcing cycle. As support for climate action increases among the highway professionals, it enhances their prioritization of economic sustainability, reinforcing the cycle whereby economic criteria further drives climate action support. Aligning climate initiatives with economic benefits is therefore crucial. Policymakers should implement life-cycle cost analysis tools and financial incentives that demonstrate the long-term economic advantages of climate-resilient infrastructure (Locatelli et al., 2020). This approach can address the significant influence of economic factors on climate action support revealed in our study.

Secondly, emphasizing efficient resource utilization in climate strategies is essential. Developing guidelines for sustainable material sourcing and promoting technologies that optimize resource use can enhance both climate action support and overall sustainability (Gálvez-Martos et al., 2018). This aligns with our finding on the importance of resource management in driving climate action support.

The non-significant influence of the perceived importance of environmental, technical, social, and project management criteria implies that these factors may not independently drive climate action support among the highway professionals. This suggests the need to rethink awareness programmes since just raising awareness about these

sustainability criteria might not be enough to promote climate action support. These sustainability criteria could, however, be integrated in or bundled with other impactful criteria such as the economic and/or resource management to promote support for climate action (Bergquist et al., 2020). For example, creating awareness of the economic benefits of adopting environmentally sustainable highway designs and construction can promote support for climate action. Moreover, incentives and tax waivers on imported materials for highway companies engaged in environmentally sustainable designs and construction can foster climate action support.

Moreover, leveraging the positive influence of climate action support on other sustainability dimensions is recommended. Integrating climate considerations into all aspects of highway projects and developing comprehensive sustainability assessment tools can foster a holistic approach to sustainable infrastructure development (Ametepey et al., 2023). Education and awareness programmes are critical to enhancing understanding of the interconnections between climate action and other sustainability aspects. Organizing workshops and incorporating climate action modules in professional development programmes can address knowledge gaps identified in our study (Williams and Schaefer, 2013). Establishing a supportive policy framework is also crucial. The policy design should, however, be localized, acknowledging regional differences. This will ensure that the design policies resonates with local cultural and regulatory contexts, ensuring greater relevance and public acceptance. Such policies should include mandating climate risk assessments in infrastructure planning and setting clear targets for reducing the carbon footprint of highway projects (OECD, 2018). Such policies can create an enabling environment for climate action in the highway sector.

Engaging a broader range of stakeholders, including local communities and environmental agencies, in climate-resilient highway planning can foster wider support for climate action (Hügel and Davies, 2020). This addresses the need for a more inclusive approach to sustainable infrastructure development. Finally, implementing robust monitoring and evaluation systems is essential to track progress and effectiveness of climate action initiatives. Developing key performance indicators and conducting regular audits can ensure continuous improvement in climate action strategies (Thacker et al., 2021). By implementing these interconnected recommendations, stakeholders in the highway infrastructure sector can work towards more effective integration of climate action with sustainable development goals, ultimately contributing to more resilient and sustainable transportation systems in developing countries.

### 5.2.2. Limitations

It is worth mentioning that this study has limitations in spite of its contribution. The study's focus on Ghana limits the generalizability of findings to other developing countries or regions, as cultural, economic, and regulatory differences could influence the observed relationships. However, as Boadu et al. (2023) mentioned, there could be similarities in construction industries in developing countries. Although the response rate was above typical for the construction sector, the final sample size was smaller than initially calculated, potentially affecting the statistical power of some analyses. The reliance on self-reported data may introduce social desirability or other response biases. Furthermore, the cross-sectional design limits causal inferences and doesn't capture how these relationships might evolve over time. The study also focuses on a specific group of stakeholders, potentially missing important perspectives from policymakers, local communities, or end-users of highway infrastructure.

In spite of considering multiple sustainability dimensions, there may be other factors influencing climate action support that were not included. The study measures perceived importance of sustainability criteria rather than actual implementation of sustainable practices, which could be an area for future research. Measurement limitations exist, as some constructs may benefit from further refinement and

validation in the specific context of highway professionals in developing countries. Additionally, cultural and regulatory differences across regions and countries can significantly shape values of highway professionals in terms of the perceived importance of sustainability criteria. Prioritization for sustainability dimensions and how these values translate into action can vary significantly across countries, based on factors including governance structures, and developmental goals. Therefore, the findings of this study should be applied with caution. It cannot be generalised across all regions and countries, except those with similar characteristics like the Ghanaian context.

