Climate change mitigation policy alternatives and citizens' preferences trade-offs

A Participatory Value Evaluation in Peru

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Preface

This thesis project is the final step of my journey toward attaining an MSc. in Complex Systems Engineering and Management. More than two years ago, I applied to this programme with the intention of gaining knowledge and practical experiences that could enable me to make professional and personal contributions to society, particularly in the field of sustainability. For this reason, I am grateful to have been presented with this research topic. Having left Peru 13 years ago, it is fulfilling to have the opportunity to contribute to my home country. In like manner, I was greatly interested in applying a novel method that is rapidly gaining prominence in the field of societal and environmental contexts.

This research delves into the identification of the trade-offs Peruvians are willing to make when presented with policy alternatives designed for climate change mitigation. This study contextualizes the contemporary discourse on environmental issues within the broader societal context, in a country where individuals often have the perception of their voices being unheard. The insights elaborated upon in this thesis are intended to offer contributions not only to the scientific community but also to society at large.

I would like to extend my gratitude to all those who have accompanied me during this journey. I am grateful to Niek Mouter, my first supervisor, for entrusting me with the chance to delve into this subject and for his invaluable feedback and guidance. Equally, I am thankful to Behnam Taebi, my second supervisor, whose unique perspective enriched my work with insightful comments. I must also express my profound thanks to Karen Trujillo for her guidance and expert suggestions, grounded in her comprehensive knowledge of the method and the societal Peruvian context. The extent to which this research was conducted would not have been possible without the generous sponsorship of the TPM Energy Transition Lab of TU Delft. Their support played a crucial role in facilitating the realization of this project. Additionally, I would like to express my gratitude to everyone who contributed to this project through interviews, informal conversations, or technical requirements.

I would also like to thank my friends who stood by me throughout the process of writing this project. Our discussions and interactions greatly enriched the depth and perspective of this work. Last, but certainly not least, I want to express my deepest appreciation to my family for their constant support during the two years of my studies. Their love and encouragement have been fundamental in keeping me motivated and focused.

Hillary A. Gonzáles Pecho
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Summary

Climate change is a topic being addressed by many countries worldwide. However, the timeline for actions against climate change started many years ago. The United Nations Framework Convention on Climate Change was ratified in 1992, and five years later, one of the first treaties to reduce greenhouse gas emissions was proposed. One of the most recent treaties is the Paris Agreement signed in 2015 by 196 parties, where they agree on a common goal: restrict global warming to be climate-neutral by 2050. Signing parties are required to define Nationally Determined Contributions, which are specific measures each government will follow in order to mitigate greenhouse gas emissions. Therefore, it is expected that governments align their national policies with such Nationally Determined Contributions. Peru by being one of the signing parties that played a relevant role before and during the Paris Agreement discussions, submitted their Nationally Determined Contributions in 2016. However, these had some limitations which prompted the authorities to update them in 2018, through a participatory process including a mixture of public and private actors' opinions. Related to this, it is interesting to review what Nationally Determined Contributions are being carried out by different signing parties, to get a wider perspective on how to deal with emissions mitigation, especially in the South American region where Peru is located. Additionally, national governmental and non-governmental institutions have proposed measures to support the government in achieving its climate goals.

Even when climate policies are implemented, their success is found to be related to society's acceptance of them. Moreover, citizens' support for policies is related to the alignment of such policies with their preferences, and research shows that citizens' preferences are based on their values. Additionally, it is known that there are balanced tensions between values, which are translated into trade-offs. Different participatory methods have been used for preference elicitation. In Peru, however, it has been found that the processes followed have an apparent entry barrier for individuals, therefore, other methods can be explored. A recently developed method is Participatory Value Evaluation, in which the participants are asked to make a selection among a set of alternatives while considering its effects and one or more restrictions. This method has been mainly applied in Europe, with some of them being focused on climate change subjects.

Further research is done on the current climate situation of the country, which includes official policy measures, as well as the ones proposed by other governmental and non-governmental institutions. Additionally, participatory processes and participation methods are investigated and compared to the Participatory Value Evaluation method. The goal of this research is twofold: first, study the trade-offs Peruvian citizens make regarding climate change mitigation measures through a Participatory Value Evaluation, and second, investigate Peruvian citizens' experience with this participatory method. Thus, the primary and the secondary research questions are defined as:

1. How do Peruvian citizens trade-off climate change mitigation measures among the two most polluting sectors, from a set of policy alternatives?

2. How is Participatory Value Evaluation perceived by Peruvian citizens and how does it differ from Dutch citizens' perception?

Based on the literature review done regarding the method, a Participatory Value Evaluation experiment is designed using the knowledge gathered from the research on the climate policy situation in Peru and its region. This includes a total of six policy measures part of the country's two most polluting sectors (i.e., Energy and Agriculture, Forestry and Other Land Use):

- Expansion of bus corridors and bike lanes

- Promote the use of electric vehicles for public transport

- Installation of solar panels in rural areas

- Improve the productivity and quality of coffee and cacao crops

- Forest restoration and commercialization

- Forest restoration and conservation

Each of the measures is accompanied by their corresponding CO_2 emission reduction and implementation costs, as well as some qualitative effects. The constraints for the choice task are based on such CO_2 emission reduction and cost of implementation. As part of the method characteristics, participants can give explain their motivation through a written statement. Additionally, a questionnaire is included to gain further insights into their values, logic and concerns about climate change and their participation, as well as about the method.

The designed Participatory Value Evaluation is conducted between July 3rd and July 17th, 2023, in a national panel reaching a total of 1968 complete responses. Quantitative and qualitative analysis is done to answer both of the research questions. Depending on the type of data gathered, the analysis process included descriptive statistics, Latent Class Analysis, or coding of open-ended answers.

It can be concluded that Peruvian citizens prefer policy alternatives that yield positive and direct environmental outcomes, especially when accompanied by minimal monetary expense. Citizens would trade off a higher cost for even a moderate reduction in harmful emissions, provided the health benefits are explicitly articulated. The inclination to make a trade-off between cost and emission reduction diminishes when health and environmental benefits are either not explicitly outlined or fail to reach a significant threshold. Finally, based on the preference patterns of the individuals, four distinct groups were identified. These are mainly dependent on their considerations of the effects each policy alternative may bring. These insights reinforce the importance individuals across different education levels, attribute to the environment, particularly regarding deforestation.

Regarding the method, it can be concluded that Peruvian citizens had a positive and favourable experience when participating in the PVE for climate change mitigation. In a similar manner to the Dutch citizens, Peruvian

individuals exhibited a positive perception of the method. In like manner, a majority of individuals believed it is a good method to involve citizens in governmental decisions regarding climate change policies. These insights seem to foster an inclination for continued engagement and provide their opinion on other subjects relevant to Peruvian society. Equally important, citizens would appreciate the real repercussions resulting from their input within the decision-making process.

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List of abbreviations

AFOLU	Agriculture, Forestry and Other Land Use
CANCC	Comisión de Alto Nivel de Cambio Climático (High-Level Commission on Climate Change)
CNCF	Consejo Nacional de Competitiviad y Formalización (National Council for Competitiveness and formalization)
COP	Conference of Parties
CV	Contingent Valuation
DCE	Discrete Choice Experiment
GDP	Gross domestic product
GHG	Greenhouse Gas(es)
IABD	Inter-American Development Bank
INEI	Instituto Nacional de Estadistica e Informatica
IPCC	Intergovernmental Panel on Climate Change
LCA	Latent Class Analysis
LULUCF	Land Use, Land-Use Change and Forestry
MDCEV	Multiple Discrete Continuous Extreme Value
MtCO2eq	Megaton CO_2 equivalent
NDC	Nationally Determined Contributions
OSINERGMIN	Organismo Supervisor de la Inversion en Energia y Mineria (Energy and Mining Investment Supervisory Agency)
PVE	Participatory Value Evaluation
RQ	Research question(s)
SQ	Sub-question(s)
UNFCCC	United Nations Framework Convention on Climate Change
WBG	World Bank Group

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Introduction

It is well known worldwide that climate change is an ongoing situation that demands the attention of every country. Even though progress has been made to mitigate it, there are still some topics that can be further addressed. This chapter provides information on the current situation and introduces the problem that will be researched (Section 1.1). Then, the primary and secondary research questions are defined, the answers to which aim to contribute to filling a knowledge gap identified via a literature review (Section 1.2). Finally, the approach and details of the research process are explained (Section 1.3).

1.1   Problem introduction

At a global level, the United Nations Framework Convention on Climate Change (UNFCCC) has appointed the Conference of Parties (COP) as the body to review the status of each party, with respect to climate change. As a result of their function, during COP 21 in December 2015, 196 parties signed the Paris Agreement to achieve a common goal: restrict global warming in order to be climate-neutral by 2050 (UNFCCC, 2016).

Different parties played an active role in the development of the Paris Agreement, one of them was Peru. A major contribution the country made while hosting COP 20 was the "Lima call for climate action", which laid out some key elements now included in the Paris Agreement (Pereira, 2022). Additionally, Peru has been acknowledged as an important support to the French COP presidency before and during COP 21 (Watts & Depledge, 2018). However, a few years after those relevant contributions at UNFCCC meetings, Peru showed a more passive approach, due to different factors within the nation (Pereira, 2022).

The UNFCCC (2016) mentions that each of the signing parties needs to set concrete actions in order to reach the overall goal of the Paris Agreement, also known as Nationally Determined Contributions (NDCs). As these are to be executed on a national level, it is assumed that governments should align their policies with those NDCs. Peru submitted their NDCs to the corresponding organism, which became valid in November 2016 (Ministerio del Ambiente, 2018a). These nonetheless, have been found to be based on a model with several assumptions and limitations, as well as discrepancies in metrics and methods (Vázquez-Rowe et al., 2019); which prompts questioning whether the country will be able to achieve its goal. However, policy-makers are encouraged to hurdle over institutional, technical, and financial limitations, for the NDCs' fulfilment (Fragkos et al., 2018).

In some situations, what is declared in climate-related policies is not always successfully implemented due to different reasons internal or external to the country (Trotter et al., 2022). As an internal matter, for instance, it has been found that citizens' support for policies is related to the alignment of such policies with their personal preferences (Mouter et al., 2021a). Moreover, Perello-Moragues & Noriega (2020) mention that policy adoption is built upon the decisions that citizens make, which are connected to their values. In their research, it is explained that preferences and decision-making are based on values, and these are enclosed in mind-frames which can be collectively shared. Moreover, a value can be understood as the significance an individual or a group of people attach to aspects of their life (de Wildt et al., 2019). It is also known that, in the context of our complex society, there are balanced tensions between values (Friedman & Hendry, 2019). Given that values can be ordered by relative importance, an agreeable combination can be reached, which can be seen as the premise for trade-offs (Perello-Moragues & Noriega, 2020). Therefore, it is said that conflicts pertaining to values might pose a risk to society's acceptance when implementing a solution (de Wildt et al., 2021).

It is relevant to involve citizens and consider their preferences, in the context of policy support. Different participatory approaches (i.e., mini-publics, referendum, opinion poll, etc) can be followed to include the population in policy-making (Mouter et al., 2021a). To have a better understanding of citizens' preferences, research on policy acceptance has been done through surveys (Edwards, 2018). However, it is worth mentioning that some issues have been found in participatory studies regarding social acceptance (Taebi, 2017). Considering that preferences are rooted in values, not all participatory approaches are the most suitable for eliciting them. For example, referendums do not provide a space for the respondent to communicate their ideas, arguments, values, or conditions behind the decision taken (Mouter et al., 2021a).

When focusing on policy-making, the impact of alternative policies can be communicated in a systematic manner to decision-makers, using appraisal methods (Mouter, 2021a). Certain appraisal methods have a monetary perspective while others consider the citizens' preferences more. Participatory Value Evaluation (PVE) is considered a preference elicitation method because it allows gathering an extensive spectrum of citizens' preferences concerning policy alternatives (Mouter, 2021a). This method shows the participants the effects each alternative entails, and allows them to explain their decision, which showcases their arguments, concerns and values (Mouter et al., 2021a). Compared to other participatory approaches, PVE exhibits citizens' value judgements, as it evaluates their preferences in the context of public policy decisions without speculating a relation between private preferences and public value (Dekker et al., 2019)

From a societal perspective, it is interesting to analyse the preferences of society concerning policies related to sustainability. Such preferences have underlying values, and bringing them to light is pertinent because climate change has a direct impact on people, not only as individuals but also as a society. Additionally, investigating society's preferences is not only relevant for public involvement in the decision-making process, but also to fill a knowledge gap in a constantly growing complex topic. Climate change can be seen as a complex situation given the different stakeholders involved and the challenges that could be found regarding stakeholders' cooperation or implementing actions for emissions mitigation, which lead to unpredictable circumstances.

The design of a PVE aims to bring benefits and useful knowledge to both society and the scientific community. A PVE has been conducted regarding climate change in the Netherlands, nevertheless, none has been yet performed outside the European region for this topic. In Peru, the government set a participatory process for the NDCs update in 2018, however, this was not focused on citizens' preferences but in a mixture of different public and private actors' opinions (Ministerio del Ambiente, 2018b). It is relevant to highlight that when it comes to a social aspect, alternatives (out of which a selection will be made) might be preferred or not, depending on the context under which they are placed (Arrow, 2012). The described situation provides an opportunity to conduct a case study on Peru as a developing country outside of Europe, within the context of sustainability policies. Therefore, the goal objective of this research is twofold: first, to study the trade-offs Peruvian citizens make regarding climate change mitigation measures through a Participatory Value Evaluation, and second, to investigate the experience of Peruvian citizens with this participatory method.

1.2 Addressing the knowledge gap

As mentioned in the previous section, different governments throughout the world are determined to take action to address climate change. In addition, the scientific community has done research to generate further knowledge on the matter. Aligning this with the focus of this research, it is relevant to review the existing literature on the topics of sustainability, climate change, policy, and citizen participation. However, there are some concepts that need to be understood in order to execute an analysis, these are presented below.

- **Climate change mitigation**

  At the Conference of Parties (COP) 21, nations around the world signed the Paris Agreement (UNFCCC, 2016). According to UNFCCC (2016), this treaty is focused on climate change by limiting global warming to 1.5 degrees Celsius through the restriction of Greenhouse Gas (GHG) emissions. Also, it is known that the actions taken with the aim of diminishing or avoiding GHG emissions, are within the scope of climate change mitigation (Kumar, 2022).

- **Policy-making**

  As previously mentioned, nations agreed on taking action with respect to climate change, and policy-making is an approach to do so. As explained by Zeinali et al. (2021), governments make practical evidence of their governance through public policies, by making decisions that can be enforced at different levels (i.e., local, national, and international).

- **Participatory Value Evaluation**

    Different methods or approaches exist for evaluating policy alternatives in the agenda of a government, and one of them is PVE. Mouter (2021b) explains that this valuation method allows the citizens to participate in the experiment and choose a project portfolio, while having a budget restriction. As a general overview, a PVE entails three main components which are presented to the participants: policy options, impacts of such options, and portfolio constraints (Mouter et al., 2021c).

1.2.1   LITERATURE REVIEW

In order to identify a clear knowledge gap that needs to be addressed, a literature review is performed, by following a qualitative approach. Two main search engines are used, namely Scopus and ScienceDirect, with the following keywords as input to perform the queries:

- Participatory Value Evaluation

- Energy policy

- Energy transition

- Sustainability policy

- Sustainability Peru

- Sustainability citizens

- Sustainability South America

- Peru climate policy

- Policy preference developing countries

   The main focus is on research published after 2015, by taking the Paris Agreement as a reference date. Another filtering criterion is the subject area (e.g., social sciences, environmental science, energy, etc). This is decided in order to find articles within the desired context. To narrow down the resulting papers, the steps suggested by Keshav (2007) are followed. Therefore, a first pass is done on the titles, abstracts, and introductions of each paper. The selection process consists of searching the keywords within the text to find the explanation of the concepts, as well as the purpose of the paper. It is decided to leave out the papers not related to the topic to be addressed. Then, from the papers found, the snowballing method is done along with the same selection criteria explained previously.

   As a result, a total of 22 papers are gathered, which in combination provide knowledge on the main topics of climate policy, public participation, and the PVE method to be used in this research. The years the papers were published range from 2015 to 2022, which sets a contemporary context for the analysis. Papers are categorized into two main groups, namely theoretical and empirical. Even when empirical papers may include an explanation

Author	Year	Type	Group
Alberini et al.	2018	Discrete choice experiment	Empirical
Aruga et al.	2021	Choice experiment	Empirical
Avalos & Torero	2015	Workshop report	Empirical
Edwards	2018	Analyses on national surveys	Empirical
Fragkos et al.	2018	Methodology proposal (modelling)	Theoretical
Giampietro & Bukkens	2022	Case study using a conceptual framework	Theoretical
Huttunen et al.	2022	Literature review	Theoretical
Jonek-Kowalska	2022	Assessment and methodology proposal	Theoretical
Kácha et al.	2022	Empirical analysis	Empirical
Kosow et al.	2022	Methodology proposal	Theoretical
Miedzinski et al.	2022	Critical assessment	Empirical
Mouter et al. (2021b)	2021	Empirical application	Empirical
Mouter et al. (2021c)	2021	Empirical application	Empirical
Mouter et al. (2019)	2019	Conceptual explanation and case study	Theoretical
Mouter	2021	Conceptual explanation	Theoretical
Pereira	2022	Case study using a analytical framework	Theoretical
Siegel & Bastos Lima	2020	Empirical assessment	Empirical
Sokołowski & Heffron	2022	Conceptual research and analysis	Theoretical
Trotter et al.	2022	Empirical analysis	Empirical
van der Hoff et al.	2022	Literature review	Theoretical
Vázquez-Rowe et al.	2019	Critical assessment	Theoretical
Zawadzki et al.	2022	Empirical design	Empirical

Table 1.1: List of literature results by general characteristics

of key concepts or theories in the introduction, but the categorization is done based on the paper's main purpose. Table 1.1 summarizes the resulting papers of the literature review search.

Furthermore, papers present information under different context levels, both geographically and environmentally. This means that some perform the analysis on a regional level such as Western Europe, while others on a national level such as the Netherlands. Also, the sustainability topic each of them focuses on, varies from specific ones like thermal energy to more general ones like climate policies. Table 1.2 lists all the papers together with the geographical context as well as the research focus.

The papers found from the performed search, show that this topic is relevant across the world, by presenting research on countries with different geographical and economic characteristics. For example, the paper from Trotter et al. (2022) focuses on countries with low and low-medium income, while the one from van der Hoff et al. (2022) analyzes a specific region related to tropical forests. This provides a nice overview of how the results of policy implementation related to the environment, may be influenced by the inherent characteristics of each country.

In terms of the environmental context, it is found that research has been done on different sectors. The literature review shows a spectrum of examples, from broad to specific, which is considered significant. For example, Trotter et al. (2022), take a general perspective on climate change policy to analyse the enabling and conflicting factors for its adoption and implementation. On a different level, the work of Aruga et al. (2021), examines citizens' willingness to make trade-offs under energy policies as a whole. With a more specific perspective, Mouter et al. (2021c) make an evaluation on the energy topic but for a thermal energy transition.

Author	Geographical context	Research focus
Alberini et al.	Italy and Czech Republic	Residential energy policies
Aruga et al.	Poland	Energy policy
Avalos & Torero	Peru	Coastal zones
Edwards	USA	Energy development
Fragkos et al.	Brazil, China, EU, India, Japan, USA	Climate policies
Giampietro & Bukkens	European Union	Energy policy
Huttunen et al.	UK, Germany, the Netherlands	Sustainability
Jonek-Kowalska	Central and Eastern Europe	Energy policy
Kácha et al.	Europe and Israel	Climate change
Kosow et al.	Peru	Sustainability policy
Miedzinski et al.	Europe	Sustainability
Mouter et al. (2021b)	The Netherlands	Flood risks
Mouter et al. (2021c)	The Netherlands	Thermal energy transition
Mouter et al. (2019)	The Netherlands	Flood risks mitigation
Mouter	Western Countries	Transport
Pereira	Peru	Climate change policy
Siegel & Bastos Lima	Brazil, Paraguay, Uruguay	Agri-food
Sokołowski & Heffron	International	Energy policy
Trotter et al.	Africa, Asia, Latin America	Climate change policies
van der Hoff et al.	Amazon, Atlantic forest, Cerrado	Forests ecosystem services
Vázquez-Rowe et al.	Peru	Climate change policy
Zawadzki et al.	The Netherlands	Sustainable energy

Table 1.2: List of literature results by geographical context and research focus

When it comes to methodologies, different ones are used by the authors. Some take a more theoretical approach like Huttunen et al. (2022), by performing a literature review. Others, carry out a choice experiment, as found in the paper by Aruga et al. (2021). One study pays special attention to grasping citizens' opinions on climate change by performing a latent class analysis. Alternatively, Kácha et al. (2022) focus on the influences of beliefs on preferences. A discrete choice method has been used to analyse the citizens' willingness to pay for residential energy policies (Alberini et al., 2018). Giving special attention to PVE in the context of climate change, research has been done by Mouter et al. (2021b) in specific topics such as flood risks and thermal energy.

Directing attention to the Peruvian context, Pereira (2022) provides a clear explanation of the Peruvian government's role with respect to climate change policy. The work of Vázquez-Rowe et al. (2019) is also under climate change policy, but with a focus on the NDCs and its feasibility. Moreover, Kosow et al. (2022) have a theoretical approach on sustainability policy design in general, while Avalos & Torero (2015) specify alternatives for issues around coastal zones. Nevertheless, neither of them has a participatory approach while using PVE as a method.

1.2.2   Defining the research question

Each paper provides valuable information about different sectors and various geographical contexts. Additionally, all of them are under the climate change topic, even when they present a distinct level of detail. Yet none of them studies a policy portfolio encompassing different sectors (e.g., biofuels, decarbonization, renewable energies, transport, etc.) while considering citizens' preferences in a Peruvian context. Even when some articles present a study done in middle-income countries, no specific study about this topic is found for Peru.

In order to fill the identified research gap, and solve the problem introduced in section 1.1, regarding climate change as a complex issue given the impact it has on society, the following primary research question is proposed:

> *How do Peruvian citizens trade-off climate change mitigation measures among the two most polluting sectors, from a set of policy alternatives?*

It is relevant to mention that in Peru, the Ministry of Environment, performs an inventory of GHG at a national level, per sector. Sectors are defined based on the Intergovernmental Panel on Climate Change (IPCC) guidelines for National Greenhouse Gas Inventories, i.e., Energy, Industry Processes and Product Use, Agriculture, Forestry and Other Land Use (AFOLU), and Waste (Ministerio del Ambiente, 2021). From the latest inventory performed, the sectors with the highest percentage of GHG emissions are *Agriculture, Forestry and Other Land Use* and *Energy*, with 65.71% and 28.32%, respectively. Therefore, the research question focuses on these as the two most polluting sectors.

Additionally, it is also interesting to analyse the perception of PVE as a method in a different cultural setting, outside of Europe. Researchers emphasize the importance of investigating the applicability of the PVE method to ascertain the extent to which its results can be generalized (Mouter et al., 2019). The paper by Mouter et al. (2021c), in particular, recommends applying the method to different countries and with different policies. A PVE has been performed in the Netherlands regarding climate policy measures aimed at achieving national goals for 2030 (Mouter et al., 2021d). Additionally, a PVE has been done in Peru, to study citizens' preferences regarding school openings(Trujillo, 2023). Based on such studies, arises an opportunity for an academic contribution by examining citizens' overarching perceptions of the PVE method. Specifically, an analysis is beneficial for the understanding of participants' perceptions under the climate policy context, and under the Peruvian cultural context. Therefore, a secondary question[1] is proposed:

> *How is Participatory Value Evaluation perceived by Peruvian citizens and how does it differ from Dutch citizens' perception?*

1.3 Research approach

The proposed questions aim to fill a knowledge gap and to do so, a research approach needs to be defined. Creswell (2014) explains in his book that research approaches can be defined as the scheme and process of bridging a general premise with a more specific method, and such approach should be chosen depending on the essence of the research problem. Therefore, this section explains the research approach suited for this specific study. Additionally, the research sub-questions needed to answer the primary and secondary research questions are outlined.

For the purpose of this research, a mixed research approach is followed, namely a case study and a quantitative approach. For the first one, Crowe et al. (2011) explain that it is convenient to use it when trying to understand

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[1]The Peruvian PVE is not included in the secondary question given that there is no published data, and a thorough analysis cannot be performed. Only general comments can be addressed

a complex event in the context of the real world; such as the outcomes of a policy or service. Moreover, Flyvbjerg (2016) highlights the possibility of generalizing from a study case for the sake of scientific growth. Given that this research is focused on generating knowledge regarding a climate mitigation portfolio in a Peruvian context, it is clear that a case study approach is a suitable choice.

Then, a quantitative approach is used for the second part of the research. This option is useful for the purpose of performing tests based on measurable variables, which is done through the analysis of their relationships (Creswell, 2014). Given that this study aims not only to design but to deploy a PVE, a quantitative approach is needed to analyse the resulting statistics. This allows for identifying the preferences Peruvian citizens have with respect to a portfolio of climate change mitigation policy alternatives.

1.3.1 Research sub-questions

It is helpful to decompose the primary and secondary research questions into a set of sub-questions, in order to have a more structured research process. Therefore, while contemplating the research objective, as well as the chosen research approach, the following sub-questions (SQ) are formulated:

- **SQ1: Which are the possible policy alternatives for climate change mitigation per sector, that could be implemented in Peru?**

  It is relevant to define the domain in which this research is set. In order to do this, basic information regarding the policy context must be gathered, specifically around climate change mitigation policy alternatives. Therefore, a desk study is needed in order to collect such particular information. The tool suitable for this part of the research is a search engine, both governmental and non-governmental. For example, the ones incorporated in web pages from the relevant ministries, as well as the Google search engine for non-governmental policy alternatives. Additionally, empirical data gathering through interviews with experts on the topic will provide further insights into discussed ideas, nonetheless, this might be a more difficult task to accomplish due to networking limitations.

- **SQ2: By what means can the Peruvian society's preferences be elicited?**

  Given that the primary research question is related to understanding society's preferences in order to identify the trade-offs they make, a suitable mean should be defined for gathering such preferences. An investigation is first done to understand individuals' preferences and their relation to values. Then, a search is executed to identify the characteristics of different preference elicitation methods. Such characteristics are analysed and then, the specific method convenient to use for this research is explained. Both searches are done by using academic search engines.

- **SQ3: How to design a PVE to obtain citizens' preference from a set of policy alternatives focused on climate change mitigation?**

  The PVE experiment design highly depends on the goal of the research. As an example, Mouter et al. (2021c) mention that setting up an experiment focused on public participation does not have the same

criterion as one focused on economic valuation. Therefore, a literature review and empirical data gathering need to be performed, in order to obtain information on the characteristics and requirements to design a PVE under the domain of this research. For this, academic search engines are used to find relevant theoretical information, as well as case studies.

- **SQ4: What information needs to be presented and requested, in order to obtain Peruvian citizens' preference and participation experience?**

  It is known that in a PVE experiment, the participants show their preference based on a presented set of policy alternatives (Mouter, 2021b). Therefore, this set needs to be defined as part of the design of the PVE and should include all the necessary data such as impacts, for subsequent analysis. In order to do this, the information obtained from SQ1 and SQ3 is used. The results from SQ1 provide a collection of different alternatives under the defined context, that could be selected. The knowledge obtained from SQ3 is helpful for structuring the portfolio of alternatives to include in the experiment. Additionally, SQ3 lays down the necessary items to include in order to obtain the participants' perception of the method. For both, it is important to keep in mind the objective of the experiment, which can be reached by the proper definition of its characteristics.

- **SQ5: What are the Peruvian society's preferences for climate change mitigation policies?**

  The relevant information expected to be obtained to answer this sub-question mainly is the preference of Peruvian citizens for climate change mitigation alternatives with respect to the selected sectors from the IPCC guidelines. From this, the trade-offs they are willing to make can also be estimated. Clearly, the method to draw this information is Participatory Value Evaluation, which as found and explained by answering SQ2, is a technique useful for preference elicitation. This will be conducted in an online environment (i.e., Wevaluate platform) with the participation of adult Peruvian citizens, recruited through a first-party panel company. Once the PVE experiment is performed, and the recommended steps of the method are followed, society's preferences can be elicited. Insights are acquired mainly through a quantitative analysis using Excel and PowerBI, because this tool allows processing Excel files in a quick and graphic manner, suitable for the data collected. This is complemented by employing Jasp, which is a tool mainly used for statistical analysis. Finally, LatentGold and Altlas.ti are used as specialized tools for a Latent Class and qualitative analysis, respectively.

- **SQ6: What is the experience of Peruvian citizens with the Participatory Value Evaluation Method?**

  As part of the experiment, participants are asked to provide their perceptions of the method. Therefore, it will be possible to outline the insights obtained from performing the PVE in Peru. These include their experience with the method, as well as their acceptance based on their participation. The analysis of the results is done in a similar way as in SQ5, by using Excel, PowerBI and Atlas.ti.

Each of the six sub-questions aims to provide relevant information to answer the main research question. Thus, they are placed in a certain order as part of the document structure, in order to have a coherent story. Figure 1.1

shows how the flow of information goes from the introduction to the conclusion, by aggregating the information gathered at each step.

CHAPTERS	CONTENT		METHOD
Introduction	Background information, problem introduction, research question, research strategy		
Research domain	Context on climate change (Peru and other countries) and preference elicitation		Desk study, empirical data gathering
	Possible policy alternatives for climate change mitigation	SQ1	
	Suitable method for preference elicitation	SQ2	Desk study
Theoretical framework	Method explanation and theoretical research		
	Characteristics and requirements for a PVE design	SQ3	Desk study, empirical data gathering
Case design	Case study set-up and data collection explanation		
	Choice task and questionnaire specifications for the PVE experiment	SQ4	Empirical data gathering
Results and analysis	Results presentation and explanation		
	Peruvian society's preference for climate change mitigation policies	SQ5	Participatory Value Evaluation
	Peruvian citizens' experience with the PVE method	SQ6	Participatory Value Evaluation
Discussion	Connection of information found with research questions		
	Peruvian citizens' trade-offs on climate change mitigation policies	RQ1	
	Peruvian citizens' perception on PVE compared to Dutch citizens'	RQ2	
Conclusion	Closing description of findings and contribution		

Figure 1.1: Research flow diagram

2
Research domain

T HE WORLDWIDE TIMELINE FOR ACTIONS AGAINST CLIMATE CHANGE goes many years back. The UNFCCC was ratified in 1992 and only five years later the Kyoto Protocol was proposed, setting up one of the first treaties with the objective of reducing GHG emissions (UNFCCC, 2023a). In relation, the secretariat appointed the COP as the body to review the status of each party member of the UNFCCC, with respect to climate change. A number of conferences have been organized with the purpose to check the progress, as well as discussing actions that could be implemented in order to fight climate change (UNFCCC, 2023b). Consequently, the Paris Agreement was established at COP 21, where 196 parties signed and committed to a common goal.

The Paris Agreement requires the committing parties to define and share with the UNFCCC their plans for taking action regarding climate change, in the form of NDCs (UNFCCC, 2016). As previously mentioned, the Framework Convention explains that the NDCs are the specific measures each government will follow in order to mitigate GHG emissions and adapt to the effects climate change may bring to their nation. It is worth reminding that the scope of this research is on mitigating measures in Peru.

Under this context, it is interesting to understand what is the current situation around climate change policy in the region Peru belongs to (section 2.1). Then, in order to have a starting point and set this research in a more specific context, an investigation is done on the current situation regarding climate change policies for mitigation in Peru(section 2.2). This includes already established measures, as well as proposed measures by governmental and non-governmental institutions, which could provide insights on policies with the potential to be implemented in Peru.

Further, as mentioned in chapter 1, it is important to consider citizens' preferences when it comes to policy-

making. This research aims to gain knowledge on citizens' preferences trade-offs through an elicitation method, therefore, methods related to the participation of citizens and the means to gather their preferences, are investigated. And this sets the base to explain the suitable method to use in this research (section 2.3).

2.1 Climate policy in South America

Policy measures are being carried out by the different signing parties from the Paris Agreement, and this could provide interesting information to get a wider perspective on how to deal with emissions mitigation. However, not all countries have the same characteristics or resources, which might be translated into the type of actions or NDCs that are proposed by their governments.

