MASTER

Preference and Acceptance of Solar and Wind Farms Near Urban Areas

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Preference and Acceptance of Solar and Wind Farms Near Urban Areas

Research Thesis

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Colophon

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Preface

This research was conducted as a final project for the master's degree in Architecture, Building and Planning at Eindhoven University of Technology. I am very happy to have been given the opportunity to conduct this research because of my interest in sustainability and urban development. Over the past months, I have had the opportunity to expand my knowledge on these topics and have learned valuable lessons that have helped me prepare for my professional career. The challenges of creating my own survey and collecting and analyzing the data gave me new insights into how proposals, recommendations and policy plans are created.

I would like to thank my supervisors Dr. Gamze Dane, Ir. Aloys Borgers, and Prof. Dr. Theo Arentze for their time and expertise. I appreciate what they have done for me and their willingness to help when needed. I would also like to thank my partner for her support throughout the project, as well as my friends and family. Without my personal network, the study would have far fewer participants and the results of the study would not have been as meaningful. In addition, I am grateful for the opportunity I have had to develop myself both professionally and personally. That said, I am proud of the results of my research and the outcomes.

I hope you enjoy reading this study as much as I enjoyed writing it.

Michel Bouwmans

Eindhoven, July 2024

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Summary

Community acceptance is one of the most important aspects of developing solar and wind farms (SWFs) in an area. Namely, the opposition of local residents could lead to delay or cancellation of projects. However, to tackle the rising problems associated with climate change (CC) and global warming, more SWFs must be built. Therefore, in this thesis, it is researched what factors contribute to acceptance and preferences regarding SWFs. The main question that is answered is:

What factors affect acceptance and preferences regarding solar and wind farm developments near urban areas?

First, the concept of community acceptance as a part of social acceptance is explained in a literature review. From here, community acceptance of SWF was divided over several elements. The first of these elements are the personal characteristics of people. The found literature suggests that personal characteristics like age, income, level of education, and gender could all be potentially influential in community acceptance. However, the findings of these studies could also be conflicting. Therefore, the effect of personal characteristics was implemented in this research. The second element is the belief in CC regarding its causes and effects. It was found in the literature that individuals who score high in CC concerns are more likely to accept green energy. For instance, if people do believe that CC is caused by humans, their willingness to accept developments rises. Another element of acceptance has to do with the implementation of a SWF in an individual's living area. While someone could be supportive of SWF to counteract the effects of CC, their opinion could change when a SWF is located in their living area. This difference is called the national-local gap. As suggested in the literature review, there are many reasons for opposition to a SWF in a living area. Two of the most important ones are NIMBY, and place protector. NIMBY is an abbreviation of Not In My Backyard. This occurs when people are in favor of green energy but do not want it in their living area. This could be due to aesthetical preferences or monetary depreciation of their dwellings. The first could be explained by the change to the scenery that a SWF could have on a place. People could be used to the aesthetics of their living environment, while a SWF could disrupt their views. Next to NIMBYism are the place protectors who have other concerns. The goal of the place protector is to preserve the perceived value of an area. They value areas based on their land use rather than on whether it has an impact on their living environment. For instance, the implementation of a SWF could mean either a forest or an agricultural field has to be transformed. A place protector can value either of those land uses as more valuable for them and, therefore, choose to sacrifice the other. A third element of acceptance of SWF is local inclusion. Communities can be concerned by the thought that they will not profit from the implementation of a SWF. Their local economy might focus on tourism and the consensus exists that tourism decreases where a SWF is located. Next to that, they often feel left out of the decision-making process and feel that companies have more influence than the local communities. Increasing the cooperation between local governments, companies, and residents could decrease the threshold of accepting a SWF.

Next to the general beliefs about CC and solar and wind farms, there are the design-specific elements of a SWF. Three elements are tested in this study. The first one is the type of farm. While producing the same amount of energy, a solar farm needs a much bigger ground floor area than a wind farm would take. Contrary to that, a wind farm is much more noticeable from a larger distance. The difference between these two types tests the importance of the NIMBYist and the place protector. The second design attribute is the distance a SWF is located from a residential area. A greater distance decreases the visual impact of a SWF. The third attribute is the land use where the SWF is placed. The locations of

the SWF created for this study are either on agricultural land or in natural areas. As suggested in the literature study, there are numerous reasons why someone would value a natural area as more important but also for the contrary. The final element that influences acceptance is the visualization of a design. Understanding the impact and creating credible designs is key to conveying a reliable message. However, standard visualization techniques focus on showing pictures or short videos in sequence. Therefore, a new form of visualization is tested. Showing videos on a split screen provides decision-makers with real-time comparability between the differences in designs. Respondents are shown two designs at once so the difference between them is clearer, more understandable, and easier to remember. However, since this is a new technique, it had to be tested how respondents react to this form of visualization and how it influences community acceptance.

The site chosen for the SWFs to be developed is located in the South of Zwolle. This area was chosen because it is close to a big city, has enough room for both a solar and a wind farm, and has a spread of nature and agricultural areas. The city is, next to this, expected to grow significantly in the upcoming years. This leads to two scenarios that can be researched. The first scenario is for the people that are already living in the area. For them there is a difference between if a SWF is located in their area or not. They can value the present situation and compare it to a situation where a SWF would be placed. In this scenario it is about the acceptance of a SWF. The second scenario is for the people that are going to live in Zwolle in the future. They cannot choose to live in the area before there was a SWF, but they can indicate how much they prefer the SWF development that is located in the area.

With all the elements of community acceptance identified a survey is built up. The first part consists of the personal characteristics of the respondent. Respondents were asked to answer multiple choice questions about their age, income, education, postal code, and gender. Following these questions, respondents had to indicate how much they agreed with two types of statements. The first type of statements were about CC, and the second type were about their general opinion on SWFs. Multiple statements per type were formulated to describe the factors of the topics related to community acceptance. Then a discrete choice experiment (DCE) was shown to the respondents about different design alternatives. Within this DCE, respondents were presented with choice sets in the form of a video. In a split screen two different design alternatives were presented. Two questions were asked after watching each video. The first question was about the preference of the respondent, testing the scenario where a SWF would be present in the area. For this question, they had three choice options. They could indicate which design they preferred, or they could indicate that they had no preference. The second question was about the acceptance of the design being realized in the respondent's living environment, testing the scenario if people already living there are willing to accept a SWF. Respondents could indicate for each design shown in a choice set if they would accept it or not. The final part of the survey consisted of statements on the experience of the visualization of the DCE. Multiple statements were formulated to research the user experience with the videos and its effect on preferences and acceptance. A total of 65 people finished the survey. With the gathered data, a descriptive analysis was performed and multinomial logit (MNL) and random parameter mixed logit models (RP-ML) could be estimated. The descriptive analysis showed that respondents' opinions were in agreement with some of the statements. These statements could, therefore, not be included in the MNL and RP-ML.

MNL and RP-ML models were estimated for each question in the DCE and a combination of the data of both resulting in a total of six models. The models of the combined data are created to test if there is a difference between preferences and acceptance. The results of the model show that in general

solar farms are more preferred and accepted than wind farms and a larger distance from the living environment increases the utility as well. The land use was not found to be a significant contributor. The MNL model of preference has a moderate performance, indicating that only a small part of the preferences can be described by the model. The performance of the acceptance model is better and can be used to estimate a significant part of acceptance. However, combining the data of both questions into one model resulted in poor performing model. This indicates that there is a difference between the two questions. The RP-ML models incorporate heterogeneity between the respondents. The coefficient of distance from the residential area was found to have a significant standard deviation. The performance of the preference and acceptance models increased slightly. The performance of the combined models had risen significantly from a very poor performing MNL model to a good performing RP-ML model. However, since the constants in this model vary significantly, it still indicates that there is a difference between acceptance and preference. The findings of the models have been used to state recommendations for future research and policy makers.

Samenvatting

De acceptatie door de gemeenschap is één van de belangrijkste aspecten van de ontwikkeling van zonne- en windmolenparken (SWF's) in een gebied. Tegenstand van omwonenden kan namelijk leiden tot vertraging of annulering van projecten. Om de toenemende problemen in verband met klimaatverandering en opwarming van de aarde aan te pakken, moeten er echter meer SWF's worden gebouwd. Daarom wordt in dit afstudeerverslag onderzocht welke factoren bijdragen aan de acceptatie van SWF's. De belangrijkste vraag die beantwoord wordt is:

Welke factoren beïnvloeden acceptatie en voorkeuren
voor de ontwikkeling van zonne- en windparken in de buurt van stedelijke gebieden??

Eerst wordt het concept van gemeenschapsacceptatie als onderdeel van sociale acceptatie uitgelegd in een literatuuronderzoek. Van hieruit werd de acceptatie van SWF door de gemeenschap verdeeld in verschillende elementen. De eerste van deze elementen zijn de persoonlijke kenmerken van mensen. De gevonden literatuur suggereert dat persoonlijke kenmerken zoals leeftijd, inkomen, opleidingsniveau en geslacht allemaal mogelijk van invloed zijn op de acceptatie door de gemeenschap. De bevindingen van deze studies kunnen echter ook tegenstrijdig zijn. Daarom is het effect van persoonlijke kenmerken in dit onderzoek geïmplementeerd. Het tweede element is het geloof in klimaatverandering (CC) met betrekking tot de oorzaken en gevolgen ervan. In de literatuur werd gevonden dat individuen die hoog scoren op het gebied van CC eerder geneigd zijn om groene energie te accepteren. Als mensen bijvoorbeeld geloven dat CC veroorzaakt wordt door mensen, dan stijgt hun bereidheid om ontwikkelingen te accepteren. Een ander element van acceptatie heeft te maken met de implementatie van een SWF in de leefomgeving van een individu. Terwijl iemand voorstander kan zijn van SWF's om de effecten van CC tegen te gaan, kan zijn mening veranderen wanneer een SWF zich in zijn woonomgeving bevindt. Dit verschil wordt de nationale-lokale kloof genoemd. Zoals gesuggereerd in de literatuurstudie, zijn er veel redenen voor verzet tegen een SWF in een woongebied. Twee van de belangrijkste zijn NIMBY en place protector. NIMBY is een afkorting van Not In My Backyard. Dit gebeurt wanneer mensen voor groene energie zijn, maar het niet in hun woonomgeving willen. Dit kan te maken hebben met esthetische voorkeuren of geldontwaarding van hun woning. Het eerste kan worden verklaard door de verandering in het landschap die een SWF kan hebben op een plek. Mensen zouden gewend kunnen zijn aan de esthetiek van hun leefomgeving, terwijl een SWF hun uitzicht zou kunnen verstoren. Naast NIMBYisme zijn er de place protectors die andere zorgen hebben. Het doel van de place protector is om de gepercipieerde waarde van een gebied te behouden. Ze waarderen gebieden eerder op basis van hun landgebruik dan op basis van de vraag of het een impact heeft op hun leefomgeving. De implementatie van een SWF kan bijvoorbeeld betekenen dat een bos of een landbouwgebied moet worden veranderd. Een place protector kan één van beide vormen van landgebruik waardevoller vinden en er daarom voor kiezen om het andere op te offeren. Een derde element van aanvaarding van SWF is lokale betrokkenheid. Gemeenschappen kunnen bezorgd zijn door de gedachte dat ze niet zullen profiteren van de implementatie van een SWF. Hun lokale economie kan zich richten op toerisme en de consensus bestaat dat toerisme afneemt waar een SWF gevestigd is. Daarnaast voelen ze zich vaak buitengesloten van het besluitvormingsproces en hebben ze het gevoel dat bedrijven meer invloed hebben dan de lokale gemeenschappen. Het verbeteren van de samenwerking tussen lokale overheden, bedrijven en inwoners zou de drempel om een SWF te accepteren kunnen verlagen.

Naast de algemene opvattingen over CC en zonne- en windmolenparken, zijn er de ontwerpspecifieke elementen van een SWF. In dit onderzoek worden drie elementen getest. De eerste is het type park. Terwijl ze dezelfde hoeveelheid energie produceren, heeft een zonnepark een veel groter grondoppervlak nodig dan een windpark. Daar staat tegenover dat een windpark veel opvallender is vanaf een grotere afstand. Het verschil tussen deze twee types test het belang van de NIMBYist en de place protector. Het tweede ontwerpattribuut is de afstand tussen een SWF en een woonwijk. Een grotere afstand vermindert de visuele impact van een SWF maar kan ten kosten gaan van een ander gebied. Het derde attribuut is het landgebruik waar het SWF wordt geplaatst. De locaties van de SWF's die voor deze studie werden gecreëerd, liggen op landbouwgrond of in natuurgebieden. Zoals gesuggereerd in de literatuurstudie zijn er tal van redenen waarom iemand een natuurgebied belangrijker zou vinden, maar ook voor het tegenovergestelde. Het laatste element dat de acceptatie beïnvloedt, is de visualisatie van een ontwerp. Het begrijpen van de impact en het creëren van geloofwaardige ontwerpen is de sleutel tot het overbrengen van een betrouwbare boodschap. Standaard visualisatietechnieken richten zich echter op het achter elkaar tonen van foto's of korte video's. Daarom wordt een nieuwe vorm van visualisatie getest. Het tonen van video's op een gesplitst scherm biedt besluitvormers real-time vergelijkbaarheid tussen de verschillen in ontwerpen. Respondenten krijgen twee ontwerpen tegelijk te zien, zodat het verschil tussen beide duidelijker, begrijpelijker en gemakkelijker te onthouden is. Omdat dit echter een nieuwe techniek is, moest getest worden hoe respondenten reageren op deze vorm van visualisatie en hoe het de acceptatie door de gemeenschap beïnvloedt.