### 5.2.3. Areas for future studies

Despite these limitations, this study provides a valuable foundation for understanding the complex relationships between sustainability attitudes and climate action support among highway professionals in developing countries. It serves as a stepping stone for future research, which can build upon these findings while addressing the identified limitations. Longitudinal studies, incorporation of more stakeholder perspectives, and exploration of the attitude-behaviour gap could further enhance our understanding of this critical area. In-depth interviews of key highway experts could be incorporated in future studies to gain deeper insight into findings of this study. It is possible for the sustainability values to vary by highway professional type, region and country, which consequently affect the value-action relationship. We therefore recommend future studies to explore how these factors influence the relationship between perceived importance of sustainability criteria and climate action support. This study explored the direct relationship between the factors, for which most of the sustainability dimensions did not have significant influence and support for climate action. We recommend future studies to expand the discussion by investigating whether or not the sustainability dimensions have indirect impact on climate actions and vice versa. Lastly, factors such as awareness, availability of technical guidelines and standards, and availability of required technology, could be explored to determine whether they play any moderating role in shaping the nexus between climate action support and sustainability dimension.

### Ethics approval

We hereby confirm that the manuscript includes a comprehensive description of all necessary ethics approvals. Specifically, it details the approval granted by the Auckland University of Technology Ethics Committee (AUTEK), associated with the institution of Auckland University of Technology, under the approval number 22/327.

### CRediT authorship contribution statement

**George Okyere Dokyi:** Writing – original draft, Visualization, Data curation, Conceptualization. **Kwame Kwakwa Osei:** Formal analysis, Data curation. **John Tookey:** Writing – review & editing, Supervision. **Funmilayo Egun Rotimi:** Writing – review & editing, Methodology, Formal analysis.

### Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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All authors have contributed significantly to this work and agree with its submission. The manuscript has not been published previously and is not under consideration for publication elsewhere.

The authors confirm that there are no conflicts of interest associated with this publication.

## Data availability

The data that has been used is confidential.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.aftran.2025.100026>.