As Peru is located in South America, it is decided to do a search on countries within the same region. Two main factors are taken into account for the selection of countries, Gross Domestic Product (GDP) and population. The GDP is commonly used by governments that want to estimate the size of their economy , therefore, is an element that can be considered to compare countries in terms of economic capacities. It is chosen as a filtering component in order to select countries with a similar economic situation, as well as with a higher GDP to get a broader range of possible measures. Additionally, the population size of the remaining countries is used to leave out smaller countries. With this, the selected countries for a benchmark are: Chile, Colombia, and Ecuador. Figure 2.1 shows the GDP per capita and population data from the selected countries.

COLOMBIA
GDP per capita: USD 6 104
Population: 51.5 millions

ECUADOR
GDP per capita: USD 5 965
Population: 17.7 millions

PERU
GDP per capita: USD 6 622
Population: 33.7 millions

CHILE
GDP per capita: USD 16 265
Population: 19.4 millions
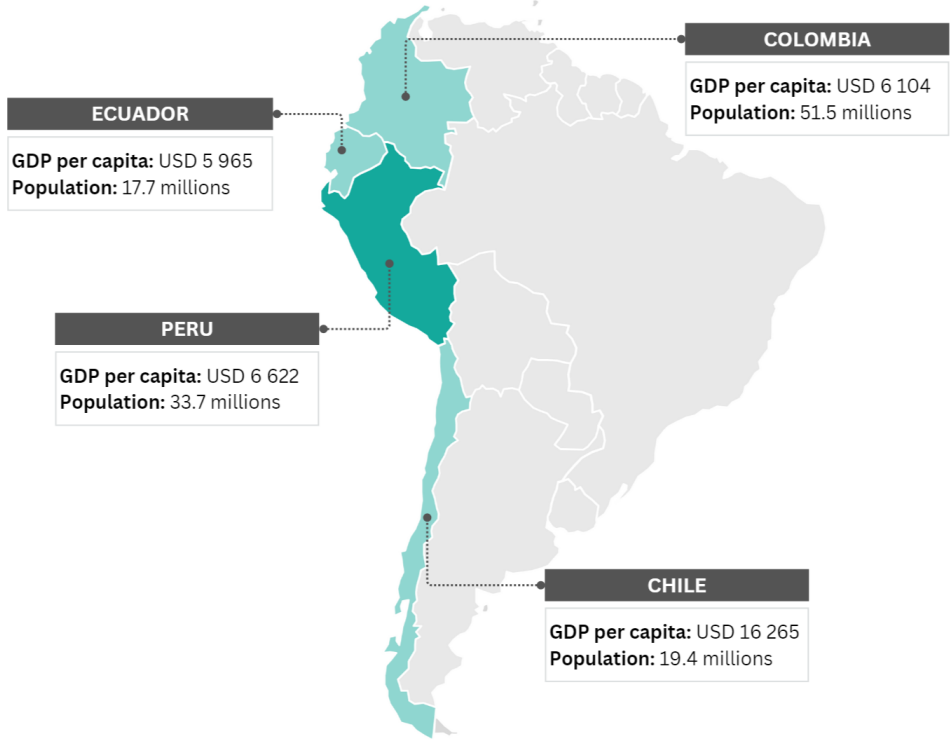
Figure 2.1: GDP per capita and population of the countries selected for a benchmark on climate policy.

For the three countries, only policy measures are considered i.e., proposed measures from organizations outside the government are not. This is because the relevant reports from those countries also follow the sector categorization as recommended by the IPCC. It should be noted that these sectors can be divided into sub-sectors, while still following the guidelines from the IPCC. The AFOLU sector is composed of *Agriculture* and *Land Use, Land-Use Change and Forestry (LULUCF)*; while the Energy sector includes *Transport* and *Energy generation*[1]. A total of 89 measures[2] are identified for the relevant sectors, table 2.1 shows the number of measures per sub-sector and country.

Sector	Sub-sector	Countries		
		Chile	Colombia	Ecuador
Energy	Transport	21	13	2
Energy	Enrgy generation	17	8	8
AFOLU	Agriculture	0	6	3
AFOLU	LULUCF	3	4	2
Total		39	31	15

Table 2.1: Number of policy measures per sub-sector per country.

2.2 Climate policy in Peru

The Peruvian government has shown an interest in climate change policy by taking a high profile in foreign climate policy during the steps leading to the Paris Agreement. In this period, the government representatives at the COPs made major contributions through the development of the conferences. It is mentioned by Pereira (2022) and Watts & Depledge (2018) that the country assisted the French presidency during COP21, an important conference due to the signing of the Paris Agreement. In fact, the country is contemplated as one of the first to agree on the GHG emissions reduction (Pereira, 2022). However, in recent years such an active role has shifted to a more passive one, due to different factors which could be related to the diverging and constant change of ideas between the national government authorities (Pereira, 2022).

2.2.1 Nationally Determined Contributions

Peru, as one of the signing parties of the Paris Agreement, drafted their intended NDCs which became official when they were submitted in 2016 (Vázquez-Rowe et al., 2019 and Ministerio del Ambiente, 2018a). However, in 2020 the Comisión de Alto Nivel de Cambio Climático (CANCC) or High Level Commission on Climate Change in English, approved the update of these measures in terms of goals transparency, understanding and ambitions (Comision de Alto Nivel de Cambio Climatico, 2021). At the end of 2020, the CANCC released a technical study, in which it is specified the differences with the originally submitted NDCs, as well as the description and details of the updated ones. The most relevant changes are the goal for CO2 emission reduction and

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[1] For the purpose of this research and to keep the terminology simple, "Mobile Combustion" and "Stationary Combustion" as mentioned by the IPCC, are expressed in this document as Transport and Energy generation, accordingly

[2] Some policy measures may apply to more than one sub-sector (e.g. an energy policy that sets standards for both energy generation and transport consumption), therefore it may seem like the totals do not add up.

the number of mitigation measures. As a result, a total of 62 measures were set as actions to be taken in order to achieve a 208, 8 MtCO2eq emission reduction (Comision de Alto Nivel de Cambio Climatico, 2020). Figure 2.2 illustrates in percentages, the number of NDCs per sector.
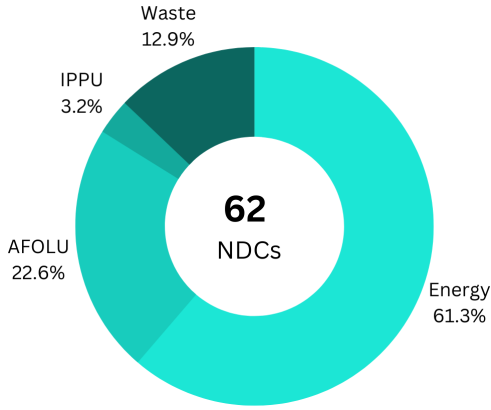
Figure 2.2: Percentage of Peruvian NDCs by sector

As mentioned in section 1.2, the focus of this research is on the most polluting sectors, namely Agriculture, Forestry, and Other Land Use (AFOLU) and Energy. Therefore it is understandable that almost 84% of the NDCs aim to mitigate emissions in those sectors. Table 2.2shows that from the total of NDCs defined by the government, 52 NDCs are related to the scope of this research.

Sector	Subsector	Number of NDCs
Energy	Transport	14
Energy	Energy generation	24
AFOLU	Agriculture	6
AFOLU	LULUCF	8
Total		52

Table 2.2: Number of Peruvian NDCs per sub-sector within the scope of this research

2.2.2   MEASURES PROPOSED BY GOVERNMENTAL INSTITUTIONS

In addition to the CANCC, different government bodies align their policies, projects and proposals with the NDCs by having goals related to the climate change topic. One of them is the Consejo Nacional de Competitividad y Formalización (CNCF) or National Council for Competitiveness and Formalization in English, which set up the National Competitiveness and Formalization Plan.

The CNCF determined 9 priority objectives in order to compete in the international market and have well-being based on sustainable economic growth (Consejo Nacional de Competitividad y Formalización, 2019). Each of the objectives is composed of a number of policy measures which intend to help with its achievement. The ninth objective aims to encourage environmental sustainability in the operation of economic activities, and for this, seven policy measures have been laid out. However, not all of them fall within the scope of this research. Table 2.3 categorizes per sub-sector, the relevant policy measures.

Sector	Sub-sector	Policy measure
Energy	Transport	Strategy for renewable energy, electromobility and clean fuels
Energy	Transport	Vehicle scrapping
AFOLU	Agriculture	Circular economy and cleaner production agreements in industry, fishing and agriculture
AFOLU	LULUCF	Instruments for sustainable management in value of natural resources and ecosystem services
All	All	Financing strategy for climate change measures
All	All	Platform for monitoring the implementation of NDCs
Total		6

Table 2.3: Policy measures to achieve objective 9 of the National Competitiveness and Formalization Plan

Another significant government body making a contribution under the climate change policy context is the Organismo Supervisor de la Inversión en Energía y Minería (OSINERGMIN) or Supervisory Agency for Investment in Energy and Mining in English. This agency published a report to provide background information and highlight what would be needed to promote electromobility in Peru (OSINERGMIN, 2019a). From their proposal, a total of 22 measures are considered in this research for the Transport sub-sector, even the ones that require a specific type of energy generation. Further in the Transport sector, the Ministerio de Transportes y Comunicaciones (2020) or Ministry of Transport and Communications in English, proposes going beyond the current state of the non-motorized system, which was expanded as a temporary solution, to a permanent one. Therefore, this is also contemplated as a measure, for this study.

2.2.3 Measures proposed by non-governmental institutions

Non-governmental organizations are also making contributions by proposing additional or complementary measures to the NDCs. It is found that non-governmental institutions such as consultancy firms and investment banks focusing on society development, have published reports with comprehensive or sector-specific proposals.

The InterAmerican Develoment Bank (2023) (IADB) is a well-known institution that provides support for 26 governments in the Latin American and Caribbean region, across different sectors (e.g., agriculture, energy, environment, transport, etc.). As part of such support, the bank performs research on relevant topics and communicates the results in its several reports. In the context of climate change related to the Paris Agreement, it is found that the report on the costs and benefits of carbon neutrality in Peru is a relevant one. Quirós-Tortós et al. (2021) perform an analysis for five sectors (i.e., energy, transport, AFOLU, waste, and industrial processes), to identify the gap for reaching carbon neutrality at a national level.

Another financial institution very close related to the IADB is the World Bank Group (WBG). Similarly to the IADB, the World Bank Group (2023) provides support to governments with the aim to promote development, however, they have a broader scope by working with 189 countries. Recently, the WBG has started to release a series of reports regarding climate and development for a number of countries, including Peru. The World Bank Group (2022c) uses the knowledge generated for the IADB's carbon-neutrality report, in order to propose specific actions per sector.

Contributors to the reports were contacted to gain a deeper understanding of the reports, the Peruvian context and the results obtained. A meeting with a Transport expert and another one with an AFOLU and Energy expert provided insightful information. From the first meeting, it is gathered that the theory for the transition towards net-zero has been outlined, mentioning that there are other co-benefits, apart from CO_2 reduction. Moreover, it should be considered that push and pull measures should go hand-in-hand. From the second meeting, it is understood that some areas of opportunity in the AFOLU sector are related to land-use rights and crop-production transformation. And when it comes to the Energy sector, there should be a willingness to invest in renewable energy, which translates to operational cost savings. Based on both reports and interviews, a total of 25 measures are identified within the scope of the four sub-sectors relevant to this research.

Furthermore, the consultancy firm Ernst&Young performed an analysis for the Asociación Automotriz del Perú or Automotive Association of Peru in English, regarding e-mobility in the country. Ernst&Young (2021) proposes a policy bundle which mainly includes a list of tax and regulatory incentives to promote electric mobility. Even when the main focus is on the transport sub-sector, there are some impacts and conditions to be met which are closely related to the energy sector.

From the search done in terms of climate policy within Peru, it can be said that the country has set a number of actions, also known as NDCs, aiming to reach the commitment made in the Paris Agreement. Additionally, it is found that different actors within and outside the government, have suggested measures as a contribution to the achievement of those actions. However, as mentioned in section 1.1, citizens should also be considered as relevant stakeholders when aiming for successful policy implementations.

2.3 PUBLIC PARTICIPATION AND PREFERENCE ELICITATION

Policy-makers will usually be inclined to bring forward policy alternatives that the public supports (Ščasný et al., 2017). In relation, Drews & van den Bergh (2015) present the aspects affecting society's acceptance of policies, specifically the ones regarding climate change, which can be categorized into three. One of the categories is "social-psychological" which contemplates the public's values, among other elements. Values can be understood as principles that individuals find as important when aiming for a favourable society, not only on a personal level but on a universal one (de Wildt et al., 2021). Literature mentions different approaches to explain how values can have an influence on acceptance. For example, the outcome "self-transcendent values" have as opposed to "self-enhancement values", the relationship between values, beliefs and norms from an individual perspective, or the values variation of a society in relation to their income (Drews & van den Bergh, 2015). Furthermore, Perello-Moragues & Noriega (2020) explain that trade-offs are assumed to be based on the balance reached through the ranking of values, given that there can be tension or conflicts between them.

As mentioned in section 1.1, it has been found that citizens' preferences are based on their values, which will ultimately have an impact on policy adoption. The research by de Wildt et al. (2019), mentions that in some situations, it is not possible to fulfil all the values at hand because those values might be in conflict with each other; which means that satisfying a value comes at the sacrifice of another one. Therefore, it can be understood that a

trade-off is done when conflict between values is encountered. Such conflict raises a risk to society's acceptance of the system that is being implemented (de Wildt et al., 2021). For this reason, it is advisable that policymakers consider those conflicts in order to increase the likelihood of society's acceptance (de Wildt et al., 2019).

Given that this research is about citizens' preference trade-offs regarding climate change mitigation policies, such preference trade-offs should be obtained while considering the relevance of the (conflicting) values backing them. Additionally, it can be concluded that citizen involvement (by contemplating their preferences) in policy-making is important, therefore, different participatory processes have been used for this purpose (Mouter et al., 2021a). In the context of climate change, however, participation has not been extensively used. It has been found that early stages in the process of policy-making have mainly shown to be laid out by expert opinion, meaning that citizens are usually considered in later steps (Itten & Mouter, 2022).

A participatory process should be based on two essential values to be considered valid (Mouter et al., 2021d). One of them is representativeness, which can be included by having a sample with a good depiction of the population. The other one is inclusiveness, which can be achieved by allowing any (adult) citizen to participate. Moreover, from the paper by Itten & Mouter (2022) it can be understood that a participatory process can be classified into two major categories: mini-publics and maxi-publics. The first one uses a small group of participants, who receive specific information to discuss and contribute with a recommendation. On the other hand, a maxi-public uses a larger group of participants, which might imply higher validity in relation to democracy. Moreover, Mouter et al. (2021a) mention referendums, opinion polls, and participatory budgeting as alternatives for public participation.

It should be noted that in the context of policy-making, the engagement with citizens can be based on three rationales (Mouter et al. 2021a,c,d) which are briefly explained as follows:

- Normative rationale: citizens have a voice regarding a governmental decision, because it has an impact on their lives. Is focused on the process of participation.

- Substantive rationale: citizens may have ideas, values, arguments and conditions that are not being considered by policy-makers. Focuses on the outcome of the participatory process.

- Instrumental rationale: citizens can have a space to grasp the dilemmas faced by policy-makers and take part in the policy decision. Focuses on the process for a specific goal, such as acceptance.

Based on the short definitions, it can be said that the substantive rationale is very much aligned with preference elicitation. However, this is not assuming that the other two rationales are neglected when the main focus is getting participants' ideas, values, arguments and/or conditions.

In relation to policy acceptance, participatory processes have been used to learn about citizens' preferences (Edwards, 2018). This is also mentioned by the Instituto Peruano de Derecho Electoral or Peruvian Institute of Electoral Law in English, in their report regarding citizen participation in Peru. There, Velásquez et al. (2021) explain that citizen participation can be categorized into four, depending on objectives, interrelationships and impact on reality. Two of those categories have the characteristic of achieving values such as respect, openness, dialogue and consensus. Moreover, the Peruvian Constitution states that citizen participation is a right and a

duty, which should also be promoted by local governments (Velásquez et al., 2021). Citizen participation can be understood as a set of mechanisms that allow civil society to take part in relevant decisions, by stating their interests (Valdiviezo, 2013). Some examples of participatory mechanisms are referendums, participatory budgets, prior consultation, among others.

Participatory budgets are one of the major mechanisms currently used in Peru. At the beginning of this century, the Peruvian Congress approved the Participatory Budget Law as a response to the notorious corruption activities of the previous government (McNulty, 2015). The main idea was to include society's input in the decision-making at different levels of the government, except at the national level (Mcnulty, 2013). Participants in these participatory processes are usually from registered civil society organizations, regional councils and government officials. In a similar fashion, workshops are held by governmental institutions to include society in the formulation of governmental plans o frameworks (Ministerio del Ambiente, 2019). In both of them, however, an entry barrier is apparent. For this reason, and to be aligned with the focus of this research on citizens' preference elicitation, different methods should be explored.

In the literature, different methods are mentioned for preference elicitation through citizen participation. Some examples are Discrete Choice Experiment (DCE), Contingent Valuation (CV), Referendum, Mini-publics (e.g., citizen assemblies), and Participatory Value Evaluation (PVE) (Mouter et al., 2021a). In relation, referendums and citizen assemblies are participatory mechanisms acknowledged by the Peruvian government (Velásquez et al., 2021). Moreover, the Ministry of Environment in Peru explains that there are different methods for the valuation of natural heritage, which can be assumed to be aligned with the environmental context of this research. In their report, DCE and CV are mentioned as stated preference methods (Ministerio del Ambiente, 2015).

Therefore, it is interesting to make a comparison between referendum and mini-publics as participatory processes, and between DCE and CV as stated preference methods. The PVE method is also included in the analyses, given its novelty for preference elicitation. The methods proposed in the paper by Mouter et al. (2021a), are next described to understand which method would be a suitable one for this research, in terms of preference elicitation under the context of this research.

2.3.1 REFERENDUM

The main advantage of this process is having a low-entry barrier, which means that a broad group of people can participate. However, this entails a high investment in time and effort (Mouter et al., 2021a). This makes it understandable why this process is usually followed for long-term decisions that the government needs to make.

Citizens are presented with a single motion, to which they are asked to declare if they are in favour or against it. An example of this is mentioned in the paper by Offe (2017), where it is mentioned that during the Brexit referendum, citizens were not able to consider different solutions. Further, participants have been known to receive no detailed explanation of the effects their choice would bring, which might lead to an uninformed decision (Offe, 2017).

Finally, referendums do not provide a space for participants to express their opinion on the measure presented to them, or propose new ideas (Mouter et al., 2021a). This leads to conclude the values behind the selection citi-

zens make cannot be fully understood. Even under these circumstances, Peruvian law demands that the resulting decision expressed by the citizens must be followed by the national authorities Velásquez et al. (2021).

2.3.2 MINI-PUBLICS

In this participatory process, a small group of people are selected to take part in a deliberation (Goodin & Dryzek, 2006). Even when a limited number of individuals participate, is important that the group is representative, to be considered as a democratic process; however, this might be a difficult task to achieve. Moreover, it has been found that this method is usually used for politically controversial topics, given it facilitates discussion (Mouter et al., 2021a).

Citizen assemblies can be regarded as mini-publics. Individuals are provided with the necessary information to discuss a specific issue or topic. In some situations, a facilitator might provide guidance during the process. These lead to assume that the discussion generates an informed outcome, however, this process of deliberation is usually time demanding. (Mouter et al., 2021a)

A positive aspect of the dialogue, is that allows the citizens to express their opinions and perceptions, which might lead to bringing forward possible solutions (Mouter et al., 2021a). Although, the limited number of participants might also translate to a limited scope of ideas. Therefore, it has been questioned to what extent mini-publics can be related to macro public policy (Goodin & Dryzek, 2006). This leads to comprehending the reason why citizen assemblies in Peru are mostly used for topics of municipal scope (Velásquez et al., 2021).

	Referendum	Mini-publics	PVE
Entry barrier	Low	High	Relatively low
Informed selection	Minimum information is provided	Details are provided and a facilitator may contribute	Necessary information is provided
Space for further comments	Not provided	Provided through open dialogue	Provided through open question
Scope of its use	Usually on a national level	Mostly on a local level	Possible on a national or local level

Table 2.4: Comparison of participatory processes

2.3.3 DISCRETE CHOICE EXPERIMENT

Rotteveel et al. (2022) explain that in this stated preference method, participants are shown at least two alternatives, but it asks them to choose only one. This method is suitable to use when assessing individuals' preferences for certain attributes, however, public budget is not considered.

Using a DCE allows the assessment of values for the identified attributes, considering that the individuals' preference is dependent on the utility they would acquire (Weatherly et al., 2014). For the experiment, Mouter et al. (2021a) explain that the policy alternatives must be broken down into the identified attributes together with their characteristics, also known as "attribute levels". The assessment consists of choice tasks with diverse

combinations of attribute levels, which are presented to the participant. Finally, discrete choice models are used to measure the preferences.

Is worth mentioning that DCEs can be classified as labelled or unlabeled. De Bekker-Grob et al. (2010) describes that this distinction is important to consider because depending on which one is used, the participant's tasks may be influenced in the experiment. Labelled experiments show specific titles for the alternatives, while unlabeled experiments are the opposite by presenting more comprehensive titles. Translating this into policy alternatives, labelled experiments include information regarding the feature of such alternatives, while unlabeled ones do not (Mouter et al., 2021a).

2.3.4 Contingent Valuation

The main characteristic of this method is that the participants are provided with the description and effects of only one proposal, in order to know their preferences. The focus is on the willingness to pay/accept the participants have, however, the degree to which their preference is related to the project attributes cannot be known (Mouter et al., 2021a).

CV is considered a stated preference elicitation method, which has been commonly done through surveys in the environmental context (Conte, 2013). In such surveys, the proposed plan is carefully described under a hypothetical scenario, allowing to perform an economic valuation for non-market-traded elements (Whitehead & Haab, 2013). The participant's willingness to pay/accept is with regard to a monetary value like tax amount or implementation cost (Mouter et al., 2021a), therefore is focused on economic values. Unlike DCE, the variation within the experiment is done through the monetary value and not on the attribute levels. Finally, Mouter et al. (2021a) explain that the assessment is done by means of econometric analysis. However, this method is critiqued on the legitimacy of the results, given the inconsistency in its validity tests, which can be related to the made-up scenario easy to be manipulated by the professional providing the experiment (Whitehead & Haab, 2013).

2.3.5 Participatory Value Evaluation

One of the characteristics of this method is that panel participants can be selected, or the process can be open to the whole population in the scope of the study (Mouter et al., 2021d), which can be regarded as a relatively low entry barrier. Through this method, participants are asked to make a selection among a set of policy alternatives while considering a public budget, in order to elicit their preferences (Rotteveel et al. 2022; Mulderij et al. 2021). Given that participants are able to assess the projects in relation to one another, preferences are with respect to the effects presented together with the alternatives (Mulderij et al. 2021; Mouter et al. 2021a).

Participatory Value Evaluation was initially proposed as an alternative to the assessment method Cost Benefit Analysis, which is an appraisal method commonly used by policymakers (Shortall & Mouter, 2021). However, it has also been introduced as a stated preference method (Rotteveel et al., 2022). In the experiment, participants are provided with the details of a number of policy alternatives, therefore, it can be compared to a labelled DCE. The difference is based on the fact that a PVE does not limit the individual to choose only one alternative (Mouter et al., 2021a). In relation, the participant faces a continuous and discrete choice task, by making a selection while

considering the restriction and information provision. Finally, preferences are measured through the use of a choice model based on Multiple Discrete Continuous Extreme Value (MDCEV) (Dekker et al., 2019).

After the choice task, participants are provided with a space to express the motivations for their selection, which allows a better understanding of their preferences and values (Mouter et al., 2021c). Also, they have the opportunity to give any additional suggestions or ideas, which might serve as input or for the consideration of the policy-maker (Itten & Mouter, 2022).

	DCE	CV	PVE
Number of alternatives	2 or more	1	2 or more
Labelled vs Unlabeled	Labelled or unlabeled	Labelled	Labelled
Information displayed	Description and attributes (if labelled)	Description and effects in detail	Description and effects
Choice task	Select only one of the alternatives presented	Select willingness to pay for the project presented	Select none or more of the alternatives presented
Restriction in choice task	No restrictions other than limiting selection	No restriction	Possible in monetary and non-monetary terms
Variation in experiment	Distinct combinations of attribute levels	Variation through the willingness to pay	Possible to vary the effects levels for each alternative
Preference elicitation	Discrete choice models	Econometric analysis	Choice model (MDCEV or portfolio)

Table 2.5: Comparison of preference elicitation methods

The main characteristics of the described participatory processes are summarized in Table 2.4. The scope reached by citizen assemblies makes this process not suitable for this research. This is because climate change policies, as presented in the previous sections of this chapter, are found to mostly have an impact on a national level. Then, when comparing the PVE to a referendum, it is found that the latter does not provide the implications of the project, which makes it difficult to identify the trade-offs participants are willing to make. Moreover, a space for the participants to explain the motivations for their selections or propose additional ideas is not possible through a referendum.

In terms of preference elicitation, the characteristics of the methods are summarized in Table 2.5. Starting with the number of alternatives or projects that can be used with each of the methods, is clear that CV is not suitable for this research. The objective is to study the trade-offs Peruvian citizens make, which is not possible to assess by presenting only one alternative to the participant. Even when CV has been used for the valuation of environmental services, the matter that is not possible to link the individuals' preference to the project attributes, is also a reason to neglect it as an option.

Following up on the relevance of being able to relate the preferences to the attributes of the alternatives, certain information needs to be shared with the participant, which means a labelled experiment is needed. Considering this, the main difference between DCE and PVE is regarding the choice task, as seen in Table 2.5. Using DCE as a method entails limiting the participant to choose only one alternative. Given that this research deals with four different sub-sectors and because the measures usually focus on a single sub-sector, it would mean forcing the individual to choose only one sub-sector. To evaluate the trade-off citizens make, they should have the freedom to state their preference, even if that means leaning towards two or more sub-sectors. Additionally, given that the focus is on climate change, an important attribute to include in the experiment is the emissions of CO_2, therefore, a restriction on non-monetary terms might be necessary to introduce.

Based on the explanation provided in terms of participation and preference elicitation, PVE is selected as the most suitable method for this research. Moreover, by facilitating the elicitation of citizens' preferences, the PVE method considers citizens' values. And by analysing the trade-offs from such preferences, the conflict between values can be mapped for the consideration of policy-makers in order to implement policies with a higher chance of acceptance. This is especially relevant in the Peruvian context given the current political instability.

2.4 POSSIBLE POLICY ALTERNATIVES AND PREFERENCE ELICITATION METHOD

Nations worldwide are taking action to mitigate climate change impacts, specifically through the setup of NDCs. Special attention is given to learning about the measures taken by countries within the South American region, given some context similarities shared with Peru. This is with the purpose of understanding which policy alternatives are relevant to implement in such a context. Different governments in the region are selected (based on GDP and population) and analysed to have a reference point. 85 NDCs, for the relevant sectors in this research, are gathered from the governments of Chile, Colombia, and Ecuador.

In relation, identifying the goals and paths the Peruvian government is currently focused on, is important. The government has defined a number of NDCs as part of the Paris Agreement, which sets a commitment to the mitigation of GHG emissions. Out of the 62 NDCs, 52 of them fall within the scope of this research, given that the other 10 are not related to the AFOLU or Energy sectors.

Additionally, different organizations within the government have also proposed or defined measures, which lead to the overall objective of contributing to climate change mitigation. An investigation of some relevant organizations provided 29 additional measures. These correspond to the CNCF, OSINERGMIN, and the Ministry of Transport and Communications. Moreover, the exploration non-governmental documents, such as reports from consultancy firms and international organizations focused on development and environment-related topics, are considered. With this, 25 measures are added to the collection of possible policy alternatives.

A total of 110 measures within the AFOLU and Energy sectors, are identified as possible policy alternatives for climate change mitigation. Considering the current climate-policy situation in Peru, as well as the interviews with field experts is also helpful for understanding which policy alternatives could be implemented in the Peruvian context.

In terms of policy-making, considering populations' preferences, has been shown to result in a better accep-

tance of policy measures. Therefore, it can be speculated that by improving policy acceptance, a more successful implementation can be done, resulting in a higher chance of achieving an end goal (e.g., greenhouse gas emission mitigation). The goal of this research, which is to study Peruvian citizens' preference trade-offs, can be related to this

It is pertinent to consider the relation of values with individuals' preferences. From section 2.3 it can be concluded that values compose the backbone of preferences; and that through the ranking the individual makes of them, trade-offs can be assumed. It is also found that participatory processes can be used as means for preference elicitation. In this regard, the current participatory processes in Peru show to have an entry barrier, making it difficult to understand the preferences of the wider public. Therefore, it is relevant to explore other participatory methods for preference elicitation.

Referendum, mini-publics, and PVE are compared as participatory methods. From the discussion, it is found that PVE is a suited participatory process when considering the goal of this research. This is mainly because it allows the application of a topic with a national reach, not possible with mini-publics. Also, as opposed to a referendum, the implications that a set of policies may bring can be included for the consideration of the participants, which facilitates the understanding of the trade-offs they would make. Three main preference elicitation methods are considered. From these, the PVE method shows to be the most suitable for this research. One reason is that the participant needs to be presented with a set of policy alternatives, which the CV method does not allow. Another reason is that the participant should be able to select more than one alternative if that is his or her preference, which is not possible with a DCE. Also, the nature of the topic means that there is a public element to it, and a DCE experiment focuses on a private willingness to pay. Additionally, PVE allows the introduction of non-monetary restrictions in the experiment, an important characteristic for this research, because climate change measures heavily rely on CO_2 emission reduction.

Finally, it is mentioned that the public has been involved in policy-making through participatory processes. To this, PVE is also considered a participation method. Therefore, PVE demonstrates to be a proper means to elicit Peruvian society's preferences.

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Theoretical framework

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PARTICIPATORY PROCESSES ALLOW FOR CITIZEN INVOLVEMENT in policy-making, from which society's preference can be obtained. As mentioned in the previous chapter, Participatory Value Evaluation (PVE) has been identified as a suitable method, given that the goal of this research is related to citizens' preferences and their experience when taking part in this participatory method. Therefore, a deeper understanding of the characteristics and requirements of PVE is needed.

This chapter first provides an overall explanation of the method theory to be used in this research (section 3.1). Then, the application of PVE is analyzed in different settings from the literature, to identify key components that need to be considered when designing a PVE (section 3.2). Finally, the main characteristics and requirements are summarized (section 3.3)

3.1 PARTICIPATORY VALUE EVALUATION

Participatory Value Evaluation (PVE) is a method that was first proposed as an alternative to the assessment method Cost Benefit Analysis, given some criticism this latter method received regarding the willingness-to-pay approach it uses (Shortall & Mouter, 2021). A major difference is that the PVE method does not speculate that public value derives solely from private choices (Dekker et al., 2019), as it incorporates the allocation of a public budget as well as of private income (Mouter et al., 2019). Moreover, given that the overall social welfare effects related to a portfolio of public project alternatives can be obtained, this method can be considered a viable alternative for assessment, comparable to other ones like Cost Benefit Analysis (Mouter 2021b; Mouter et al. 2019). The main favourable characteristics of the PVE method are explained next.

Initially developed for the assessment of societal value in public infrastructure projects being considered by the government, PVE is employed to elicit for citizens' preferences (Mouter et al. 2021c; Mulderij et al. 2021). PVE operates as a preference elicitation method because citizens' preferences are obtained by allowing them to express their advice to the government on policy-related decisions, as emphasized in the research by Mouter et al. (2021d) and Mouter et al. (2022). Additionally, PVE can be inferred as a participatory approach, as it facilitates the involvement of a broad and distinct public for policy-making (Mouter et al. 2021a; Dekker et al. 2019), and provides insight into how the citizens make trade-offs on values (Itten & Mouter, 2022).

In terms of the method's application, Mouter et al. (2021c) mention that a PVE can have a focus on either economic evaluation or participation, depending on the research's objectives. A PVE for economic evaluation seeks to acquire knowledge of citizens' preferences regarding policy measures, serving as input for establishing their ranking. Nevertheless, when the PVE method is employed for participation, it seeks to actively involve citizens in policy design and assessment. To achieve this, it is imperative that stakeholders' goals are fulfilled, and that information flows between the public and policymakers are facilitated in both directions. Additionally, Mouter et al. (2022) indicate that research through preference elicitation should guarantee participants a feeling of repercussion derived from their choices, thereby mitigating potential hypothetical bias.