De locatie die gekozen is voor de te ontwikkelen SWF's ligt in het zuiden van Zwolle. Dit gebied is gekozen omdat het dicht bij een grote stad ligt, genoeg ruimte heeft voor zowel een zonne- als een windpark, en een spreiding heeft van natuur- en landbouwgebieden. Daarnaast wordt verwacht dat de stad de komende jaren flink zal groeien. Dit leidt tot twee scenario's die onderzocht kunnen worden. Het eerste scenario is voor de mensen die al in het gebied wonen. Voor hen maakt het verschil of er een SWF in hun buurt is of niet. Ze kunnen de huidige situatie waarderen en vergelijken met een situatie waarin een SWF zou worden geplaatst. In dit scenario gaat het om de acceptatie van een SWF. Het tweede scenario is voor de mensen die in de toekomst in Zwolle gaan wonen. Zij kunnen er niet voor kiezen om in het gebied te gaan wonen voordat er een SWF was, maar ze kunnen wel aangeven in hoeverre ze de voorkeur geven aan de ontwikkeling van SWF's in het gebied.

Met alle geïdentificeerde elementen van gemeenschapsacceptatie is een enquête opgebouwd. Het eerste deel bestaat uit de persoonlijke kenmerken van de respondent. Respondenten werd gevraagd meerkeuzevragen te beantwoorden over hun leeftijd, inkomen, opleiding, postcode en geslacht. Na deze vragen moesten de respondenten aangeven in hoeverre ze het eens waren met twee soorten stellingen. Het eerste type stellingen ging over CC en het tweede type over hun algemene mening over staatsinvesteringsfondsen. Meerdere stellingen per type werden geformuleerd om de factoren te beschrijven van de onderwerpen die verband hielden met de aanvaarding door de gemeenschap. Vervolgens werd een discreet keuze-experiment (DCE) getoond aan de respondenten over verschillende ontwerpalternatieven. Binnen dit DCE kregen de respondenten keuzesets te zien in de vorm van een video. In een gesplitst scherm werden twee verschillende ontwerpalternatieven gepresenteerd. Na het bekijken van elke video werden twee vragen gesteld. De eerste vraag ging over de voorkeur van de respondent om het scenario te testen waarbij een SWF al aanwezig zou zijn in het gebied. Voor deze vraag hadden zijn er drie keuzemogelijkheden. Respondenten konden aangeven welk ontwerp hun voorkeur had, of ze konden aangeven dat ze geen voorkeur hadden. De tweede vraag ging over de aanvaarding van het ontwerp dat gerealiseerd zou worden in de leefomgeving van de respondent, waarbij het scenario getest werd of mensen die er al wonen bereid zijn om een SWF te aanvaarden. Respondenten konden voor elk getoond ontwerp in een keuzeset aangeven of ze het zouden accepteren of niet. Het laatste deel van de enquête bestond uit stellingen over de ervaring van de visualisatie van de DCE. Er werden meerdere stellingen geformuleerd om de gebruikerservaring met de video's en het effect ervan op voorkeuren en acceptatie te onderzoeken. In totaal hebben 65 mensen de enquête ingevuld. Met de verzamelde gegevens werd een beschrijvende analyse uitgevoerd en konden multinomiale logit (MNL) en random parameter mixed logit modellen (RP-ML) worden geschat. Uit de beschrijvende analyse bleek dat het merendeel van de respondenten het eens waren over sommige stellingen. Deze stellingen konden daarom niet worden opgenomen in de MNL en RP-ML.

MNL- en RP-ML-modellen werden geschat voor elke vraag in de DCE en een combinatie van de gegevens van beide, wat resulteerde in een totaal van zes modellen. De modellen van de gecombineerde data zijn gemaakt om te testen of er een verschil is tussen voorkeuren en acceptatie. De resultaten van het model laten zien dat zonneparken over het algemeen meer worden geprefereerd en geaccepteerd dan windparken en dat een grotere afstand tot de woonomgeving ook het nut vergroot. Het landgebruik bleek geen significante bijdrage te leveren. Het MNL voorkeursmodel presteert matig, wat aangeeft dat slechts een klein deel van de resultaten voorkeuren kan worden beschreven door het model. De prestaties van het acceptatiemodel zijn beter en kunnen worden gebruikt om een aanzienlijk deel van de acceptatie te schatten. Het combineren van de gegevens van beide vragen in één model resulteerde echter in een slecht presterend model. Dit geeft aan dat er een verschil is tussen de twee vragen. De RP-ML modellen houden rekening met heterogeniteit tussen de respondenten. De coëfficiënt van afstand tot de woonwijk bleek een significante standaardafwijking te hebben. De prestaties van de voorkeurs- en acceptatiemodellen zijn licht gestegen. De prestaties van de gecombineerde modellen waren significant gestegen van een zeer slecht presterend MNL-model naar een goed presterend RP-ML-model. Omdat de constanten in dit model echter significant variëren, geeft het nog steeds aan dat er een verschil is tussen acceptatie en voorkeur. De bevindingen van de modellen zijn gebruikt om aanbevelingen te doen voor toekomstig onderzoek en beleidsmakers.

List of Abbreviations

CC	Climate change
DCE	Discrete Choice Experiment
MNL	Multinomial Logit
RP-ML	Random Parameter Mixed Logit
SWF	Solar and wind farm
NIMBY	Not in my back yard
LL	Log-Likelihood

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1. Introduction

In this chapter, the research topic will be introduced, starting with the relevance of the topic and the definition of the problem related to it. A main research question will be stated, accompanied by several sub-questions. Then, the research design will be discussed, and this chapter ends with a reading guide for this entire research.

1.1. The Challenge

All regions around the world are affected by climate change (IPCC, 2021). Extreme weather events, like heatwaves, droughts, and frequent downpours, are becoming more common (Easterling et al., 2000). These weather changes can put lives at risk (NOAA, 2021). The earth's surface temperature has increased by 1°C since the pre-industrial area and a further increase is expected, accompanied by more extreme weather (Lindsey & Dahlman, 2023). To mitigate climate change and its effects, the Paris Agreement was established. It aims to keep global temperatures from rising more than 2°C above pre-industrial levels by 2100 (United Nations, 2015). However, world leaders pursue a rise limited to 1.5°C. To reach this goal, greenhouse emissions must peak before 2025 and decline by 43% by 2030 as illustrated in Figure 1 (United Nations, 2015). There are multiple future expectations based on the global carbon emissions. Even if the carbon emissions lower drastically, the earth surface temperature will continue to rise in the upcoming years. However, if the emissions are not decreased, the global temperature will rise more drastically. Therefore, it is necessary to decrease the emissions. The energy sector, accounting for around seventy-five percent of greenhouse gas emissions, plays a crucial role in reaching this goal (International Energy Agency, 2021). The most important way to decrease the emissions is by replacing polluting gas, coal, and oil-fired power generation with renewable energy sources like solar and wind (Saber & Venayagamoorthy, 2011). Therefore, to decrease the effects of climate change and global warming, more solar and wind farms must be built. However, the implementation of solar and wind farm has been subjected to many challenges itself. One of them being the rejection by local communities to the implementation of a solar or wind farm near their living environment. However, little is known about the relative importance of arguments brought forward to describe community acceptance as a whole.

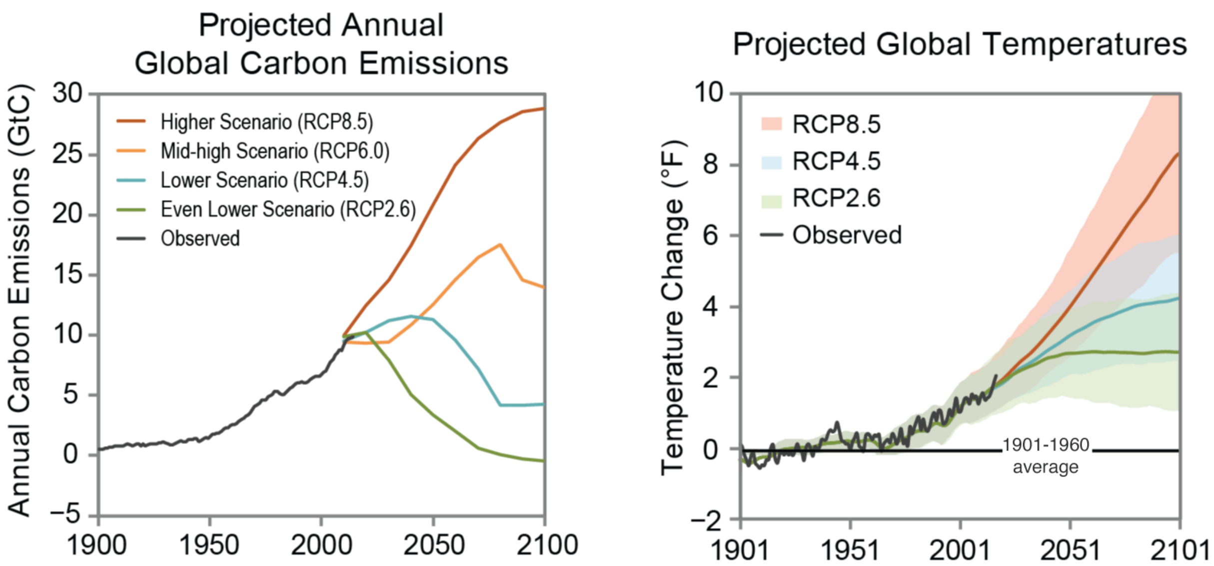

Figure 1: Global warming past, present, and future (Wuebbles et al., 2017)

1.2. Target Area

Zwolle is a city that is aware of the effects of climate change. It is vulnerable to extreme weathers because of its location between two rivers (Municipality of Zwolle, 2021). The Room for the River program allowed the river to expand for the first time in centuries through dike relocations and floodplain excavations, as shown in Figure 2 (Beekers, et al., 2018). This plan shows a few of the efforts made to expand the room for the river and create more natural areas to cope with the effects of climate change. However, new challenges arise, such as an increasing number of people that want to become residents of Zwolle. The expected number of people living in Zwolle will rise from 135.000 in 2023 to 150.000 in 2050 (CBS, 2023a). By developing a thousand dwellings a year, Zwolle wants to tackle the housing shortage in the region. 60% will be developed within the existing city and the other 40% will be realized in the suburban residential environment of Zwolle (Municipality of Zwolle, 2021).

Figure 2: River and floodplains near Zwolle (DaMatriX, 2019)

In addition to tackling the housing shortage, Zwolle aims to be energy-neutral by 2050. Currently, most of the buildings in the city are heated with natural gas. To be a gas-free city by 2050, 1.500 dwellings per year must be disconnected from natural gas (Energieteam gemeente Zwolle, 2018). Therefore, investments in sustainable energy are needed for both the short and long term. The aim of the municipality hereby is to generate locally and regionally (Municipality of Zwolle, 2021). In the Regional Energy Strategy of West Overijssel, it is described that the municipality of Zwolle has to produce 359 GWh of energy via solar and wind (Zegeren, 2020). To achieve this goal, more solar and wind farms must be built.

1.3. Research Questions

Since developments of SWFs have a significant impact on the city and its residents, local communities often become opponents of the proposals (Roddis et al., 2018). This opposition often results to delays of projects which impedes the goal of producing renewable energy. Therefore, to be able to achieve this goal, it is vital to have an understanding of what shapes community acceptance of SWFs. This research aims to find out how the resistance of communities against renewable energy projects can be mitigated. As will be explained in the literature review, there are many determinants of community acceptance related to renewable energy projects. However, little is known about the relative importance of these determinants affecting community acceptance as a whole. In the case of Zwolle, the probability of resistance to future SWF developments is high because of the lack of space and growing population. For this city especially it is, therefore, important to understand what influences community acceptance of SWFs. The main research question that arises is:

What factors affect acceptance and preferences regarding solar and wind farm developments near urban areas?

To answer this main question, the following sub-questions are formed:

1. How do different design attributes affect acceptance and preferences of solar and wind farms?
2. How can videos be used to visualize design alternatives and predict acceptance and preferences?
3. How do personal characteristics relate to the determinants of acceptance and preferences of solar and wind farms?
4. How aware are people of the causes and effects of climate change and how does this affect acceptance and preferences of solar and wind farms?
5. How do beliefs on solar and wind farms affect acceptance and preferences of solar and wind farms?

1.4. Scientific Relevance

The origin of this research lies in the cooperation with the 4TU.RE Centre alliance that focuses on climate-resilient urban development in the Zwolle region (4TU.RE Centre, 2022). The alliance consists of the TU Delft, Universiteit Twente, TU Eindhoven and The Wageningen University. For this project, these universities worked together with the municipality of Zwolle and the regional water authority. Their aim was to find out how spatial developments and investments in the upcoming 10 to 20 years interact with a changing water system in the long run until 2100. However their focus was be mainly on water safety, while this study focuses on the energy transition in the area which is another element of a climate-resilient city.