## References

- AFRY, 2022. Closing the Value Action Gap. <https://afry.com/en/insight/closing-value-a-action-gap>. Accessed 27/12/2024.
- Ajzen, I., 1985. From intentions to actions: a theory of planned behavior. In: Kuhl, J., Beckmann, J. (Eds.), *Action Control*. SpringerLink, pp. 11–39.
- Ali, L., Nawaz, A., Iqbal, S., Aamir Basheer, M., Hameed, J., Albasher, G., Shah, S.A.R., Bai, Y., 2021. Dynamics of transit oriented development, role of greenhouse gases and urban environment: a study for management and policy. *Sustainability* 13 (5), 2536. <https://doi.org/10.3390/su13052536>.
- Ametepey, S.O., Aigbavboa, C.O., Thwala, W.D., 2023. Climate change response in sustainable road infrastructure development. In: *Sustainable Road Infrastructure Project Implementation in Developing Countries: An Integrated Model*. Emerald Publishing Limited, pp. 105–111. <https://doi.org/10.1108/978-1-83753-810-220231009>.
- Anderson, J.C., Gerbing, D.W., 1988. Structural equation modeling in practice: a review and recommended two-step approach. *Psychol. Bull.* 103 (3), 411–423. <https://doi.org/10.1037/0033-2909.103.3.411>.
- Assaad, R., El-Adaway, I.H., Abotaleb, I.S., 2020. Predicting project performance in the construction industry. *J. Constr. Eng. Manag.* 146 (5). [https://doi.org/10.1061/\(ASCE\)CO.1943-7862.0001797](https://doi.org/10.1061/(ASCE)CO.1943-7862.0001797).
- Bardi, A., Schwartz, S.H., 2003. Values and behavior: strength and structure of relations. *Personal. Soc. Psychol. Bull.* 29 (10), 1207–1220. <https://doi.org/10.1177/0146167203254602>.
- Bemelmans-Videc, M.-L., Rist, R.C., Vedung, E.O., 2011. *Carrots, Sticks, and Sermons: Policy Instruments and their Evaluation*, vol. 1. Transaction Publishers.
- Bentler, D., Kadi, G., Maier, G.W., 2023. Increasing pro-environmental behavior in the home and work contexts through cognitive dissonance and autonomy. *Front. Psychol.* 14. <https://doi.org/10.3389/fpsyg.2023.1199363>.
- Bergquist, P., Mildenerger, M., Stokes, L.C., 2020. Combining climate, economic, and social policy builds public support for climate action in the US. *Environ. Res. Lett.* 15 (5), 054019. <https://doi.org/10.1088/1748-9326/ab81c1>.
- Boadu, E.F., Sunindijo, R.Y., Wang, C.C., Frimpong, S., 2023. Factors constraining the promotion of health and safety in public works procurement in developing countries. *Int. J. Constr. Manag.* 23 (9), 1611–1621. <https://doi.org/10.1080/15623599.2021.1990716>.
- Bostrom, A., O'Connor, R.E., Böhm, G., Hans, D., Bodi, O., Ekström, F., Halder, P., Jeschke, S., Mack, B., Qu, M., Rosentrater, L., Sandve, A., Sælensminde, I., 2012. Causal thinking and support for climate change policies: international survey findings. *Glob. Environ. Chang.* 22 (1), 210–222. <https://doi.org/10.1016/j.gloenvcha.2011.09.012>.
- Bouman, T., Verschoor, M., Albers, C.J., Böhm, G., Fisher, S.D., Poortinga, W., Whitmarsh, L., Steg, L., 2020. When worry about climate change leads to climate action: how values, worry and personal responsibility relate to various climate actions. *Glob. Environ. Chang.* 62, 102061. <https://doi.org/10.1016/j.gloenvcha.2020.102061>.
- Bouman, T., Steg, L., Perlaviciute, G., 2021. From values to climate action. *Curr. Opin. Psychol.* 42, 102–107. <https://doi.org/10.1016/j.copsyc.2021.04.010>.
- Brulle, R.J., Pellow, D.N., 2006. Environmental justice: human health and environmental inequalities. *Annu. Rev. Public Health* 27 (1), 103–124. <https://doi.org/10.1146/annurev.publhealth.27.021405.102124>.
- Byrne, B.M., 2010. *Structural Equation Modeling with AMOS: Basic Concepts, Applications, and Programming (Multivariate Applications Series)*, 1st ed vol. 396. Taylor & Francis Group, New York.
- Casillas, C.E., Kammen, D.M., 2012. Quantifying the social equity of carbon mitigation strategies. *Clim. Pol.* 12 (6), 690–703. <https://doi.org/10.1080/14693062.2012.669097>.
- Chen, X., Peterson, M.N., Hull, V., Lu, C., Lee, G.D., Hong, D., Liu, J., 2011. Effects of attitudinal and sociodemographic factors on pro-environmental behaviour in urban China. *Environ. Conserv.* 38 (1), 45–52. <https://doi.org/10.1017/S037689291000086X>.
- Chester, M.V., Allenby, B., 2019. Toward adaptive infrastructure: flexibility and agility in a non-stationarity age. *Sustain. Resilient Infrastruct.* 4 (4), 173–191. <https://doi.org/10.1080/23789689.2017.1416846>.
- Chitsa, M., Sivapalan, S., Singh, B.S.M., Lee, K.E., 2022. Citizen participation and climate change within an urban community context: insights for policy development for bottom-up climate action engagement. *Sustainability* 14 (6), 3701. <https://doi.org/10.3390/su14063701>.
- Cimato, F., Mullan, M., 2010. Adapting to Climate Change: Analysing the Role of Government (1). <https://research.fit.edu/media/site-specific/researchfitedu/coast-climate-adaptation-library/europe/united-kingdom-amp-ireland/DEFRA.-2010.-Adapting-to-CC-Analysing-the-Role-of-Government.pdf>.
- Climate ADAPT, 2019. *Climate Proofed Standards for Road Design, Construction and Maintenance*. The European Climate Adaptation Platform Climate-ADAPT is a Partnership between the European Commission and the European Environment Agency. <https://climate-adapt.eea.europa.eu/en/metadata/adaptation-options/climate-proofed-standards-for-road-design-construction-and-maintenance>.
- Colvin, R.M., Jotzo, F., 2021. Australian voters' attitudes to climate action and their social-political determinants. *PLoS One* 16 (3), e0248268. <https://doi.org/10.1371/journal.pone.0248268>.