A PVE experiment can be deployed through either a panel or open consultation; Mouter et al. (2021d) explain the main differences between these to approaches. A panel consultation leans more towards a substantive rationale, thus offering reliable depiction of the citizens' principles, concerns and values. On the other hand, an open consultation follows a normative rationale, facilitating the inclusiveness of the population. Regardless of the chosen consultation type, participants take part in an online experiment (Mouter et al. 2021c; Mulderij et al. 2021; Mouter et al. 2021a). The intention is to simulate the position policymakers find themselves in when making policy decisions, therefore, participants are presented with three main elements (Mouter et al., 2021c):

- **Policy alternatives:** measures or projects the government is contemplating (Mulderij et al., 2021).

- **Effects of the alternatives:** information regarding the effects those measures or projects would have. These can be presented as qualitative and/or quantitative (Dekker et al., 2019). With this, the participant is able to ponder on the benefits as well as the disadvantages between all the displayed alternatives (Mouter, 2021b).

- **One (or more) constraint(s):** early experiments used a restriction in terms of monetary values such as a public budget, which participants had to allocate into the different policy alternatives (Mouter et al., 2019). However, recent studies show that is not mandatory to have the restriction in economic values, but also as targets or limits regarding the environment or healthcare system (Mouter et al. 2021a,d).

Through the presentation of a number of policy alternatives, along with their positive/negative effects as well as a restriction, citizens encounter the trade-offs related to a decision-making process (Mouter et al., 2021c). Thus, participants are asked to choose the combination of alternatives they would recommend to the government given the specified constraint (Mouter et al. 2021c,d). This choice not only explains their policy support, but also reflects the trade-offs they are willing to make (Shortall & Mouter, 2021). Additionally, participants are encouraged to elaborate on their decisions via written statements, and they also have the opportunity to propose additional

alternatives (Mouter et al. 2021c,d; Itten & Mouter 2022). Providing written reasoning to substantiate their choices offers valuable insights into their values, logic and concerns. Simultaneously, inviting participants to suggest alternatives beyond the presented options sheds light on opportunities not being considered, and enhances our comprehension of the broader social landscape.

The selection made by participants serves as input for a choice model, which is subsequently utilized to obtain their preferences in relation to the presented policy alternatives, their effects and overarching constraint(s) (Mouter et al. 2021a; Mulderij et al. 2021; Rotteveel et al. 2022). This choice model is based on Multiple Discrete Continuous Extreme Value (MDCEV) (Dekker et al., 2019). The econometric approach of MDCEV aims to deal with situations in which various alternatives are demanded at the same time, but cannot be interchanged (Bhat, 2008). Within the context of a PVE, each of the citizens' preferences can be aggregated, resulting in the social welfare effects associated with the initially presented alternatives (Mouter et al., 2019). Furthermore, this can be employed rank the policy alternatives according to the valuation done by individuals, and brief the government on the findings and optimal policy portfolio (Mulderij et al. 2021; Shortall & Mouter 2021; Dekker et al. 2019).

3.2 Review of previous method applications

Over the last few years, the PVE method has been applied mainly in Europe, across various domains such as health or flood risks. Notably, a recent study conducted in Austria by Hössinger et al. (2023), focused on CO_2 emissions within the transport sector. Additionally, the method has been employed in the Netherlands for climate-related policies (see Mouter et al., 2021d), from which relevant knowledge can be acquired. Drawing from a literature review, this section exhibits the purpose, design details, design process, and analysis process of such cases. As well as the acceptance, strengths and weaknesses, limitations of the studies, and proposed avenues for further research. Table 3.1 shows the complete list of research studies under consideration.

3.2.1 Purpose

PVE has been applied across a diverse range of topics and at various scope levels. Several are centred around the environmental contexts, addressing subjects such as climate targets, flood risks, thermal energy transition, or considerations for the future of energy. Particularly noteworthy is the most recent study found in the literature, which aimed to comprehend citizens' preferences concerning policy measures in relation to CO_2 reduction. Another recurring focus is health, with PVEs delving into areas like Covid-19 measures, health in the low-income population, or disinvestment in healthcare interventions.

In terms of scope, PVE experiments have been conducted both on a national and local level. Cases at the national level predominantly originate from the Netherlands. Further, experiments on a local level have been carried out in locations such as Utrecht, locations nearby the "de Waal" river, Friesland, among others.

Beyond the diversity in topics and scope, each PVE has been designed and released bsed on a specific goal. While the majority aims to understand society's preferences, some PVEs have had the goal of raising awareness or seeking their input on policy alternatives; while promoting citizen participation.

Author	Title
Dekker et al. (2019)	The Economics of Participatory Value Evaluation
Hössinger et al. (2023)	Give citizens a task: An innovative tool to compose policy bundles that reach the climate goal
Itten & Mouter (2022)	When Digital Mass Participation Meets Citizen Deliberation: Combining Mini-and Maxi-Publics in Climate Policy-Making
Mouter et al. (2019)	An Introduction to Participatory Value Evaluation
Mouter et al. (2021d)	Broad support for ambitious climate policy if four conditions are met
Mouter et al. (2021c)	Including young people, cutting time and producing useful outcomes: Participatory value evaluation as a new practice of public participation in the Dutch energy transition
Mouter et al. (2021a)	Public participation in crisis policymaking. How 30,000 Dutch citizens advised their government on relaxing COVID-19 lockdown measures
Mouter et al. (2022)	Stepping into the shoes of the policy maker: Results of a Participatory Value Evaluation for the Dutch long term COVID-19 strategy
Mouter (2021b)	Willingness to allocate public budget and Participatory Value Evaluation
Mulderij et al. (2021)	Citizen preferences regarding the public funding of projects promoting a healthy body weight among people with a low income
Rotteveel et al. (2022)	If you were a policymaker, which treatment would you disinvest? A participatory value evaluation on public preferences for active disinvestment of health care interventions in the Netherlands
Shortall & Mouter (2021)	Social and distributional impacts in transport project appraisals

Table 3.1: List of literature results on PVE applications

3.2.2 Design process

As mentioned in section 3.1, participants engaged in the experiment encounter three main elements (i.e., policy alternatives, their corresponding effects, and one or more constraints). Consequently, the design process encompasses the delineation of them. In most instances, the initial phase involves outlining the policy alternatives to be considered. An exception is observed in the research done by Mouter et al. (2021c) where the process commences with the definition of overarching goals in collaboration with stakeholders[1]. This development of alternatives advances from general concepts to more specific formulations, guided by one or more selection criteria.

Subsequently, the specification of the effects associated with each policy alternative follows. From the analysed cases, it can be inferred that researchers do an investigation on relevant information. Validation of this information is occasionally sought from experts, as deemed necessary. Furthermore, certain studies mention that it is not mandatory to have effect estimations in precise numbers, opting instead for informative bandwidths. A similar approach applies to the definition of constraint(s). These may ask the participant to either reach a minimal threshold or abstain from surpassing a maximum value. Further, the restriction can also be flexible, as described in the research by Mouter et al. (2019).

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[1] The purpose of such research is more on raising awareness through participation, and less on preference elicitation.

Some studies explicitly mention that an experimental design is carried out. This practice encompasses varying the values of the alternatives' effect estimates, creating distinct combinations. The purpose of this is to diminish the correlation among estimates (Mouter et al. 2022; Rotteveel et al. 2022). Another aspect only mentioned in a few studies, namely the ones by Mulderij et al. (2021) and Rotteveel et al. (2022), is the deployment of a pilot. This pilot phase has the main objective of improving the information provided to the participant.

Concluding the design process, the socio-demographics of the participants that are relevant to take part in the experiment, are outlined. Most cases describe that only the adult population is selected to participate. Depending on the study's scope, whether national or local, the specific regions are demarcated. This definition of socio-demographic characteristics aims to achieve a representative sample of the population. It is implied that in this step it is also determined if the consultation would be panel or open.

3.2.3 DESIGN DETAILS

Specific design details derive from the design process, revealing alignment with the established goal of the experiment. Among these details is the determination of the consultation format, which could be open, panel, or both. An open consultation tends to align with the normative rationale, while a panel consultation leans more towards a substantive rationale (Mouter et al., 2021d). The analysed cases exhibit that most of them have been done through a panel consultation, from which one of them also opened on a national level. A factor related to the consultation type is the participant count. The review of the literature shows that the number of participants can range between 617 and 26, 293. However, most experiments typically feature approximately 2,000 participants.

Regarding the three foundational components comprising a PVE, diversity is evident. The number of alternatives varies from 2 to 25, with their effects being qualitative, quantitative or a mix of both. While monetary values typically underpin the imposed constraints, some experiments utilize alternative metrics like healthcare system capacity. An interesting example is the PVE released on climate policies, which uses two constraints, one for budget and another one for CO_2 emissions. Particularly intriguing is a recent PVE that takes an unconventional approach, in which it was decided to have a non-binding goal (Hössinger et al., 2023). Table 3.2 provides select examples of the three primary elements drawn from three PVEs. However, for simplicity, not all details are included.

3.2.4 ANALYSIS PROCESS

Once the experiment has been released and results have been gathered, a comprehensive analysis is conducted, encompassing both participants' choices and responses to the questionnaire. As mentioned in section 3.1, the choice model used to elicit participants' preferences, is based on MDCEV. Examining the existing literature reveals the predominance of two major models: MDCEV and the portfolio choice model. Mulderij et al. (2021) explain the appropriateness of MDCEV in instances where the participant is requested to specify the implementation (or not) of a policy measure and the budget allocation. From the analysis an optimal portfolio can be identified, representing the combination of measure alternatives maximizing utility (Mouter et al. 2021a, 2022).

Source	Measures	Effects	Restriction (s)
Mouter et al. (2021d)	- More windmills at sea - Introduction of kilometer charge - Introduction meat tax	CO_2, cost, health, employment, nature, etc.	min. 27 Megatons CO_2 max. 15 billion euros
Mulderij et al. (2021)	- Local sports coach - Fruit and vegetable boxes - Sports vouchers	Reach, costs, expected weight loss, etc.	max. 100, 000 euros
Mouter et al. (2019)	- Sleeuwijk combination project - Sleeuwijk classical project - Oosterhout combination project	Protection against flooding, biodiversity, nature area, etc.	max. 700 million euros

Table 3.2: Examples of design details from previous PVEs

The analysis of the written explanations accompanying participants' choices is approached through a qualitative methodology. While not all cases explicitly detail this analysis, some reference the utilization of random sampling or software tools like ATLAS.ti. This is with the purpose of understanding individuals' reasoning and motivations, thus adding depth to the interpretation of their choices.

It is also found that further analysis than only eliciting the preferences can be done. For example, one of the cases makes use of Latent Class Analysis (LCA). This analytical technique entails categorizing observations into distinct groups by identifying patterns of preferences, which allows to classify the participants according to certain characteristics.

3.2.5 PUBLIC ACCEPTANCE

Section 2.3 delves into the link and importance of involving citizens and their preferences in the context of policy acceptance. Studies employing the PVE method illustrate this within diverse experimental settings. Results from the analysed cases substantiate the importance of considering citizens' preferences for achieving public acceptance of policies. Policy-makers could align the insights from the experiment with their decisions, for example, with respect to the allocation of public budget (Mulderij et al., 2021). Another example is that it allows decision-makers to relate the public's acceptance of a set of policies to climate goals (Hössinger et al., 2023). Additionally, some studies explain that acknowledging societal resistance to policy alternatives might enable policy-makers to determine ways to mitigate public discontent, and even promote society's acceptance. Another insight gathered from the applications of PVE, is related to communication. Certain research studies highlight the importance of providing the participants with relevant information both during and after the experiment.

Expanding on the theme of public acceptance, some experiments asked the participants to select how the government should weigh the advice they are giving through the experiment, versus that of scientists. Although contextual variations are discernible, in the majority of cases weight allocation leans towards considering the advice of the experts.

In terms of the acceptance of the method itself, research shows that participants feel involved in the process of policy-making. In addition to fostering involvement, participants have provided favourable feedback regard-

ing gaining awareness of the situation at hand, and their support for the use of the method on various subject domains.

3.2.6   Strengths and weaknesses

As part of their investigation, researchers identified some strengths and weaknesses of the method for each of the settings it was applied in. Some of the strengths highlighted are related to the accessibility the experiment provides. This accessibility stems from the fact that citizens engage in an online platform, and they are provided with clear but evidence-based information. Additionally, responses not only disclose which policy alternatives the respondents prefer but also unveil the motivations behind their preferences, which can be informed to the policy-makers. Another strength found is in terms of time investment, as it is considered that both the design and response time are low.

With respect to the weaknesses of the method, the comments can be roughly categorized into aspects: information provision and the experience while performing the experiment. In terms of the information provided, certain studies mention that respondents expressed there were not enough alternatives to choose from or that they would've liked some specific alternatives to be included. However, this limitation could be mitigated by incorporating a space for the participant to provide further comments via open-ended questions. In terms of experience, it is found that some citizens prefer offline environments, given that it provides a space for deliberation with other individuals. Additionally, a concern emerges that not all social groups have the necessary resources to access the online environment.

3.2.7   Limitations and further research

Each of the experiments exhibited certain limitations which were identified when the researchers analysed the experience in retrospect. For example, sometimes citizen engagement for participation can sometimes prove challenging, and if the experiment is mentally demanding then they might abandon the experiment before completing it. Geographical limitations were also found, implying that even for the same topic, responses might diverge when the method is applied in a different geographical context. Itten & Mouter (2022) relates this limitation to the cultural peculiarities of each region, and Mulderij et al. (2021) also links it to the economic situation.

Based on the recognized limitations, researchers propose some future research to be considered. A primary recommendation involves extending the method's application to various regions, countries, and diverse subject matters. In terms of the participants, studies advise using a heterogeneous population and investigating how distinct groups of individuals show different preferences. Concerning the design phase, one study recommends including the citizens in the early stages, thereby influencing the set of alternatives presented to the participants. Moreover, regarding the information presented, another research advises giving the participant the option of choosing to visualize the information in a simplified or complex manner.

PVE is a method used for participation and preference elicitation, which has been applied across different topics and contexts, including one related to climate policy. From the research published, some key points can be identified in order to understand how to design a PVE with the purpose of preference elicitation through citizen participation.

The design details, scope definition (i.e., local or national, panel or open consultation), and socio-demographic delineations should be defined and aligned with the overarching goal of the PVE. As part of such design, the main three elements to be included are the set of policy alternatives, their corresponding effects and at least one (flexible) constraint. Notably, these elements should be presented with clarity to the general public. They should also be evidence-based, even when precise estimates are not required.

Through the presentation of these core elements within a choice task to individuals, and by gathering their choices, participants' preferences can be obtained. The analysis is done by using a choice model, where some cases apply the portfolio choice model while others MDCEV. Supplementary analysis such as LCA, can also be done to enrich the insights, depending on the goal of the research.

Researchers mention the strengths and limitations of the method by analysing its application in different settings, from which some advice is derived. These comments have the potential to provide insights when designing a PVE. Therefore, in addition to what is said by literature about the design and analysis process, such observations can be considered in order to have a more robust PVE experiment.

4

Case design

The goal of this research is twofold: First, study the trade-offs Peruvian citizens make regarding climate change mitigation measures through a Participatory Value Evaluation, and second, investigate Peruvian citizens' experience with this participatory method. Consequently, the PVE should be aligned with such a goal, and it can be assumed that decisions and selections made as part of the design process, are translated into the PVE experiment.

The knowledge obtained from the literature reviewed in Chapter 3, is considered for the design of a PVE with a focus on climate change mitigation policies. First, the purpose and scope of the PVE are defined (section 4.1). Then, the process for selecting the policy alternatives for each sub-sector is explained in order to define the measures to be presented in the experiment (section 4.2). The quantitative and qualitative effects for each of the alternatives chosen to be provided as main and additional information to the participants, are also described (section 4.3). In relation, the reasoning for the selection of constraints in terms of emissions and monetary value is outlined (section 4.4). Then, the dynamics of the choice task is explained (section 4.5). As part of the final steps of the design process, a questionnaire asking about individuals' motivations, opinions and sociodemographic characteristics is defined (section 4.6). Additionally, results from the pilot test are presented in order to explain the necessary adjustments in the design (section 4.7). Some conclusions are done from the design process to highlight relevant information (section 4.8).

4.1 Purpose and scope

To achieve the first part of the goal for this investigation, the research question is: *How do Peruvian citizens trade-off climate change mitigation measures among the two most polluting sectors, from a set of policy alternatives?* Therefore, the main purpose of the PVE experiment is to elicit Peruvian citizens' preferences with regard to policy alternatives for climate change mitigation.

Given that the focus is on understanding the preferences of the Peruvian population, a national representation is desired. In order to achieve this, the same approach as most of the previous PVE applications (reviewed in section 3.2) is followed. This means that the panel consultation type is chosen.

For the second part of the goal, the question set is: *How is Participatory Value Evaluation perceived by Peruvian citizens and how does it differ from Dutch citizens' perception?* For this reason, the PVE also has the purpose to gather the perceptions of the individuals participating in the PVE experiment.

4.2 Policy alternatives

The trade-offs this research aims to understand, are in relation to policy alternatives, therefore, not on already defined or ongoing measures from the government. However, for the same reason, it is essential to know about such measures when deciding on which policy alternatives to include in the experiment. This is beneficial because (even slightly) different alternatives to those of the government can be analysed, while still considering the country's current situation in terms of climate policy.

For the selection of alternatives, it is considered the access to the information necessary to set up the PVE (i.e., effects, relation to constraints). Hence, the policy measures from countries in the region are treated as an inspiration for alternatives that could be implemented in Peru, but not as fully ready-to-implement alternatives given that country-specific characteristics have an influence on the effects values. Reports and proposals prepared for the Peruvian context are, therefore, more suitable to consider as policy alternatives with enough information to be included in the experiment.

To select the policy alternatives to include in the PVE, policy measures from the Peruvian and other Latin-American governments identified in sections 2.2 and 2.1 are categorized in main topics within each of the four sub-sectors in the scope of this research. The same procedure is done with the proposed measures gathered in section 2.2. Measures or alternatives with a very general description are left out, given the importance of having information access, as mentioned earlier. Additionally, measures not closely related to the citizens (e.g., freight transport, energy in construction, etc.) were also neglected. This approach provides a clear overview of which topics would be interesting to investigate in terms of citizens' preferences.

4.2.1 Transport

For the Transport sub-sector, it is found that public transport has received special attention in Peru and neighbouring countries. As seen in Table 4.1 32% of the NDCs within the transport sector are solely focused on public transport, however, categories such as bike infrastructure and travel behaviour also incorporate the public trans-

portation factor. Therefore, it would be interesting to understand the citizens' preferences on this topic. Within this topic, five relevant measures proposed by the WBG, OSINERGMIN and Ernst&Young, are identified. By reading about each of them in more detail, it is decided to use two of the proposals by the WBG as a base for this research, given the specifications and details provided in their documents.

Categories	Countries				Proposed measures
	Peru	Chile	Colombia	Ecuador	
Public transport	32%	34%	21%	17%	3
Infrastructure	11%	0%	0%	0%	1
Travel behaviour	5%	0%	8%	0%	1
Tax	5%	3%	29%	25%	3
Regulation	16%	9%	13%	8%	0
Electricity supply	0%	0%	0%	8%	4
Charging stations	0%	16%	4%	17%	1
Benefits	0%	6%	17%	17%	1
Market	0%	3%	0%	0%	1
Research	0%	9%	0%	0%	2
Knowledge facilitation	0%	3%	0%	0%	1
Scrapping	11%	6%	0%	8%	1
Traffic management	5%	6%	0%	0%	0
Government vehicles	0%	0%	4%	0%	0
Alternative fuels	16%	0%	0%	0%	0
Bike infrastructure	0%	3%	4%	0%	2
Total	100%	100%	100%	100%	21

Table 4.1: Percentage of NDCs by category per country, within the transport sub-sector. And the number of proposed measures

- Promoting non-motorized transport in Lima and main intermediate cities.
  A plan has been drafted by the World Bank Group and the Metropolitan Municipality of Lima to encourage the use of non-motorized transport, mainly by expanding the current infrastructure in the Metropolitan Area, which includes Lima and Callao. The objective is to have 1, 383 km of bike infrastructure by 2040. Starting from this initiative, it has also been proposed to implement a bike network in Arequipa, Cusco, Ica, Puno and Trujillo; given that these are the main intermediate cities. A total of almost 3, 300 km of non-motorized infrastructure would result from the implementation in all 6 locations (World Bank Group, 2022a).

- Expand the Bus Rapid Transit system in Lima and implement it in the main intermediate cities.
  An extension of approximately 10 km on the North part of the Bus Rapid Transit system in Lima, also known as "Metropolitano", is currently being implemented. However, adding more kilometres as well as implementing a BRT system in other major cities, would bring greater benefits. The scope is the same as the non-motorized transport measure, i.e., the cities considered for implementation are Arequipa, Cusco, Ica, Puno and Trujillo. The end goal is to have a total of 400 km of BRT system in all locations by 2050, however, a short-term goal is to have 130 km by 2030 (World Bank Group, 2022a).

From the description of both proposed measures, it is evident the similarity of their scope in terms of the locations for implementation. Additionally, the World Bank Group (2022a) mentions how both them complement

each other. For example, accessibility to public transport modes like a BRT system, is increased by providing a non-motorized transport infrastructure like bike lanes. Because of those reasons, it is decided to combine both measures as a single one, to define T1 as the first measure for the PVE experiment (see image 4.1).

Figure 4.1: Policy alternative T1

From the interview held with the transport expert (section 2.2) it was cleared up that the measures leading to alternative T1, do not contemplate vehicle electrification. Some categories mentioned in Table 4.1 are related to vehicle electrification, for example, electricity supply, charging stations, or benefits. Additionally, the report by the World Bank Group (2022c) highlights the importance of a transition towards electric vehicles in order to achieve decarbonization in the transport sector. A similar statement is also done by OSINERGMIN (2019a). For this reason, it is decided to add a second policy alternative to the PVE, focusing on vehicle electrification. However, only one by the WBG was found as the most comprehensive one.

- Electrification and travel behaviour for the decarbonization of the transport sector.
  The use of electric vehicles should be promoted for the different types of transport, i.e., private, public, freight and passenger. This, calls for a high investment due to the need for improvement of vehicle fleet, infrastructure and technology. The expected result for 2050 is to achieve zero emissions in the transport sector, by setting the right context in order to have electric vehicles at appealing prices when compared to fossil-fueled vehicles (World Bank Group, 2022a).

The focus of T1 on public transportation is considered for the definition of the second measure, as they are within the same sub-sector. This would also facilitate the comparison the participant will make during the choice task. The proposal just described, is adjusted to mention only public transportation, resulting in T2 as a second measure in the PVE (see image 4.2).
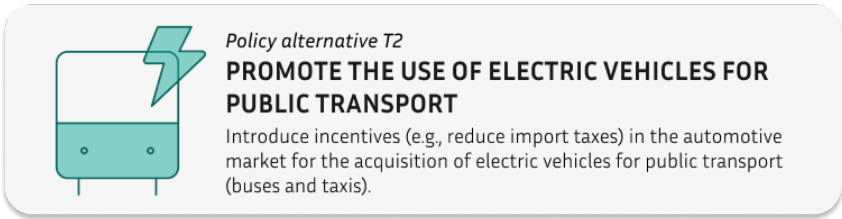

Figure 4.2: Policy alternative T2

A slightly different approach is taken for the selection of a policy alternative in the Energy generation sub-sector. This is because details regarding the proposed measures, are more difficult to specify from the gathered information. From the NDCs analysis (Table 4.2), it is found that the Peruvian government is focusing on residential applications, given that 30% of the NDCs within the sub-sector are related to implementations for residences. By reviewing policy measures from the different countries mentioned in section 2.1 under the same topic, an interesting NDC from Colombia is identified.

| | Countries | | | | Proposed |
Categories	Peru	Chile	Colombia	Ecuador	measures
Renewable energy	10%	17%	0%	40%	1
Regulation	20%	17%	11%	0%	1
Electricity generation	20%	25%	11%	0%	1
Residential application	30%	8%	11%	20%	0
Public application	10%	8%	0%	0%	0
Recycling	10%	0%	0%	0%	0
Infrastructure	0%	8%	0%	20%	0
Energy management	0%	8%	22%	0%	2
Knowledge facilitation	0%	8%	0%	0%	0
Alternative sources	0%	0%	22%	0%	0
Smart grid	0%	0%	11%	0%	0
Energy efficiency	0%	0%	11%	20%	0
Total	100%	100%	100%	100%	5

Table 4.2: Percentage of NDCs by category per country, within the Energy Generation sub-sector. And the number of proposed measures

- Electricity generation.
  A measure part of the Plan Integral de Gestión del Cambio Climático or Comprehensive Climate Change Management Plan in English, aims to diversify the Colombian energy matrix and promote self-generation of alternative energy sources. Additionally, it tries to focus on energy generation in Non-Interconnected Zones. For this, the suggestion is to encourage the implementation of cost-effective solutions (Gobierno de Colombia, 2020).

Further research on electricity generation from alternative energy sources is done. The report "Energías Renovables: Experiencia y perspectivas en la ruta del Perú hacia la transición energética" or in English "Renewable Energies: Experience and perspectives on Peru's route to the energy transition" by OSIGERMIN is found relevant.

- Potential of renewable energy resources in Peru.
  The Peruvian context and geographical location are considered, to mention the potentiality of different sources for renewable energy generation. The resource with the highest potential is the hydroelectric one, followed by solar. However, the technical potential is not currently being fully exploited, as only 7.12% of the hydroelectric potential and 1.14% of the solar potential is installed nowadays (OSINERGMIN, 2019b).

From the proposed measures identified in section 2.2, the report by the IADB on carbon neutrality, provides some suggestions for the development of alternative energy sources.

- Carbon-neutral scenario for the energy sector.
  It is expected to have an increase in energy generation from wind and solar energy plants. However, it also mentions the possibility of having solar panels on the roofs, and how this type of installation is assumed to be in greater proportion than big-scale solar energy solutions (Quirós-Tortós et al., 2021).

It is found that there is a low percentage of solar energy potential installed in Peru. However, the IADB mentioned that solar energy would play a significant role in achieving a carbon-neutral scenario. Additionally, several Peruvian NDCs give special attention to residential applications when it comes to the energy generation sub-sector. Therefore, it is fitting to focus on a measure that contributes to raising the percentage of the installed potential of solar energy, through the implementation of a solution that can be applied in residences. This would also keep the policy alternative closely related to the citizens like T1 and T2, maintaining coherence within the Energy sector. Based on the explanation provided and together with the insights gained from the Colombian NDC regarding electricity generation, E1 is defined as the third measure to be included in the PVE (see image 4.3).

Policy alternative E1
INSTALLATION OF SOLAR PANELS
Install solar panels in homes of rural areas without electricity supply.
This represents approximately 570,000 households nationwide.
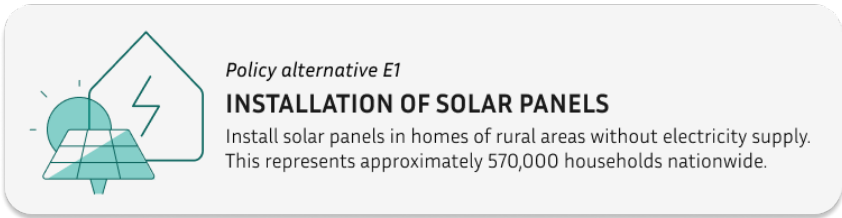
Figure 4.3: Policy alternative E1

4.2.3 AGRICULTURE

In terms of the Agriculture sub-sector, it is found that the measures planned by the government, are mainly focused on livestock and crop fields. Table 4.3 shows that about 50% of the NDCs within the Agriculture sub-sector, are regarding livestock, and 33% regarding food crops. Reading through the materials provided by the WBG detailing the proposed measures, it can be said that the concepts related to measures focused on crop fields might be easier to grasp by the wider audience when compared to the ones focused on livestock, due to the complexity of the system. For example, silvopastoral systems also include a livestock aspect, given that by improving the condition in which grass is currently, production related to livestock would also improve (World Bank Group, 2022b). Therefore, from the measures gathered in section 2.2, the one about crop improvement is reviewed.

- Coffee and cacao farming under agroforestry systems
  Nowadays there is a lack of the necessary knowledge and support to farmers, regarding their main agricultural activities. This causes poor use of the soil, resulting in low productivity and deforestation. This proposal aims to have a platform in which technical support, financing, and technology are provided to farmers, in order to avoid deforestation (World Bank Group, 2022b).

Categories	Countries				Proposed measures
	Peru	Chile	Colombia	Ecuador	
Livestock production systems	50%	0%	0%	100%	0
Field substitution	17%	0%	0%	0%	0
Crop improvement	33%	0%	34%	0%	1
Tax	0%	20%	0%	0%	0
Financing	0%	20%	0%	0%	0
Regulation and monitoring	0%	40%	0%	0%	0
Carbon sequestration	0%	20%	0%	0%	0
Silvopastoral systems	0%	0%	17%	0%	1
Food process and consumption	0%	0%	50%	0%	2
Agroforestry production system	0%	0%	0%	0%	1
Total	100%	100%	100%	100%	5

Table 4.3: Percentage of NDCs by category per country, within the Agriculture sub-sector. And the number of proposed measures

The proposed measure by the WBG is aligned with the main topics that the Peruvian government is focusing on. Moreover, the information is clearly explained and enough details are provided in their report. For both reasons, it is decided to use the proposal, in order to define A1 as the fourth measure in the PVE (see image 4.4).

Figure 4.4: Policy alternative A1

4.2.4 Land Use, Land-Use Change and Forestry

In the LULUCF sub-sector, Table 4.4 exhibits the different importance each of the countries gives to the identified categories, which can be attributed to the specific ecosystems each of them has. In the Peruvian context, the NDCs presented by the government show a focus on forest management and forest restoration, both representing almost half of the NDCs within the sub-sector. Therefore, special attention is paid to the proposed measures from section 2.2, which are related to those topics and fit with the government focus. Two policy alternatives are identified as relevant to consider, mainly for the details in the information gathered.

- Commercial timber plantations.
  Deforested areas can still be reforested, meaning that some species of trees could be planted in those areas. This opens an opportunity window for timber plantations, and an intention for its commercialization. A main condition for this, is to allow the involved parties to be able to widen their land rights, which can be achieved by granting them use or property rights. It is estimated that allocating rights of use and/or property for 300, 000 hectares, would be enough for a scenario in which sustainable growth is expected (World Bank Group, 2022b).

| | Countries | | | | Proposed |
Categories	Peru	Chile	Colombia	Ecuador	measures
Forestry management	29%	0%	0%	100%	1
Forest conservation	14%	0%	0%	0%	0
Regulation	14%	0%	29%	0%	1
Forest restoration	29%	0%	14%	0%	2
Agroforestry system	14%	0%	0%	0%	0
Financing	0%	50%	0%	0%	0
Carbon sequestration	0%	50%	0%	0%	0
Wood production	0%	0%	14%	0%	0
Food production	0%	0%	14%	0%	0
Consumers	0%	0%	14%	0%	0
Fees	0%	0%	14%	0%	0
Total	100%	100%	100%	100%	4

Table 4.4: Percentage of NDCs by category per country, within the LULUCF sub-sector. And the number of proposed measures

- Forest plantation for restoration.
  A great part of reforestation is destined for the restoration and recovery of the ecosystem. This will result in the recovery of ecosystem services, which is expected to turn the restored forest into a net carbon sink. One of the conditions for the implementation of this measure is granting rights of use and/or property for 1.7 million hectares, in order to achieve sustainable growth by 2050. Additionally, the economic benefits to be accrued after the implementation, should be communicated effectively for the preservation of this proposal (World Bank Group, 2022b).

Even when both measures propose reforestation, the main difference relies on the end purpose which could be either for commercial use or for restoration. For this reason, it is decided not to combine them, but to keep them separate. Based on the comprehensive information provided in the reviewed report by the WBG, U1 and U2 are defined as two different policy alternatives, and included as the final measures in the PVE experiment (see images 4.5 and 4.6).

Policy alternative U1
COMMERCIAL FOREST RESTORATION
Enable the temporary allocation of 0.3 million hectares of deforested forest to companies, communities and organizations by giving them rights of use and/or ownership (e.g., timber plantations) for the commercialization of timber.