This outcome of this study provides insights on preferences and acceptance of utility scale solar and wind farms. Where most studies focus on determinants related solely to solar or wind farms, this study combines both and offers a set of predictors regarding different design alternatives. The findings of numerous studies have been combined to identify possible determinants. This study extents these findings by combining them into a single model. Next to this, normal visualization of SWF designs focusses on showing pictures, text, videos, or virtual reality. However, pictures and text do not convey the same level of interpretability as a video does. On the other hand, the downside of a video is that they can be lengthy, unclear, and hard to follow. Next to that, when two videos are shown separately of each other, a participant has to remember the first video to be able to compare it to the other. This results in a less pleasant experience and less informed choices. Therefore, in this study, a new manner of visualization is opted. Videos that are shown in split screen, showing one design on one half of the screen and another on the other half. The potential increase in ease of understanding differences between designs can help to increase community acceptance and accelerate the energy transition.

1.5. Societal Relevance

Reducing the effects of CC is one of the biggest societal challenges of today. The most profound way of doing this is by minimizing the global carbon emissions. The emissions of the energy sector can be significantly decreased by developing clean renewable sources of energy like solar and wind farms. Moreover, renewable energy sources have significant societal relevance because of their potential impact on public health, economic growth, and environmental sustainability. Transitioning from polluting sources like coal, oil, and natural gas to renewable sources like solar and wind farms is beneficial for public health. Namely, the air pollution caused by these fuels contributes to many diseases. Moreover, the use of pollutants accelerates CC, which leads to more extremes in the weather. Next to global benefits, there are also regional benefits. Implementing a SWF will create more jobs for that area which especially for rural areas can lead to stimulus of the local economy. However, despite the advantages of SWFs, there are many concerns by local residents. Projects often face opposition from communities because they are afraid of depletion of the area and are not well informed about the plans. Therefore, it is crucial to understand the preferences and clarifying the plans to understand community acceptance and combat CC.

1.6. Research Design

To conduct the research, this paper will be structured as illustrated in Figure 3. Firstly, a literature review will be presented discussing what the determinants of community acceptance can be as well as a site analysis of the area. In the next chapter, the DCE will be explained. In eight steps it will be clarified in what way the survey will be built up. Following that, the analysis methods are explained. The analysis starts with descriptive statistics followed by MNL and a RP-ML models. Then, in the fourth chapter, the findings of these analyses will be shown, and conclusions will be drawn on that. In the final chapter, the research questions will be answered, and further recommendations will be discussed.

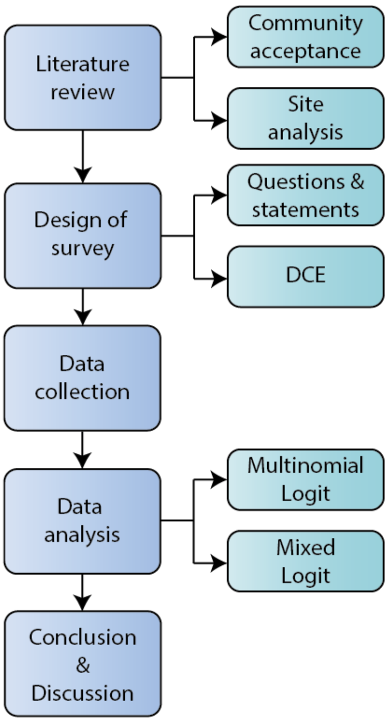

Figure 3: Research design

2. Literature

In this chapter, an elaborate literature review on community acceptance will be presented. Firstly, the importance of the subject will be described, followed by the determinants that shape it. Next to this, the effect of videos as a visualization technique in conveying a message will be described and connected to community acceptance. A conclusion will be drawn from the findings resulting in a research gap and proposed research questions.

2.1. Community Acceptance

Community acceptance is, next to socio-political and market acceptance, one of the three elements of social acceptance, as shown if Figure 4 (Wüstenhagen et al., 2007). Socio-political acceptance refers to support for a technology or policy from the public, and the role of the citizens (Van Rijnsoever et al., 2015). This element of acceptance is often tested via opinion polls that represent the attitude of citizens (Cousse, 2021). Market acceptance bridges national politics and local communities. It involves the consumers that adopt a technology and the investors that want to support its manufacturing and use (Sovacool & Lakshmi Ratan, 2012). The final element of acceptance, community acceptance, refers to the responses of communities to specific proposals or projects, in this case, the realization of a solar and wind farm in Zwolle (Batel, 2018). The term "community" hereby refers to a group sharing the same identity, responsibilities, and interests within a specific geographical area (Guan & Zepp, 2020). Although each element of social acceptance is fundamental in the implementation of renewable energy technologies (Wolsink, 2018), the focus of this research will be on community acceptance. Practice has found that without community acceptance, realizing a project may not be possible, despite the proposal having sufficient socio-political and market acceptance (Bertsch et al., 2017; Juárez-Hernández & León, 2014; Knauf, 2022). The level of community acceptance of renewable energy projects is influenced by numerous determinants. In this research, they are categorized over personal characteristics, climate change, local involvement, impact on daily life, design, and visualization.

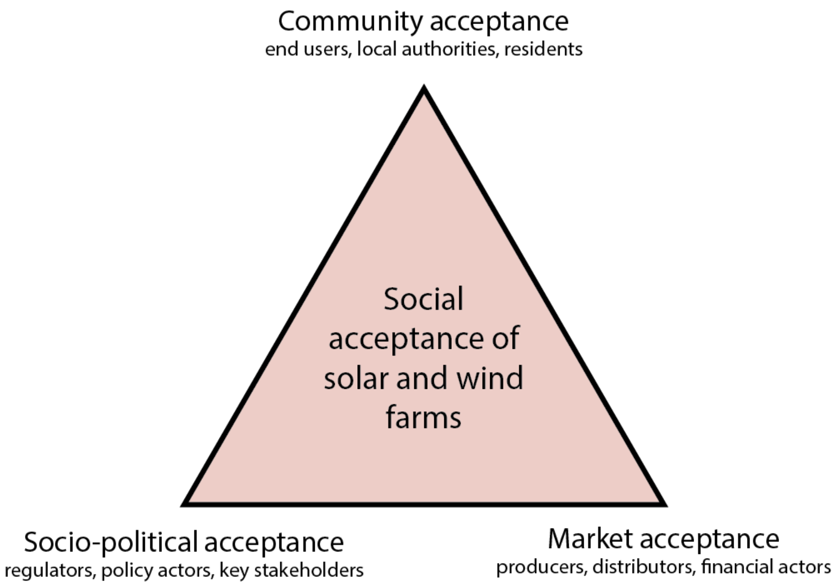

Figure 4: The triangle of social acceptance of solar and wind farms derived from (Wüstenhagen et al., 2007)

2.1.1. Personal Characteristics

Several studies suggest that personal characteristics relate to the attitude of people toward renewable energy projects. Acheson (2012) has found that people with a higher level of education tend to be more aware of the necessity of the energy transition. This study found that a higher percentage of lower-educated respondents, compared to higher-educated ones, believed that environmental problems have been exaggerated. In addition to that, it was found that a higher percentage of the higher-educated people believed that an offshore wind power would be beneficial to the region. Age, work status, and legal residence were concluded to be insignificant in explaining attitudes. The findings of Ladenburg (2010) suggest that gender, education, and income relate to the attitude towards offshore wind farms. More specifically, people with a higher level of education have a more negative attitude toward renewable energy than lower-educated people. This finding is, therefore, contradictory to the finding of Acheson (2012). In the study of Ladenburg it was found that females are more positive than males and a lower household income relates to a more positive attitude. Comparable results were found by (Firestone & Kempton, 2007). However, contrary to Acheson (2012), Firestone & kempton (2007) found that higher levels of education result in a more positive attitude towards offshore wind developments. In another study of Ladenburg (2008), a negative correlation between age and attitude was found. He found that older people tend to be less in favor of renewable energy than young people. A possible explanation of this difference is found by Ladenburg & Dubgaard (2007). They found that younger people have no demand for reduction of visual disamenities related to wind farms. Krueger et al. (2011) confirm the relation by adding that older people are more likely to prefer coal/natural gas alternatives over offshore wind, hence concluding that they are less positive. Similar results are found by Ek & Persson (2014), and Greenberg (2009). In those studies it was also found that older people are more in favor of coal and natural gas compared to younger people.

Familiarity can be one way of mitigating the negative visual effects of wind turbines. De Vries et al. (2012) conducted a study showing people an undisturbed landscape and others with a wind turbine divided over different designs. It was found that the design and distance had little impact on how people perceived the landscape. The outcomes were always more negative compared to the undisturbed landscape. However, he also found that the perceived impact on the landscape increases with age. This can be because young people are more familiar with wind turbines throughout their lives than old people, hereby suggesting that the negative visual impact of wind turbines might be minimized over time. Other findings that connect to earlier studies are explained by Klick & Smith (2010), and Ladenburg (2009). In those studies it was found that public's understanding of wind power is relatively poor and that experience with such a development also depends on previous experiences. They suggest that the difference between the attitudes of different age groups might be a generational difference.

Because of the contradictions in the literature, it can be concluded that there is no hard generalization possible about how personal characteristics relate to the attitude of people toward renewable energy projects. These contradicting findings may be due to different study methods, sample sizes, or cultural differences.

2.1.2. Climate Change

Climate change (CC) is one of the sub-categories that influence community acceptance. Namely, communities that have a broader understanding of the effects of CC are more likely to accept renewable energy developments (Cook et al., 2016). Ntanos et al. (2018) found that environmental protection is the most important reason for people to invest in renewable energy. Weber & Stern (2011) discovered that the majority of people believe in the existence of CC. However, the level of understanding of the potential causes and effects of CC varies significantly. They found that this could be due to political ideology or people's worldview in general. For example, Leiserowitz et al. (2020) found that only 56% of the residents of the United States believe CC is due to anthropogenic actions whilst there is much scientific evidence that some CC effects are human-driven (Höök & Tang, 2013; Oldenborgh et al., 2021; Li et al., 2021).

Spence et al. (2012) investigated the psychological distance to CC, hereby identifying four dimensions; temporal, social, geographical, and uncertainty. Their findings suggest that reducing psychological distance by means of risk communication, increases people's preparedness to act and concerns. These findings suggest that people might not deem renewable energy as necessary because of the psychological distance from the effects of CC. However, the effects of CC are evident around the world, with longer droughts and colder winters that people have to adapt to (Easterling et al., 2000; Guillard et al., 2021).

The emission of greenhouse gases like methane and carbon dioxide during the combustion process of fossil fuels is a significant contributor to CC (Olabi & Abdelkareem, 2022). Isah (2013) found that since the beginning of the 20th century industrial activity grew massively accompanied by a massive increase in the emissions of greenhouse gases. As a result of this, health problems arise that threaten human beings (Gustavsson et al., 2021). McMichael et al. (2006) described the health effects related to climate change. Their findings are shown in Figure 5. They state that anthropogenic greenhouse gas emissions leads to changes in temperature, humidity, and wind patterns. A result of these changes are more severe, and more frequent, weather extremes. This again, will lead to more storms, floods, and bushfires, putting health at risk. Another environmental effect of CC is the increase in pressure on ecosystems which could lead to food poisoning and unsafe drinking water. A third environmental effect is the rise in sea level that leads to impaired crop and livestock. The final environmental effect that they discuss is environmental degradation that can lead to mental health problems and physical problems.

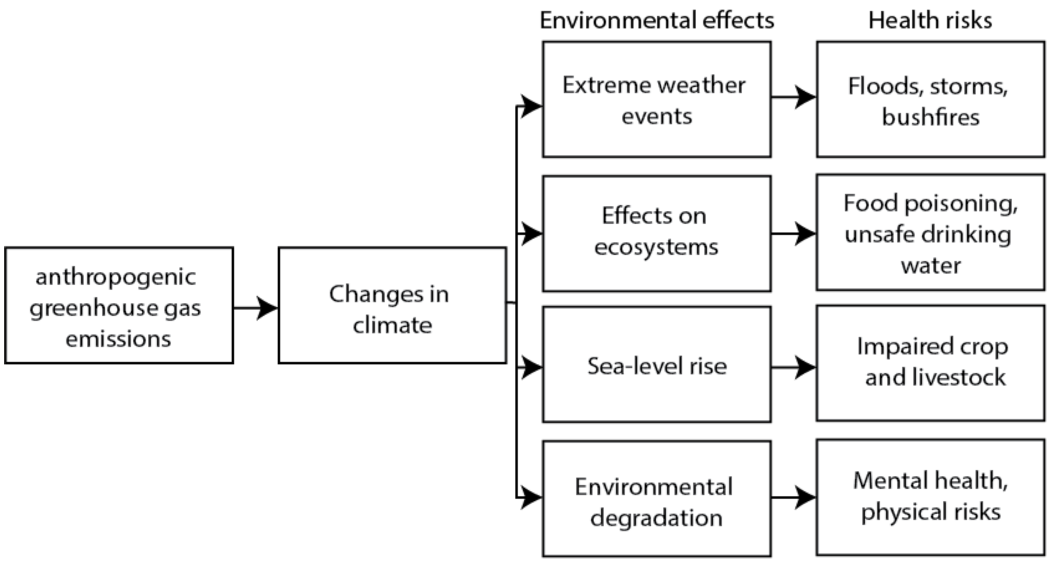

Figure 5: Environmental effects and health risks due to anthropogenic greenhouse gas emissions

2.1.3. Local Involvement

As stated before, the opposition of people to renewable energy projects can come from their lack of knowledge, their perception, and fear of such projects (Assefa & Frostell, 2007). Providing communities with information about the process and involving them in the decision-making could help mitigate this problem and result in a higher level of acceptance and a change of attitude (Jobert et al., 2007). One way of involving people is by developing community-owned projects. Because of the local involvement, Walker & Devine-Wright (2008) found that support and investment in the project had grown compared to other projects that did not involve local communities. Next to this, renewable energy technologies can create new job opportunities and stimulate economic growth. However, government policies, regional economic conditions, and industry structure influence the number of jobs that are created (IRENA, 2012). Susskind et al. (2022) investigated the siting process of multiple renewable energy projects in The United States and found that local communities often raise opposition when project owners do not adequately involve them or take their concerns into account. However, one of the challenges that arise with this is that companies and communities must have common goals to become effective partners. In practice, a study by Goedkoop & Devine-Wright (2016) found that a lack of trust often leads to tough relationships because communities accuse companies of solely being profit-driven. On the other side, companies do not deem community representatives as capable in decision-making. Therefore, this study emphasizes that community involvement might not be the solution to increasing community acceptance. However, Brennan & Van Rensburg (2016) have found that when locals are involved in the planning and implementation process, community acceptance does grow. Ek & Persson (2014) even found that people are willing to pay more for energy when a community has partial ownership of a renewable energy project. These findings suggest that community involvement potentially could be beneficial for community acceptance, but that it also is dependent on how it is perceived.