- Cross, M.S., Zavaleta, E.S., Bachelet, D., Brooks, M.L., Enquist, C.A.F., Fleishman, E., Graumlich, L.J., Groves, C.R., Hannah, L., Hansen, L., Hayward, G., Koopman, M., Lawler, J.J., Malcolm, J., Nordgren, J., Petersen, B., Rowland, E.L., Scott, D., Shafer, S.L., Tabor, G.M., 2012. The adaptation for conservation targets (ACT) framework: a tool for incorporating climate change into natural resource management. *Environ. Manag.* 50 (3), 341–351. <https://doi.org/10.1007/s00267-012-9893-7>.
- Czinkota, M., Kaufmann, H.R., Basile, G., 2014. The relationship between legitimacy, reputation, sustainability and branding for companies and their supply chains. *Ind. Mark. Manag.* 43 (1), 91–101. <https://doi.org/10.1016/j.indmarman.2013.10.005>.
- Ding, D., Maibach, E.W., Zhao, X., Roser-Renouf, C., Leiserowitz, A., 2011. Support for climate policy and societal action are linked to perceptions about scientific agreement. *Nat. Clim. Chang.* 1 (9), 462–466. <https://doi.org/10.1038/nclimate1295>.
- Drews, S., van den Bergh, J.C.J.M., 2016. What explains public support for climate policies? A review of empirical and experimental studies. *Clim. Pol.* 16 (7), 855–876. <https://doi.org/10.1080/14693062.2015.1058240>.
- Duncan, S., Hjelmskog, A., Papies, E.K., 2024. No agency and responsibility for the privileged? Perceptions of climate action among high socioeconomic status citizens in the United Kingdom. *Energy Res. Soc. Sci.* 115, 103604. <https://doi.org/10.1016/j.erss.2024.103604>.
- Dunlap, R.E., Jones, R.E., 2002. Environmental concern: Conceptual and measurement issues. *Handbook of environmental sociology* 3 (6), 482–524.
- Eriksen, S., Schipper, E.L.F., Scoville-Simonds, M., Vincent, K., Adam, H.N., Brooks, N., Harding, B., Khatri, D., Lenaerts, L., Liverman, D., Mills-Novoa, M., Mosberg, M., Movik, S., Muok, B., Nightingale, A., Ojha, H., Sygna, L., Taylor, M., Vogel, C., West, J.J., 2021. Adaptation interventions and their effect on vulnerability in developing countries: help, hindrance or irrelevance? *World Dev.* 141, 105383. <https://doi.org/10.1016/j.worlddev.2020.105383>.
- Eriskin, S., Brown, K., 2011. In: Klein, R.J.T., Gill, T. (Eds.), *Sustainable Adaptation to Climate Change: Prioritising Social Equity and Environmental Integrity*, 3. Earthscan.
- Essiz, O., Yurteri, S., Mandrik, C., Senyuz, A., 2023. Exploring the value-action gap in green consumption: roles of risk aversion, subjective knowledge, and gender differences. *J. Glob. Mark.* 36 (1), 67–92. <https://doi.org/10.1080/08911762.2022.2116376>.
- Fairbrother, M., 2022. Public opinion about climate policies: a review and call for more studies of what people want. *PLoS Clim.* 1 (5), e0000030. <https://doi.org/10.1371/journal.pclm.0000030>.
- Fiack, D., Cumberbatch, J., Sutherland, M., Zerphey, N., 2021. Sustainable adaptation: social equity and local climate adaptation planning in U.S. cities. *Cities* 115, 103235. <https://doi.org/10.1016/j.cities.2021.103235>.
- Fornell, C., Larcker, D.F., 1981. Evaluating structural equation models with unobservable variables and measurement error. *J. Mark. Res.* 18 (1), 39–50. <https://doi.org/10.1177/002224378101800104>.
- Franco, C., Ghisetti, C., 2022. What shapes the “value-action” gap? The role of time perception reconsidered. *Econ. Politica* 39 (3), 1023–1053. <https://doi.org/10.1007/s40888-022-00282-8>.
- Franz, B., Leicht, R., El Asmar, M., Molenaar, K., 2022. Methodological consistency for quantitative analysis and reporting in project delivery system performance research. *J. Constr. Eng. Manag.* 148 (9). [https://doi.org/10.1061/\(ASCE\)CO.1943-7862.0002338](https://doi.org/10.1061/(ASCE)CO.1943-7862.0002338).
- Fuso Nerini, F., Sovacool, B., Hughes, N., Cozzi, L., Cosgrave, E., Howells, M., Tavoni, M., Tomei, J., Zerriffi, H., Milligan, B., 2019. Connecting climate action with other sustainable development goals. *Nat. Sustain.* 2 (8), 674–680. <https://doi.org/10.1038/s41893-019-0334-y>.
- Gálvez-Martos, J.-L., Styles, D., Schoenberger, H., Zeschmar-Lahl, B., 2018. Construction and demolition waste best management practice in Europe. *Resour. Conserv. Recycl.* 136, 166–178. <https://doi.org/10.1016/j.resconrec.2018.04.016>.
- Geach, I., 2016. *Investigating the Role of Sustainability in Contractor Selection and Evaluation*. Willmott Dixon.
- GHIE, 2023. Ghana Institution of Engineering - Members in Good standing. Ghana Institution of Engineering. <https://ghie.org.gh/individuals/#>.
- GHIS, 2021. 2021 Certification/Registration of Members in Good Standing. <https://ghis.org.gh/wp-content/uploads/2021/10/2021-Members-In-Good-Standing-6215-1.pdf>.
- Gifford, R., Nilsson, A., 2014. Personal and social factors that influence pro-environmental concern and behaviour: A review. *International journal of psychology* 49 (3), 141–157.
- Ha, S., Kim, K., Kim, K., Jeong, H., Kim, H., 2017. Reliability approach in economic assessment of adapting infrastructure to climate change. *J. Manag. Eng.* 33 (5). [https://doi.org/10.1061/\(ASCE\)ME.1943-5479.0000530](https://doi.org/10.1061/(ASCE)ME.1943-5479.0000530).
- Hagen, B., Middel, A., Pijawka, D., 2016. European climate change perceptions: public support for mitigation and adaptation policies. *Environ. Policy Gov.* 26 (3), 170–183. <https://doi.org/10.1002/eet.1701>.
- Hair, J.F., Henseler, J., Dijkstra, T.K., Sarstedt, M., 2014. *Common Beliefs and Reality about Partial Least Squares: Comments on Rönkkö and Evermann*. Faculty Publications.
- Helm, S.V., Pollitt, A., Barnett, M.A., Curran, M.A., Craig, Z.R., 2018. Differentiating environmental concern in the context of psychological adaptation to climate change.