Figure 4.5: Policy alternative U1

Policy alternative U2

FOREST RESTORATION

Enable the temporary allocation of 1.2 million hectares of deforested forest to companies, communities and organizations by giving them rights of use and/or ownership for forest restoration (e.g., planting trees).
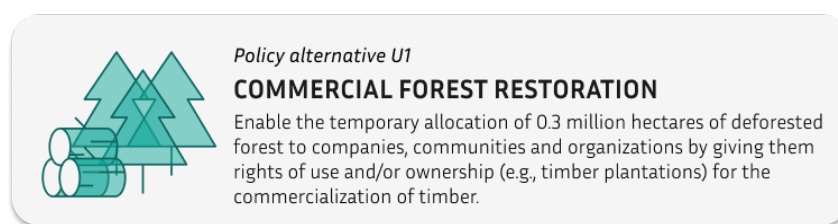
Figure 4.6: Policy alternative U2

The short and long descriptions previously displayed, are kept simple in order to be understandable by citizens with different levels of knowledge for climate change. The short description is presented in the main window of the choice task, this is to provide the necessary information to the participants when selecting their preference. However, long descriptions are included in the "Information" pop-up window of their corresponding policy alternative, to avoid overwhelming the participants with a lot of text (see Appendix A.2).

4.3 ALTERNATIVES EFFECTS

The main effects identified for the policy alternatives defined in the previous section can be categorized into quantitative and qualitative. The following sections provide further explanations and details on each of them.

4.3.1 QUANTITATIVE EFFECTS

Quantitative effects are the same for all alternatives in order to have a standardized point of comparison. Given that this research is focused on climate change mitigation, and because this is related to greenhouse gas emissions, it is understandable that a relevant effect to consider is the reduction of CO_2 emissions. For this, data provided by the reports on which the defined alternatives are based, is used. It should be noted that E1 is the exception, given it is not fully funded on a specific report but on a combination of proposals, however, details on the calculations are explained.

Data on the amount of CO_2 emissions that could be reduced for the years 2030 and 2050, is available in the reports by World Bank Group (2022c) and Quirós-Tortós et al. (2021), with some extra details in the supporting documents by World Bank Group (2022a) and World Bank Group (2022b). It is decided to use values for 2030 to give a sense of immediacy to participants. To support this, it can be said that individuals usually would prefer short-term benefits over long-term benefits, when making choices (Mullainathan & Thaler, 2001).

The expected decrease of emissions, is a forecast with respect to the base scenario, as specified in the report by Quirós-Tortós et al. (2021). This means the reductions are under a set of general and sector-specific assumptions. One of the most relevant assumptions to highlight, is that no mitigation actions are executed apart from the ones already implemented up to 2018. Another premise is that the population's habits will follow the same tendency.

Even when standard assumptions have been set, there are some uncertainty factors that may lead to different results in terms of CO_2 mitigation (Quirós-Tortós et al., 2021). However, the same report points out that there is a significant reduction in all the plausible scenarios that were explored. Additionally, the sectors within the scope

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of this research (i.e., transport, energy generation, agriculture and LULUCF) are the ones with the most amount of CO_2 that could be reduced, in all the scenarios examined by the authors.

From the theory reviewed in section 3.1, it is found that the effects presented to the participants, would allow them to ponder on the benefits and disadvantages of each alternative. The reduction of CO_2 emissions can be seen as a benefit, therefore, a second qualitative effect is defined. Another effect found to apply to all of the alternatives is the amount of money it would cost to implement each of the alternatives. This characteristic is especially interesting to include because alternatives with similar degrees of mitigation, might have very different costs of implementation. The cost values for this effect, are gathered in the same manner and under the same assumptions as the ones previously explained for CO_2 emissions. Likewise, there are some uncertainty factors that might have an impact on the real amount of money needed for implementation. Even, when 43% of the plausible scenarios analysed would require a larger amount of investment, the net benefits would remain positive (Quirós-Tortós et al., 2021).

As previously mentioned, the needed details for the E1 measure are not fully available in the reports used for the other ones. For this reason, further research was done in order to gather the relevant data and calculate the effects of the policy alternative regarding solar panels. Given that E1 focuses on homes not connected to the electricity matrix, the first data to find is this number of homes at a national level. For this, it is known that Peru has approximately a population of 34, 000 million citizens and that each home is composed of 3.5 people (Instituto Nacional de Estadistica e Informática, 2017). Then, Instituto Nacional de Estadística e Informática (2021) (INEI) or National Institute of Statistics and Informatics in English, mentions that 94.1% of Peruvian households are connected to the energy matrix. With this information, it can be estimated that 573, 142.86 homes fall within the scope of policy alternative E1 (see mathematical operation 4.1).

$$(34, 000, 000/3.5) * (1 - 0.941) = 573, 142.86 \; homes \tag{4.1}$$

Assuming a 20% efficiency from solar panels (TNO, 2023), it can be said that 5 times more of kWp/home-day will be needed. Knowing that Peru has a 0.4521 tCO_2-MWh of emission factor (Ministerio de Economía y Finanzas, 2021), the tons of CO_2 emitted per year can be estimated (see mathematical operation 4.2). Which is translated into Megatons for the upcoming 7 years leading to 2030, resulting in an estimated reduction of 2.2 $MtCO_2eq$. Finally, the cost of implementation is assumed to be 1, 500 USD per kWp [cite], which leads to approximately 4,300 million USD of investment for the defined scope.

$$(573, 142.86/0.20 * 0.4521)/(1, 000 * 365) = 472, 890.14 \; tCO2 - a \tag{4.2}$$

Table 4.5, relates each policy alternative to its corresponding amount of CO_2 reduction and implementation costs. The first effect is expressed in $MtCO_2$, while the second one is in millions of US dollars. The implementation of all the measures would bring an estimate of 24.88 MtCo2 mitigation and would cost approximately 39, 422 million USD.

Measure	CO$_2$ reduction for 2030 [MtCO2eq]	Cost of implementation [million USD]
T1	0.49	1,230
T2	4.08	31,860
E1	3.31	4,300
A1	4	603
U1	2	129
U2	11	1,300
Total	24.88	39,422

Table 4.5: Quantitative effects for each measure

4.3.2 QUALITATIVE EFFECTS

The qualitative effects for each of the alternatives, are identified from the reports by the WBG and IADB mentioned trough out this chapter. Additionally, further research is done, with the purpose of gathering more details (e.g., reports on the already planned north extension of the BRT system in Lima). It should be mentioned that the descriptions vary per effect, therefore, in order to standardize them and to avoid cognitive burden on the participant, these are presented on three levels: high, medium, and low; based on the specifications indicated in the reports. As a result, Table 4.6 summarizes the effects identified for each measure and their corresponding level, with the exception of *economic development* which will be next explained.

Effect	T1	T2	E1	A1	U1	U2
Economic development	x	x	x	x	x	x
Accesibility	high	-	medium	-	-	-
Health	high	medium	high	-	-	-
Travel time	high	-	-	-	-	-
Congestion	high	medium	-	-	-	-
Deforestation	-	-	-	medium	low	low
Soil quality	-	-	-	high	medium	medium
Carbon squestration	-	-	-	-	high	high
Jobs	medium	-	-	high	high	low

Table 4.6: List of effects identified for each measure and their impact level

It is evident that all the alternatives mention an impact on the country's *economic development*, thus it is pertinent to select it as one of the effects to include in the PVE. Following the same reasoning of avoiding cognitive burden to the participant, it is decided to not include the degree of the impact each of the measures has. In turn, a brief description of how each of them contributes to this specific effect is defined (see Table 4.7).

The rest of the effects can be regarded as sector-specific, given that they are mostly shared within the same sector (i.e., Energy and AFOLU). The selection of which sector-specific effect to include, is based on trying to incorporate different degree levels within each sub-sector. For example, if one measure has a value of "low" for an effect, the other one(s) within the same sub-sector should have either "medium" or "high".

Measure	Economic development effect description
T1	Informality in public transport is reduced, and the value of properties in areas close to new transport lines increases.
T2	Positive effect on the Gross Domestic Product (GDP) due to a lower demand for oil.
E1	Affects positively, especially in remote areas without access to electricity.
A1	Income for farmers due to the increase in the value of coffee and cocoa as a product.
U1	Income for the government and hectare owners due to access to the carbon market and timber production.
U2	Income for the government due to access to the carbon market. Income to native communities (shares on carbon stocks or money), due to recovered ecosystem services.

Table 4.7: Descriptions of the economic development effect for each measure

For the Energy sector, which includes the sub-sectors of Transport and Energy Generation, it is found that all three measures only have the *health* effect in common. This effect also fulfils the selection criteria explained previously, given that two different levels are included within each sub-sector (i.e., high and medium). Therefore, it is decided to include it as a qualitative effect in the PVE experiment. The description for each of the policy alternatives is shown in Table 4.8.

Measure	Health effect description
T1	More active lifestyle due to greater access to bike lanes, increasing life expectancy. In addition, a reduction in traffic accidents is expected.
T2	Positive effect on the health (cardiorespiratory, hearing, eye, and mental) of society, due to the reduction of environmental pollution (respiratory, visual, sound) from vehicles.
E1	Improves respiratory health for household members, due to the reduction in the burning of fossil fuels such as firewood.

Table 4.8: Descriptions of the health effect for each measure

The AFOLU sector includes the sub-sector of Agriculture and LULUCF, which share three sector-specific effects. McKinsey & Company (2022) states that in order to reach a carbon neutrality scenario, is important to prioritize putting a stop to deforestation and promoting reforestation. Therefore, the *deforestation* effect is selected and included in the PVE. Given that measures U1 and U2 are within the same sub-sector and have the same "low" level, another effect should be incorporated. Adding the *soil quality* effect would not cover the criteria of having different levels within each sub-sector. The *jobs* effect offers the diversity needed for a more comprehensive comparison between alternatives in the LULUCF sub-sector, by having U1 as "high" and U2 as "low". Therefore, this last qualitative effect is selected for the PVE. Table 4.9 shows the description for both sector-specific effects.

Measure	Deforestation effect description	Jobs effect description
A1	Focus on preventing deforestation by reducing migratory agriculture and land abandonment.	High potential for job formalization due to the export of coffee and cocoa.
U1	Focus on already deforested forests not on preventing deforestation.	High potential for job formalization.
U2	Focus on already deforested forests not on preventing deforestation.	Low potential for job formalization in the communities depending on the business model.

Table 4.9: Descriptions of the deforestation and jobs effects for each measure

Figure 4.7 summarizes and illustrates which qualitative effects are considered for each measure in the PVE experiment. The description for each of them are be included in the "Information" pop-up window of their corresponding policy alternative (see Appendix A.2). This will allow the participant to have access to it, without overloading the main window with text.
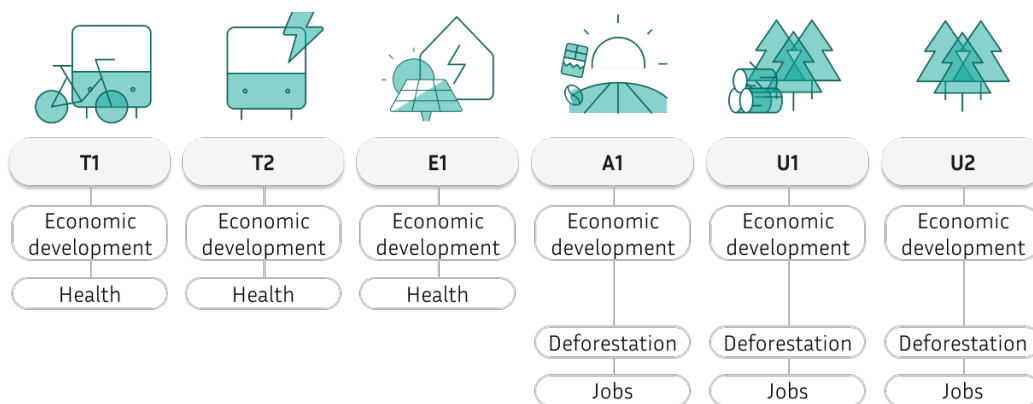

Figure 4.7: Qualitative effects per policy alternative

4.4 Constraint(s)

The context of this research is under climate change mitigation, therefore, it is suitable to have the amount of CO_2 emission as a constraint. This also keeps the experiment aligned with the commitment the Peruvian government has in relation to GHG emissions mitigation. Ministerio del Ambiente (2018a) mentions in their report of NDCs actualization, the goal of having no more than 208.8 MtCO2eq of net emissions in 2030.

The values used for the CO_2 constraint are based on the ones previously explained and summarized in Table 4.5. However, displaying the exact values (e.g., 0.49 MtCO2 for the first alternative) might not be fully comprehensible to the average Peruvian citizen. To keep the experiment simple, the percentage that each measure represents out of all 6 of them, is calculated (Table 4.10).

The expected amount of CO_2 mitigation by implementing all of the policy alternatives is 24.88 MtCO2eq, which can be translated to almost 12% of the commitment made by the government. It would be logical to set a similar percentage as a restriction for the participants of the PVE. To validate this, the minimum value on a scale

Measure	CO2 reduction for 2030 [MtCO2eq]	Percentage [%]
T1	0.49	2
T2	4.08	17
E1	3.31	13
A1	4	16
U1	2	8
U2	11	44
Total	24.88	100

Table 4.10: CO2 constraint values

from "0" to "1" (see section 4.5) is selected for all of the measures, to test if the 12% is an achievable target. It is found that a 10% of emission reduction is barely achieved in this scenario. To allow the participants to select some measures with a value of "0", the restriction should be below 10%. Setting a low restriction such as 1%, is noticeably related to the scenario in which all of them are "0", therefore, this would not be a suitable option. Based on this, 5% falls in the middle of both scenarios and is set as a minimum constraint for the cumulative effect [1] of CO2 reduction. A flexible constraint of 50% is also added, with the purpose of illustrating which values would bring more benefits. This means the participants will see a warning message if their selection is between 10 and 50% but they will be able to continue with the experiment. On the other hand, if the selection results in a CO2 reduction of less than 5% then the participant is not able to continue. Both minimum and flexible restriction values are depicted by using a gauge graph as shown in Figure 4.8.
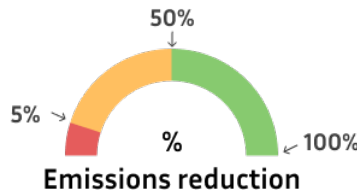

Figure 4.8: CO2 constraint visualization

The constraint on CO2 emission reduction, invites the participant to achieve a high percentage. However, this research studies the trade-offs between policy alternatives, which would be difficult to identify if the participant selects all of the alternatives (i.e., reaches 100%). To avoid this from happening, a second constraint needs to be introduced.

As identified in the review of previous PVE applications (section 3.2), most experiments include a restriction in monetary values, usually by using a budget determined by the government. This research is not based on planned projects from the government, which means no specific governmental budget is considered. However, each of the policy alternatives has a cost of implementation (Table 4.5), which adds up to 39, 422 million USD if all alternatives would to be implemented. Such value is used as a guide to define the values for the monetary constraint. Given that the purpose of introducing the second restriction is to avoid the individual selecting all

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[1] The explanation of how the selection of preferences is related to the CO2 effect, is in section 4.5

of the alternatives, the maximum constraint is set at 39, 000 million USD. In a similar way as done for the CO_2 constraint, a flexible restrictive value is included to illustrate which values would be more disadvantageous in terms of expenditure. For this, if a selection is below 10, 000 million USD then the participant does not get a warning message. To keep consistency between the constraints, the restriction for the cost of implementation is also represented using a gauge, as displayed in Figure 4.9.

Figure 4.9: Cost of implementation constraint visualization

4.5 Choice task

The central part of the PVE is the choice task the participants need to do, which is based on the set of alternatives presented, their effects, and the constraints. Given that the PVE is set in an online environment, a main screen is displayed when the choice task is reached (see Figure 4.10). This includes a short description of each of the six alternatives (1), the quantitative impact each of them has (2), and labels regarding the degree of implementation (3). On the right side of the screen, the constraints gauges are displayed (4). Additional information such as long descriptions and qualitative effects can be accessed by clicking on the information button (5), for each of the measures. Finally, the participant is able to sort and compare the alternatives by using the corresponding buttons (6). Appendix A.2 includes in more detail, the screens shown in the online environment for the choice task.
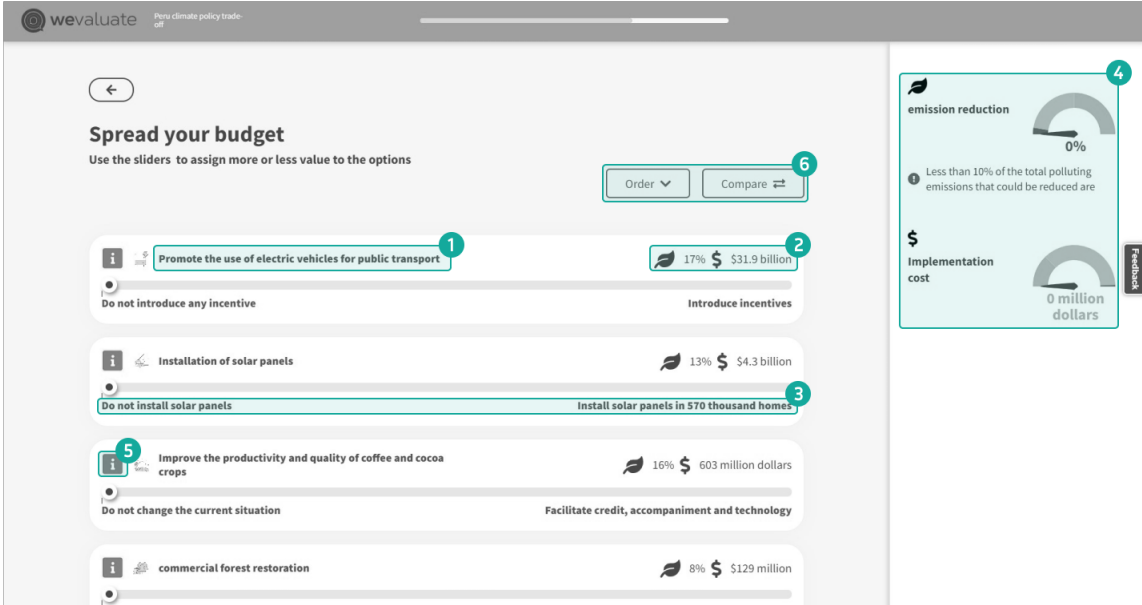

Figure 4.10: Main screen of choice task with highlights on its components

For the purpose of this research, the choice task is regarding the preferences on the six policy alternatives while considering the effects such selection would bring. Participants are not asked whether they prefer or not a measure, but the extent to which they prefer it. This is facilitated by the use of a slider, where the minimum value represents no implementation, while the maximum value means full implementation of the measure being assessed, with a total of 10 steps in between. Such values are labelled for each of the alternatives based on the description provided, to aid in the choice process to the participant. The sliders are linked to the constraints (which are based on the quantitative effects), meaning that selecting a full implementation entails its corresponding CO_2 reduction and implementation cost. Consequently, any step in between is in proportion to that total value.

Individuals state their preferences by sliding each of the six controls. Figure 4.11 illustrates this using policy alternative E1 as an example. The short description is the one defined in section 4.2 and the maximum value on the slider is specified as *"Install solar panels in 570 thousand homes"*, based on the alternative's long description. Full preference on the measure means a 13% reduction of CO_2 emissions and a 4, 300 million USD cost of implementation (see sections 4.3 and 4.4). Given that the slider is halfway on the bar, the quantitative effects are translated into an approximate of 7% reduction and 2, 150 million USD cost of implementation.
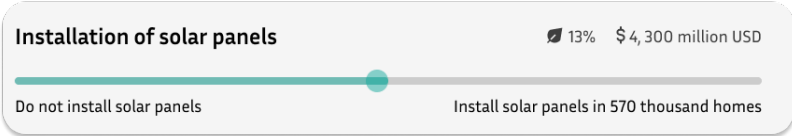

Installation of solar panels   🌿 13% $ 4, 300 million USD

Do not install solar panels   Install solar panels in 570 thousand homes

Figure 4.11: Choice example when alternative E1 is not fully preferred.

The constraint gauges on the right side of the screen, show the aggregated values, depending on the preferences stated by the participant on all the measures. Warning messages appear below each of those, whenever the indicator falls within the yellow or red range, which are delineated by the flexible and restrictive limits. Continuing with the example of policy alternative E1, Figure 4.12, illustrates the gauges that would be displayed if a participant slightly prefers that alternative and none of the others.

Emissions reduction   **Cost of implementation**

7%   2, 150 M USD

(!) Less than 50% of the total pollutant emissions that could be reduced are being reduced

Figure 4.12: Constraints gauges example when alternative E1 is not fully preferred.

The restrictive limits for each of the constraints are set mainly with the purpose of avoiding the participant choosing the implementation of none or all of the measures. This is because in such situations, it would be difficult to analyse the citizens' trade-offs. Therefore, if any of the constraints has a value within the red range, a pop-up window with a warning message is shown, and the participant is not allowed to continue to the next step. If any of the constraint values fall within the flexible restriction, the pop-up window shows a warning message, but

the participant can continue to the next step. Table 4.11 shows whether the participant can or cannot continue to the next step, depending on the different scenarios[2] of the values of the constraints, and Appendix A.2 depicts them in the online environment.

		Cost of implementation		
		<10M USD	10 - 39M USD	>39M USD
% Emission reduction	<5%	No	No	-
	5 - 50%	Yes	Yes	No
	>50%	Yes	Yes	No

Table 4.11: Scenarios allowing or not allowing th participant to move forward, depending on the values of the constraints

When finalizing the choice task, the participants are requested to motivate their selection. As mentioned by the theory on PVE (section 3.1), participants are provided with a space to make a written statement to openly explain what motivates their choices. Following this, a text box is placed for each of the alternatives, and the individuals can decide whether to fill them out or not. Appendix A.2 shows the environment presented to the participants.

4.6 Questionnaires

One of the strengths of the PVE method, as mentioned in section 3.2 is that it allows the participants to provide the arguments and concerns for their selection. However, the written motivations from the choice tasks are kept optional and not mandatory. The review of previous method applications shows that a questionnaire after the choice task is also included. To have a better understanding of the values, logic and concerns, different types of questions (i.e., open, likert, multiple choice, checkbox, drop-down list) are included as mandatory in a final questionnaire (see Appendix A.3). Given the topic similarity, special attention is paid to the prompts used in the Dutch PVE on climate policy, and are used as a guide for outlining the questionnaire section in the Peruvian PVE.

The first question aims to provide insights in relation to how were the effects considered by the participants when making a selection. The example provided in the report by Mouter et al. (2021d) is adapted for this PVE. A checkbox-type question is used, to allow the individuals to select one or more of the options, as well as to include one that is not listed. Figure 4.13 depicts the question and the options that can be selected.

When preferring a measure, I primarily considered whether the effects:

- [ ] affected me directly
- [ ] affected the Peruvian society
- [ ] affected future generations
- [ ] affected the environment
- [ ] other: _____

Figure 4.13: Question 1 in the questionnaire after choice task

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[2]It is found that it is not possible to have a selection where the emission reduction is below 5% and the implementation cost is above 39, 000 million USD

Next, through a 5-point likert-type question, the participants must select the extent to which they agree or disagree with a series of statements (Figure 4.14). The first four statements are in relation to the knowledge needed to provide advice as an individual and as a society. The following two statements are related to the PVE method, which are decided to be included in order to gain insights into the applicability of the method. The last statement aims to understand policy acceptance given the citizen participation through this method.

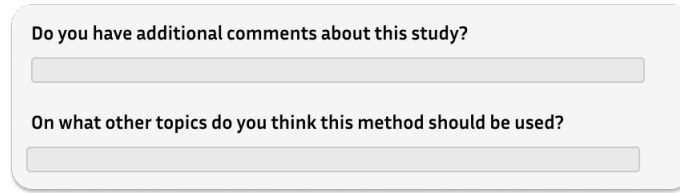**Figure 4.14:** Question 2 in the questionnaire after choice task

The Dutch PVE on climate policy also shows a question regarding the weigh that should be assigned to the citizens' recommendations as opposed to the scientists' recommendations. A similar question evaluating the weight versus the political parties' recommendations, is not considered relevant to include in the Peruvian PVE, as it does not match with the purpose of this research. Therefore, the third question in the PVE for this research is about the balance between citizens' and scientists' recommendations (see Figure 4.15).

Figure 4.15: Question 3 in the questionnaire after choice task

Then, open questions are asked regarding the method. However, the purpose of these is for gathering data that would serve as recommendations for further research. The participants are invited to provide any additional comments regarding this study, as well as to suggest any topics they consider relevant to investigate by using PVE. Figure 4.16 illustrates both open questions.
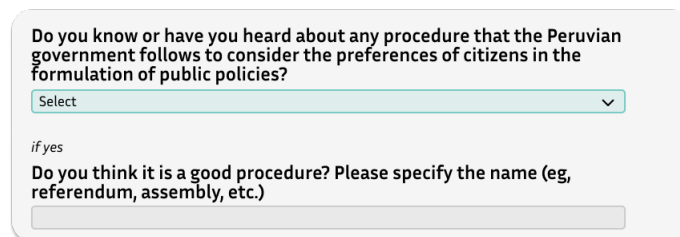

Do you have additional comments about this study?

On what other topics do you think this method should be used?

Figure 4.16: Questions 4 and 5 in the questionnaire after choice task

Finally, some socio-demographic characteristics are asked. Specifically, the participant is requested to select their gender, age range, highest educational level obtained, and residence location. These three questions are helpful for having a more detailed analysis.

In addition to the questionnaire presented after the choice task, three questions are added before the choice task. The first question aims at understanding the average knowledge regarding participatory processes in Peru. This can be related to the secondary research question, which is about the perception of Peruvian citizens regarding PVE. For this, the respondents are asked whether they know about a process currently followed by the government for policy-making. If the answer is *"yes"*, then they are asked to elaborate on the type and their opinion on it (see Figure 4.17). Based on the answers received, it can be analysed whether citizens' perceptions of PVE vary between participants who have knowledge of participatory processes, to those who do not.

Do you know or have you heard about any procedure that the Peruvian government follows to consider the preferences of citizens in the formulation of public policies?

Select

if yes

Do you think it is a good procedure? Please specify the name (eg, referendum, assembly, etc.)

Figure 4.17: Question 1 in the questionnaire before choice task

To have a starting point for the analysis, it is also relevant to understand the average knowledge of the citizens, regarding how each of the country's sectors contributes to climate change. The Ministry of Environment in Peru, makes reference to a public opinion study done in 2014 to mention the low level of education regarding climate change (Ministerio del Ambiente, 2016). However, such a statement alone cannot be considered as a reference for this research, due to the absence of details. For this reason, participants are asked to indicate which is the most and the least pollutant sector, based on their knowledge. Given that such information can be inferred from the emission reduction in the choice task, both questions are placed before it in order to avoid imposing a bias on the respondent. The main purpose of those questions is to gain further insights into the citizens' preferences for a sub-sector over the others. Answers can later be linked to the preferences from the choice task, and check whether

they relate to their perception of a specific sector. A drop-down list is used, with the four sub-sectors in the scope of this research as options (see Figure 4.18). With this, participants are also informed in a simple manner, about the sectors that are considered for this research.

Based on your knowledge, which of the following sectors is the most polluting?

Select	⌄
Transport	
Electric power generation	
Agriculture	
Forest	

Based on your knowledge, which of the following sectors is the least polluting?

Select	⌄

Figure 4.18: Questions 2 and 3 in the questionnaire before choice task

4.7 Pilot test

From the cases of previous PVE applications reviewed in section 3.2, some mention the launch of a pilot test. The main purpose of this is to improve the PVE based on the feedback received from the test. Performing a pilot can be beneficial for the experiment because the prospect of having a successful outcome, increases by allowing the identification of troublesome points and re-design them (Brooks et al., 2016). This can be seen as a good practice, therefore, the approach by Mulderij et al. (2021) and Rotteveel et al. (2022) is followed.

A pilot test is arranged through the panel company Dynata, with the objective of reaching 50 respondents. The pilot test ran at a national level from June 23rd, 2023 to June 26th, gathering more participants than the set goal (see Appendix B.1 for details on the socio-demographics). A total of 61 valid responses[3] are reviewed for an initial analysis and for the identification of improvement points, which are found to have an impact on the choice task and questionnaires. The updated online environment can be found in Appendix A.4 and A.5.

4.7.1 Preliminary findings

From the questionnaire before the choice task, it can be said that nearly 90% of the respondents consider "Transport" as the most pollutant sub-sector (see graph 4.19a), and almost 50% consider "Agriculture" as the least pollutant (see graph 4.19b). Further analysis of this, shows that slightly over 50% of the individuals that selected the Transport sector as the most pollutant, consider the Agriculture sector as the least one.

In terms of previous knowledge of participatory processes, only 11 participants selected "yes" as an answer. This means that only they are familiarized with a process the government follows, for considering the preferences of the population for policy-making. The process that is mentioned the most is "referendum", followed by "Assembly". It should be mentioned that two of the answers are comments, but do not describe a specific method. An illustration and further details of the answers can be found in Appendix B.3.

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[3] Responses are considered valid if they are complete. Drop-outs were checked but not found

(a) Most pollutant sectors.

Sectors
- Agriculture
- Forestry
- Energy generation
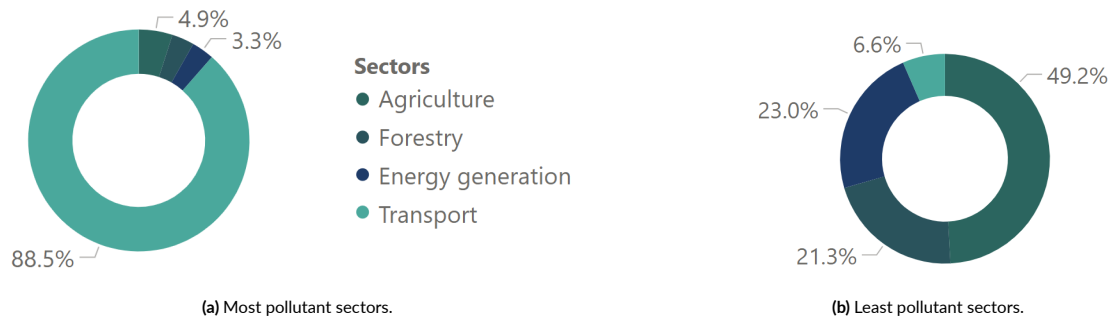- Transport

(b) Least pollutant sectors.

Figure 4.19: Most and least pollutant sectors according to respondents from the pilot test.

Results from the selections done in the choice task show that on average, participants choose to reduce 62% of CO_2 emissions and spend approximately 21, 650 million USD. Moreover, it is found that the majority of participants achieve at least a 50% of emissions reduction, and spend no more than 28, 000 million USD.
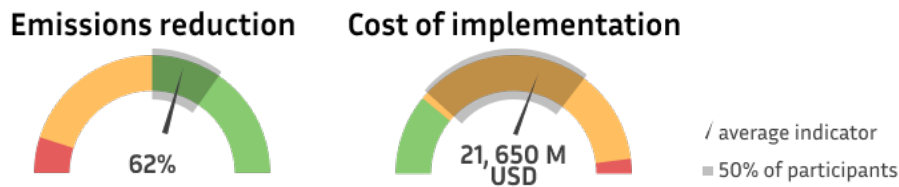

Figure 4.20: Average results and majority range from the choice task of the pilot test.

Reviewing the preferences of each of the policy alternatives the following points are found. The majority of respondents have a medium preference (between 4 and 7) for the measures on transport, energy generation, and agriculture. However, policy alternative T1 (i.e., expansion of BRT and bike lanes) shows the highest number of participants with a low preference for it. It is no surprise that measure U2 (i.e., forest restoration and conservation) is the most preferred one, given the high percentage of emission reduction it has. Appendix B.3 illustrates the percentages that each of the possible preference values (range from 0 to 1) represents per policy alternative.

Results from the questionnaire show that 67% of the participants considered whether the effects affected Peruvian society. The concern for future generations and the environment was also mentioned by more than half of the participants (61% and 57% respectively). Finally, only 21% of the participants mentioned that they considered whether the effects affected them directly. The respondents specified no additional reasons.

From the question asking the participants the extent to which they agree with a series of statements, the following insights are found. Half of the participants are neutral about having enough knowledge for delivering their advice. However, also nearly half of the participants agree that the study provided them with enough information to give advice. This can be related to the 60% of participants that agree on being convinced of their selection. On the other hand, most of the respondents are either neutral (32%) or disagree (26%) that the Peruvian population has enough knowledge to give advice.