2.1.4. Impact on Daily Life

In general, there is much support for renewable energy (Segreto et al., 2020). However, there has been strong opposition to projects (Sütterlin & Siegrist, 2017), especially when it comes to actual on-site implementation (Huijts et al., 2012; Wüstenhagen et al., 2007). This indicates that there is a difference between acceptance in general and acceptance in the own living environment. The gap between public- and local acceptance is called the “national-local gap” or the “social gap” (Bell et al., 2013; Tidwell et al., 2018; Wüstenhagen et al., 2007). An explanation of the national-local gap could be the not-in-my-backyard (NIMBY) phenomenon. This phenomenon depicts that people are in favor of renewable energy projects but do not want them in their living environment because of the expected impact on their daily life (Dear, 1992; Devine-Wright, 2009). Opposed to NIMBY, there is the PIMBY phenomenon, which is an abbreviation of Please-In-My-Backyard. For example for agrarians, wind turbines can provide economic benefits, because they can get monetary compensation for renting out their land (van Wijk et al., 2021). Besides that, they help to benefit the image of rural areas as smart producers and users of technology (Brinkman & Hirsh, 2017). Another explanation for the resistance of development of renewable energy, can be found in the typical pattern of acceptance. Before a project is planned there is high acceptance, during the siting phase the acceptance decreases, and once a project is finalized, the acceptance rises again. This is visualized with the findings of Wolsink (2007) in Figure 6. This V-shape can be linked to the national-local gap and NIMBY as they explain the first two parts of the shape. The final rise in attitude can be explained by people overestimating the negative impact of a development during the proposal phase. This means that the expected negatives related to a development post realization can be exaggerated in the proposal phase.

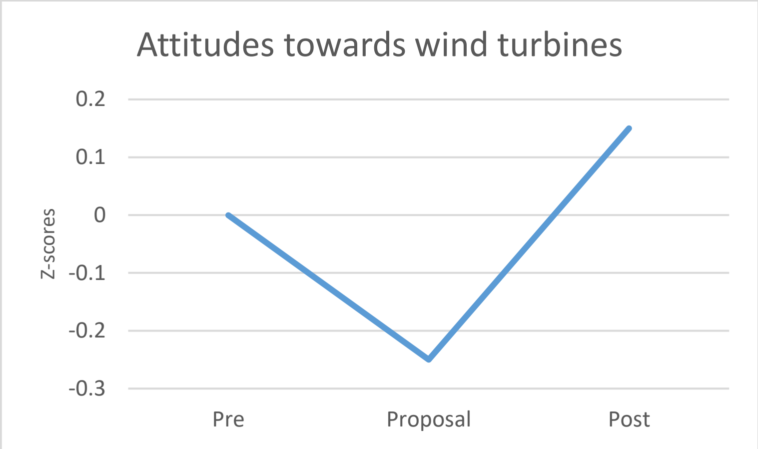

Figure 6: Attitudes towards wind turbines

Boyle et al. (2019) found that, especially in the case of wind turbines, people are against developments in their living environments. One of the arguments that has been brought forward is the depreciation of the landscape because of the visual obstruction by wind turbines (Broekel & Alfken, 2015). Other studies have found similar results stating that residential areas will suffer from aesthetically (O'Neil, 2021). Roddis et al. (2018) add that wind turbines can eventually lead to social deprivation of the area. These findings suggest that living near a wind turbine decreases people's well-being. However, on the other side Kunugi et al. (2021) found that having a view of wind power turbines has a positive effect on the subjective well-being of residents. But they also found that a larger distance from them further increases well-being.

Next to NIMBYism, residents can have landscape concerns that are not based on aesthetic or visual appreciation of the landscape, but on the experience of living or spending time in a particular place (Bell et al., 2013). In their work, Bell et al. (2013) describe these people as so-called 'place-protectors'. Place protector concerns differ from NIMBYism concerns because they focus on place attachment. Place attachment is the positive experience of people in their socio-physical environment. Their concerns are, therefore, not self-interested, but revolve around the value they see in a certain space. They are likely to oppose a project if they feel the value of the affected land is lower than the value of another land. Bell also states that compared to people with NIMBY concerns, place protectors might be less interested in monetary compensation.

2.1.5. Design

Susskind et al. (2022) found that, out of the projects they investigated that faced community opposition, 62 percent included the potential impact on property values. This concern can be substantiated by the results of research by Dröes & Koster (2021) about property values in The Netherlands in proximity to a solar farm or wind turbine. They concluded that wind turbines on average lower property values by 5.4% within two kilometers and solar farms at 2.6% within one kilometer. However, they also suggest that a smaller wind turbine results in a smaller decrease in price. Contrary to this, the findings of Lang et al. (2014) suggest that wind turbines have no significant impact on house prices. Furthermore, they state that the lower bound of statistically possible impacts is still outweighed by the positive externalities generated from CO2 mitigation.

There are different sizes of wind turbines as can be seen in Figure 7. The size of most utility-scale wind turbines operating in Overijssel at this moment are 3MW wind turbines with a shaft height of close to 100 meters (RIVM, 2024). A wind turbine with a capacity of 3 MW produces an average of 7 million kWh of electricity annually. This is enough for about 2,000 households (Green choice, 2020). A 250 W solar panel delivers 250 kWh of power annually on average (Jongh, 2022). Therefore, to produce the same amount of power as a 3MW wind turbine, 28.000 solar panels would have to be installed. As a comparison, around 30,000 solar panels fit on a ten-hectare park (Ost, 2023). This means that to replace one wind turbine, ten hectares of land, possibly a natural area, have to be transformed into a solar farm.

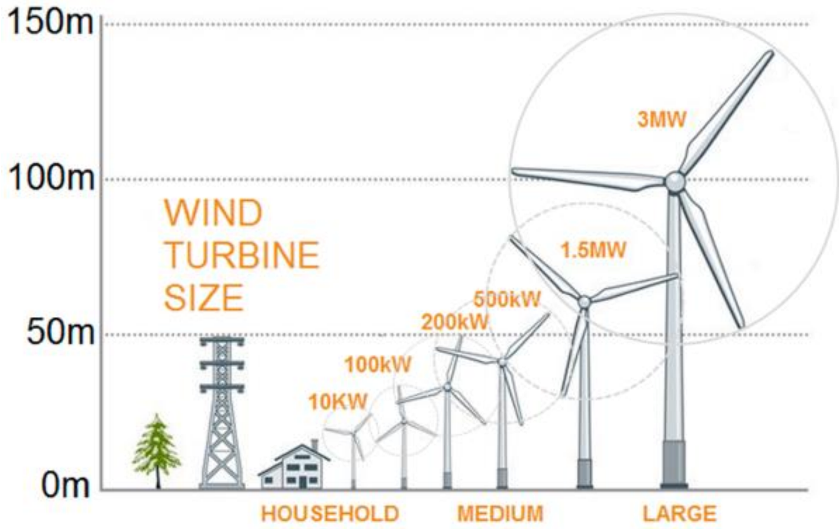

Figure 7: Different sizes of wind turbines (Calautit et al., 2018)

The demand for space of solar farms is one of the greatest among renewable energy technologies. Large areas are required for central systems which could lead to a reduction of cultivable land (Gibson et al., 2017). This leads to complex decision-making dictating the use of land for food or energy (Hanse et al., 2014). Therefore, the energy generated is likely to be seen as competitive with the food produced (Srinivasan, 2009). Russi (2008) conducted a study where similar trade-offs had to be made and found that the benefits of a large-scale biodiesel production factory would not be comparable to the costs in terms of land requirements. However, Prados (2010) states that agricultural land is preferred for solar farms because those areas are well exposed to solar radiation and are easily accessible. Wind energy requires a smaller footprint than solar power, and therefore less land has to be redeveloped (Gibson et al., 2017). However, other negativities that do come with wind turbines but not with solar farms are the impact on the biodiversity of a region. Evidence is accumulating that insects are frequently killed by operating wind turbines, a single turbine might kill up to 40 million insects per year (Voigt, 2021). Globally, wind turbines kill hundreds of thousands of birds and bats every year. Next to this, wind parks can affect bird migrations and trigger population declines. They also increase ambient temperature and noise which can be harmful for some species (Gibson et al., 2017). Unfortunately, this cannot be compared to the impact of solar farms on wildlife, because little is known about this (Lovich & Ennen, 2011).

There is also the noise that nearby wind turbines produce. This could result in a risk to human health because of loss of sleep (Karasmanaki, 2022). Sound decreases over distance, meaning that this risk can only be reduced by locating wind turbines at a suitable distance. Susskind et al. (2022) analyzed the causes for opposition to renewable energy projects and found that 26% of all projects faced opposition if public health and safety risks did not appear to be taken seriously. Over half of these projects were about wind energy, indicating that wind energy projects are most likely to be faced with health and safety concerns by communities.

The visual impact of solar farms on the other hand is not something that has been researched extensively. Tsoutsos et al. (2005) suggest some design implications, like the size of the installation, to mitigate the visual impact. Unfortunately, next to this, there is not much literature about the visual impact of solar farms. However, an indirect visual impact is the glare that can come from solar farms. Glare is the temporary loss of vision or details by the human eye because of glistering (Chiabrando et al., 2009). This can be seen as an indirect negative visual effect of solar farms. A way of mitigating the visual risks is proper siting and design. Another way the control the visual impacts is the use of color (Gunerhan et al., 2009).

2.1.6. Visualization

The role of visualization in decision-making is becoming increasingly important (Downes & Lange, 2011). Visual controversies over the siting of new solar and wind power facilities are affecting the realization process of renewable energy projects (Phadke, 2010). In the context of understanding an architectural representation, vision plays a critical role, which is strongly subject to the representation type (Marr, 1982). However, there is little research on applying different visualization approaches (Shahin et al., 2014; Yalim et al., 2023). Four ways of communicating a design will be discussed including their advantages and disadvantages.

The first way is via text. This is a traditional method of conveying information and has a low exposure time. This means that people take up information fast without having to spend much time. A text can easily be implemented in an online survey, which can then be filled out by respondents that is convenient for them. This increases the possibility of someone participating in the research and, therefore, increases the number of respondents (Schneiders, 2020). In addition, a text can be created without the use of specialists or expensive software tools. Creating a text is a cheap way of conveying a message. However, on the other side there are also some disadvantages to conveying a message by text. For one, a text leaves much room left for personal interpretation. A text read by one person can be understood differently by another. Next to this, it is also one of the methods where recalling the information is harder (Schneiders, 2020).

The second way is via edited photographs or sketches. In the field of architecture, edited photographs or sketches are frequently used in visual impact assessments to provide a feeling of the scale of a proposed development (David et al., 2022). An advantage of this over a text is that the room for interpretation lowers and it is easier for respondents to recall the information. However, these visualizations often fail to address the actual visual impact of a project (Takacs & Goulden, 2019). Next to this, they are more time consuming to create than texts and have to be created by experts using expensive software.

The third way is via videos. Videos have gained importance over the past years in the field of visualization (León & Bourk, 2018; Plank et al., 2017). The growth of this use of videos reflects the demand by the scientific community to communicate their research in modern ways (Ferreira et al., 2021). Depending on how they are used, they can either have a positive or negative effect on community acceptance. Because of the ease of understanding of a video, it may provide a positive contribution to more effective and efficient decision-making (Martins et al., 2022). Putortì et al. (2020) found that videos are a clearer way of communicating content to non-expert audiences then written text. Furthermore, alike text and photographs, can videos be implemented in an online survey which is beneficial for the number of respondents that can be reached. Another benefit of videos, that is not well researched, is that designs can be shown simultaneously. The comparison between designs is, therefore, much clearer and understandable compared to showing them in sequence. Via a split screen format, two designs can be shown on display at the same time. Decision makers afterwards do not have to recall what one design looks like to compare it to another. They can make the comparison while directly viewing both designs. However, there are some challenges in creating a good video. Namely, a video should be brief and easy to understand (García-Avilés & de Lara, 2018). Next to this, there is also the chance that respondents are subjected to cyber sickness (LaViola Jr., 2000). A final disadvantage compared to virtual reality, is that the route of the video is predefined, which leaves less room for interaction with the virtual environment (Zhao, 2023).