- Glob. Environ. Chang. 48, 158–167. <https://doi.org/10.1016/j.gloenvcha.2017.11.012>.
- Hornsey, M.J., Fielding, K.S., 2020. Understanding (and reducing) inaction on climate change. *Soc. Issues Policy Rev.* 14 (1), 3–35. <https://doi.org/10.1111/sipr.12058>.
- Hügel, S., Davies, A.R., 2020. Public participation, engagement, and climate change adaptation: a review of the research literature. *WIREs Clim. Change* 11 (4). <https://doi.org/10.1002/wcc.645>.
- Ibrahim, A.H., Shaker, M.A., 2019. Sustainability index for highway construction projects. *Alex. Eng. J.* 58 (4), 1399–1411. <https://doi.org/10.1016/j.aej.2019.11.011>.
- IET-GH, 2023. Individual Members in Good Standings. Institution of Engineering and Technology, Ghana. <https://ietgh.org/individual-members-in-good-standings/>.
- IPCC, 2018. Summary for policymakers. In: *Global Warming of 1.5°C*. Cambridge University Press, pp. 1–24. <https://doi.org/10.1017/9781009157940.001>.
- Jenatabadi, H.S., Ismail, N.A., 2014. Application of structural equation modelling for estimating airline performance. *J. Air Transp. Manag.* 40, 25–33. <https://doi.org/10.1016/j.jairtraman.2014.05.005>.
- Jones, N., McGinlay, J., Kontoleon, A., Maguire-Rajpaul, V.A., Dimitrakopoulos, P.G., Gkoumas, V., Riseth, J.A., Sepp, K., Vanlay, F., 2022. Understanding public support for European protected areas: a review of the literature and proposing a new approach for policy makers. *Land* 11 (5), 733. <https://doi.org/10.3390/land11050733>.
- Kahan, D.M., Jenkins-Smith, H., Braman, D., 2011. Cultural cognition of scientific consensus. *J. Risk Res.* 14 (2), 147–174. <https://doi.org/10.1080/13669877.2010.511246>.
- Kaiser, F.G., Gerdes, R., König, F., 2023. Supporting and expressing support for environmental policies. *J. Environ. Psychol.* 87, 101997. <https://doi.org/10.1016/j.jenvp.2023.101997>.
- Kollmuss, A., Agyeman, J., 2002. Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behavior? *Environmental education research* 8 (3), 239–260.
- Lawler, J.J., Tear, T.H., Pyke, C., Shaw, M.R., Gonzalez, P., Kareiva, P., Hansen, L., Hannah, L., Klausmeyer, K., Aldous, A., Bienz, C., Pearsall, S., 2010. Resource management in a changing and uncertain climate. *Front. Ecol. Environ.* 8 (1), 35–43. <https://doi.org/10.1890/070146>.
- Leiserowitz, A., Roser-Renouf, C., Marlon, J., Maibach, E., 2021. Global warming's six Americas: a review and recommendations for climate change communication. *Curr. Opin. Behav. Sci.* 42, 97–103. <https://doi.org/10.1016/j.cobeha.2021.04.007>.
- Liu, X., Vedlitz, A., Shi, L., 2014. Examining the determinants of public environmental concern: evidence from national public surveys. *Environ. Sci. Pol.* 39, 77–94. <https://doi.org/10.1016/j.envsci.2014.02.006>.
- Locatelli, L., Guerrero, M., Russo, B., Martínez-Gomariz, E., Sunyer, D., Martínez, M., 2020. Socio-economic assessment of green infrastructure for climate change adaptation in the context of urban drainage planning. *Sustainability* 12 (9), 3792. <https://doi.org/10.3390/su12093792>.
- Loy, L.S., Spence, A., 2020. Reducing, and bridging, the psychological distance of climate change. *J. Environ. Psychol.* 67, 101388. <https://doi.org/10.1016/j.jenvp.2020.101388>.
- Malhotra, B., Sharma, V., 2023. Investigating employees' perception of antecedents and consequences of mergers and acquisitions in HR perspective: an empirical analysis from India. *Int. J. Bus. Innov. Res.* 30 (1), 36. <https://doi.org/10.1504/IJBIR.2023.128336>.
- McCright, A.M., Dunlap, R.E., Xiao, C., 2013. Perceived scientific agreement and support for government action on climate change in the USA. *Clim. Change* 119 (2), 511–518. <https://doi.org/10.1007/s10584-013-0704-9>.
- Mohai, P., Pellow, D., Roberts, J.T., 2009. Environmental justice. *Annu. Rev. Environ. Resour.* 34 (1), 405–430. <https://doi.org/10.1146/annurev-environ-082508-094348>.
- O'Connor, R.E., Bord, R.J., Yarnal, B., Wiefek, N., 2002. Who wants to reduce greenhouse gas emissions? *Soc. Sci. Q.* 83 (1), 1–17. <https://doi.org/10.1111/1540-6237.00067>.