It can be said that the method was received positively by the participants, given that 46% agree on PVE being a good method for involving citizens in climate change policies, and 31% completely agree. Similar opinions are received for the statement "The government should use this method more often". Additionally, the acceptance

of climate policies if the study the individuals just participated in, is considered. For this, 80% of the respondents at least agree that they would support the final decision. Details on the extent to which the participants agree with the set of statements presented to them, are found in the Appendix B.3.

Regarding the question of how should the government balance the advice of citizens versus the scientists', most participants (55%) believe the government should weigh the advice from the citizens the same as the one from the scientists. This is followed by a 30% of the respondents, who state the government should allocate "more weight to the advice of the scientists than of the citizens". Finally, the open questions requesting further comments on the study and suggestions for additional topics to use PVE, are reviewed in order to adjust some design details of the experiment. A more thorough interpretation is done based on the results gathered from the final PVE (i.e., after such adjustments).

4.7.2 UPDATES ON CHOICE TASK

The following changes described have an impact on the part of the experiment where participants are asked to make a selection, regarding their preferences over a set of policy alternatives. Adjustments are done based on the written statements of the respondents' motivations from the pilot test, and the guidance of PVE experts.

- Option to skip choice task.
  Reviewing the choice task with a PVE expert, it is found that there is a possibility a participant has no preference for either of the policy alternatives. Therefore, a checkbox is included at the bottom of the choice task screen, which blocks the use of the sliders when selected (see Figure 4.21). This type of election is still to be considered for the analysis. For the participants that decide to skip the choice task, a different "motivation" screen is presented (see Appendix A.4). Nevertheless, they are still provided with the space to explain their decision.
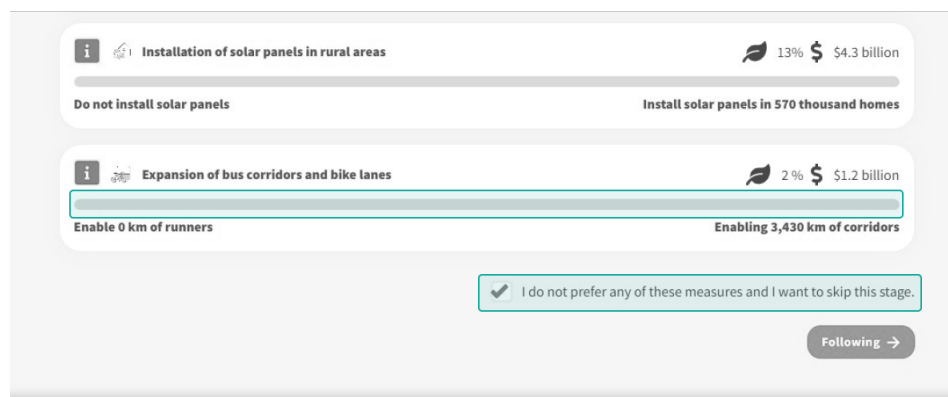

Figure 4.21: Checkbox button and blocked sliders when selected

- Short description for policy alternative E1.
  Motivations for this measure mentioned urban areas or larger city implementations. It can be assumed that not all of the participants paid attention to the long description, which states the scope of the implemen-

tation for rural homes not connected to the electricity grid. Therefore, this is made explicit in the short description. Figure 4.22 highlights the difference between the initial and updated description.

Figure 4.22: Updated description for policy alternative E1

- Short description for policy alternatives U1 and U2.
  Comments for both measures mention the importance of safeguarding the forest, however, no major clarifications are found on why its restoration is preferred over its commercialization (and vice versa). For this, the short descriptions are adjusted to make the distinction more evident to the respondents. Figures 4.23 and 4.24 highlight the difference between the initial and updated descriptions for measures U1 and U2, respectively.
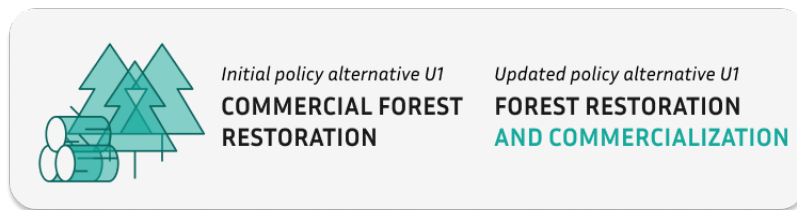
Figure 4.23: Updated short description for policy alternative U1

Figure 4.24: Updated short description for policy alternative U2

- Slider labels for policy alternatives U1 and U2.
  Following the premise of the previous explanation, the labels for the sliders are updated to a unit of measure more relatable to the average citizen. Therefore, *hectares* are changed to its equivalent in *soccer fields* (Table 4.12), based on the official information on pitch dimensions provided by the FIFA: Fédération Internationale de Football Association (FIFA, 2023).

	Hectares	Soccer fields
Measure U1	0.3 million	420 thousand
Measure U2	1.2 million	1 million 680 mil

Table 4.12: Equivalent of soccer fields for the hectares in the scope of measures U1 and U2

- Additional information for policy alternatives U1 and U2.
  A respondent made explicit the lack of understanding of these measures. Due to this, and linked to the previous two points, the phrasing of the long descriptions (Table 4.13) and qualitative effects are adjusted with the intention of being more clear.

	Updated description
Measure U1	Temporarily assign the equivalent of 420 thousand soccer fields of deforested forest to companies, communities, and organizations, who will have rights of use and/or ownership for the sale of wood (for example, wood plantations).
Measure U2	Temporarily assign the equivalent of 1 million 680 thousand soccer fields of deforested forest to companies, communities, and organizations, who will have rights of use and/or ownership for forest restoration (for example, planting trees).

Table 4.13: Updated long descriptions for policy alternatives U1 and U2

4.7.3 Updates on questionnaires

The adjustments on both questionnaires are based on the answers obtained, as well as on the discussion with PVE experts. It should be mentioned that slight changes were done in the order of the questions, with the purpose of presenting a coherent flow.

- Placement of question regarding knowledge of participatory processes.
  After reviewing the questionnaires and getting input from PVE experts, it is found that this question would fit better in the final questionnaire. This change, would not bring a risk of biasing the respondent. Therefore, it is placed after asking the participants about their opinion on the PVE method.

- Changing the type of question regarding other topics to implement a PVE.
  One of the open questions asked the participants for suggestions in order to deploy a PVE in a different field. It is found that some topics are mentioned more frequently than others. For this reason, the textbox is switched to a checkbox with a list of topics, as well as the option "other", allowing the participants to include any topic not mentioned. By making this adjustment, the analysis for the larger sample is simplified. Figure 4.25 illustrates the updated question.

Figure 4.25: Updated question regarding topics suggestions for future PVEs

- Additional questions.

  Based on the motivations and responses, three questions are added. This is with the purpose to provide a designated space in which the participants can give their opinion in a structured manner. Table 4.14 shows some translated quote examples that prompted the additional questions.

Question	Quotes
Through which medium would you like to be informed about climate change policies?	*"These are points that I had not been informed in as much detail as now, thank you!"* *"In order to have more realistic results of the study, the government must previously provide information on the subject to the Peruvian population through short and well-explained commercials on TV or radio so that they can better respond to the study."*
Do you think the government should allocate more resources to measures against climate change or should it allocate them to projects not related to climate change?	*"I do not consider it necessary because the transport routes are the main problem"* *"The bike lanes should be better implemented, indicate their use well, not place them where they want and generate more chaos."*
What other measures to reduce emissions would you suggest?	*"The most polluting factor, which is mining, was missing."* *"The government must create awareness of how important it is for citizens to collaborate with protection in order to have a good result in terms of climate."*

Table 4.14: Motivations for the questions added to the final questionnaire

4.8 PVE MAIN CHARACTERISTICS FOR PREFERENCES TRADE-OFFS ELICITATION

The design of a PVE plays an important role when aiming to achieve the goal set for a research. The characteristics defined are presented to the participants through the experiment, who will state their preferences and motivations based on such information. Given the different elements that should be considered for a PVE, is beneficial to

have a structured design process. For this reason, the main steps recommended by literature, are followed for this research; including the one of a pilot test, which aims to improve the design of the PVE.

First, the purpose and scope are defined as a starting point. To be aligned with the two-fold goal of this research, the purpose of the PVE is to elicit Peruvian citizens' preferences for climate policy alternatives, as well as their perceptions of the method. Being the focus of this research on Peruvian society, a national representation is sought, which could be achieved through a panel consultation.

Then, what is found from the desk study on proposed measures by similar countries in the region and non-governmental organizations, is analysed. This results in the selection and description of a set of 6 policy alternatives. Necessary adjustments are done after the pilot test, leaving the following final (translated) measures:

- T1: Expansion of bus corridors and bike lanes

- T2: Promote the use of electric vehicles for public transport

- E1: Installation of solar panels in rural areas

- A1: Improve the productivity and quality of coffee and cacao crops

- U1: Forest restoration and commercialization

- U2: Forest restoration and conservation

For each of the policy measures, quantitative and qualitative effects are defined. Given this research is focused on climate change and based on the information found for each of the alternatives, the quantitative effects are *CO2 emissions* and *Cost of implementation*. Values for both effects are identified for all six measures. Most qualitative effects, on the other hand, vary per sector. *Economic development* is identified in the research of all policy alternatives, therefore, is selected as the first qualitative effect. For the sector-specific effects, a selection criteria is followed, in terms of level of impact. Transport and Electricity generation sub-sectors, have *Health* as a relevant effect. For Agriculture and LULUCF, the qualitative effects selected are *Deforestation* and *Jobs*.

Another important decision is regarding the constraint(s). For this PVE is decided to use the quantitative effects as constraints. This is because, as understood throughout this research, CO2 emissions is one of the most relevant forms of measure in the context of climate change, and because adding a monetary restriction allows the participant to weigh the advantages and disadvantages in quantifiable terms. Information specified for each of them during the definition of the effects, is used as a guide to determine the flexible and restrictive constraint values, which determine whether the participant can continue or not to the next step of the PVE.

Having defined the policy alternatives, its effects and constraints, the choice task is set up. The individuals state their preferences for each of the measures presented to them, in an online environment. They do so by using sliders, where the farthest to the right, means the higher the preference. There are 11 possible values that can be selected with the slider, which goes from 0 to 1. The selected values for all measures are accumulated and represented with an indicator in each of the gauges illustrating the constraints. These aggregated values are also checked versus the flexible and restrictive constraint values. After the pilot test, is decided to include the

option of skipping the choice task. However, whichever the selection is, participants are invited to provide their motivations.

Finally, following what is found in the literature, a series of questions are asked to the participants of the PVE. It is not often that a questionnaire is included before the choice task, however, it is found that Peruvian society does not have a high knowledge level regarding climate change. For this reason, a couple of questions about their understanding of most and least pollutant sectors are added before the choice task, to avoid biasing their response. Regarding the questionnaire after the choice task, the questions are focused on gaining more insights with respect to their motivations, policy acceptance, perception of the method and knowledge regarding participatory processes. The answers from the questionnaires and choice task, are to be analysed in order to identify relevant information that contributes to answering the primary and secondary research questions.

5

Results and analysis

The designed PVE is conducted within a panel on a national level, to identify trade-off preferences of Peruvian citizens, concerning climate change policy alternatives for emission mitigation. Ethical approval for the study was granted by the Human Research Ethics Committee of Delft University of Technology on March 31st, 2023. Consistent with previous PVE applications, a sample of 2,000 respondents from the national Peruvian population was set as a target. Data was gathered between July 3rd and July 17th, 2023, through the online panel company Dynata. Below is the link to the PVE survey, conducted in Spanish, in which citizens participated.

<div style="background:#f0f0f0;padding:1em;text-align:center;color:#2e7d72;">Climate policy trade-offs in Peru</div>

Out of the 2, 378 participants who provided their informed consent, a total of 2, 373 valid responses[1] were received, yielding a dropout rate of 17.1%. The complete dataset comprised 1,968 responses, accounting for 98.4% of the intended target, which is a significant proportion to have a meaningful analysis. A supplementary analysis between the outcomes of the pilot test and the full-scale implementation can be done to ascertain their compatibility for integration. However, to keep a legitimate analysis, only answers from the final PVE are considered.

In the following sections, different analyses are undertaken based on the acquired results. First, the socio-demographic traits of the sample are outlined (section 5.1). Second, the Peruvian citizens' preferences are described from a quantitative and qualitative perspective (section 5.2. Thereafter, an explanation is provided for responses regarding the participatory method and policy acceptance (section 5.3). For each section, different tools

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[1] Responses are only considered valid if they have values in all mandatory questions, unless is a drop-out (i.e., no question is answered after a certain step.)

are employed depending on the analysis done. Quantitative analysis and graphical visualizations are facilitated through Excel and PowerBi. For more specialized statistical analysis, Jasp is employed, while Atlas.ti is useful for the qualitative analysis of open-ended questions. Finally, LatentGold is selected for the cluster analysis.

5.1 Socio-demographic characteristics

The current population in Peru is approximately 33 million 726 thousand according to the latest estimations by the Instituto Nacional de Estadistica e Informática (2023). In their report "Situación de la población Peruana al 2023", the INEI highlights the major characteristics of the Peruvian population for the current year. However, the data focuses on the younger population and lacks the necessary details to assess the representativeness of the sample. For this reason, the analysis is based on the results from the most recent census conducted in 2017. Census data including population distribution by gender, age group, educational attainment, and region is sourced from the report published by the same institution (see Instituto Nacional de Estadística e Informática (2018)).

From the total sample, 50.05% of the respondents identified as female, 49.49% as male and 0.46% did not specify their gender. These proportions closely resemble the gender composition of the national Peruvian population, which the latest census reports as 50.8% female and 49.2% male. However, when including the age group to the analysis, it was revealed that the population aged 46 years and over is under-represented for both genders (see details in Appendix C.1). Figure 5.1 illustrates the percentages per age group and gender from the total of respondents, excluding the ones who chose not to specify their gender.
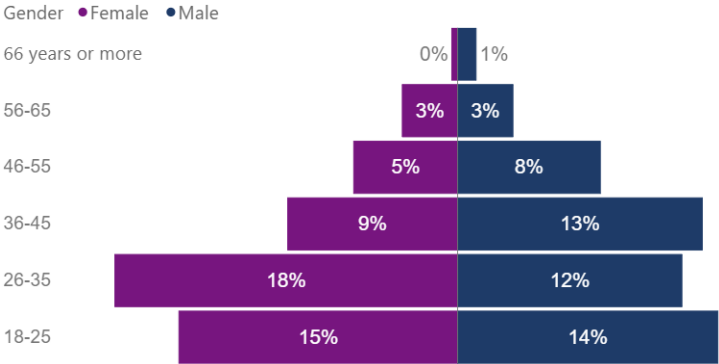

Figure 5.1: Age-gender pyramid: percentages of total sample per category

Peru is composed of 25 regions, which can be categorized as Coast, Highlands or Amazon. The coastal regions, with Lima accounting for approximately 32% of the population, hold the majority of the population. Yet, even when considering this distribution, the coast is over-represented in the sample (see Appendix C.2 for details). Figure 5.2 provides a visual representation of the respondent distribution across each region, categorized by Coast, Highlands and Amazon. Participants were also asked to select their education level. Close to 80% of the participants reported having attained a Graduate education degree, followed by a 20% who completed High School education. Comparing these figures to the actual national distribution in terms of education suggests an over-representation of individuals with graduate degrees (details are found in Appendix C.1). Relating this to the findings concerning "residence", the INEI reports that rural areas exhibit lower rates of Graduate education

attainment compared to urban areas ([Instituto Nacional de Estadística e Informática, 2018](#)). Given that rural areas are predominantly situated in the Highlands and Amazon regions, it is understandable why people with lower education level is under-represented in the sample.
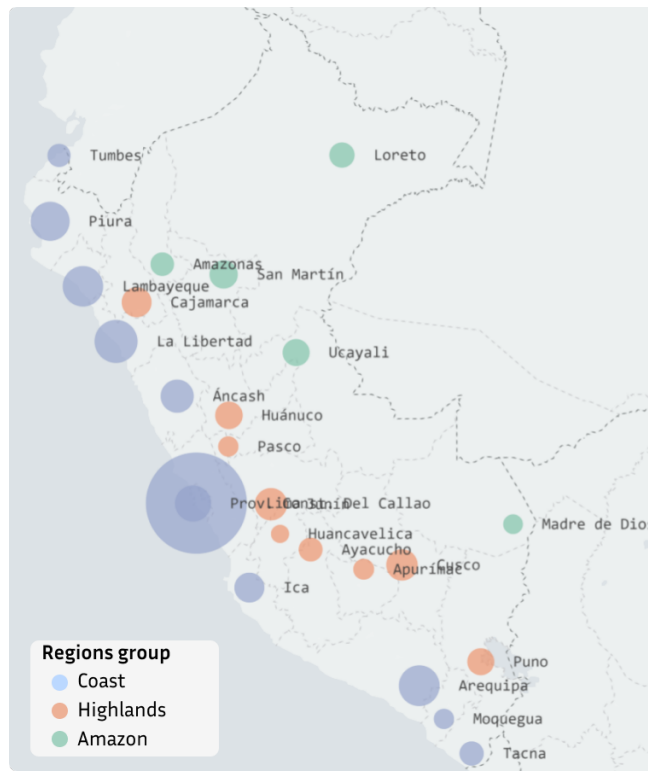

Figure 5.2: Number of respondents per region

5.2 Peruvian citizens' preferences for climate change mitigation policy alternatives

Participants were asked to state the extent to which they prefer each of the measures presented to them, however, they also have the option to skip the choice task. The results indicated that approximately 8% of the respondents chose this last option, and none provided a written motivation for their selection. This leads to the assumption that these respondents do not have a preference for any of the measures presented to them. Relating this information to the socio-demographic characteristics, it can be inferred that the individuals who do not prefer any of the policy alternatives are mostly 35 years or younger and have attained at least a High School diploma (see table C.4 in Appendix C).

From the citizens who decided to participate in the choice task, it is possible to obtain their stated preferences in the experiment through numerical values[2]. Figure 5.3 illustrates the percentages of the participants who selected each value for each policy alternative. It is evident that measure *U1: Forest restoration and commercialization* has the highest proportion of individuals who consider it as the least preferred option (i.e., selecting a value of 0), accounting for 10% of respondents. On the other hand, the most preferred measure is clearly *U2: Forest*

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[2] Participants are not able to visualize the values, however, these are in relation to the position in which they set the slider in the online environment

restoration and conservation, with a substantial 34% of individuals showing a full preference for it (i.e., selecting a value of 1). The second most preferred measure is *E1: Installation of solar panels in rural areas*, as 23% of the respondents assigned a value of 1 to it.
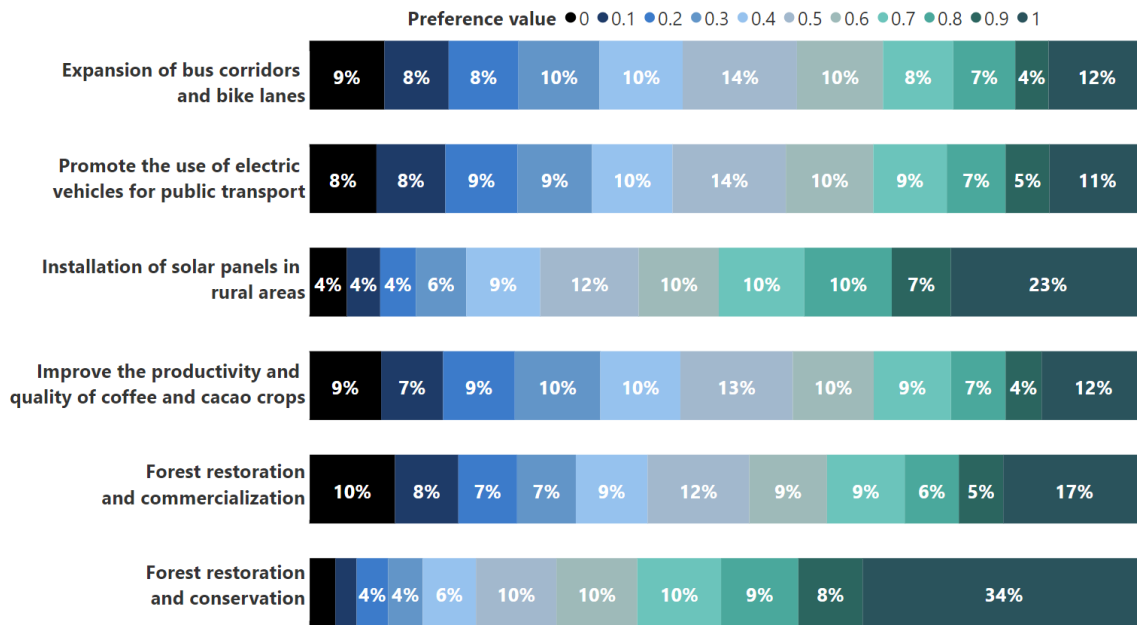

Figure 5.3: Percentages of the preference value selected for each policy alternative.

Descriptive statistics reveal a high *W-value* in the Shapiro-Wilk test[3] for all of the policy alternatives (Table 5.1), which could potentially lead to the assumption of a normal distribution in the samples. Nevertheless, the p-value for all of them is below 0.05, indicating the rejection of the null hypothesis and concluding there is no normal distribution at any of the policy alternatives. However, the large size of the sample might contribute to the low p-value (Gómez-de Mariscal et al., 2021). Consequently, due to the presence of a median of 0.5 in 4 out of the 6 measures, mean values are chosen for the analysis; which also provides a more evident distinction between alternatives.

	T1	T2	E1	A1	U1	U2
Mode	0.500	0.500	1.000	0.500	1.000	1.000
Median	0.500	0.500	0.700	0.500	0.500	0.800
Mean	0.493	0.501	0.634	0.499	0.528	0.706
Std. Deviation	0.306	0.306	0.301	0.308	0.329	0.292
Skewness	0.086	0.058	-0.417	0.087	-0.061	-0.710
Kurtosis	-1.000	-1.032	-0.853	-1.021	-1.176	-0.515
Shapiro-Wilk	0.948	0.948	0.920	0.946	0.928	0.875
P-value of Shapiro-Wilk	<.001	<.001	<.001	<.001	<.001	<.001

Table 5.1: Descriptive statistics for each of the measures' preferences

Based on the estimated average preference values, it is evident that *U2: Forest restoration and conservation* is

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[3] This statistical test has the null hypothesis that the distribution of the sample is normal (King & Eckersley, 2019)

the most preferred measure, while *T1: Expansion of bus corridors and bike lanes* is the least preferred. This shows that although *U1: Forest restoration and commercialization* has the highest proportion of participants who chose it as their least preferred measure, the higher average value for U1 than for T1 can be attributed to its negative skewness value. Additionally, with a nearly similar preference as T1, policy alternatives *T2:Promote the use of electric vehicles for public transport* and *A1:Improve the productivity and quality of coffee and cacao crops* are on average, among the least preferred measures.

Moreover, the negative skewness and kurtosis values show that the preference distribution for policy alternative *U2: Forest restoration and conservation* is significantly concentrated towards higher values, reinforcing the identification of such measure as the most preferred one. On the other hand, skewness and kurtosis values for measure *T1: Expansion of bus corridors and bike lanes* are comparatively lower. This interpretation suggests that while T1 shows to be the least preferred among the other ones, there is no manifestation of a strong inclination for selecting low preference values.

Further analysis of the least and most preferred measures on average, can be done. From respondents who selected a preference value of 0 for the least preferred measure (i.e., *T1: Expansion of bus corridors and bike lanes*), it can be said that they also tend to exhibit low preferences for measures *T2:Promote the use of electric vehicles for public transport*, *A1:Improve the productivity and quality of coffee and cacao crops*, and *U1: Forest restoration and commercialization*. On the other hand, nearly half of these respondents express a high preference for measure *U2: Forest restoration and conservation* (see Appendix C.5 for details).

Performing a similar analysis on the most preferred alternative (i.e., *U2: Forest restoration and conservation*), it becomes evident that participants who have a high preference for this measure, also hold high values for policy alternatives *E1: Installation of solar panels in rural areas*, *U1: Forest restoration and commercialization* and *A1:Improve the productivity and quality of coffee and cacao crops*, in this specific order. However, preferences for measures *T1: Expansion of bus corridors and bike lanes* and *T2:Promote the use of electric vehicles for public transport* are more widely distributed across the 11 possible values, showing only a small inclination toward higher preference values. Based on this, it can be said that participants who favour measure *U2: Forest restoration and conservation*, also tend to prefer almost all of the remaining policy alternatives (see Appendix C.6 for details).

Measure	Average preference	CO_2 emissions reduction [%]	Cost of implementation [million USD]
Expansion of bus corridors and bike lanes	0.49	1.0%	588
Promote the use of electric vehicles for public transport	0.50	8.5%	15950
Installation of solar panels in rural areas	0.63	8.2%	2709
Improve the productivity and quality of coffee and cacao crops	0.50	8.0%	302
Forest restoration and commercialization	0.53	4.2%	68
Forest restoration and conservation	0.71	31.2%	923

Table 5.2: Average preferences per measure and their corresponding quantitative effects.

Furthermore, by taking into consideration the quantitative effects defined for each of them in the design of the PVE (as explained in section 4.3), it is possible to calculate the percentage of CO_2 emissions reduction and cost of implementation corresponding to the identified average preferences. The estimations provided in Table 5.2

indicate that citizens' average preferences for the set of policy alternatives, result in a 61% reduction of CO_2 emissions and entail a total of 20, 586 million USD for its implementation. These values, along with the respective median and quartiles, are compared against the associated constraints and illustrated in Figure 5.4. The percentage of CO_2 emissions reduction value does not violate any restrictive constraint, while the cost of implementation remains within the limits of the flexible restriction.
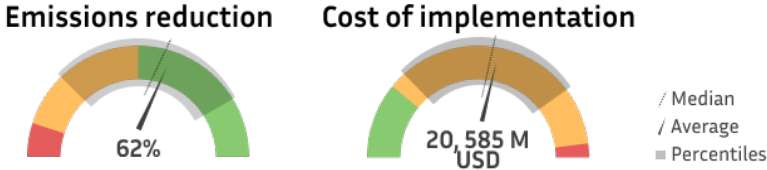

Figure 5.4: Average, median and quartiles of quantitative effects from the results of the choice task.

After the participants had stated their preferences for each policy measure, they were also offered the opportunity to provide written motivations for their selections. Taking into account that the quantitative effects resulting from the average preferences have already been examined based on the choice selections, these written motivations are used to analyse the qualitative effects. To achieve this, Atlas.ti software is employed to check each motivation and identify relevant references to the effects as delineated in section 4.3. To facilitate this process, a list of keywords associated with each description of the qualitative effects is established (see Appendix C.7 for the full list).
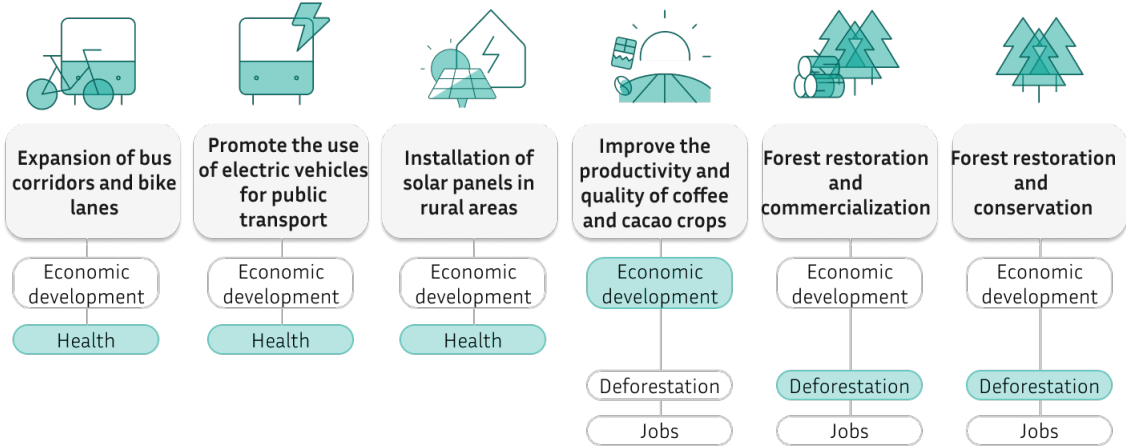

Figure 5.5: Qualitative effects most mentioned per policy alternative.

Figure 5.5 highlights the most mentioned effects for each policy measure. In the context of the Energy sector, is evident the importance of the *Health* factor in citizens' preferences for the corresponding measures. The data indicates that this effect was mentioned at least twice as often as the other one. These results can be related to the preference values, given that each motivation is linked to a specific choice selection. Within this sector, the health effect frequently emerges in responses corresponding to medium to high preference values, particularly for policy alternative *E1: Installation of solar panels in rural areas*. For instance, a respondent mentioned: *"I think it's very*

good, not only for reducing pollution, but also because we take advantage of our resources and improve the quality of life of people who live far away."

On the other hand, the health aspect is also occasionally mentioned by the respondents who selected lower preference values concerning the least preferred measure (i.e., *T1: Expansion of bus corridors and bike lanes*). Citizens express concerns that the introduction of buses to the existing transportation network could aggravate air pollution. Others mentioned that although cycling is a healthier option, many individuals might opt for cars due to their quicker travel times. When it comes to policy alternative *T2:Promote the use of electric vehicles for public transport*, individuals highlight the cost associated with acquiring electric vehicles as a drawback, even when they are in favour of its health-related benefits.

In terms of the AFOLU sector, there is a distinction in the most mentioned effect between sub-sectors. In the context of the Agriculture sub-sector, respondents frequently specify *Economic development* as a relevant effect, particularly among those who expressed medium to high preference for the given Agriculture measure. Citizens commonly believe that prioritizing export activities is important to improve economic development in the country and provide benefits to the farmers. For example, one of the respondents explained: *"It is important because we have excellent product quality but we need to raise our export promotion, we need to instruct farmers to improve that quality and get government support to export this excellent product."*

In the LULUCF sector, and for both policy alternatives the predominant effect is *Deforestation*. When relating this outcome to the preference values, tthe mention of this effect for the policy measure regarding commercialization (i.e., *U1: Forest restoration and commercialization*), is distributed relatively evenly across the 11 possible preference values. People expressed the prevalence of (illegal) logging in the Amazon region, and they would prefer a measure that avoids relying on this activity for generating revenue.

Considering policy measure *U2: Forest restoration and conservation* is the most preferred alternative, it is understandable that the "deforestation" effect is particularly emphasized in the highest preference value. One respondent's motivations provides a clear example: *"By restoring and conserving forests, not only natural habitat species are preserved. Rather, a constant reserve of unlimited raw materials is generated (depending on the amount of time it takes to grow the plant species used). Which, with a controlled and measured use, can generate in the long term not only economic benefits but also environmental, improving the quality of the air and the life of the species that live there."*

5.2.1 Individuals' considerations when preferring a measure

Before starting the choice task, participants were asked to select which sectors they believed were the least and most pollutant, based on their own opinions. This can be compared to their subsequent selections in the choice task to analyse whether their designation of a specific sector as the most pollutant correlates with their preference for a measure related to that sector. Responses from participants who completed the pre-questionnaire but later skipped the choice task have been excluded from this analysis, given that no values are obtained from their preferences. Among the responses that were considered, the majority of respondents selected Agriculture as the least pollutant (Figure 5.6a). Moreover, it was observed that these 1060 individuals tend to exhibit a higher preference

for policy alternative *U2: Forest restoration and conservation*, followed by *E1: Installation of solar panels in rural areas*. Examining the measure associated with their choice of the least pollutant sector, *A1: Improve the productivity and quality of coffee and cacao crops*, they mostly showed a medium preference for it (see table C.8 in the Appendix for details).

In terms of the most pollutant sector, a larger group of respondents selected Transport (Figure 5.6b). Specifically, 82% of respondents shared this opinion, and this group is also inclined to prefer measures *U2: Forest restoration and conservation* and *E1: Installation of solar panels in rural areas*. On the other hand, data shows that these individuals have a medium preference for policy alternatives *T1: Expansion of bus corridors and bike lanes* and *T2: Promote the use of electric vehicles for public transport* (see table C.9 in the Appendix for details).
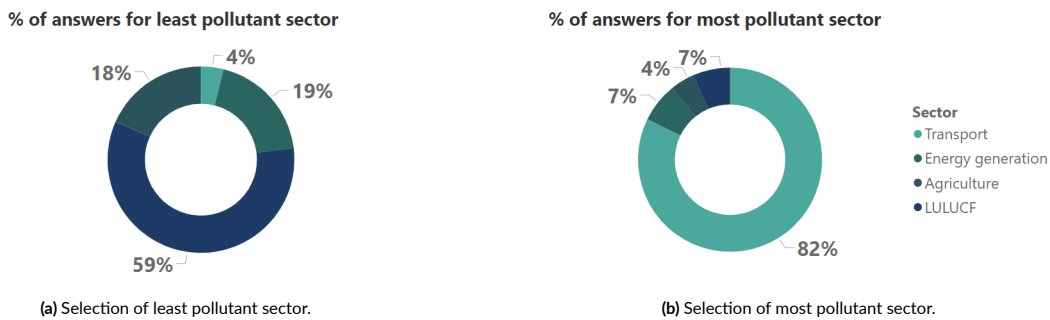

% of answers for least pollutant sector

4%
18%
19%
59%

(a) Selection of least pollutant sector.