Virtual reality is a relative new method of communicating information (Korkut & Surer, 2023). One of the positive effects it could have is the increased understanding and empathy by its users since it can ease the tasks of visualizing a landscape environment (Fogarty et al., 2018). Three-dimensional representations in a virtual environment can offer a 3D terrain visualization environment that does not require multiple views, by being able to view plans and elevations simultaneously (Carbonell-Carrera et al., 2021). Because of this, virtual environments may provide a positive contribution to more effective and efficient decision-making. However, there are some downsides to virtual reality as well. Special head mounted gear is needed to be immersed in the virtual environment. Not many people have access to this gear, meaning that the number of participants that can be reached is far less compared to the other methods. Next to this, is it much harder to create a virtual environment where a user is free to walk through and the time spend in a virtual environment will be much longer than when a video is shown since there is no predefined path. Next to this, designs would have to be shown sequentially. Users would have to recall other designs to be able to compare them. And finally, there is the chance of the cyber sickness (LaViola Jr., 2000). Immersive virtual reality users is heavily subjected to feelings of dizziness, nausea, and headaches (Somrak et al., 2019).

2.2. Case Study

The city of Zwolle has been chosen as a case study because of it's vulnerability to climate change effects as explained in the introduction. In this subchapter, the plans of the municipality are explained as well as other development possibilities.

2.2.1. Plans of the Municipality for the City

The municipality published an energy guide in 2017 showing what areas could potentially be used to develop SWFs. The left part of Figure 8 shows where wind turbines can be placed according to the current laws and policies. The total number of wind turbines that could be developed is twenty (Municipality of Zwolle, 2017). Next to that, some areas are excluded at this moment but still show potential. The brown areas, East of the city, are used by the military as a low-flying route. If this route is to be lifted, development of wind turbines is possible. The yellow areas could be used if the function of the dwellings located close to those areas is changed to 'wind turbine houses'. The distance between a wind turbine house and a wind turbine is allowed by law to be much shorter than the distance between a normal dwelling and a wind turbine (RVO, 2020). The right part of Figure 8 shows the potential locations for solar farms. The municipality values parking areas and water as the most promising locations for solar farms since the function of the area can be maintained.

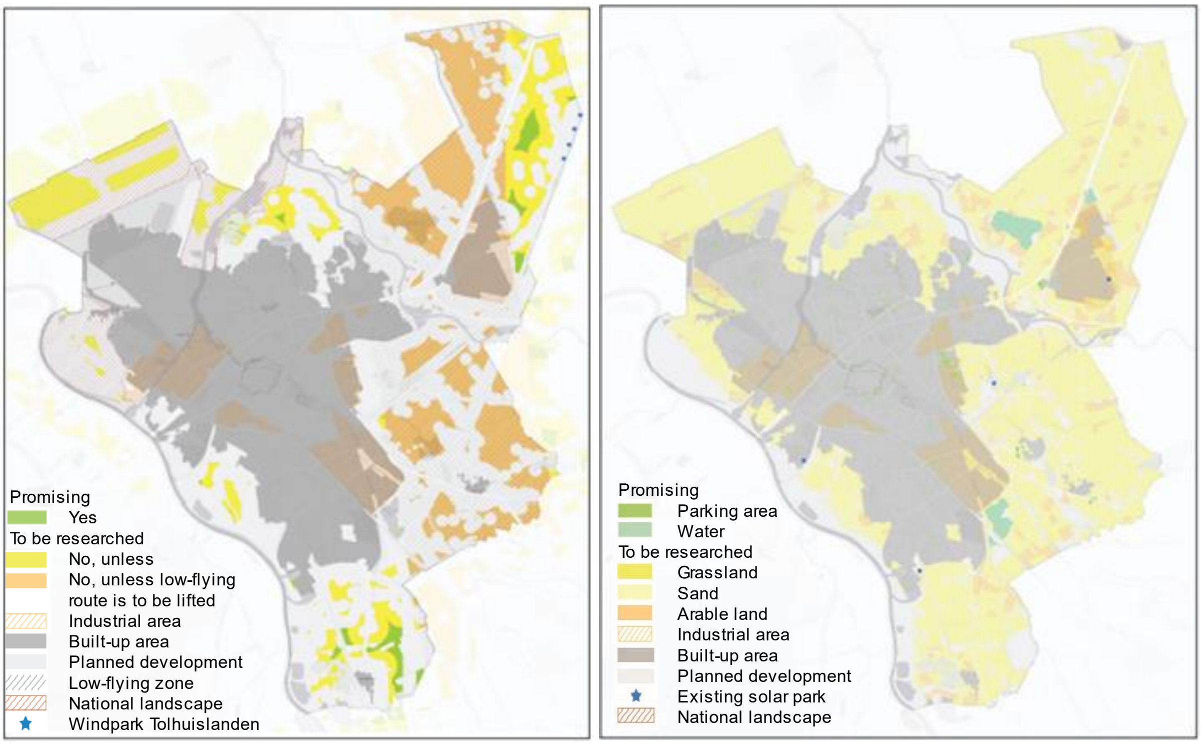

Figure 8: Possible areas for wind- (left), and solar (right) developments in Zwolle according to laws and policies (Municipality of Zwolle, 2017)

2.2.2. Delineation of the Research Area

Multiple factors were looked at to choose a location within this area that is suitable for this research. The first one is whether an area shows potential for the development of both solar and wind parks. The Western and Eastern parts of the municipality do not have a certainty that wind turbines are allowed to be developed. Therefore, they will not be investigated. On the other side, the North, North-Eastern, and South part of the municipality do show promising areas for both solar and wind. However, the area North of the city is scarce which could lead to limited design possibilities and, therefore, choice sets.

The Northeastern part does cover a bigger area; however, this area is close to an existing wind park, potentially making the design options less useful or meaningful. The South side of the municipality covers a part of the river area, which is a leading factor in many design decisions in Zwolle. Therefore, the Southern part of the municipality will be used as a case study.

2.2.3. Development Possibilities

The possible allocation of SWFs in Zwolle Zuid is based on two publications by the municipality. The first one is the energy guide published in 2017 (Municipality of Zwolle, 2017), and the second one is the environmental vision published in 2021 (Municipality of Zwolle, 2021). They indicate which areas are promising or less promising and why. The environmental vision is based on the energy guide but limits the number of locations even further. However, in this publication, the municipality stated that there are possibilities in which more areas can be used when policies are changed or lifted. Because of this, a scenario will be used in this research where all locations can be used to develop SWFs. It must be noted that even in this scenario the preferred minimum distance between a wind turbine and residential function remains as it is. There are criteria for the minimum distance a wind turbine has to be placed from a residential area. this is calculated by a rule of thumb: mast height plus half the rotor diameter or the maximum throw distance at nominal speed. This results in a minimum distance of close to 200m for a 3MW turbine (RVO, 2020). The area that can be used if all laws and policies are either changed or lifted is shown in Figure 9. The allocation of solar farms is less restricted. There are no rules for the minimum distances between a solar farm and a dwelling. Spread out over the entire area there is space for around 300 hectares of solar farm.

Figure 9: Possible locations wind turbines

Land Use

The area is divided into five different types of land use, as illustrated in Figure 10. In the Northern part of the region lies the biggest residential area, which consists of the southern neighborhoods of the city. Additionally, there is a smaller residential area in the South-West as well, which consists of a few farmhouses. The final residential area is a small village in the South-West part of the area that has actually become a neighborhood of Zwolle and has 800 residents. Farmland can mostly be found in The East and West parts of the area. The industrial area consists of some small companies. The parks are adjacent to the residential area. The IJssel river runs through the natural area and the remainders of this area are mainly used as floodplains. The river branches out into two small lakes. This is beneficial since the municipality prefers lakes for the development of solar farms (Municipality of Zwolle, 2017). Next to the lakes, the floodplains, parks, and agricultural fields can be redeveloped.

Figure 10: Land use

2.3. Conclusion and research gap

The three dimensions of social acceptance related to the development of SWFs are discussed in the literature review. The focus of this study will be on community acceptance, since this is found to be the decisive factor in the development of renewable energy projects. Namely, the opposition of communities against these developments could lead to delays, cost increases, or even complete cancellation of a planned projects (Bertsch et al., 2017; Juárez-Hernández & León, 2014; Knauf, 2022). Therefore, it is important to understand what determinants define community acceptance. Numerous possible determinants have been identified that are divided over six categories. These categories are personal characteristics, climate change, local involvement, impact on daily life, design, and visualization.

Many previous studies suggest what factors influence community acceptance, but the findings of one study can be contradictory to the findings of another, especially in the case of personal characteristics. The findings of Ladenburg (2010) suggest that people with a higher level of education have a more negative attitude toward renewable energy than lower-educated people, which is contrary to the finding of Acheson (2012). Therefore, no conclusions can be drawn about what personal characteristics are influential on community acceptance. More research on this topic is needed and it will, therefore, be included in this study. In general, there is much support for renewable energy (Segreto et al., 2020). However, when it comes to actual on-site implementation, there is much opposition (Huijts et al., 2012; Wüstenhagen et al., 2007). This social gap could have multiple explanations like NIMBY (Bell et al., 2013; Tidwell et al., 2018; Wüstenhagen et al., 2007). However, what the effect of this is on community acceptance has not been well researched in previous studies. Furthermore, the lack of local involvement could be a reason for opposition of a development. Providing communities with information about the process and involving them in the decision-making could result in a higher level of acceptance (Jobert et al., 2007). However, one of the challenges that arise with this is that companies and communities must have common goals to become effective partners. In practice, it was found that a lack of trust often leads to tough relationships (Goedkoop & Devine-Wright, 2016). Next to this, there is the ‘national-local gap’, which partially can be explained by NIMBY. People are in favor of renewable energy projects but do not want them in their living environment (Dear, 1992; Devine-Wright, 2009). This is potentially dependent on the design of a SWF. Where on the one hand a wind farm has a large vertical reach but a small surface area, a solar farm on the other hand has a large surface area but a small vertical reach. Large areas are which could lead to a reduction of farm land or natural areas (Gibson et al., 2017).

Next to the determinants directly related to SWFs and CC, there is the role of visualization in decision-making, which is becoming increasingly important (Downes & Lange, 2011). Visual controversies over the siting of new solar and wind power facilities are affecting the realization process of renewable energy projects (Phadke, 2010). In the context of understanding an architectural representation, vision plays a critical role, which is strongly subject to the representation type (Marr, 1982). However, there is little research on applying different visualization approaches. Videos have gained importance over the past years in the field of visualization and could be used as a simple and understandable way of communicating a design (León & Bourk, 2018; Plank et al., 2017). Nonetheless, there are some challenges in creating a good video. Namely, a video should be brief and easy to understand (García-Avilés & de Lara, 2018). However, little is known about how to create a good video.

The southern region of the city of Zwolle is chosen as a case study to research the effect of different design attributes on community acceptance. The area offers a variety of different land uses and the municipality has clear goals about how much renewable energy they want to produce in the future. This area has some challenges in the future regarding renewable energy and will likely be subjected to factors related to community acceptance of a SWF.

3. Methodology

In this chapter, the methodology of this research will be described. In the first section, the measurement approach is discussed. Hereafter, the steps to develop a DCE are formulated. From this, the content of the survey will be created and at the end of this chapter, the analysis methods will be explained.

3.1. Measurement Approach

Figure 11 illustrates various methods to measure preference and choice. The difference between revealed and stated models is the type of data that is used. Revealed models are based on observations of real situations and stated models are based on observations in hypothetical situations. Stated models are divided into preference and choice modeling. Preference modeling then can be split into compositional and decompositional. Compositional modeling is a research type where respondents are asked to rate the importance of a variable. Identification of preferences cannot be identified using this research type. However, by using decompositional modeling, instead of compositional modeling, the relative importance of variables can be estimated. Stated choice modeling uses hypothetical situations where participants choose which situation they prefer. This is the most useful research type if new situations have to be presented to respondents (Kemperman, 2000). In addition to that, revealed choice modeling is not possible since the placing of the solar and wind farms is hypothetical in a non-existing situation. Therefore, a Discrete Choice Experiment (DCE) will be conducted.