- OECD, 2018. Climate-Resilient Infrastructure. <https://www.oecd-ilibrary.org/docserver/4fd9eaf-en.pdf?expires=1722461686&id=id&accname=guest&checksum=62BCDD1E4EBC28FF1BFF2738532D66A8>.
- Okogwu, Casandra, Agho, Mercy Odochi, Adeyinka, Mojisola Abimbola, Odulaja, Bukola A., Eyo-Udo, Nsison Louis, Daraojimba, Chibuike, Banso, Adeyinka Alex, 2023. Exploring the integration of sustainable materials in supply chain management for environmental impact. *Eng. Sci. Technol. J.* 4 (3), 49–65. <https://doi.org/10.51594/estj.v4i3.546>.
- Pajardi, D., Vagni, M., La Spada, V., Cubico, S., 2020. International cooperation in developing countries: reducing fatalism and promoting self-efficacy to ensure sustainable cooperation. *Sustainability* 12 (2), 547. <https://doi.org/10.3390/su12020547>.
- Paloniemi, R., Vainio, A., 2011. Why do young people participate in environmental political action? *Environ. Values* 20 (3), 397–416. <https://doi.org/10.3197/096327111X13077055166108>.
- Parvaiz, S., 2024, January 23. Role of Sustainable Resource Management in Combating Climate Change. JK Policy Institute. <https://www.jkpi.org/role-of-sustainable-resource-management-in-combating-climate-change/>.
- PEW Center, 2010. Who's Winning the Clean Energy Race? Growth, Competition and Opportunity in the World's Largest Economies. [https://www.pewtrusts.org/-/media/legacy/uploadedfiles/wwwpewtrustsorg/reports/global\\_warming/g2020reportpdf.pdf](https://www.pewtrusts.org/-/media/legacy/uploadedfiles/wwwpewtrustsorg/reports/global_warming/g2020reportpdf.pdf).
- Prati, G., Albanesi, C., Pietrantonio, L., 2017. The interplay among environmental attitudes, pro-environmental behavior, social identity, and pro-environmental institutional climate. A longitudinal study. *Environ. Educ. Res.* 23 (2), 176–191. <https://doi.org/10.1080/13504622.2015.1118752>.
- Princ, K., Ogorevc, M., Slabe-Erker, R., Bartolj, T., Murovec, N., 2021. How does Schwartz's theory of human values affect the proenvironmental behavior model? *Balt. J. Manag.* 16 (2), 276–297. <https://doi.org/10.1108/BJM-08-2020-0276>.
- Rattanachot, W., Wang, Y., Chong, D., Suwansawas, S., 2015. Adaptation strategies of transport infrastructures to global climate change. *Transp. Policy* 41, 159–166. <https://doi.org/10.1016/j.tranpol.2015.03.001>.
- Rawat, A., Kumar, D., Khatri, B.S., 2023. A review on climate change impacts, models, and its consequences on different sectors: a systematic approach. *J. Water Clim. Change*. <https://doi.org/10.2166/wcc.2023.536>.
- Rhemtulla, M., Brosseau-Liard, P.É., Savalei, V., 2012. When can categorical variables be treated as continuous? A comparison of robust continuous and categorical SEM estimation methods under suboptimal conditions. *Psychol. Methods* 17 (3), 354–373. <https://doi.org/10.1037/a0029315>.
- Rhodes, E., Axsen, J., Jaccard, M., 2017. Exploring citizen support for different types of climate policy. *Ecol. Econ.* 137, 56–69. <https://doi.org/10.1016/j.ecolecon.2017.02.027>.
- Richardson Moberg, K., 2024. Environmentally friendly urban development: changes in decision-makers' attitudes, problem perceptions and policy preferences over three decades. *J. Environ. Plan. Manag.* 67 (4), 919–941. <https://doi.org/10.1080/09640568.2022.2142539>.
- Sagiv, L., Roccas, S., 2017. What personal values are and what they are not: taking a cross-cultural perspective. In: Roccas, S., Sagiv, L. (Eds.), *Values and Behavior*. Springer, Cham. [https://doi.org/10.1007/978-3-319-56352-7\\_1](https://doi.org/10.1007/978-3-319-56352-7_1).
- Sagiv, L., Roccas, S., 2021. How do values affect behaviour? Let me count the ways. *Personal. Soc. Psychol. Rev.* <https://doi.org/10.1177/10888683211015975>.
- Salon, D., Murphy, S., Sciarra, G.-C., 2014. Local climate action: motives, enabling factors and barriers. *Carbon Manag.* 5 (1), 67–79. <https://doi.org/10.4155/cmt.13.81>.