% of answers for most pollutant sector

4% 7%
7%
82%

Sector
- Transport
- Energy generation
- Agriculture
- LULUCF

(b) Selection of most pollutant sector.

Figure 5.6: Most and least pollutant sectors according to respondents from the pilot test.

In the questionnaire after the choice task, participants were asked what did they consider when expressing a preference for a particular measure. This was a checkbox question, allowing respondents to select one or more options, and an open-ended field labelled "other" enabled them to provide additional input. Figure 5.7 shows the frequency of each of the options selected by the participants who did not skip the choice task. Most of them, considered whether the effects affected *the environment* when preferring a measure, followed by *future generations* and *the Peruvian society*. A smaller portion of participants noted that their preferences were influenced by the potential direct impact on themselves. Finally, a total of 8 comments were gathered, mostly mentioning economy-related factors such as cost, measure efficiency and economic development.
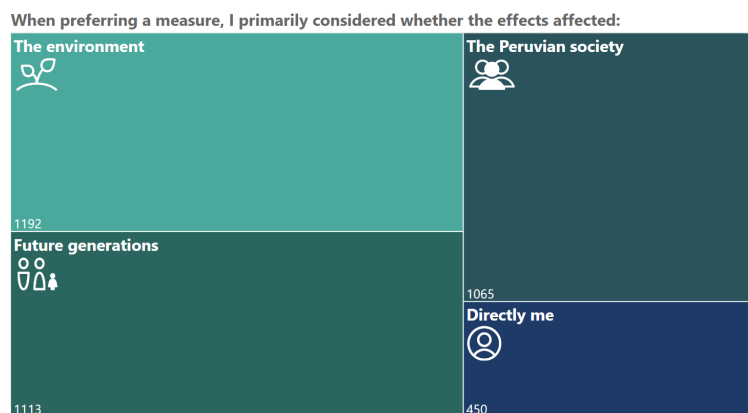

When preferring a measure, I primarily considered whether the effects affected:

The environment
1192

The Peruvian society
1065

Future generations
1113

Directly me
450

Figure 5.7: Number of answers categorized by what was considered by respondents when preferring a measure.

Since participants had the flexibility to select multiple options, it is possible to examine the potential correlations between these selections. For this, a dummy variable was employed to translate the qualitative data. Figure 5.8 depicts these correlations, revealing that the strongest association from all the possible pairs is between *The environment* and *Future generations*, which has also been identified as statistically significant. This leads to inferring that participants who took into account whether a measure's effects impacted *the environment* were also likely to consider if affected *future generations*, over its impact on *the Peruvian society*, for example.
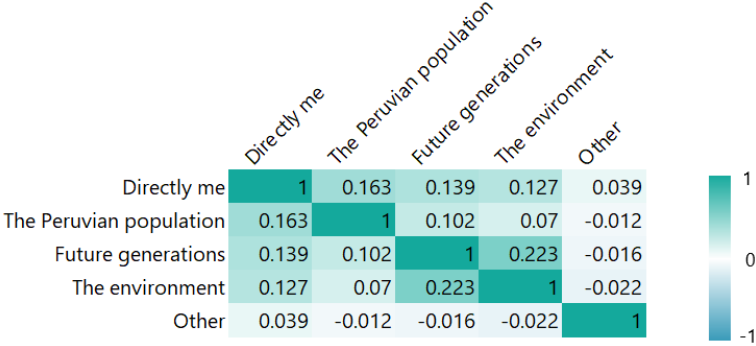

Figure 5.8: Correlation between what could be considered by participants when preferring a measure.

5.2.2 Cluster analysis

In a Latent Class Analysis (LCA) observations are grouped based on the identification of similarities in the response patterns (i.e., homogeneity within groups) while preserving heterogeneity between clusters or classes (Aflaki et al., 2022). Additionally, observed characteristics can be used to identify which of them explains the class membership of the observations.

Therefore, citizens' preferences are grouped based on their selection patterns. In alignment with the specific objectives of the questions encompassed in the final questionnaire, the analysis of class membership focuses on socio-demographic attributes, consideration of the effects' impact, and support for resource allocation to climate change projects. To facilitate the analysis process, preference values were categorized into four levels: *none* (value of 0), *low* (values of 0.1, 0.2, and 0.3), *medium* (values of 0.4, 0.5, 0.6, and 0.7), and *high* (values of 0.8, 0.9, and 1). The same approach was followed for the age, education level, residence, and the consideration of effects impacts. It is worth noting that participants who did not specify their gender were excluded from the analysis due to their limited representation.

LatentGold was employed to estimate various models with different cluster numbers, from which it was identified that a 4-cluster model effectively balances homogeneity within groups and heterogeneity between groups[4] (see Table C.10 in the Appendix for details). First, the p-value of each characteristic added to the model separately was considered, to later test adding different combinations of them to the model. Finally, it was revealed that class membership's explanation is underscored by two factors. Specifically, at a confidence level of 90% education level play a role in class membership, whereas, at a more rigorous 95% confidence level, the consideration

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[4]Considering the lowest Bayesian Information Criterion and that there were no significant residual associations from the Bivariate Residuals

of effects impacts shows to also be a determinant. However, when evaluating both characteristics jointly, there is no unique effect of education level on class membership (see Tables C.11 and C.12 in the Appendix for details). Next, each of the identified clusters is explained, accompanied by an illustration of their preference. Additional information regarding the associated intervals of CO_2 reduction and implementation cost can be found in table C.13 from the Appendix C.2)

- Cluster 1: High preference for measures while looking after future generations or the environment.
  The majority of individuals in this cluster tend to state a high preference for most of the policy alternatives. Measures from the transport sub-sector are the exception, however, when considering the probability of selecting a medium preference, the proportion reaches 80%. Moreover, individuals with a higher education degree, who consider how the effects of each measure affect future generations or the environment, tend to lean towards having a high preference for the alternatives presented. This cluster comprises 37% of the sample.
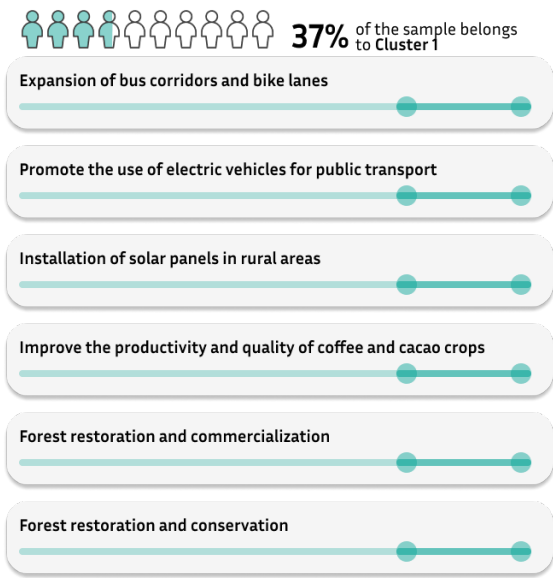

Figure 5.9: Cluster 1 profile.

- Cluster 2: Medium preference for all measures while looking after the Peruvian society.
  Regardless of the sector, the majority of individuals would tend to have a medium preference for the measure presented to them. The probability of an individual belonging to this cluster increases when such an individual considers whether the effects impact Peruvian society. This cluster is likely to encompass citizens who attained a higher education level, however, not to the extent observed in cluster 1. Approximately 34% of the sample is associated with this cluster.
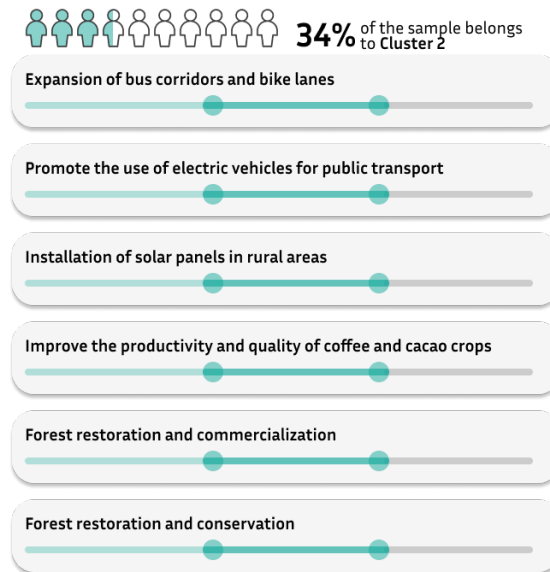
Figure 5.10: Cluster 2 profile.

- Cluster 3: Low preference for most measures while considering how they would be affected.
  A clear majority of individuals express a low preference for five of the six policy alternatives. For measure *Forest restoration and conservation*, 35.6% of the participants indicated a low preference (a), and the same proportion indicated a medium preference (b). Comparable to cluster 2, this group is predominantly represented by citizens with higher educational degrees. Moreover, the probability of belonging to this cluster increases for the individuals who consider the direct impact of the effects on them, while it decreases for those considering any other of the options. Roughly 19% of the sample aligns with this cluster.
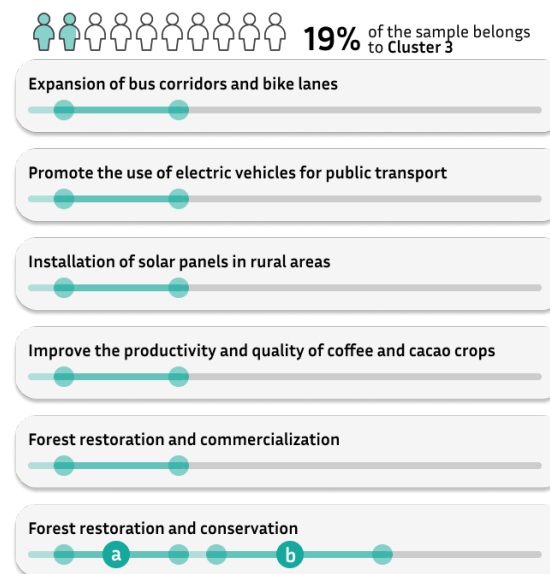

Figure 5.11: Cluster 3 profile.

- Cluster 4: Only preference for tackling deforestation and hesitant about solar panels, while looking after the environment.

  The majority of individuals in this cluster do not prefer 4 out of the 6 policy alternatives presented to them. The first exception is for one of the measures focused on deforestation. It was found that the majority of individuals would tend to have a high preference for measure *Forest restoration and conservation*. The second exception is regarding the alternative *Installation of solar panels in rural areas*. In this case, a distinct polarization is evident between the 37% of individuals who do not prefer it at all (a) and the 38% who hold a strong preference (b). Additionally, individuals who consider the measures' effects on the environment would tend to exhibit the described preferences. Lastly, citizens with basic education levels, are likely to belong to this cluster. Approximately 10% of the sample aligns with this cluster.
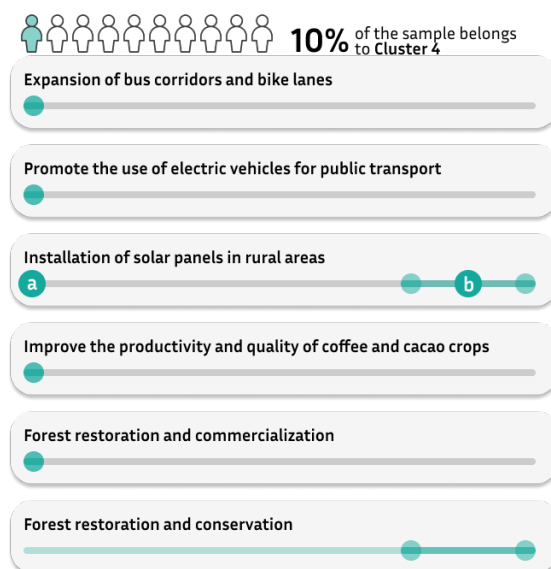

Figure 5.12: Cluster 4 profile.

5.2.3 Preference for measures not included in the PVE

In the questionnaire after the choice task, participants were provided with a textbox to suggest additional measures aimed at reducing emissions. From the total of 1968 answers received, 8% did not contain any proposal[5]. Among the remaining 1, 806 comments, special attention is given to those provided by participants who chose to skip the choice task. As previously mentioned in this section, it can be inferred that individuals who opted to skip the choice task, do not have a preference for any of the presented measures. Consequently, it is intriguing to uncover the type of measures they would potentially prefer.

For the purpose of analysis, responses with no proposals are excluded, leaving 114 comments available for review. Atlas.ti was employed to code the responses, identifying the most commonly mentioned topics among the respondents. Given that a single proposal could align with multiple topics, it is expected that comments may be

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[5] Answers similar to "No" or "No opinion" were disregarded

associated with one or more codes. Figure 5.13 illustrates the frequency of the identified categories, where is clear that *Pollution* and *Transport* are the most recurring topics. These are followed by *Forestry*, *Policy management*, and *Recycling*. Next, the responses received regarding these categories are consolidated, to provide an overview of the suggestions put forth by citizens who did not prefer any of the presented policy alternatives.
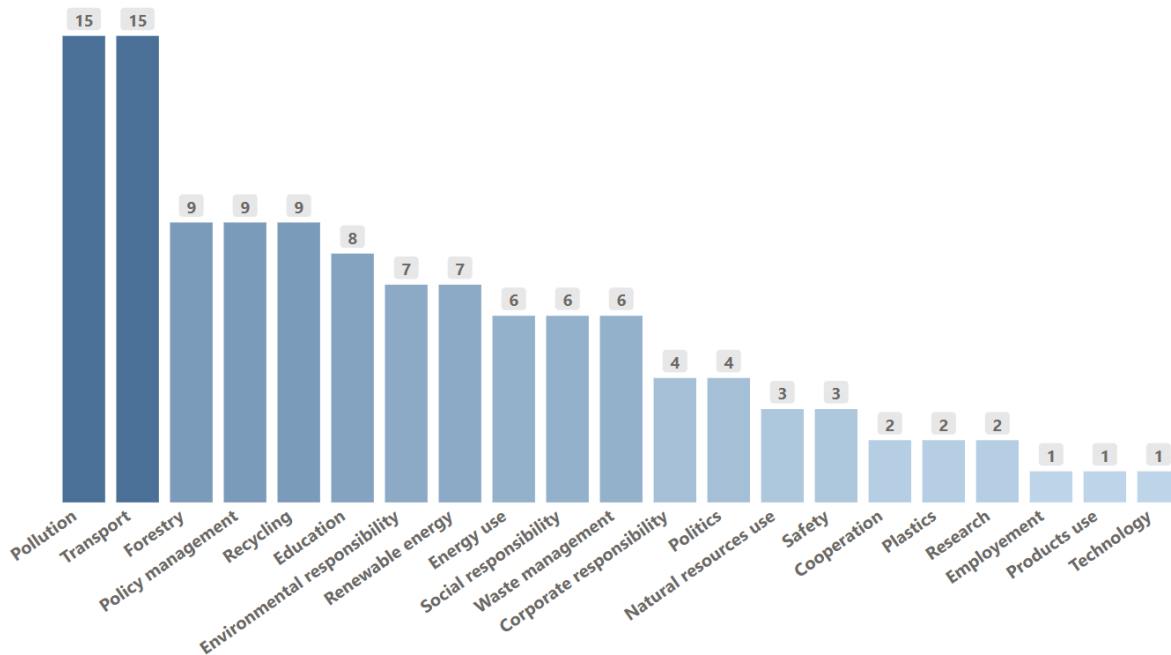

Figure 5.13: Frequency for each category identified from the proposed measures of participants who skipped choice task.

- Pollution
  Numerous comments suggest that citizens would prefer measures which are directly aimed at mitigating air pollution. They indicate a preference for actions such as companies taking responsibility for their emissions, discouraging the use of polluting vehicles (i.e., using fossil fuels), as well as suppressing open waste burning at dumpsites. Additionally, one of the participants proposed the implementation of measures to address water pollution concerns.

- Transport
  Analyzing this category is of particular interest since two of the policy alternatives in the choice task belong to the transport sector. Based on the majority of comments, it becomes evident that citizens are inclined towards the reduction of fossil fuel usage. They propose measures such as the scrapping of old vehicles and increasing the use of electric cars. Although policy alternative *T2:Promote the use of electric vehicles for public transport* mentions vehicle electrification, participants suggest an alternative approach by focusing their recommendations on private transport. Only one respondent left a comment regarding freight transport, however, it was not specified if the emission reduction should be done through electrification.

- Forestry
  Similar to the preceding category, it is intriguing to examine the different approaches proposed, consider-

ing that two policy alternatives concerning LULUCF are presented in the choice task. Most of the participants advocate for an increase in tree planting, which is closely aligned with the policy alternative *U2: Forest restoration and conservation*. However, some of the respondents mention that logging activities should be reduced, which is not explicitly addressed by any of the measures.

- Policy management
  This category is not related to a specific sector, but rather to the activities that should be undertaken by the government on a regular basis. Comments from the participants suggest that while they believe the government should take action through climate change policies, they emphasize that the government should also avoid neglecting the monitoring and oversight of such policies.

- Recycling
  The waste sector was not included in this study due to the low contribution to CO_2 emissions in relation to the other sectors. However, citizens do consider that waste management presents an area of potential improvement within the country. Specifically, respondents suggest the implementation of measures aimed at promoting recycling.

Lastly, a small group of participants put forth suggestions for measures that extend beyond climate change concerns. These include having a focus on employment, technology, and safety for the entire Peruvian society and with specific attention to children and women.

5.3 Peruvian citizens' participation and acceptance

Following the choice task, a set of questions was introduced to gain insights into the citizens' perceptions of participatory processes and policy acceptance, within the context of using PVE as a method. This primarily involved a series of statements that required participants to indicate the degree to which they agreed or disagreed with each statement. These are complemented by giving them the opportunity to provide more in-depth opinions through various types of questions. As depicted in Figure 5.14, the majority of respondents tend to agree with most of the statements, with the exception of two. Next, the results for each of them are further explained.

Approximately 76% of the participants are convinced of their selection of measures. Moreover, it was noteworthy to find the same proportion of respondents (44%) who are neutral and who are in agreement with the statement of having sufficient knowledge to advise the government on the climate change topic. Further, it is found that the majority agreed that the study provided them with enough information to provide their advice. Notably, a total of 661 individuals agree or strongly agree with all three statements. Among them, 56% are 35 years or younger, and in terms of educational attainment, 54% have a university degree.

Further on the knowledge provision, participants were asked about their preferred medium for being informed of climate change policies. For this, they could select one or more of the options, in addition to suggesting other possible mediums. Figure 5.15 shows that social media emerges as the favoured medium, which is understandable given the large number of young participants and the prevailing socio-technological landscape. Nearly 60% of those who selected social media fall within the 35 years or younger age group. Not far behind, television ranks
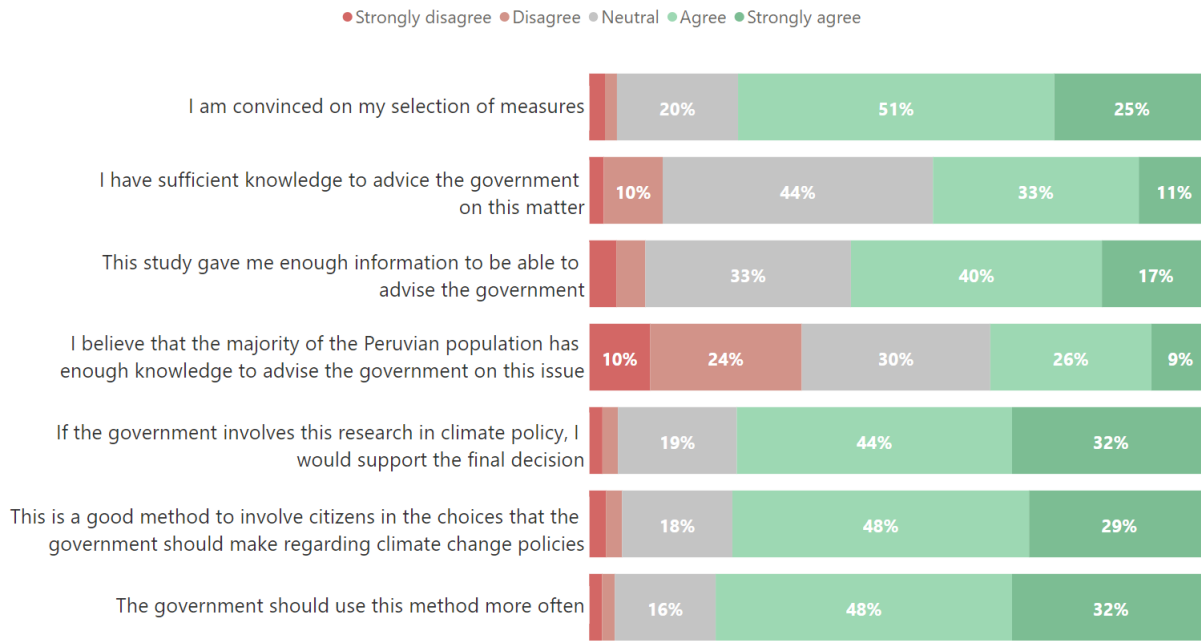
Figure 5.14: Percentages of the extent to which participants agree with each statement.

as the second most popular information source, with a difference of only 175 participants when compared to social media. This preference for television aligns with its recognition as an important communication medium within the country (El Comercio Perú, 2022). In terms of age groups, 285 individuals between 46 and 65 years old, chose television as their preferred medium, thus making it the most frequently mentioned option within two age groups. In contrast, the remaining four age groups, predominantly selected social media, followed by television. Radio and written press are not as favoured by having approximately 700 participants selecting each of them. Finally, additional inputs received through the open text box were categorized to facilitate the analysis. The most recurrent suggestion was for *Public area advertisement*, which includes billboards, posters, and flyers (see Appendix C.14 for the frequency of each category).
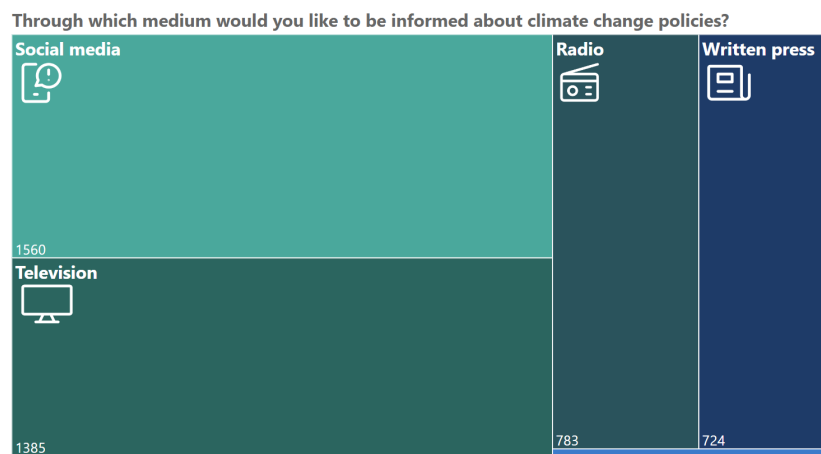

Figure 5.15: Number of answers categorized by medium.

Regarding knowledge in terms of society as a whole, there is a lack of strong consensus both in favour of and against the notion that the majority of the Peruvian population has enough knowledge to advise the government on the topic of climate change policies. Raising the knowledge level of the population in this subject, could potentially result in the government receiving informed advice from the citizens. This emphasizes the importance of identifying the preferred medium through which individuals would like to be informed.

Participants were also asked how the government should weigh the advice of the citizens versus the one of the scientists. As illustrated in Figure 5.16, it is evident that the majority of individuals believe the government should assign equal importance to the advice from both groups. There is a slight inclination towards assigning more weight to the advice of the scientists, with 25% of the participants leaning toward this option. This might be related to the individuals' perception regarding the sufficiency of knowledge the population has in order to advice, as explained in the previous paragraph.

How should the government weigh the advice of citizens in relation to the advice of scientists?

55%

17%

8%

11%

9%

Follow the advice of scientists

Give equal value
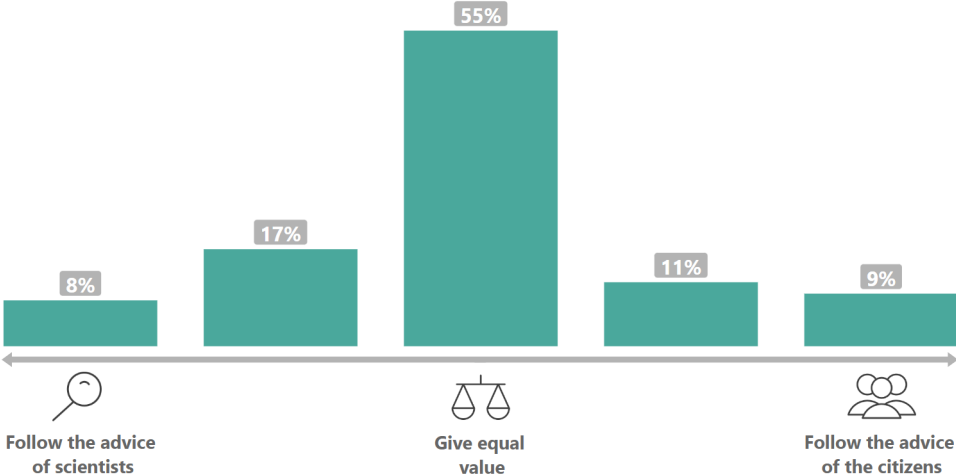
Follow the advice of the citizens

Figure 5.16: Percentage of respondents per selection of how the government should weigh the advice.

Additionally, an analysis reveals that individuals with no formal education, primary school, or high school, mostly suggest attributing more importance to the advice of the citizens. On the other hand, 64% of the participants holding a university degree lean towards prioritizing the advice of the scientists, while people with higher non-university degrees are virtually divided equally between the two. Table 5.3 shows the percentages per each education level, excluding participants who opted to give equal value to both citizens' and scientists' advice.

Nevertheless, when considering the entire sample, it becomes evident that despite the absence of a substantial inclination in giving more weight to the citizens' advice over the scientists' advice, the majority of participants (strongly) agree that they would support the final decision if the government incorporates this research in the nation's climate policy. Comparing this with participants' familiarity with other participatory processes for policy-making, it is found that a large number of respondents are not aware of processes that consider citizens' preferences in the political context. Among the ones who are familiar, some do not think is a good procedure, while others were not able to specify the name of the method (see Appendix C.15 for details).

	University	Non-university	High school	Primary school	None
Government should follow the advice of the scientists	19%	15%	18%	25%	-
Government should give more value to the advice of the scientists than of the citizens	45%	34%	24%	-	-
Government should give more value to the advice of the citizens than of the scientists	20%	29%	29%	50%	33%
Government should follow the advice of the citizens	16%	21%	29%	25%	67%
Total	100%	100%	100%	100%	100%

Table 5.3: Percentages of respondents by selection of weigh allocation per education level.

The question regarding resource allocation provides further insights into the citizens' support for climate change measures. The findings reveal a substantial majority of the respondents selected that the government should allocate more resources to measures for battling climate change (Figure 5.17). This is in line with the earlier interpretation regarding the citizens' support of the government's final decision based on this research. Participants who selected a resource allocation to projects not related to climate change (6%), exhibit a virtually equal distribution across high school, non-university, and university education levels (see Table C.16 in the Appendix). On the other hand, the participants who think the government should allocate more resources to climate change measures, are predominantly citizens with a university degree (see Table C.17 in the Appendix). Both cases show a similar distribution in terms of age groups, which also follows the distribution of the whole sample.

Do you think that the government should allocate more resources to measures against climate change or should it allocate them to projects not related to climate change?

● To measures against climate change ● To projects NOT related to climate change
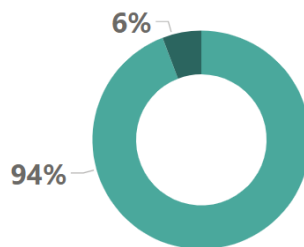
6%

94%

Figure 5.17: Percentage of respondents by selection of resource allocation

For a more comprehensive understanding of citizens' perception of the method, they were first asked about their level of agreement regarding whether PVE is a good method to involve citizens in the choices that the government should make for climate change policies. Figure 5.14 depicts that nearly the majority of participants agree with the statement and 29% strongly agree. This leads to indicate a positive reception of the methodology among the participants.

Subsequently, participants had to select to what extent they agreed with the idea of the government using this method more often. And in a similar proportion to the previous statement, approximately 80% of the respondents provide a favourable response. Moreover, Figure 5.18 shows that the majority of participants suggest the application of the PVE method in contexts related to topics such as *citizen safety*, *education*, and *public health*, among others.

On what other topics do you think this method should be used?
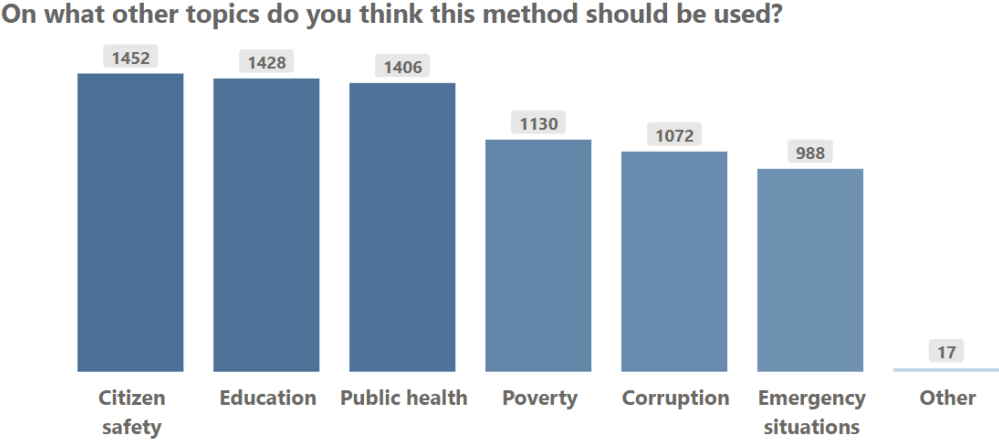
Figure 5.18: Frequency of the topics selected by the respondents

Considering that the participants who agree or strongly agree with both statements "This is a good method to involve citizens in the choices that the government should make regarding climate change policies" and "The government should use this method more often" constitute the vast majority, it is understandable that the socio-demographic composition of this group follows the distribution of the whole sample. Thus, the equivalent percentages are observed across the categories of gender, age groups and education levels (Table 5.4)[6]. Given that people with no formal education are under-represented, the absence of this group in the selection of agree/strongly agree, does not shift the percentages values.

Age group	University	Non-university	High school	Primary school	None
18-25	13%	8%	7%	<1%	-
26-35	17%	8%	5%	<1%	-
36-45	11%	8%	4%	<1%	-
46-55	6%	4%	2%	-	-
56-65	3%	2%	1%	-	-
over 66 years old	1%	<1%	<1%	-	-
Total	**51%**	**29%**	**19%**	**<1%**	**-**

Table 5.4: Socio-demographics of the respondents who (strongly) agree with "This is a good method to involve citizens in the choices that the government should make regarding climate change policies" and "The government should use this method more often"

Finally, a space was provided for participants to share further comments about this study. Approximately 700 valid[7] comments were reviewed and coded with the use of Atlas.ti. The word cloud representation (Figure 5.19)

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[6]Gender distribution is not included to keep the table simple, however, it can be mentioned that females are represented by a 51%

[7]Comments not containing any words or only "no" as an answer were filtered out

showcases the prevailing themes recurrently addressed within these 700 comments[8]. An overall positive response towards the method was perceived, with participants expressing an interest in receiving similar surveys on different subjects. However, a subset of respondents also offered constructive suggestions for potential improvement across various aspects. On the other hand, negative sentiments were often related to the broader political landscape of the country. Next, the most frequently raised themes were grouped based on the affinity found between them when reading the comments. This enables a more comprehensive explanation, supplemented with translated comments as examples.