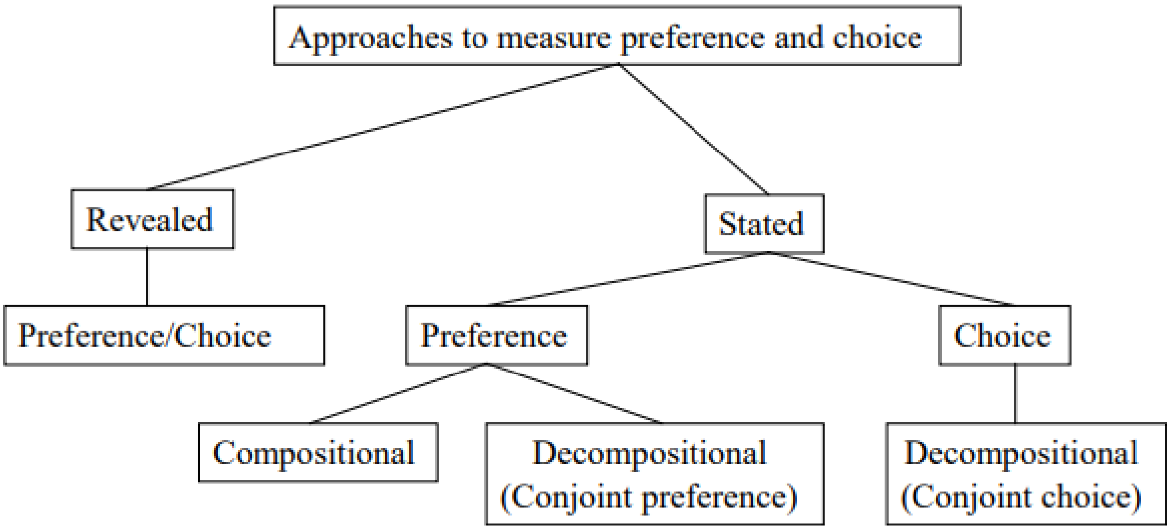

Figure 11: Approaches to measure preference and choice (Kemperman, 2000)

3.2. Discrete Choice Experiment

The process that will be used to develop the DCE is developed by Hensher et al (2015) and is shown in Figure 12. It starts in stage 1 with defining the problem. The second stage deals with refining the alternatives, the attributes, and the level of the attributes. In this stage, the content of the DCE is created. In the third stage, the considerations regarding the design of the attributes and levels are determined. Then, in the fourth stage, the experimental design will be generated. Followed by this, the attributes are located in design columns in stage 5. In stage 6 different combinations of choice sets are determined followed by a randomization in stage 7. When all these stages have been completed, the final stage is reached. In this stage, the final survey will be constructed including the choice sets and other variables needed to answer the research questions.

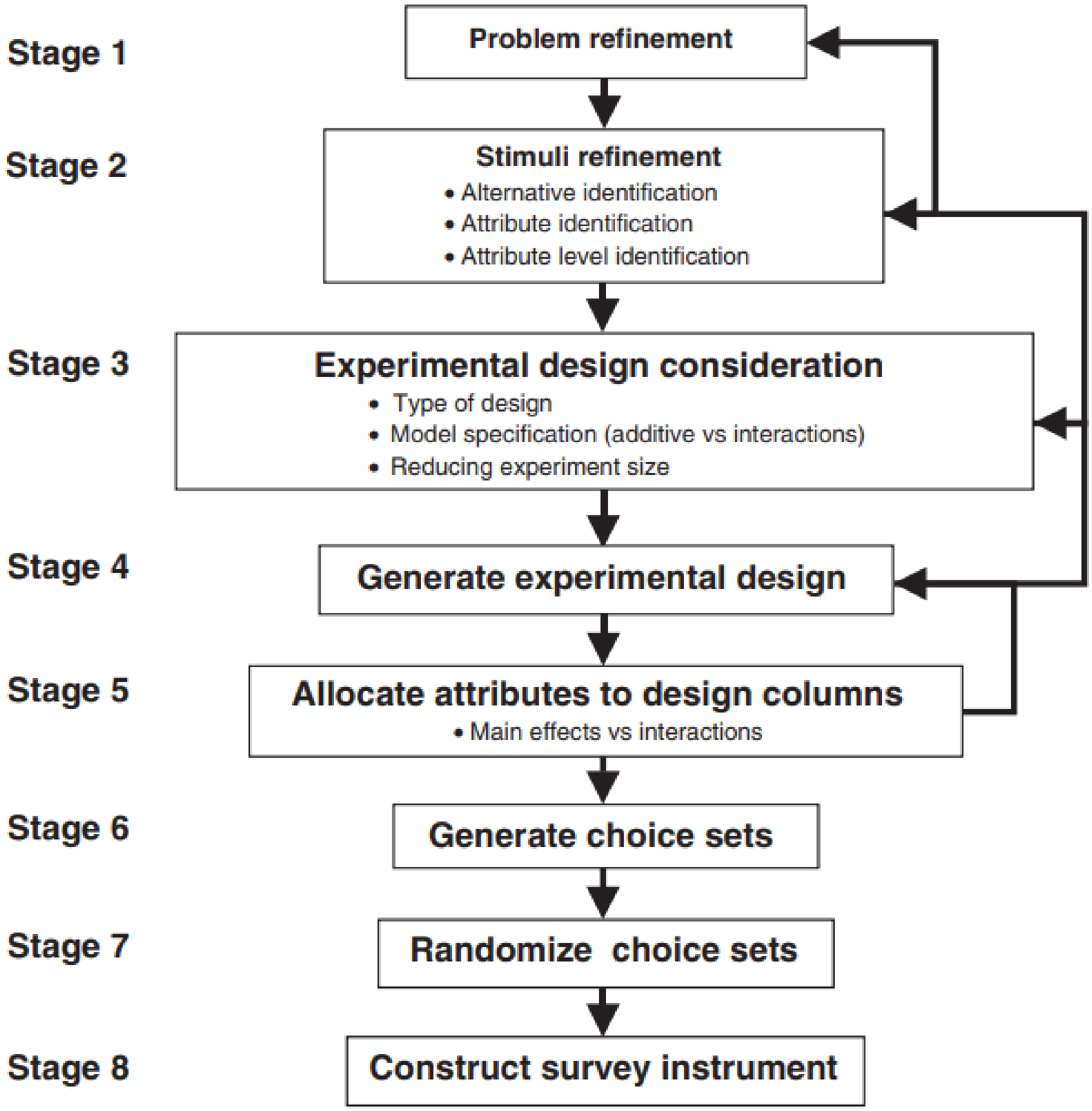

Figure 12: DCE design process (Hensher et al, 2015)

3.2.1. Stage 1: Problem Refinement

As discussed in the literature review, there is much research on community acceptance of solar and wind farms. However, most of the research falls short in holistically describing the subject. They focus only partiality on what defines community acceptance as a whole. As derived in the literature review, five categories together help to determine community acceptance as a whole. These categories and their subcategories are shown in a conceptual model in Figure 13. The arrows indicate their link to community acceptance.

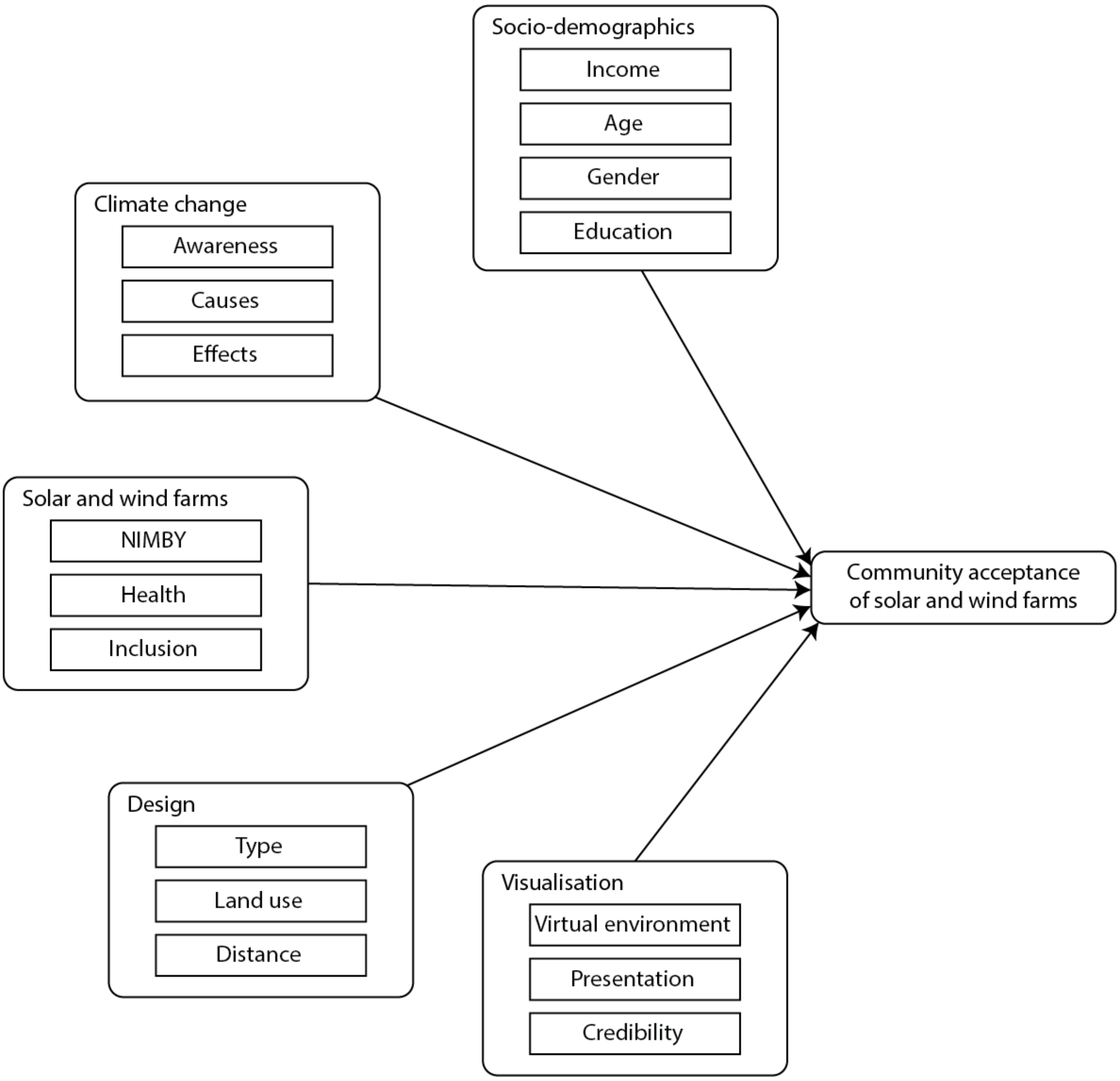

Figure 13: Conceptual model community acceptance of solar and wind farms

3.2.2. Stage 2: Stimuli Refinement

The attributes are derived from the literature study and the case study. They have to be visualizable in a VR environment and form a trade-off. The first attribute is about the land use. Based on the case study, the land use and functionality of the area within the South of the municipality is not the same at all places. The potential trade-off that arises alongside this is what ground function people are willing to transform. The second attribute is the ratio between solar farms and wind turbines. The trade-off that arises with this attribute is the area that has to be transformed to generate the same amount of energy as a wind turbine does to a solar farm is much bigger. Therefore, that area loses its current functionality but on the other side, the negative impacts of a wind turbine as discussed in the literature study are avoided. The final attribute is based on NIMBYism versus the place protector. The trade-off is that people choose a development furthest from where they live, affecting the landscape of another area or dealing with noise and other negativities of having a renewable energy project near a living environment, but saving a higher valued landscape.

Land use

There are different land uses within the area, as described in the site analysis. There are the Natura 2000, the national green network, lakes, arable lands, grasslands, forests, and residential areas. Excluded from the development are the residential areas because there are separate goals for solar on the roof. The remaining land uses can be categorized as either natural area or farm land. A trade-off between different elements has to be made. On the one side, there are the economic benefits of agriculture that are potentially diminished by the development of a wind- and solar farm, on the other side there are the environmental values of a natural area. Therefore, the trade-off becomes about what people perceive as more important in their area, economic or environmental values. Two levels of this attribute will be considered. Either a full development in a natural area or on farmland. Figure 14 shows the floodplains and water area that together form the natural area and Figure 15 shows the farm lands.

Figure 14: Natural areas

Figure 15: Farm land

Wind or solar

The goal of the municipality is to generate 359 GWh of solar- and wind energy by 2030 divided over 201 GWh solar on the roof, and 158 GWh of solar on-field or wind energy. To generate this amount of energy, 24 wind turbines or 240 hectares of solar farms have to be developed. However, looking at the area available in the case study, it is not possible to have 24 wind turbines. The developments will have to be spread across multiple areas within the municipality to reach the goals. As described in the site analysis, multiple locations are being looked at for the developments. Therefore, not all of the 158 GWh has to be produced in the researched area. Producing 10GWh is a more suitable amount for the area. Although performance of wind turbines is heavily subjected to the area where they are placed and the amount of wind, on average, two 3MW wind turbines are needed to generate this amount of power (CBS, 2023b). To generate the same amount of energy using solar, over eight hectares, or roughly 50.000 solar panels must be placed. An example of these developments are shown in Figures 16 and 17.

Figure 17: Example of wind farm

Figure 16: Example of a solar farm

Distance to living environment

Some people are concerned with the negative visual impact of wind and solar farms near their living environment (Dear, 1992). As described in the literature study, people perceive many risks, including health and safety issues, a decrease in dwelling prices, and aesthetic deterioration, with the development of renewable energy projects (Boyle et al., 2019). The two distances that can be used in the designs are shown in Figure 18. The first level is within one kilometer of the largest residential area in the region. This area is indicated in yellow.. The second level is indicated in green and concerns a distance of over one kilometer from the residential area. The visual impact of a SWF decreases with an increases in distance from the residential area. The minimum distance between a dwelling and a wind turbine has been taken into account and the mainstream of the river will not be used. However, the other land uses like the floodplains, agricultural fields, and branches of the river can be used to develop a SWF.