- Sanchez, A.X., Lehtiranta, L.M., Hampson, K.D., 2015. Use of contract models to improve environmental outcomes in transport infrastructure construction. *J. Environ. Plan. Manag.* 58 (11), 1923–1943. <https://doi.org/10.1080/09640568.2014.969832>.
- Schwartz, S.H., 1992. Universals in the content and structure of values: theoretical advances and empirical tests in 20 countries. In: Zanna, M. (Ed.), *Advances in Experimental Social Psychology*, vol. 25. Academic Press, pp. 1–65.
- Schwartz, S.H., 2005. Robustness and Fruitfulness of a Theory of Universals in Individual Values. *Valores E Trabalho*, pp. 56–85.
- Schwartz, S.H., 2012. An overview of the Schwartz theory of basic values. *Online Read. Psychol. Cult.* 2 (1). <https://doi.org/10.9707/2307-0919.1116>.
- Schwartz, S.H., Cieciuch, J., Vecchione, M., Davidov, E., Fischer, R., Beierlein, C., Ramos, A., Verkasalo, M., Lönnqvist, J.-E., Demirutku, K., Dirilen-Gumus, O., Konty, M., 2012. Refining the theory of basic individual values. *J. Pers. Soc. Psychol.* 103 (4), 663–688. <https://doi.org/10.1037/a0029393>.
- Shi, X., 2020. More than smart pavements: connected infrastructure paves the way for enhanced winter safety and mobility on highways. *J. Infrastruct. Preserv. Resil.* 1 (1), 13. <https://doi.org/10.1186/s43065-020-00014-x>.
- Shwom, R., Bidwell, D., Dan, A., Dietz, T., 2010. Understanding U.S. public support for domestic climate change policies. *Glob. Environ. Chang.* 20 (3), 472–482. <https://doi.org/10.1016/j.gloenvcha.2010.02.003>.
- Silvius, A.J.G., Schipper, R.P.J., 2014. Sustainability in project management: a literature review and impact analysis. *Soc. Bus.* 4 (1), 63–96. <https://doi.org/10.1362/204440814X13948909253866>.
- Simon, M., 2023. Key predictors for climate policy support and political mobilization: the role of beliefs and preferences. *PLOS Clim.* 2 (8), e0000145. <https://doi.org/10.1371/journal.pclm.0000145>.
- Sovacool, B.K., 2018. Bamboo beating bandits: conflict, inequality, and vulnerability in the political ecology of climate change adaptation in Bangladesh. *World Dev.* 102, 183–194. <https://doi.org/10.1016/j.worlddev.2017.10.014>.
- Stern, P.C., Dietz, T., Abel, T., Guagnano, G.A., Kalof, L., 1999. A value-belief-norm theory of support for social movements: the case of environmentalism. *Hum. Ecol. Rev.* 6 (2), 81–97.
- Stokes, L.C., Warshaw, C., 2017. Renewable energy policy design and framing influence public support in the United States. *Nat. Energy* 2 (8), 17107. <https://doi.org/10.1038/nenergy.2017.107>.
- Swanson, K., 2021. Equity in urban climate change adaptation planning: a review of research. *Urban Plan.* 6 (4), 287–297. <https://doi.org/10.17645/up.v6i4.4399>.
- Tam, K.P., Chan, H.W., 2018. Generalized trust narrows the gap between environmental concern and pro-environmental behavior: Multilevel evidence. *Global environmental change* 48, 182–194.
- Thacker, S., Adshead, D., Fantini, C., Palmer, R., Ghosal, R., Adeoti, T., Morgan, G., Stratton-Short, S., 2021. Infrastructure for Climate Action. [https://content.unops.org/publications/Infrastructure-for-climate-action\\_EN.pdf](https://content.unops.org/publications/Infrastructure-for-climate-action_EN.pdf).
- Tobler, C., Visschers, V.H.M., Siegrist, M., 2012. Addressing climate change: determinants of consumers' willingness to act and to support policy measures. *J. Environ. Psychol.* 32 (3), 197–207. <https://doi.org/10.1016/j.jenvp.2012.02.001>.
- Toplis, C., 2015. International Climate Change Adaptation Framework for Road Infrastructure. United Nations, 2023a. Climate Action. United Nations. <https://www.un.org/sustainabledevelopment/climate-action/>.
- United Nations, 2023, October 20. Peace, Dignity and Equality on a Healthy Planet. United Nations. <https://www.un.org/en/our-work/support-sustainable-development-and-climate-action>.
- Vezirgiannidou, S.-E., 2009. The climate change regime post-Kyoto: why compliance is important and how to achieve it. *Glob. Environ. Politics* 9 (4), 41–63. <https://doi.org/10.1162/glep.2009.9.4.41>.