Figure 5.19: Wordcloud of topics mentioned as further comments

- Participatory process
  Individuals showed appreciation for the chance to engage in the survey, express their ideas and have their opinions considered for policy-making. They acknowledged that it was an interesting method to involve citizens in a matter of collective repercussions for Peruvian society. Most comments exhibited a favourable stance toward citizen participation and expressed their support for the method. However, a fraction of respondents specified that not everyone possesses adequate information to offer well-informed advice, and they suggested the inclusion of experts in the participation. The distribution of comments across the topics encompassed within this category is presented in Figure 5.20.

  - *"Well, I liked it and the way in which this practical and simple survey is presented caught my attention, I also liked the fact that you could explain yourself and say what you think"*

  - *It is the first time that I participate in a survey like this and I found it very interesting and quite important that new initiatives are being taken to know what Peruvians think about future projects to be implemented.*

  - *"Well no, although remember that an average citizen does not have the capacity for experience and thought that a scientist, which is his field of expertise."*

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[8] It should be clarified that a single comment can be relevant to one or more topics, depending on what the individual brought up.
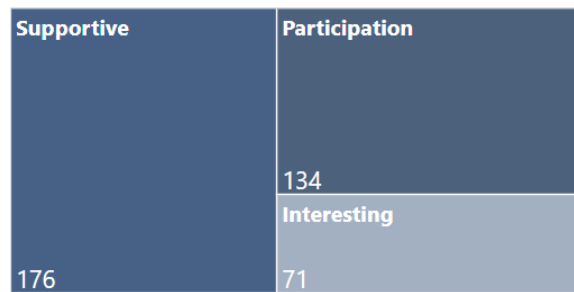
Figure 5.20: Number of comments categorized as "supportive", "participation" or "interesting"

- Peruvian citizens and information

  Participants mentioned this was a good method for not only being informed of policy alternatives but also for educating them about climate change itself and raising awareness in the population. In relation, recommended communicating this information among diverse social groups, particularly the younger generation and different regions in the country. Moreover, inclusiveness also emerged as a recurring topic. Participants recommended considering the groups of people that would be affected by climate change or the implementation of the policy alternatives. For example, rural and native communities who often lack internet access. Additionally, a few comments were critical about the sufficiency of the information provided to the citizens, either through the study or in general. Figure 5.21 shows the number of comments under the topics: informative, inclusive, and awareness.

  - *"It is a very good way to provide knowledge about gas emission reduction measures that the government can implement."*

  - *"Consider the opinion of all Peruvians, not only of one sector, but also of the Amazonian tribes, the communities of the mountains, among others."*

  - *"That it is important that people learn more about the subject."*
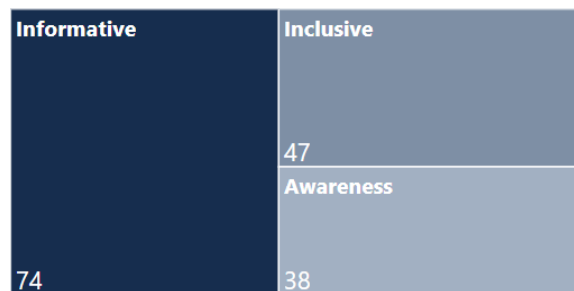

Figure 5.21: Number of comments categorized as "informative", "inclusive" or "awareness"

- Sense of continuity

  Citizens questioned the impact or practical use of their opinions. Several participants expressed a desire for feedback on the survey results or their publication to a broader audience. Additionally, while appreciative of the opportunity to be heard, society believes the government has the final decision on policy implemen-

tation. There was a negative sentiment concerning the follow-up the government would give to advice provided. To this, respondents recommended setting up a structured plan and keeping a close relationship with it. In total, 83 comments were received from participants who expressed their opinions regarding the continuity of their input.

– *"It is necessary to disclose results, consequences, etc."*

– *"Surprised and it is interesting to be heard. Action and results are expected."*

– *"Unfortunately the government is not involved with these issues and I think it will not, it is deficient."*

- Politics and policy-making

Most comments reflect a negative sentiment regarding the actions the government should take to fight climate change. There is a strong perception of dishonesty, with mentions of corruption and selfishness attributed to politicians. Participants believe that the government should promote measures related to climate change, supported by research conducted by experts. However, they find it unfortunate that politicians make the final decisions. Figure 5.22 illustrates the number of comments falling into this category, where participants mentioned the need for a closer relationship with research.

– *"Stop the corruption that has only managed to destroy the country, only out of ambition and self-interest. More drastic laws to care for the environment."*

– *"Governments must work together with scientists."*

– *"Unfortunately the government is not involved with these issues and I think it will not, it is deficient."*

Figure 5.22: Number of comments categorized as "politics" or "research"

- Survey design

In terms of the interaction participants experienced during the survey, the majority mentioned that everything was clear to them. A few participants, however, found certain aspects not entirely clear and suggested that the survey could be made more graphical and placed within a scenario closer to reality. While participants appreciate concise and simplified information, some expressed a desire for more details. Related to this, several respondents proposed the inclusion of other aspects (e.g., mining, water, private companies, etc), with some of them even proposing policy alternatives. Figure 5.23 illustrates the number of comments among the topics explored in this category.

– *"It must be very concise but clear and understandable information."*

– *"If you want to reach citizens without scientific knowledge, you must improve the visualization of data, through graphics, in addition to being more interactive."*

– *"Detail a little more about the actions that would be taken in each measure presented."*

Design	Policy alternative
	27
	More topics
39	24

Figure 5.23: Number of comments categorized as "design", "policy alternative" or "more topics"

6

Discussion

THE PARTICIPATORY VALUE EVALUATION FOR PREFERENCES ELICITATION aimed to encompass a broad and diverse sample from the Peruvian population, in order to have a comprehensive depiction of their principles, concerns and values. The primary objective of this research was to study the trade-offs that Peruvian citizens make regarding climate change mitigation measures, using this method (Section 6.1). Additionally, the study aimed to gain insights into their perception of the method and compare it to the responses of the Dutch citizens (Section 6.2). Based on these findings, along with an acknowledgement of the study's limitations, scientific relevance and further research can be proposed (Section 6.3).

6.1 PERUVIAN CITIZENS' TRADE-OFFS FOR CLIMATE CHANGE MITIGATION

Participants encountered a situation in which they had to make some trade-offs when stating their preferences for a set of policy alternatives. These alternatives included positive/negative effects, along with overall constraints (Mouter et al., 2021c). Specifically, the participants were presented with 6 policy alternatives, each accompanied by quantitative and qualitative effects, as well as restrictions in terms of CO_2 emissions and financial expenditure. This approach prompted participants to ponder on the advantages and disadvantages of the displayed alternatives (Mouter, 2021b), thereby providing insights into their value-based trade-off decisions within the context of climate change. The preferences of a total of 1,968 Peruvian citizens were considered, which represents a 98,4% of what case studies usually aim for.

Prior to engaging in the choice task, participants were requested to select which were the most and least pollutant sectors based on their opinion. From their responses, it was found that 59% of the participants perceived

"Agriculture" as the least pollutant sector, while 82% regarded "Transport" as the most polluting. It is understandable that individuals who selected "Agriculture" as relatively less polluting, would not have a strong preference for the implementation of a measure targeting this sector. On the other hand, one might expect individuals to prefer measures aimed at the 'Transport' sector, given it was perceived as the most polluting. However, this last assumption did not hold true, as respondents who made this selection, exhibited a higher preference for measures in the "LULUCF" and "Energy generation" sub-sectors. This emphasizes the need for further analysis to comprehend what trade-offs Peruvian citizens make when preferring a policy alternative for climate change mitigation.

As explained by the theory on PVE, participants are able to assess the projects in relation to one another. Consequently, preferences are in relation to the effects presented alongside the policy alternatives (Mulderij et al. 2021; Mouter et al. 2021a). Based on this, a quantitative and qualitative analysis can be undertaken to gain a deeper understanding of citizens' values, logic and concerns.

Quantitative analysis indicates that, on average, the policy alternative *Forest restoration and conservation* emerges as the most preferred option. This measure yields the highest level of CO_2 reduction in comparison to the other five alternatives, and a medium cost of implementation. Skewness and kurtosis values show a prominent concentration around high preference values. Moreover, qualitative data shows that a large portion of individuals considered the potential impact that this measure could have on already deforested areas. Most of the respondents who have a strong preference for this measure, also tend to state a similar preference for alternatives *Installation of solar panels in rural areas*, and *Forest restoration and commercialization*. This is in line with the estimated average preference values.

The second most preferred measure is *Installation of solar panels in rural areas*. This policy alternative is characterized by a medium reduction in CO_2 emissions and a medium-high cost of implementation. Descriptive statistics explain the relatively high preference, however, not as prominent as with measure *Forest restoration and conservation*. The preference for this measure in the "Energy" sector is primarily motivated by the perceived health benefits it would bring to the individuals impacted by its implementation.

Next, policy alternative *Forest restoration and commercialization*, which offers a relatively low reduction in CO_2 emissions and incurs a low cost of implementation, is also one of the most preferred measures. Nonetheless, the skewness and kurtosis values indicate only a slight inclination towards a high preference. Similar to what was expressed towards the policy alternative *Forest restoration and conservation*, citizens value the focus placed on deforested forests. Although, it's worth noting that they are not in favour of supporting logging activities.

There is no substantial difference between the average preference values for measures *Improve the productivity and quality of coffee and cacao crops* and *Promote the use of electric vehicles for public transport*. Even when the kurtosis value for the "Agriculture" measure is larger, the skewness to the right of the transport-related alternative, slightly elevates its average preference value. Policy alternative *Promote the use of electric vehicles for public transport* has a medium CO_2 emissions reduction but the highest implementation cost among the 6 measures. For this measure, participants factored in the expense associated with acquiring electric vehicles, even in the presence of the positive health advantages associated.

Participants exhibited, on average, a medium preference for policy alternative *Improve the productivity and quality of coffee and cacao crops*. It offers a similar reduction in CO_2 emissions as the measure *Promote the use of electric vehicles for public transport*, but is the second-least expensive to implement among the six options. The main motivation for preferring this policy alternative is related to the economic advantages it promises for stakeholders such as farmers, as well as its potential benefits for the nation as a whole.

Finally, when examining the average preference values, the policy alternative *Expansion of bus corridors and bike lanes* sows to be the least preferred measure. This measure ranks at the bottom regarding CO_2 emissions reduction and entails a medium-low cost of implementation. Descriptive statistics reveal that individuals' preferences for this measure are spread rather evenly across the available preference values. The main motivation for a low preference is related to health concerns. Some participants explained that a shift in behaviour from society is needed in order to see the health benefits associated with bike lanes. Additionally, concerns were raised about potential increased pollution if more buses were introduced. The overall perception held is that a broader systemic transformation is required within the transportation sector.

As a result, on average there is a CO_2 emission reduction of 62%, coupled with an estimated implementation cost of 20,585 million USD. To complement these descriptions, it was found that participants mainly considered whether the effects of the alternatives would affect *the environment* and *future generations* when preferring a measure. This aligns with recurring motivations tied to health and deforestation aspects. Moreover, a comparison with another PVE conducted on climate change revealed there is a similar trend in the Netherlands. It was interesting to find that Dutch citizens also primarily considered the effects on the environment followed by the effects on future generations (Mouter et al., 2021d). Given that individuals from different countries reveal common priorities and concerns related to climate change, it might indicate shared values and suggest that certain perspectives are relevant across various cultural contexts when addressing climate challenges and sustainable development. Furthermore, 57% of the Peruvian territory is made up of the Amazon region (World Bank Group, 2022c), making the AFOLU sector one of the most relevant ones in the country. Related to this, McKinsey & Company (2022) suggests achieving a balance between land usage requirements and safeguarding forests, while also providing assistance to communities that rely on these forests for their livelihoods.

Further analysis of the responses from individuals who took part in the choice task, revealed response patterns resulting in four distinct groups. The first one is characterized by citizens with a higher education level who hold strong environmental concerns and prioritize the well-being of future generations. This leads them to have a high preference for most of the presented policy alternatives. The second group of individuals have a medium preference for all measures, based on their consideration of potential impacts on Peruvian society. The third cluster is constituted of individuals who take into account the direct impacts on themselves, having a higher probability of displaying a low preference for most alternatives. Finally, the fourth group is characterized by citizens possessing a basic educational background who exhibit a notable concern for the environment. These individuals tend to show a high preference for the policy alternative *Forest restoration and conservation*, however, are hesitant toward the *Installation of solar panels in rural areas*. These insights reinforce the importance individuals attribute to the environment, particularly regarding deforestation. It can be said that citizens across different education levels

share a substantial preference for the policy alternative *Forest restoration and conservation*.

Additionally, there were approximately 8% of participants who decided to skip the choice task. This can be inferred as an indication that they did not have a preference for any of the policy alternatives. Upon analyzing the alternative measures they would propose, the topics of pollution, transport, and forestry were among the most frequently mentioned. Several individuals raised their concerns regarding the air pollution stemming from vehicles, open waste burning and private companies. Comments addressing solutions for reducing pollution from transportation recommended the scrapping of old vehicles and the introduction of electric vehicles. The issue of deforestation also emerged prominently, with individuals in favour of an increase in tree-planting initiatives alongside a reduction in logging. From this, it can be inferred that participants who opted to skip the choice task, are also motivated by health and deforestation aspects when it comes to considering policy alternatives for climate change mitigation.

From the aforementioned findings, it can be concluded that Peruvian citizens exhibit a clear preference for policy alternatives that yield positive and direct environmental outcomes, especially when accompanied by minimal monetary expense. A noteworthy example is the allocation of rights to use and/or own deforested forest, with the objective of land restoration and conservation. Interestingly, citizens would trade off a higher cost for even a moderate reduction in harmful emissions, provided the health benefits are explicitly articulated. This is especially in cases when these health benefits stand to impact a societal group in need. However, the inclination to make a trade-off between cost and emission reduction diminishes when health and environmental benefits are either not explicitly outlined or fail to reach a significant threshold. This is the case, even when the cost of implementation is medium-low, as evidenced by policy options such as the expansion of bus corridors and bike lanes.

6.2 Peruvian citizens' perception of PVE method

Following the completion of the choice task, participants were asked a number of questions, which provided valuable input for understanding their experience with the participatory method. These results can be compared to other PVE applications, however, special attention is placed on the PVE concerning climate change policy in the Netherlands. This is owing to the thematic resemblance between the two studies. Additionally, as mentioned in section 2.3, there are three rationales that should be considered within the context of policy-making and participatory processes. While the present study primarily centred on comprehending citizens' preferences, which can be related to the substantive rationale, it is important to note that the normative and instrumental rationales were also afforded attention, albeit not to the fullest extent. Therefore, this discussion encapsulates all three rationales.

A salient strength of the PVE method, as mentioned in the literature, resides in its capacity to provide clear but evidence-based information to the general public. In line with this premise, similar to the Dutch PVE study on climate change policies, the majority of the respondents agree that the study provided them with enough information to advise the government. They conveyed that the information presented to them was clear, concise and simple. However, some individuals expressed a desire for more information, data in a more graphical format or encompassing a broader array of policy alternatives. In the report by Mouter et al. (2021d), it is mentioned that citizens have different needs in terms of the information they deem essential in order to give their advice.

Moreover, a different case found in the literature proposes offering participants the flexibility to choose how to visualize the information. Socio-demographic characteristics can also be considered to complement the discussion of those two remarks (i.e., more information and data in a different format). It is worth noting that the respondents who were convinced of their selection, believe in possessing sufficient knowledge to give their advice and agree the study provided them with enough information, are in their majority 35 years or younger (56%) or hold a university degree (54%). Nonetheless, people with other educational backgrounds or older generations, who might not be as accustomed to an online environment, might have distinctive information requirements compared to the rest of the respondents.

The third remark regarding the set of policy alternatives is also mentioned in the literature, prompting the incorporation of an open-ended question that allows the participants to propose additional measures. This aspect can be related to the substantive rationale. Notably, Dutch citizens were more focused on the number of policy alternatives presented to them rather than the specific thematic areas addressed. However, it should be mentioned that the context and scope of the policy alternatives in the Peruvian PVE differed from that of the Dutch case.

Related to the provision of information, individuals noticed that their engagement in the survey fostered a better understanding of what could be done by the government, as well as of climate change in general. This knowledge enhancement was perceived as a way to raise awareness in society. Different cases in the literature also mention this aspect as positive and relate it to the instrumental rationale (Mouter et al. 2021a,c,d). For instance, Dutch PVE participants mentioned that their involvement provided insights into the dilemmas faced by the government and contributed to personal awareness (Mouter et al., 2021d). When asking the Peruvian citizens through which medium they would like to be informed about climate change, the majority favoured social media, particularly those aged 35 or younger (60%).

In terms of policy acceptance, the different cases of PVE reviewed in section 3.2, support the importance of understanding the citizens' preferences for achieving public acceptance in the context of policy-making. In Peru, legal frameworks like the Participatory Budget Law, have been established with the purpose of including society's input in the decision-making processes. Therefore, to align with the normative rationale for participation, Peruvian citizens were asked to what extent they would support the final decision of the government if this research would be considered in it. Approximately, 76% of the participants agreed with the statement, a proportion surpassing the 50% of Dutch participants who agreed with a similar statement. Moreover, Peruvian citizens made comments that the government should promote measures grounded in research done by experts. However, unlike the Dutch PVE, the majority of Peruvian participants have the opinion that the government should assign equal weight to both societal and scientific advice. In the Netherlands, 31% of the panel participants believe the government should prioritize scientists' recommendations, in contrast to the 25% of the Peruvian participants. Furthermore, it was found that citizens holding a university degree would tend to suggest to the government assign more weight to scientists' advice, while individuals with primary school education or no formal education lean more towards valuing citizens' input.

Continuing with the normative rationale, the Peruvian Constitution dictates that citizen participation is a right and a duty, which should also be promoted by local governments (Velásquez et al., 2021). However, given

the characteristics of the methods currently employed, the situation in Peru shows a significant entry barrier for participatory processes. In this context, participants were asked to what extent they believed PVE is a good method to involve citizens in governmental decisions regarding climate change policies. In a similar proportion as the Dutch citizens, 77% of the Peruvian individuals agreed with the statement. This resembles the results from the first Peruvian PVE, where 82% of respondents agreed that it serves as an effective method for involving citizens in decision-making, specifically regarding the re-opening of schools and health-related measures (Trujillo, 2023).

Moreover, several participants made explicit their appreciation for their opinions being taken into consideration, which goes in hand with the sense of involvement identified in the literature. Additionally, PVE theory explains that it allows the inclusion of a broad and diverse public in the policy-making process (Mouter et al. 2021a; Dekker et al. 2019). Although the online format of PVE lowers the entry barrier to participation, individuals recommended accounting for social groups without internet access. Further, research through preference elicitation should guarantee to the participants a feeling of repercussion derived from their choices (Mouter et al., 2022). In this regard, participants expressed their interest in receiving feedback on the survey results. On the other hand, they were discouraged by the tangible actions the Peruvian government would take, not only based on their advice but in relation to climate change policy at large. A similar opinion is put forward by the Dutch citizens, however, their concerns were more focused on the potential impact of their contributions.

Lastly, researchers across different PVE study cases, propose to apply the method to diverse subjects, therefore, participants were asked their opinion on this. Similar to both the Dutch participants and those involved in the first PVE in Peru (i.e., the study on school openings by Trujillo (2023)), 80% of the Peruvian citizens participating in this study agree that the government should use the PVE method more often. Among the suggested topics are those focused on citizen safety, education and public health (physical and mental).

Based on the outlined findings, it can be concluded that Peruvian citizens generally had a positive and favourable experience when participating in the PVE for climate change mitigation. This is substantiated by the observation that the participants who agree it was a suitable method for climate change policies, and expressed the government should use it more often share comparable socio-demographic characteristics as the broader participant pool. Further, in a similar manner to the Dutch citizens, Peruvian individuals exhibited a positive perception of the method. This seems to foster an inclination for continued engagement and provide their opinion on other subjects relevant to Peruvian society. However, it is imperative to acknowledge that citizens would appreciate the real repercussions resulting from their input within the decision-making process.

6.3 Scientific relevance

The PVE method has been applied across different topics, particularly within the European region. The one designed, developed and executed as part of this research was the first one within the context of climate change in Latin America. Insights obtained from the analysis of the results could significantly contribute to an issue of vital importance in our contemporary landscape, given the commitment of parties to the Paris Agreement. While the establishment of a regulatory framework is undoubtedly necessary, an equally crucial aspect is the engagement of society itself, facilitated through the active participation of citizens. This proactive involvement holds the

potential to reinforce the objectives laid out in the climate change roadmap for the year 2050. Additionally, this research aims to not only gain insights from the results but also to contribute to the robustness of the method, by learning from the limitations encountered.

Findings from the analysis of trade-offs undertaken by Peruvian citizens in relation to climate change policy alternatives for mitigation, demonstrate to be aligned. However, it is imperative to acknowledge that the sampled population exhibited an over-representation of urban areas, particularly the capital city. Therefore, the socio-demographic characteristics of the sample should be taken into consideration when interpreting and extrapolating the outcomes of this research. This consideration holds particular relevance for future PVE studies, particularly in the context of developing countries where urban areas are usually over-represented. As a suggestion, extending the duration of the experiment beyond the two-week span, which was followed in this research, is recommended. A more representative sample would enable a more in-depth analysis of potential influences stemming from other socio-demographic variables, such as age or region, on the observed response patterns.

Nevertheless, the results of this research offer valuable insights into the trade-offs made by Peruvian citizens. Stakeholders engaged in climate change projects and policy-making are invited to take these findings into consideration. It is expected that by doing so, a greater prospect of acceptance and impact can be achieved. Furthermore, future research could delve into cross-country comparisons, examining nations with both similar and contrasting characteristics. This could contribute to understanding the preferences and trade-offs of citizens in different contexts.

Moreover, concerning the trade-offs, it was not possible to estimate an optimal portfolio as suggested by the literature. The tool currently devised for this specific purpose does not possess the capability to formulate an optimal project portfolio considering the specific characteristics encompassed in this research. Previous PVEs have only conducted such optimization for "yes or no" preferences, rather than for "to what extent" preferences. Therefore, it is suggested that researchers make an effort to adapt or design a suitable tool to find an optimal portfolio given the characteristics of this experiment.

Finally, Peruvian citizens expressed their support for the method and suggested various topics in which they would like to have it implemented. Consequently, further research could be conducted on such topics, in order to assess whether the findings from this study remain consistent in different contexts.

7
Conclusion

Climate change actions are on the agenda of several countries around the world. This can be related to the fact that 196 parties signed the Paris Agreement to achieve a common goal: restrict global warming in order to be climate-neutral by 2050 (UNFCCC, 2016). Signing parties in South America have defined a set of NDCs as requested by the Agreement. The government of Peru, as part of this region and by having committed to the common goal mentioned, also has NDCs in different sectors in order to achieve its climate goal (Ministerio del Ambiente, 2018a). Additionally, different governmental and non-governmental stakeholders have proposed additional measures to contribute to the set target. These include, for example, OSINERGMIN, the Ministry of Transport, the World Bank Group, and the Inter-American Development Bank.

However, the literature explains that policy adoption is built upon the decisions that citizens make, which are connected to their values (Perello-Moragues & Noriega, 2020). Given that preferences are based on values, is important that citizens' preferences are considered in order to have a higher chance of policy acceptance. For this, individuals can be involved in policy-making through participatory processes (Mouter et al., 2021a). In Peru, it has been interpreted that current participatory processes have a high entry barrier. Different methods, including the Participatory Value Evaluation, have been proposed and used to understand citizens' preferences, and it can be said that the selection of which one to use depends on the objective of the investigation. With this, the goal of this research is twofold: first, study the trade-offs Peruvian citizens make regarding climate change mitigation measures through a Participatory Value Evaluation, and second, investigate Peruvian citizens' experience with this participatory method. This, with the focus on the two most polluting sectors according to the National inventory on GHG, namely AFOLU and Energy. Based on this a primary and secondary research question were defined:

- How do Peruvian citizens trade-off climate change mitigation measures among the two most polluting sectors, from a set of policy alternatives?

- How is Participatory Value Evaluation perceived by Peruvian citizens and how does it differ from Dutch citizens' perception?

A literature review was done on the PVE method in order to learn the main aspects of the design of one with the purpose of preference elicitation. From such a search, it is found that the main three factors are: a set of alternatives, their effects, and one or more constraints. Based on this, the necessary information was gathered and the design of a PVE was outlined. As suggested by the literature, a pilot test was deployed which led to making some adjustments to the design.

The PVE to elicit Peruvian citizens' trade-off when it comes to climate change policy alternatives for mitigation, was conducted between July 3rd and July 17th, 2023 through the online panel company Dynata, with the aim of having a sample of 2, 000 participants. From the analysed results, both research questions can be answered.

First, Peruvian citizens make their trade-offs mainly depending on the benefits offered by the presented measures, with a strong emphasis on the positive impact these measures have on the environment, particularly the extent of CO_2 reduction. This consideration is linked to their valuation of the effects on health and deforestation. Consequently, it can be inferred that Peruvian citizens might be inclined to accept a relatively lower reduction in CO_2 emissions if a policy alternative demonstrates a pronounced positive effect on health and forest conservation. Specifically, the latter is highly preferred by citizens across different education levels, who share an environmental concern. In light of this, it is advisable for national climate change objectives to be achieved through the approval of Peruvian citizens, that CO_2 reduction efforts should be related to significant and evident benefits for health and forest preservation. This approach could facilitate a more positive reception among the citizens and enhance the likelihood of successful policy implementation.

Second, in terms of the perception of the method, the results from the PVE on climate change mitigation policies substantiate the findings from the PVE conducted regarding school openings during a public health crisis. In comparison to the Dutch PVE on climate change, no substantial difference was found between the perceptions of Peruvian citizens and Dutch citizens. Both exhibit an overall positive experience, accompanied by minor suggestions to enhance the presentation of information. In both instances, participants expressed they would support the decision of the government if their participation was to be considered. In this context, Peruvian citizens made a greater emphasis compared to Dutch participants, their concern for the real consideration of their advice by the authorities. Nonetheless, they remain enthusiastic about engaging in similar surveys targeting other areas of national importance. Therefore, participants would greatly appreciate the communication regarding the utilization of their input. As described by numerous respondents, this would contribute significantly to the current political landscape of the country.

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A

Online environment

The platform WeValuate, facilitates the Participatory Value Evaluation process. Through a website, participants first visualize an introductory message, then proceed to the choice task, explain their motivations and answer the defined questionnaire. Each of the subsections of this appendix include the screens that are shown to the participant. Below is the link to the PVE (in Spanish), used for this research.

Climate policy trade-offs in Peru

A.1 Introduction message

The first screen shown to the participant introduces the purpose of the survey in general terms and who is conducting the research (Figure A.1), followed by the structure of the participatory process with a brief explanation for each part (Figure A.2). Then, the participants must accept the confidentiality agreement before starting with the PVE (Figure A.3).

Figure A.1: Introduction page.

Figure A.2: Participatory process structure.

Figure A.3: Confidentiality agreement.

If the participant decides to continue with the survey, the following screen explains the uncertainty of the data presented to them (Figure A.4). Then, the context in which the participant needs to state their preferences is described, including a video with a short tutorial on how to interact with the platform (Figure A.5).

Figure A.4: Effects uncertainty.

Figure A.5: Situation introduction.

For the choice task, the participants are displayed a main screen (Figure A.6). There, they can see the sliders they would use to state their preferences for each of their measures, as well as their corresponding quantitative effects. On the right side of the screen, are the constraint gauges, for the defined restrictions.
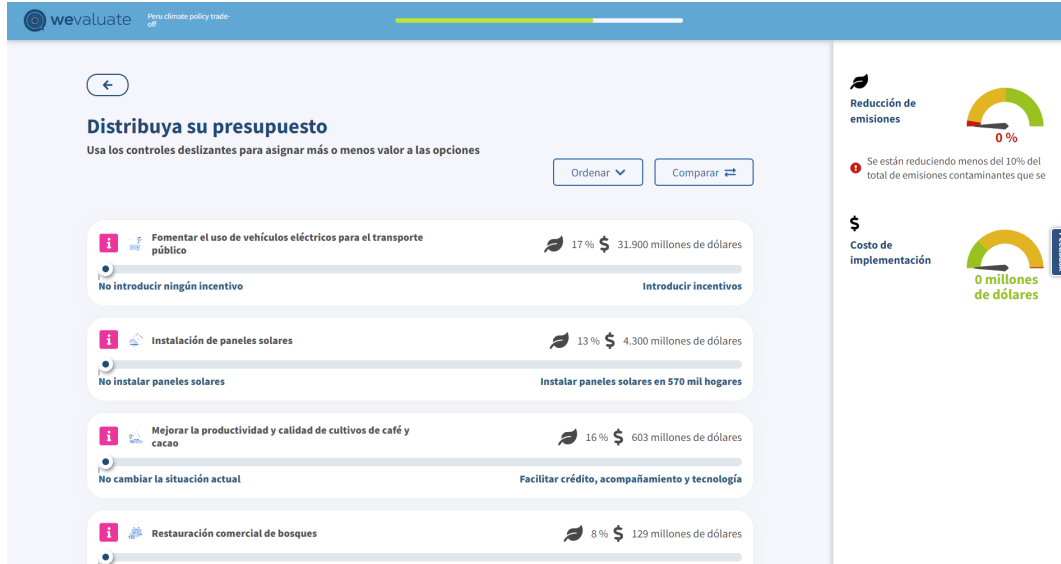
Figure A.6: Main screen of choice task.

The participants can click on the pink information button, to read more details about each of the policy alternatives (Figure A.7). The additional information includes a long description, qualitative effects, quantitative effects, and a reminder of uncertainty. The platform also allows the participants to sort and compare the measures, by clicking in the corresponding buttons (Figure A.8).

Figure A.7: Example of the pop-up screen with additional information of policy alternative E2.

Figure A.8: Visualization when the compare button is selected

After the participants have made a selection, the platform checks whether the cumulative values for CO_2 and costs comply with the restrictions. They will be shown a pop-up screen with different warning messages depending on such values. If at least one of the restrictions is infringed, the participant is not allowed to continue. If both constraints are met, the warning message shows its resulting values for a final check from the participant (Figure A.9).
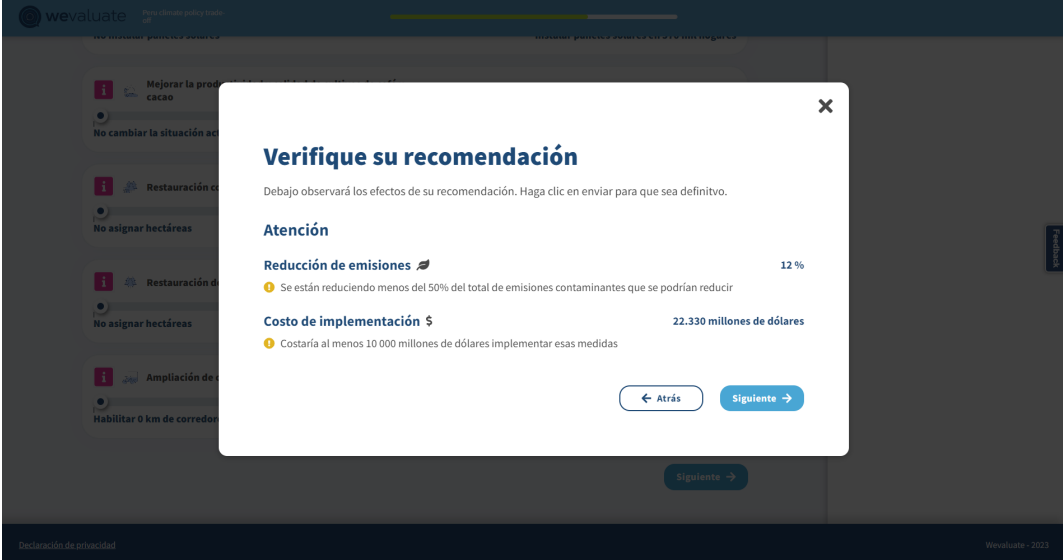
Figure A.9: Example of the pop-up warning message when both constraints are met.