Figure 18: Distance from residential area

3.2.3. Stages 3, 4 & 5: Experimental Design

The experimental design was determined by using the statistical program SAS and can be seen in Appendix A. There are three attributes shown in each alternative consisting of two levels. A full factorial design consists of eight choice sets. This is an achievable number of choice sets to be tested in a survey and, therefore, there is no need to reduce this number and use a frictional factorial design. A selection of four choices will be shown to each respondent.

3.2.4. Stages 6 & 7: Choice Sets and Randomization

The eight design alternatives are paired in choice sets using SAS on demand software. This software is used to create efficient choice sets to test each design attribute. A result of this, is a difference in how many times it is needed to present an alternative in a choice set. Each respondent will see four different choice sets. For LimeSurvey to be able to show four choice sets, four blocks of choice sets had to be created as illustrated in Table 1. The order in which these blocks are shown to a respondent is randomized but each respondent only sees one of the two choice sets of a block. Thus, either one of the eight choice sets can be the first choice set that a respondent sees. Then from the remaining three blocks one choice set is chosen, then from the remaining two blocks, and then from the last block. Therefore, there are a total 8x6x4x2 = 384 different orders in which the choice sets can appear to a respondent.

Table 1: Pairing of choice sets

Block	Choice set	Alternative	Type	Location	Land use
1	1	2	Wind	Close	Farm
		7	Solar	Far	Natural
	2	8	Solar	Far	Farm
		1	Wind	Close	Natural
2	3	2	Wind	Close	Farm
		3	Wind	Far	Natural
	4	5	Solar	Close	Natural
		3	Wind	Far	Natural
3	5	5	Solar	Close	Natural
		4	Wind	Far	Farm
	6	7	Solar	Far	Natural
		1	Wind	Close	Natural
4	7	3	Wind	Far	Natural
		6	Solar	Close	Farm
	8	8	Solar	Far	Farm
		5	Solar	Close	Natural

3.2.5. Stage 8: Survey Development

In this subchapter, the elements of the DCE will be elaborated on. LimeSurvey is used for creating the survey. Firstly, respondents will be asked about their personal characteristics information in a questionnaire. This data is needed to find out if the sample is a good representation of the population and to find out if community acceptance determinants are scored differently by different personal characteristics groups. Secondly, the respondents will be asked about their beliefs on CC and their opinion about the development of solar- and wind farms, via contingent valuation. This data can be used to explore why people make certain decisions during the experiment. Then, the respondents will be presented with four choice sets in a DCE. As stated in chapter 2, there are several advantages of visualizing choice sets in a video compared to classical visualization techniques. After watching the videos of the environments, the respondents will be asked which of the environments they prefer and whether each alternative is acceptable. The final part of the survey consists of a number of questions about the usability of videos in visualizing a design. The survey can be found in Appendix B.

3.2.5.1 Personal characteristics

the survey starts with some questions about the demographics of the respondent. These questions are answered anonymously and with the privacy of the respondent of upmost importance. The informed consent form that has to be agreed on before the survey can be found in Appendix C. The questions that are asked are about the respondents postal code, age, gender, level of education, and income. These questions are formed from what comes forth as possible determinants of community acceptance of solar- and wind parks. To increase the level of privacy and minimize the chance that the given answers can be used to trace back a respondent, the questions are in a multiple-choice form. Instead of providing information about their exact age and income, respondents can indicate in which category they fit.

3.2.5.2 Statements

After finishing the questions about the personal characteristics, respondents are presented with a list of statements they have to value. The valuation will range between strongly disagree and strongly agree via a 7-point Likert scale. These statements are divided over two subjects. Firstly, the respondents will be asked about their opinion on CC in general. The second part will consist of statements about the development of solar- and wind farms in their community.

Climate Change Statements

1. CC is happening

The first statement is based on the findings of Weber & Stern (2011) who discovered that the majority of people believe in the existence of CC. Next to that, Cook et al. (2016)) found that a broader understanding of the effects of CC increases the probability people accept renewable energy developments. In addition to that, Ntanos et al. (2018) found that environmental protection is the most important reason for people to invest in renewable energy.

2. CC is mainly caused by human activities

Leiserowitz et al. (2020) found that only 56% of the residents of the United States believe that CC is due to anthropogenic actions. Other studies claim that there is much scientific evidence that some CC effects are human-driven (Höök & Tang, 2013; Oldenborgh et al., 2021; Li et al., 2021).

3. I am concerned about the effects of climate change

One of the effects of CC is the health problems arise that threaten human beings (Gustavsson et al., 2021). McMichael et al. (2006) described them in more detail. They state that environmental effects of CC increase in pressure on ecosystems which could lead to food poisoning and unsafe drinking water, the rise in sea level, and the impairment of crop and livestock.

4. I think climate change will have negative consequences for me personally

Spence et al. (2012) investigated the psychological distance to CC. Their findings suggest that reducing the psychological distance results in an increase of people's preparedness to act. Another effect of CC that could result in personal impact, is the environmental degradation that can lead to mental health and physical problems (McMichael et al., 2006).

5. Extremes in the weather, such as heavy showers and long droughts, are becoming more common

The effects of CC are evident around the world, with longer droughts and colder winters that people have to adapt to (Easterling et al., 2000; Guillard et al., 2021). McMichael et al. (2006) described that results of CC include more severe, and more frequent, weather extremes, which will lead to more storms, floods, and bushfires, putting health at risk.

6. The use of pollutants, such as fossil fuels, contributes to climate change

The emission of greenhouse gases like methane and carbon dioxide during the combustion process of fossil fuels is a significant contributor to CC (Olabi & Abdelkareem, 2022). McMichael et al. (2006) state that anthropogenic greenhouse gas emissions lead to changes in temperature, humidity, and wind patterns. Isah (2013) found that since the beginning of the 20th century industrial activity grew massively accompanied by a massive increase in the emissions of greenhouse gases.

Solar and wind farm statements

1. More solar and wind farms should be built to combat climate change

There has been strong opposition to renewable energy projects (Sütterlin & Siegrist, 2017). This can come from a lack of knowledge, perception, and fear of such projects (Assefa & Frostell, 2007). However, other studies find that there is much support for renewable energy (Segreto et al., 2020).

2. Solar and wind farms have a negative impact on the appearance of an area

O'Neil (2021) found that residential areas will suffer aesthetically from the implementation of a renewable energy development. Roddis et al. (2018) add that wind turbines can eventually lead to social deprivation of the area. One of the arguments for this that has been brought forward is the depreciation of the landscape because of the visual obstruction by wind turbines (Broekel & Alfken, 2015).

3. Citizens and local companies should be included in the decision-making process of solar and wind farms

Providing communities with information about the process and involving them in the decision-making could result in a higher level of acceptance and a change of attitude (Jobert et al., 2007). Because of the local involvement, Walker & Devine-Wright (2008) found that support and investment in the project had grown. Susskind et al. (2022) found that local communities often raise opposition when project owners do not adequately involve them or take their concerns into account. In practice, a study by Goedkoop & Devine-Wright (2016) found that a lack of trust often leads to tough relationships. Brennan & Van Rensburg (2016) have found that when locals are involved in the planning and implementation process, community acceptance does grow. Ek & Persson (2014) even found that people are willing to pay more for energy when a community has partial ownership of a renewable energy project.

4. I would not mind a solar or wind farm being built in my living environment

Developments mostly face opposition in the implementation phase (Huijts et al., 2012; Wüstenhagen et al., 2007). Boyle et al. (2019) found that, especially in the case of wind turbines, people are against developments in their living environments. An explanation of the national-local gap could be NIMBY (Dear, 1992; Devine-Wright, 2009). Next to this, residents can have landscape concerns that are not based on aesthetic or visual appreciation of the landscape, but on the experience of living or spending time in a particular place (Bell et al., 2013).

5. Solar and wind farms could have a positive impact on the local economy

Renewable energy technologies can create new job opportunities and stimulate economic growth. However, government policies, regional economic conditions, and industry structure influence the number of jobs that are created (IRENA, 2012). Wind turbines can provide economic benefits for farmers because they can get monetary compensation for renting out their land (van Wijk et al., 2021).

6. I am afraid that a solar and wind farm will have a negative impact on my health

Kunugi et al. (2021) found that having a view of wind power turbines has a positive effect on the subjective well-being of residents. However, the noise that is produced by wind turbines could result in a risk to human health because of loss of sleep (Karasmanaki, 2022). Susskind et al. (2022) analyzed the causes for opposition to renewable energy projects and found that projects faced opposition if public health and safety risks did not appear to be taken serious.

Visualization of Designs Statements

To answer the final sub-question, if videos are a useful tool to assess community acceptance of wind and solar farms, respondents are asked to score statements about the presentation of the designs. As suggested by Martins et al. (2022), a video could enhance the understanding and scale of an intervention, and therefore, lead to more informed decision-making. The statements derived from the literature study that cover the visualization challenges of a solar or wind farm development are:

1. The differences in design between the left and right halves of each video were clearly visible

One of the positive effects a video could have, is the increased understanding of a design. Namely, a video can ease the tasks of visualizing a landscape environment (Fogarty et al., 2018). However, if two designs are shown in the same area it is unknown whether respondents are able to clearly see the differences.

2. I experienced dizziness while watching the videos

It is known that, mainly in virtual reality, individuals can be subjected to the feeling of nausea, disorientation, eye strain, and headaches (Sharples et al., 2008). Because respondents have to watch two videos at the same time, it is probable that this can occur.

3. I could easily divide my attention between the left and right halves of a video

This statement is specifically created for this research. Two designs are simultaneously shown in split screen in the same video. Therefore, it could be that respondents are not able to divide their attentions over both halves of a video. No literature was found where this visualization technique was used.

4. The videos showed a credible representation of reality

A video can ease the tasks of visualizing a landscape environment (Fogarty et al., 2018). Putortì et al. (2020) found that videos are a clearer way of communicating content to non-expert audiences then written text. Therefore, this statement is created to research the credibility of the designs.

5. The impact of possible developments was clearly visualized

Visual controversies over the siting of new solar and wind power facilities are affecting the realization process of renewable energy projects (Phadke, 2010). Edited photographs are frequently used in visual impact assessments to provide a feeling of the scale of a proposed development. However, these visualizations often fail to address the actual visual impact of a project (Takacs & Goulden, 2019)

6. The videos took too long to stay focused

One of the challenges in creating a good video is its length. Namely, a video should be brief and easy to understand (García-Avilés & de Lara, 2018). However, there is no literature found stating how long a video showing an architectural design should be.

3.2.6. Discrete Choice Experiment

The discrete choice experiment is presented to the respondents after the SWF statements. In this part of the survey, two designs are shown per choice set and respondents are asked about their preferences. The choice sets are presented in videos because of its advantages compared to other visualization techniques. A video is easier to understand and less subjected to personal interpretation of a respondent compared to written text and sketches or edited photographs. An immersive virtual reality environment increases the understanding even further, but would drastically lower the number of people that could participate. Another advantage of videos over virtual reality is that two designs can be shown simultaneously. However, this is a new form of using videos as a way to present different designs. It is unclear of respondents are able to focus on both designs at once and if this is beneficial to showing two design videos in sequence.

The DCE in the survey is presented as follows. First, a short text explaining that an area will be shown where hypothetical SWFs are located is used as an introduction. Then, as shown in Figure 19, a map of the area is presented to the respondents. On this map the route through the area is visualized as well as the different land uses in the area. A legend on the right side offers information about the route, land uses, and how a SWF development is visualized on the map.

Figure 19: Introduction page DCE

Two maps are presented on the next page as shown in Figure 20. Both of these maps show a different SWF development in the area. The addition of this maps makes it more clear and easier to understand what type of SWF they will look at and at which location and land use it is developed.

Figure 20: Maps showing developments

The video showing the designs in the area is on the same page underneath the maps. This is done to make it clearer which design will be shown on which side of the video. Respondents can look at a video as many times as they want and can press pause at any given moment. Next to that, they can also watch the videos in full screen. The designs shown in the videos are created using several software applications. The base map of the area is based on the aerial view chart of Google Maps and the Map Tiles API. Via RenderDoc, a snip of the Google Maps chart could be taken and uploaded into Blender. Via a Transmutr extension of Blender, the base map could be uploaded into SketchUp. In SketchUp, the SWF developments could be placed to create eight different design alternatives. The SketchUp files are then uploaded into Lumion to add objects like crops, houses, farm animals, cars and boats to create a vibrant lively area. Lumion was then used to create video renders of all the designs. These renders are uploaded into Adobe Premiere Pro to create the split screen videos as shown in Figure 21.

Figure 21: Example of a video

After watching a video, respondents are asked two questions. The first question is about preferences in design attributes if a SWF was already placed in an area before the respondent lived there. The second question is about the acceptance of a design in the living area if there was no prior SWF development in the area. Both these questions are relevant for the case study since there are already a lot of people living in the area, but the city will also expend in the upcoming years making it probable that new dwellings will be built near a SWF. The questions are formulated as:

1. Where would you rather live, in the residential areas of the left or right design?

For this question, the scenarios are that a respondent has to choose between two design alternatives. There is no choice alternative to reject the designs. Respondents have to indicate which design they prefer. If they do not prefer one design over the other one, they can choose the ‘no preference option’. The answer alternatives of this question are:

- The left design
- The right design
- No preference

2. Imagine you lived in one of the residential areas on the map before there was a solar or wind farm. Would you then agree if the design was realized?