- Wang, L., Xue, X., Zhao, Z., Wang, Z., 2018. The impacts of transportation infrastructure on sustainable development: emerging trends and challenges. *Int. J. Environ. Res. Public Health* 15 (6), 1172. <https://doi.org/10.3390/ijerph15061172>.
- Wang, Y., Zhang, S., Xu, S., 2022. Impact of efficient resource management practices on sustainable performance: moderating role of innovative culture-evidence from oil and gas firms. *Front. Psychol.* 13. <https://doi.org/10.3389/fpsyg.2022.938247>.
- Watson, J., Byrne, R., Morgan Jones, M., Tsang, F., Opazo, J., Fry, C., Castle-Clarke, S., 2012. What are the Major Barriers to Increased Use of Modern Energy Services among the World's Poorest People and are Interventions to Overcome these Effective? *CEE Review*, p. 11.
- Weder, F., Tugarat, A., Lemke, S., 2020. Sustainability as cognitive "friction": a narrative approach to understand the moral dissonance of sustainability and harmonization strategies. *Front. Commun.* 5. <https://doi.org/10.3389/fcomm.2020.00008>.
- Williams, S., Schaefer, A., 2013. Small and medium-sized enterprises and sustainability: managers' values and engagement with environmental and climate change issues. *Bus. Strateg. Environ.* 22 (3), 173–186. <https://doi.org/10.1002/bse.1740>.
- You, H., Lambert, J.H., Clarens, A.F., McFarlane, B.J., 2014. Quantifying the influence of climate change to priorities for infrastructure projects. *IEEE Trans. Syst. Man Cybern. Syst.* 44 (2), 133–145. <https://doi.org/10.1109/TSMC.2013.2248709>.
- Zibenberg, A., Greenspan, I., Katz-Gerro, T., Handy, F., 2018. Environmental behavior among Russian youth: the role of self-direction and environmental concern. *Environ. Manag.* 62 (2), 295–304. <https://doi.org/10.1007/s00267-018-1032-7>.