As a final step of the choice task, the individuals are provided with a space to express their motivations. For this, a textbox is placed for each of the policy alternatives, and the sliders with their selected values are displayed as a reminder (Figure A.10).
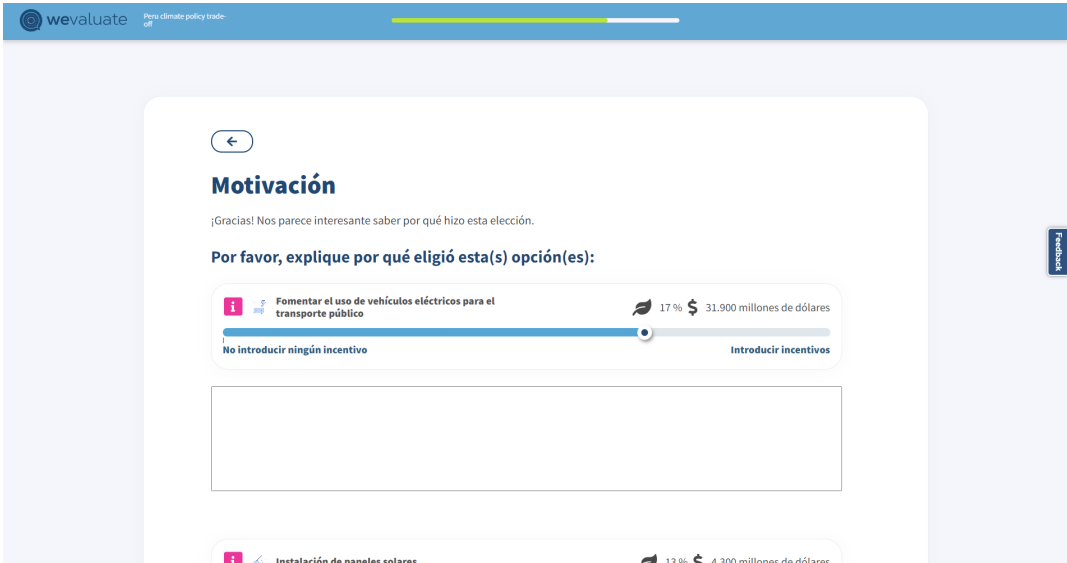
Figure A.10: Screen displayed inviting the participants to provide a motivation for their selection.

Before the participants start with the choice task and the situation has been explained, they are asked three mandatory questions. For each of them, they can choose their answer by clicking on one of the options from the corresponding drop-down lists (Figure A.11).

Figure A.11: Questionnaire before the choice task.

After the choice task has been completed and motivations have been explained or not, a final questionnaire is presented to the participants. First, a checkbox-type question related to their selection from the choice task (Figure A.12. Then, a Likert-type question about their knowledge, policy acceptance and the procedure (Figure A.13).

Figure A.12: Question 1 from the final questionnaire.

Figure A.13: Question 2 from the final questionnaire

On the same page, the participant can scroll down to the following questions. The third one is regarding the weigh that should be allocated to the advice of the citizens versus the one of the scientists. Then, they are asked to provide further comments on the study they just participated in, and any suggestions for other topics in which the PVE method could be applied (Figure A.14).

Figure A.14: Questions 3, 4 and 5 from the final questionnaire

Finally, each of the participants must provide their basic socio-demographic information. This includes, gender, range of age, highest level of education obtained, and region of residence (Figure A.15).

Figure A.15: Questions 6, 7, 8, and 9 from the final questionnaire

A.4 Choice task after pilot

A particular change done in the main screen was adding a checkbox to allow the participants to skip the choice task. This is found by scrolling down to the bottom of the screen, and when is checked, the sliders are not active (Figure A.16). If the participant chooses this option, then they are requested to provide their motivation for it (Figure A.17), however, the screen is different than Figure A.10.
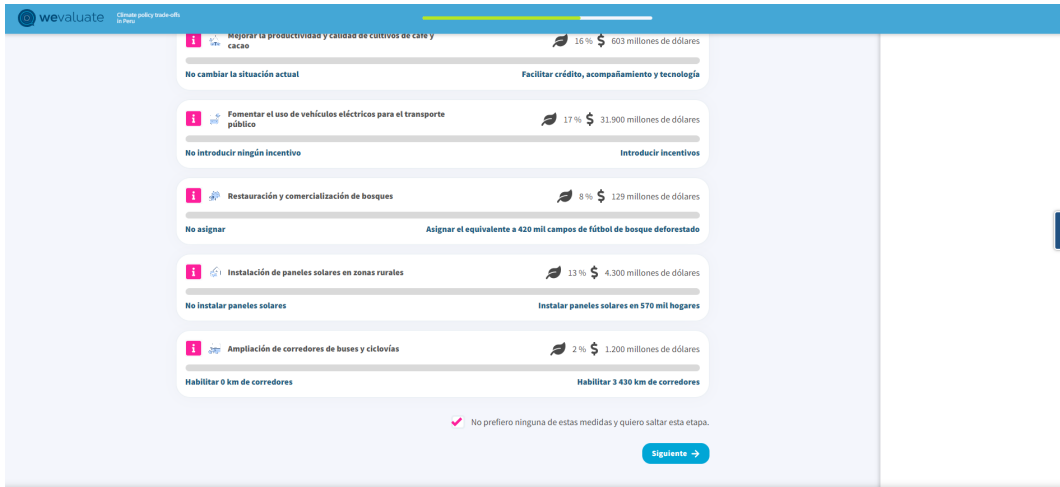
Figure A.16: New main screen with the option to skip the choice task

Figure A.17: Motivation screen when the participant chooses to skip the choice task

One of the three questions from the questionnaire before the choice task was shifted to the one at the end, therefore, only two questions remained (Figure A.18).

Figure A.18: New visualization of the questionnaire before the choice task.

In the final questionnaire, three questions were added and one was adapted, based on the pilot test. First, the participants can suggest any additional measure alternatives through an open question (Figure A.19). For the second question added, the participants can choose one or more options to answer through which media they would like to know more about climate change. And for the third question added, they are asked to select whether the government should allocate more resources to measures related to climate change or to other purposes (Figure A.20).
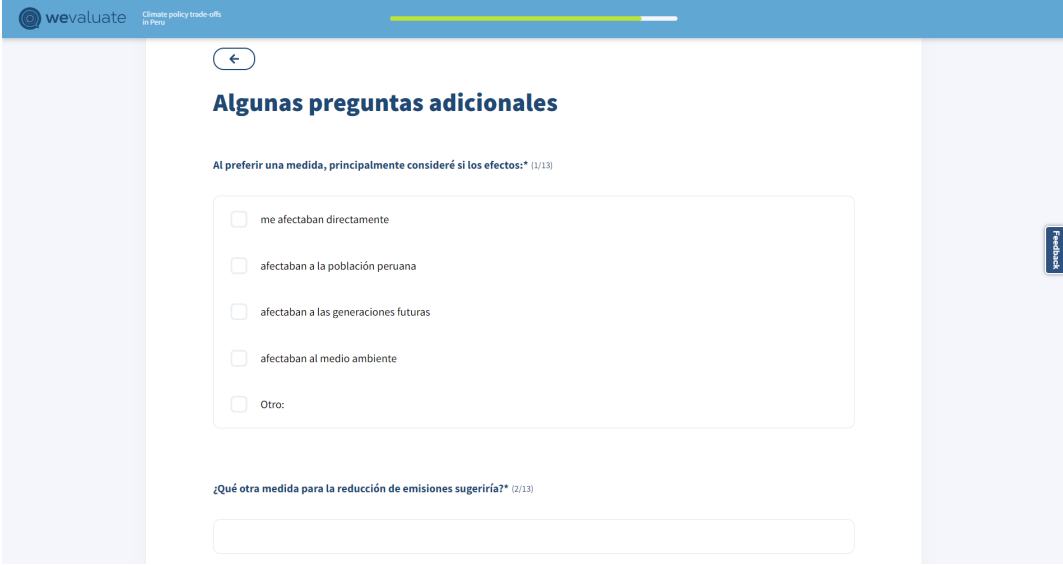
Figure A.19: Screen with new space to leave suggestions for additional measures.
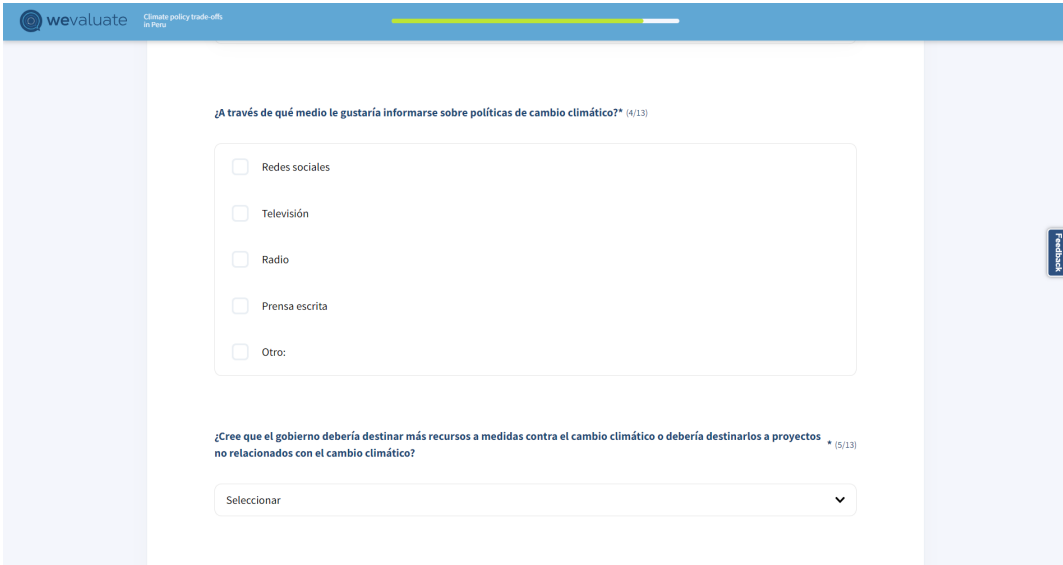
Figure A.20: Screen with new questions about medium for information and resource allocation.

The question asking the participants to provide suggestions for different topics to use a PVE, was adapted. In the new version, they can select one or more options that they consider relevant and provide additional answers

(Figure A.21).

Figure A.21: New version of the question regarding topics for PVE.

B

Pilot test information

B.1 Socio-demographics from pilot test

From the pilot test, over 60% of the respondents were women, therefore, the sample is not representative of the Peruvian population. Figure B.1 also shows that there is no balance between age ranges. Additionally, there is an over-representation of people with higher education (Figure B.2).
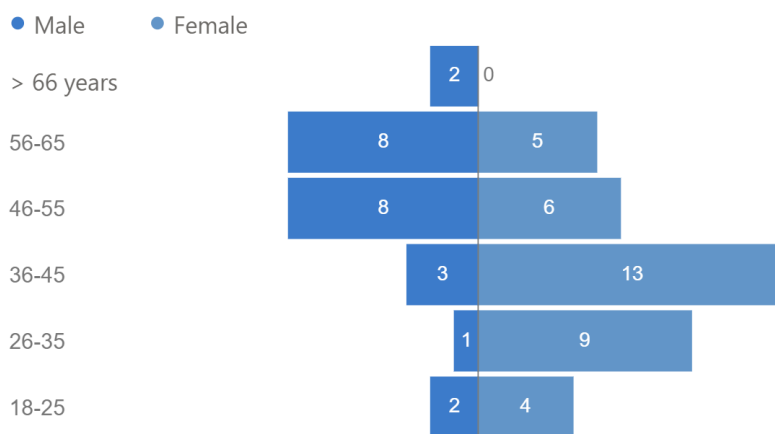
Figure B.1: Age and gender pyramid from the respondents of the pilot test.

9.84%

52.46%

37.70%

Education
- Upper (university)
- Upper (non-university)
- High school
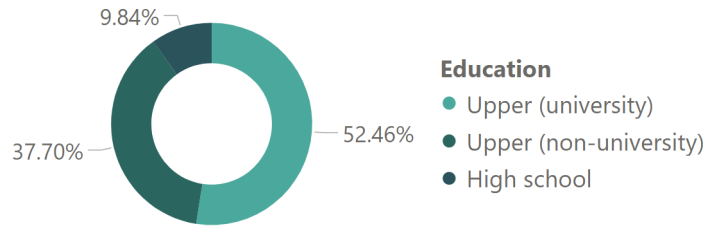
Figure B.2: Percentages of respondents by education level.

B.2 Choice task results

Preliminary results show that *T1: Promote the use of electric vehicles for public transport*, is the policy least preferred, with 15% of the respondents selecting a value of 0 or 0.1 for it. On the other hand, the most preferred measure is *U2: forest restoration and conservation*, where 28% of the individuals indicated a value of 1 for it. Figure B.3 also illustrates that the rest of the measures have on average a medium preference from the participants.

Preference value ● 0 ● 0.1 ● 0.2 ● 0.3 ● 0.4 ● 0.5 ● 0.6 ● 0.7 ● 0.8 ● 0.9 ● 1
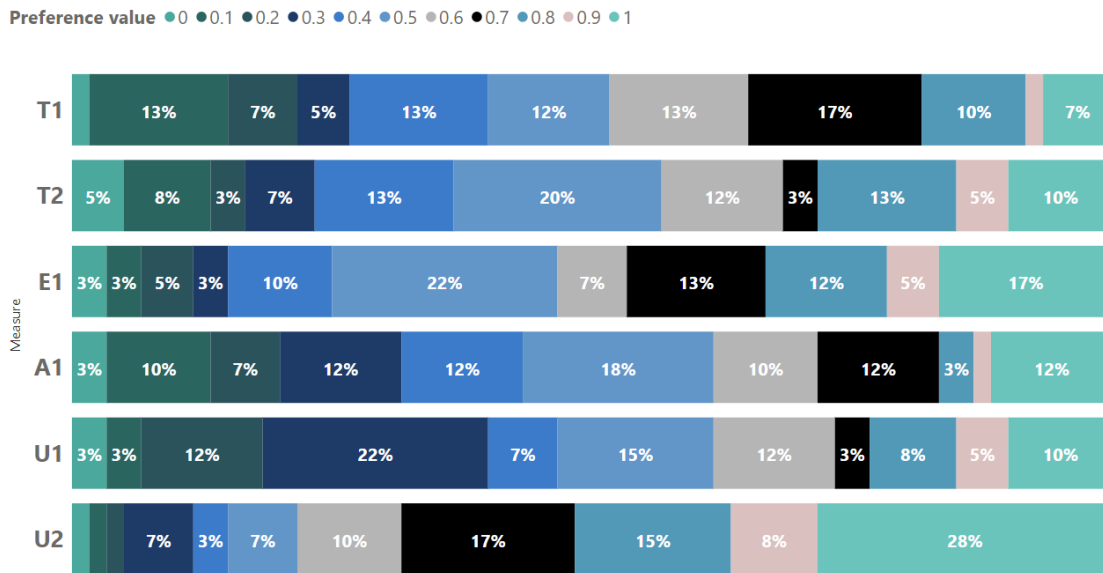
Figure B.3: Percentages each of the preferences values represent, based on the selection by the participants from the pilot test

B.3 Questionnaire results

From the 61 respondents, only eleven stated that they knew about a process in which the government considers the citizens for policy-making. The most mentioned was referendum, followed by assembly and conferences. The other two comments did not specified, but provided their opinion (Figure B.4).
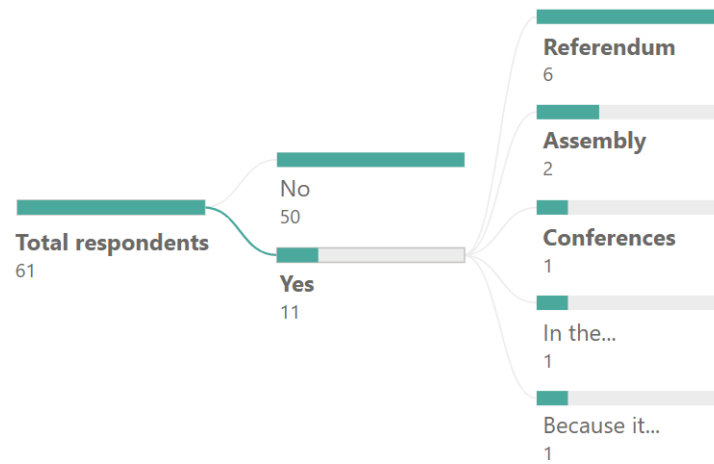
Figure B.4: Processes for participation in policy-making, which the participants are familiar with.

Table B.1 shows the percentages of the participants that agree or disagree with a series of statements. From the results, it can be said that most of them believe the study provided them with enough information to complete the survey. This, can be related to the knowledge and confidence with which they gave their advice. However, most of them are inclined to disagree that the majority of the Peruvian population would be in the same position. Finally, most of the respondents had a positive response towards the PVE method, which suggests also a high agreement on policy acceptance.

Statement	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
This study gave me enough information to be able to advise the government	3.3%	8.2%	22.9%	49.2%	16.4%
I am convinced on my selection of measures	1.6%	0%	9.8%	63.9%	24.6%
I have sufficient knowledge to advise the government on this matter	1.6%	4.9%	50.8%	36.1%	6.6%
I believe that the majority of the Peruvian population has enough knowledge to advise the government on this issue	13.1%	26.2%	32.8%	23%	4.9%
This is a good method to involve citizens in the choices that the government should make regarding climate change policies	1.6%	6.6%	14.8%	45.9%	31.1%
The government should use this method more often	1.6%	1.6%	16.4%	41%	39.3%
If the government involves this research in climate policy, I would support the final decision	3.3%	0%	16.7%	50%	30%

Table B.1: Level of agreement percentage for each statement presented in the pilot test.

C
Additional information of results

C.1 Socio-demographics

The tables provided in this section display a comparison between the observed socio-demographic characteristics and the expected ones, which are derived from the actual Peruvian population.

		Observed		Expected	
Gender	Age	Number	Percentage	Number	Percentage
Female	18-25	287	14.6%	128	6.6%
Female	26-35	353	17.9%	239	12.4%
Female	36-45	175	8.9%	210	10.9%
Female	46-55	107	5.4%	166	8.6%
Female	56-65	57	2.9%	119	6.2%
Female	66 years or more	6	0.3%	130	6.8%
Male	18-25	268	13.6%	123	6.4%
Male	26-35	231	11.7%	226	11.7%
Male	36-45	252	12.8%	198	10.3%
Male	46-55	147	7.5%	155	8.1%
Male	56-65	57	2.9%	112	5.8%
Male	66 years or more	19	1.0%	116	6.0%
Other	other	9	0.5%	-	-

Table C.1: Observed and expected observations in terms of gender and age groups

	Observed		Expected	
Region	**Number**	**Percentage**	**Number**	**Percentage**
Coast	**1686**	**85.7%**	**1318**	**65.9%**
Lima	1095	55.6%	651	32.3%
La Libertad	119	6.0%	123	6.1%
Arequipa	101	5.1%	92	4.7%
Lambayeque	99	5.0%	79	4.1%
Piura	88	4.5%	124	6.3%
Prov. Const. Del Callao	68	3.5%	69	3.4%
Áncash	51	2.6%	70	3.7%
Ica	35	1.8%	61	2.9%
Tacna	14	0.7%	23	1.1%
Tumbes	11	0.6%	15	0.8%
Moquegua	5	0.3%	12	0.6%
Highlands	**198**	**10.1%**	**461**	**24.9%**
Junín	47	2.4%	80	4.2%
Cusco	42	2.1%	81	4.1%
Cajamarca	35	1.8%	85	4.6%
Huánuco	25	1.3%	44	2.5%
Puno	23	1.2%	71	4.0%
Ayacucho	13	0.7%	39	2.1%
Apurímac	6	0.3%	25	1.4%
Pasco	5	0.3%	16	0.9%
Huancavelica	2	0.1%	20	1.2%
Jungle	**84**	**4.3%**	**189**	**9.2%**
San Martín	28	1.4%	55	2.8%
Ucayali	23	1.2%	37	1.7%
Loreto	17	0.9%	61	3.0%
Amazonas	12	0.6%	25	1.3%
Madre de Dios	4	0.2%	11	0.5%

Table C.2: Observed and expected observations in terms of Region of residence

	Observed		Expected	
Education level	**Number**	**Percentage**	**Number**	**Percentage**
None	4	0.2%	97	5.0%
Primary school	17	0.9%	377	19.5%
Secondary school	387	20.1%	798	41.3%
Higher education (non-university)	569	29.5%	277	14.3%
Higher education (university)	953	49.4%	381	19.7%

Table C.3: Observed and expected observations in terms of education level

The tables within this section offer comprehensive insights into the analysis of preferences, encompassing a detailed presentation of results from the Latent Class Analysis conducted through LatentGold software.

Age group by gender	Education level					Total
	Higher education (university)	Higher education (non-university)	Secondary school	Primary school	None	
Female	**18.0%**	**11.8%**	**18.6%**	**3.7%**		**52.2%**
18-25	6.2%	3.7%	7.5%	-	-	17.4%
26-35	5.6%	1.2%	4.3%	1.9%	-	13.0%
36-45	-	1.9%	3.1%	-	-	5.0%
46-55	3.7%	3.1%	2.5%	-	-	9.3%
56-65	1.9%	1.9%	1.2%	1.9%	-	6.8%
66 years or older	0.6%	-	-	-	-	0.6%
Male	**13.7%**	**17.4%**	**14.3%**	**-**	**0.6%**	**46.0%**
18-25	3.1%	5.0%	5.0%	-	-	13.0%
26-35	3.7%	3.1%	3.7%	3.7%	0.6%	11.2%
36-45	2.5%	3.7%	5.0%	-	-	11.2%
46-55	1.9%	3.7%	0.6%	-	-	6.2%
56-65	1.9%	1.2%	-	-	-	3.1%
66 years or older	0.6%	0.6%	-	-	-	1.2%
Not specified	**0.6%**	**-**	**1.2%**	**-**	**-**	**1.9%**
18-25	-	-	-	-	-	-
26-35	-	-	-	-	-	-
36-45	-	-	0.6%	-	-	0.6%
46-55	-	-	0.6%	-	-	0.6%
56-65	-	-	-	-	-	-
66 years or older	0.6%	-	-	-	-	0.6%
Total	**32.3%**	**29.2%**	**34.2%**	**3.8%**	**0.6%**	**100%**

Table C.4: Socio-demographic characteristics of participants that skipped the choice task

	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	Total
T2	35%	10%	10%	4%	8%	4%	4%	4%	6%	1%	15%	100%
E1	22%	5%	3%	2%	4%	8%	10%	9%	4%	4%	28%	100%
A1	36%	9%	3%	6%	6%	9%	4%	4%	2%	4%	17%	100%
U1	40%	7%	6%	2%	2%	4%	5%	4%	2%	1%	25%	100%
U2	14%	2%	4%	2%	1%	5%	3%	9%	4%	9%	48%	100%

Table C.5: Proportion of preferences for each measure, when the preferences for T1 is 0.

	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	Total
T1	13%	7%	6%	6%	7%	12%	9%	7%	8%	4%	22%	100%
T2	12%	9%	7%	5%	6%	12%	8%	8%	7%	5%	20%	100%
E1	4%	2%	1%	3%	5%	8%	6%	8%	9%	9%	45%	100%
A1	10%	5%	6%	6%	8%	10%	9%	7%	6%	6%	28%	100%
U1	13%	6%	4%	3%	5%	9%	5%	7%	5%	4%	39%	100%

Table C.6: Proportion of preferences for each measure, when the preferences for U1 is 1.

	Qualitative effect	Keywords
T1	Economic development	Desarrollo, desarrollar, crecimiento, progreso, avance, económico, economía informalidad, formalidad, público, sociedad, comunidad, población, propiedades.
	Health	Salud, bienestar, contaminación, polución, vida, vitalidad, activo, activa, energía, accidentes, seguridad, transito, tráfico
T2	Economic development	Desarrollo, desarrollar, crecimiento, progreso, avance, económico, economía, PIB, producto, interno, bruto
	Health	Salud, bienestar, contaminación, polución, petróleo, combustible, fósiles, aire, cardiorrespiratoria, auditiva, ocular, mental, respiratoria, visual, sonora, ruido
E1	Economic development	Desarrollo, desarrollar, crecimiento, progreso, avance, económico, economía, zonas, región, comunidad, ciudada, pueblo, alejadas, apartada
	Health	Salud, bienestar, energía, electrica, contaminación, polución, combustible, fosiles, fosil, leña, respiratoria, cardiorrespiratoria
A1	Economic development	Desarrollo, desarrollar, crecimiento, progreso, avance, económico, economía, producción, agricultores, cultivadores, producto, producción
	Deforestation	Bosque, bosques, árbol, árboles, plantas, selova, madera, deforestación, forestal, tala, reforestación, reforestar, plantar, tierras, terreno
	Jobs	Empleo, ocupación, oficio, venta, ganancia, beneficio, exportación
U1	Economic development	Desarrollo, desarrollar, crecimiento, progreso, avance, económico, economía, producción
	Deforestation	Bosque, bosques, árbol, árboles, plantas, selova, madera, deforestación, forestal, tala, reforestación, reforestar, plantar, tierras, terreno
	Jobs	Empleo, ocupación, oficio, venta, ganancia, beneficio
U2	Economic development	Desarrollo, desarrollar, crecimiento, progreso, avance, económico, economía, producción
	Deforestation	Bosque, bosques, árbol, árboles, plantas, selova, madera, deforestación, forestal, tala, reforestación, reforestar, plantar, tierras, terreno
	Jobs	Empleo, ocupación, oficio, venta, ganancia, beneficio

Table C.7: Keywords used for the each qualitative effect, per measure

	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	Total
T1	9%	8%	8%	10%	10%	13%	11%	9%	7%	4%	12%	100%
T2	9%	9%	8%	9%	8%	14%	11%	9%	6%	5%	12%	100%
E1	4%	3%	4%	5%	9%	11%	10%	10%	11%	7%	24%	100%
A1	8%	7%	9%	10%	9%	13%	10%	9%	7%	5%	14%	100%
U1	10%	7%	7%	8%	7%	12%	9%	9%	6%	6%	17%	100%
U2	3%	2%	3%	4%	7%	9%	10%	10%	10%	6%	35%	100%

Table C.8: Proportion of the preferences for each policy measure from respondents who selected "Agriculture" as the most least sector

	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1	Total
T1	9%	7%	9%	10%	10%	14%	10%	9%	8%	4%	11%	100%
T2	8%	8%	8%	9%	10%	13%	10%	9%	7%	6%	12%	100%
E1	4%	4%	4%	6%	8%	12%	10%	10%	11%	7%	23%	100%
A1	8%	8%	9%	10%	9%	14%	10%	9%	7%	4%	12%	100%
U1	10%	8%	7%	7%	9%	12%	9%	9%	6%	5%	17%	100%
U2	3%	3%	4%	4%	7%	11%	9%	10%	9%	8%	33%	100%

Table C.9: Proportion of the preferences for each policy measure from respondents who selected "Transport" as the most pollutant sector

	LL	BIC(LL)	Npar	L^2	df	p-value	Class.Err.
1-Cluster	-13162.8	26460.58	18	4949.873	1789	7.2E-294	0
2-Cluster	-12343.4	24964.2	37	3311.006	1770	1.90E-96	0.0804
3-Cluster	-12011	24441.98	56	2646.298	1751	1.10E-39	0.1005
4-Cluster	-11737.8	24038.14	75	2099.967	1732	2.20E-09	0.1402
5-Cluster	-11667.6	24040.11	94	1959.447	1713	2.70E-05	0.1559
6-Cluster	-11619.4	24086.24	113	1863.088	1694	0.0024	0.1695
7-Cluster	-11562.5	24114.93	132	1749.284	1675	0.1	0.1897
8-Cluster	-11538.4	24209.25	151	1701.116	1656	0.22	0.1982
9-Cluster	-11517.4	24309.69	170	1659.07	1637	0.35	0.2196
10-Cluster	-11505.8	24428.91	189	1635.795	1618	0.37	0.2451

Table C.10: LCA models summary

Model for Clusters						
Intercept	Cluster1	Cluster2	Cluster3	Cluster4	Wald	p-value
	0.2865	0.5305	-0.0449	-0.7721	61.5248	2.80E-13

Covariates	Cluster1	Cluster2	Cluster3	Cluster4	Wald	p-value
Education level						
Basic	-0.1057	-0.0395	-0.0339	0.1791	5.7017	0.13
Higher	0.1057	0.0395	0.0339	-0.1791		
Affected						
Directly me	-0.4459	0.1927	0.3784	-0.1252	36.5685	0.00026
Future generations	0.3322	-0.0736	-0.14	-0.1186		
More than one option	0.2654	-0.2069	-0.1152	0.0567		
The Peruvian society	-0.1582	0.3351	-0.0148	-0.1621		
The environment	0.0066	-0.2474	-0.1084	0.3492		

Table C.11: LCA covariates parameters

	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Cluster Size	0.3668	0.342	0.1947	0.0965
Indicators				
Expansion of bus corridors and bike lane				
High	0.4512	0.1272	0.0063	0.2033
Medium	0.3861	0.6748	0.1836	0.1609
Low	0.1195	0.1872	0.7302	0.0675
None	0.0432	0.0108	0.0798	0.5684
Installation of solar panels in rural areas				
High	0.7944	0.1941	0.0692	0.3821
Medium	0.1772	0.719	0.3607	0.2398
Low	0.0215	0.0835	0.5414	0.0089
None	0.007	0.0034	0.0287	0.3692
Improve the productivity and quality of coffee and cacao crop				
High	0.5014	0.0628	0.0335	0.2205
Medium	0.3487	0.6891	0.1745	0.2248
Low	0.1246	0.2204	0.6967	0.0497
None	0.0253	0.0278	0.0952	0.505
Forest restoration and commercialization				
High	0.5996	0.109	0.0499	0.2257
Medium	0.2554	0.6876	0.2509	0.1598
Low	0.1049	0.1675	0.6033	0.0285
None	0.04	0.0358	0.0958	0.5861
Forest restoration and conservation				
High	0.834	0.2765	0.272	0.566
Medium	0.1485	0.6414	0.3559	0.1383
Low	0.0143	0.082	0.3556	0.0193
None	0.0032	0	0.0166	0.2764
Promote the use of electric vehicles for public transport				
High	0.4286	0.155	0.035	0.2081
Medium	0.3598	0.6441	0.2777	0.2023
Low	0.1603	0.1861	0.6353	0.1075
None	0.0513	0.0148	0.052	0.482
Covariates				
Education level				
Basic	0.1662	0.1957	0.1953	0.2714
Higher	0.8338	0.8043	0.8047	0.7286
Affected				
Directly me	0.019	0.0477	0.0565	0.0303
Future generations	0.1204	0.1051	0.0968	0.085
More than one option	0.6515	0.5313	0.5733	0.5835
The Peruvian society	0.089	0.1925	0.1336	0.1023
The environment	0.1201	0.1235	0.1398	0.1989

Table C.12: 4-Cluster profile

	CO₂ emissions reduction [%]		Cost of implementation [million USD]	
	Min	Max	Min	Max
Cluster 1	80%	100%	31546	39432
Cluster 2	40%	70%	15773	27602
Cluster 3	10%	48%	3943	12350
Cluster 4 - a	35%	44%	1040	31900
Cluster 4 - b	46%	57%	4480	32503

Table C.13: Intervals of CO2 emission reduction and cost of implementation per Cluster

The tables presented in this section include additional information and details used for the analysis of the questionnaire results.

Category of proposed medium	Frequency
Public area advertisement	9
Campaigns	3
Informative talks	3
Educational institutions	2
Designated website	1
Surveys	1
No opinion	1

Table C.14: Frequency of the categorized additional communication mediums for climate change policy

Method	Frequency
Not specified	114
Workshop	79
Referendum	57
Assembly	47
Voting	4
Participatory budget	3
Conferences	3
Other	4

Table C.15: Answers to what other methods the individuals know in relation to participation for policy making

Age group	University	Non-university	Secondary school	Primary school	None
18-25	6%	9%	10%	-	-
26-35	11%	8%	6%	2%	-
36-45	9%	10%	7%	1%	-
46-55	5%	3%	5%	-	-
56-65	4%	1%	1%	-	-
over 66 years old	2%	1%	1%	-	-
Total	**37%**	**31%**	**30%**	**3%**	**-**

Table C.16: Percentages by age group and education level of participants who selected to allocate resources to projects not related to climate change

Age group	University	Non-university	Secondary school	Primary school	None
18-25	13%	8%	7%	<1%	-
26-35	17%	8%	5%	<1%	<1%
36-45	10%	7%	4%	<1%	<1%
46-55	6%	4%	2%	-	-
56-65	3%	2%	1%	<1%	-
over 66 years old	<1%	<1%	<1%	-	-
Total	**50%**	**29%**	**19%**	**1%**	**<1%**

Table C.17: Percentages by age group and education level of participants who selected to allocate resources to projects related to climate change