Respondents are asked to indicate, for each design, if they would accept it to be realized. They can choose if they accept both, only one, or neither. Although this appears to be a multiple-choice question, this actually is a binary choice per design. Each design is independently graded on acceptance. Namely, if a respondent indicates that only the left design is acceptable, this also means that the right design is not. The answer alternatives for this question are:

- Yes, both designs
- Only the left design
- Only the right design
- No, neither designs

3.3. Limitations of Research Method

The ideal length of an online survey is between ten and fifteen minutes and the maximum length is between 20 and 28 minutes (Revilla & Höhne, 2020). More than a third of surveys take longer than fifteen minutes (GRIT, 2015). Short surveys have several advantages over long surveys: they return higher completion rates (Fan and Yan, 2010), and have fewer random errors associated with fatigue or boredom (Galesic & Bosnjak, 2009). If the number of choice sets is too high, the survey becomes too long in duration and survey fatigue can appear by the respondents (Jeong et al., 2022). Therefore, it is of importance to limit the number of choice sets, statements and other questions.

It will take respondents three to five minutes to complete fifteen to twenty questions in an online survey (Taylor,2018). The choice sets will take more time, since two videos have to be watched before choosing between them. because of this, the number of choice sets heavily influences the length of the survey. The aim of the length of the survey is fifteen to twenty minutes to minimize the chance of survey fatigue. To do this, the number of questions and statements will be limited to around twenty, and the number of choice sets will be limited to four.

It is important that the privacy of the respondents is ensured because otherwise they might give untruthful answers (Debois, 2022). By explaining for what purpose the research is being conducted, respondents are better informed and more likely to answer truthful. Another way of ensuring privacy is to keep the questions as limited ascertainable as possible. This mostly regards the questions about the personal characteristics of people. If respondents do not want to answer a question, they can choose the prefer not to say option for every question. The entire survey will be conducted anonymously by respondents. There will be no questions about name, phone number, or exact post address. However, for the results, it is important to know whether or not a respondent is living in the municipality of Zwolle, since the goal is to find out how people living in that area value the determinants.

3.4. Number of Respondents

There are multiple ways to determine the minimum number of respondents. For instance, the formula of Orme can be used (Orme, 1998). This formula has been widely adopted as a rule of thumb (de Bekker-Grob et al., 2015). However, Rose & Bliemer (2013) suggest a different method for calculating sample size. They indicate that at least 30 responses are needed per alternative. There are eight alternatives in total which results in 240 responses for this research. Each respondent will see four choice sets and, therefore, 240/4 = 60 respondents are needed. For the acceptance question, less respondents are needed since respondents are asked if they accept a design eight times. Therefore, only 240/8 = 30 respondents are needed for this question. The minimum number of respondents required to have enough respondents per alternative for both questions, therefore, is 60. Multiple methods are used to reach this number:

1. The survey is spread by email to neighborhood associations in Zwolle to reach as many people as possible that are familiar with the area. A person that is familiar with the area is likely to value it differently from someone who does not know the area. If 30 respondents had reacted from Zwolle, the national-local gap could have been thoroughly investigated.

2. The survey is spread by phone to the personal network of the researcher. An advantage of this is that by contacting people personally, they are more willing to participate in the research. However, a downside of this is that the personal network mainly consists of students with a low income. Because of this, the sample is not generalizable for The Netherlands.

3. The third way the survey is spread is by posting it on social media platforms such as Instagram and Facebook. People on those platforms can participate in the research and spread the survey on their social media pages.

4. The final way the survey is spread is on a local news website. The survey and a small text were posted on a site that is frequently visited by people that are interested in the area. The post is shown in Figure 22.

Figure 22: Post on local website

3.5. Data Analysis

A descriptive analysis is performed to describe the gathered data. The sample will be compared to the entire Netherlands. Via a multinomial logit and mixed logit, the attributes that contribute to community acceptance are identified.

3.5.1. Data Preparation

The models are created using NLOGIT software. Effect coding was used because of its benefits over dummy coding. Namely, the use of effect coding allows NLOGIT to include data of respondents that indicated that they preferred not to answer some of the question. If dummy coding was used, all the data of that respondent would be skipped, even when they did not answer only one question. The coding scheme can be found in Table 2. As can be seen in the table, the 'I prefer not to say' option is coded as 0. This means that this option has no effect on the part-worth utility of that attribute.

Table 2: Attribute levels and effect coding

Attribute	Level	Coding
Type	Solar	-1
	Wind	1
Location	Close to residential area (< 1km from Zwolle)	-1
	Far from residential area (> 1km from Zwolle)	1
Land use	Farm	-1
	Nature	1
Age	Under the age of 25 years	-1
	I prefer not to say	0
	Over the age of 25 years	1
Gender	Male	-1
	I prefer not to say	0
	Female	1
Resident of Zwolle	No	-1
	I prefer not to say	0
	Yes	1
Level of education	Lower educated (from primary education to secondary vocational education)	-1
	I prefer not to say	0
	Higher educated (from higher vocational education to PhD)	1
Income	Lower income (< €20.000 annually)	-1
	I prefer not to say	0
	Higher income (> €20.000 annually)	1
Statements	Strongly disagree, disagree, somewhat disagree, neither agree nor disagree, somewhat agree	-1
	Agree, strongly agree	1

3.5.2. Descriptive Analysis

First, the personal characteristics are visualized in tables to gain insight into the distribution of the sample over the different categories. It is tried to merge answer options containing less than 30 participants to have a sufficient number to analyze. If this number cannot be reached, it is checked if a choice options can be merged into groups close to thirty respondents. Then, to compare if the personal characteristics data of the respondents is comparable to that of residents of The Netherlands, the chi-square goodness-of-fit tests is used as created by Pearson (McHugh, 2013; Rolke & Gongora, 2021).

Since the sample and Dutch population differ in size, the expected and observed percentages of each category of the population are calculated. The expected percentages hereby are based on the Dutch population. These percentages are recalculated according to the sample size to find the expected number of responses per category. The data for the population is calculated using CBS data. Age (CBS, 2023c), Gender (CBS, 2023d), Resident Zwolle (CBS, 2023e), Education (CBS, 2023f), Income (CBS, 2023g). For the degrees of freedom combined with the significance level, a critical chi-square value is calculated. The significance level is set at $\alpha = 0.05$, which is the standard for this kind of research (Kim & Choi, 2021). If the Chi-square test-statistic is higher than the critical value, it results in $p < .05$ indicating that there is no significant comparison between the personal characteristics data of the sample and the population.

Then, the results of the statements are visualized in tables as well to gain insight over the distribution. Crosstabs are used to show differences between socio-demographic groups regarding their response to the statements. The spearman's rank order correlation is used to measure the strength and direction of the monotonic relationship between two variables. The assumption that has to be met to perform the test is that both variables need to be at least an ordinal measurement. There is no requirement for normality. The closer to ±1 the correlation coefficient is, the stronger the correlation. The following guide is used to describe the strength of the correlation (Schober & Schwarte, 2018).

- 0.00 - 0.19 Very weak
- 0.19 - 0.39 Weak
- 0.39 - 0.59 Moderate
- 0.60 - 0.79 Strong
- 0.80 - 1.00 Very strong

3.5.3. Multinomial Logit Model

A Multinomial Logit (MNL) model is a type of logistic regression. The model estimates via a set of predictors the probability of an event occurring. The MNL model estimates the relationship between the categorical dependent variable and independent variables by using the logistic function. The goal is to create a parsimonious model that explains a substantial portion of the variance in the outcome variable (Hensher et al., 2005). The model will be created using NLOGIT software.

During the DCE, respondents are asked to choose between alternatives. Random utility models can then be used to analyze these choices (Hensher et al., 2015). A random utility model is derived as follows. A decision maker n must choose from a number of J alternatives. The decision maker chooses the alternative with the highest utility. The utility a decision maker n receives from alternative j is noted as U_{nj}, j =1,…, J. However, the decision maker's utility cannot be observed. Only attributes of the alternatives X_{nj} $\forall j$, and attributes of the decision maker S_n. The function that can be specified that relates to the utility function of the decision maker is $V_{nj} = V(X_{nj}, S_n)\ \forall j$. However, since not all elements of utility can be observed, $V_{nj} \neq U_{nj}$. The elements of utility that are not captured by V_{nj} are added to the function as ε_{nj}. Since ε_{nj} is unknown, it is treated as random. From this, equation 3.1 is formed

$$U_{nj} = V_{nj} + \varepsilon_{nj} \qquad \text{(eq. 3.1)}$$

U_{nj} = Utility decision maker n has from alternative j
V_{nj} = Utility based on observable attributes of decision maker n and alternative j
ε_{nj} = Unobservable utility of decision maker n and alternative j

The structural utility of decision maker n for alternative j is calculated as shown in equation 3.2. The parameters $\beta, \gamma, and\ \delta$ represent the weights of their corresponding variables; β_0 represents the constant for each alternative (SWF-design). Note that the structural utility of the base alternative ('no preference' in the preference task; 'not acceptable' in the acceptance task) is always equal to 0. Also note that the X-variables differ per SWF-design and that the Z and W-variables vary per individual.

$$V_{nj} = \beta_0 + \sum\nolimits_k \beta_k X_{jk} + \sum\nolimits_l \gamma_l Z_{nl} + \sum\nolimits_m \delta_m W_{nm} \qquad \text{(eq. 3.2)}$$

V_{nj} = The structural utility of alternative j for individual n
X_{jk} = The value of attribute k of alternative j
Z_{nl} = The value of personal characteristic l of individual n
W_{nm} = The score on statement m by individual n

A MNL model is created for the preference question, the acceptance question, and a combination of both. In the preference model, if V_{nj} surpluses zero, a decision maker is likely to prefer the design with the highest utility. In the acceptance model, a positive outcome of V_{nj} means a higher probability of acceptance of that design. The third MNL that is created combines both the data of the preference question and the acceptance question. It answers the question if there is a difference between preference and acceptance. If both can be measured using the same parameters it means that the structural utility of preference and acceptance is similar. However, the constants are expected to differ.

The probability that decision maker n chooses alternative i over other alternatives is calculated as the probability that the structural utility of alternative i is bigger than that of other alternatives (Train, 2009). The equation that is derived from this is shown in equation 3.3.

$$P_{ni} = \frac{e^{V_{ni}}}{\sum_j e^{V_{nj}}} \qquad \text{(eq. 3.3)}$$

$e^{V_{ni}}$ = The exponential of the value associated with decision maker n and alternative i

The McFadden Rho-square test is used to calculate the models performance. This is done by comparing the Log-likelihood (LL) of the null model to that of the base model where all parameters are equal to zero. The calculations for the LL are shown in equation 3.4 (McFadden, 1974):

$$LL\,(\beta) = \sum_{n}^{N} \sum_{i} y_{ni} \ln\,(P_{ni}) \quad \text{(eq. 3.4)}$$

$LL(\beta)$ = Log-likelihood with estimated parameters (β)
N = Total number of choices made in the model
i = Alternative
y_{ni} = Choice (n) made for alternative (i),Yes (1) No (0)
P_{ni} = Probability that choice (n) is made for alternative (i)

The McFadden's Rho-square test is then used to calculate the goodness-of-fit. A ρ^2 value between 0.20 and 0.40 is considered as an excellent fit. The ρ^2value is calculated as shown in equation 3.5 (McFadden, 1974):

$$\rho^2 = 1.0 - (\frac{LL(\beta)}{LL(0)}) \quad \text{(eq. 3.5)}$$

$LL(\beta)$ = Log-Likelihood of estimated model
$LL(0)$ = Log-Likelihood of null model

3.5.4. Random Parameters Mixed Logit Model

A mixed logit model is a flexible version of the standard logit model that can estimate a random utility model. Normal logit models cannot take random taste variation, correlation in unobserved factors over time, and unrestricted substitution patterns into account. However, each of these limitations can be resolved by creating a type of mixed logit model. A benefit of a mixed logit model simulation of choice probabilities is that is straightforward and easy to interpret (Train, 2009).

The random parameters mixed logit (RP-ML) is a type of mixed logit model used to find heterogeneity amongst the respondents. In a RP-ML model, a random component is added to the β's which is specific for an individual respondent. By doing this, the variation in respondents' taste is incorporated. The differences in parameters between respondents are hereby identified. The model returns to the normal multinomial logit model if the standard deviation of the random components equals zero (Hensher et al., 2015). The performance of this model can be determined using the equations of the LL and ρ^2 as explained in section 3.5.3.

3.6. Conclusion

A survey, including a DCE, is formed to research the preferences of people regarding solar and wind farm developments. First, the problem had to be refined. The biggest problem found in the literature was the lack of holistic research. Therefore, it was chosen to create an experiment that does not cover either solar or wind farms but both, as well as other aspects like personal characteristics, and opinions on climate change. Next to this, a new style of visualizing designs in a video is purposed. Instead of sequentially showing designs, two designs will be shown simultaneously in the same video. This is done to increase the ease of understanding the differences between designs. Together, these elements help to increase the knowledge on community acceptance of SWFs.

Design attributes of the SWFs are chosen based on their importance and effect. These attributes concern the distance from a residential area, type of land use, and type of development. Each attribute consists of two different levels and in total eight different design alternatives are created. These design alternatives are paired in choice sets and shown to respondents. Respondents provide their opinion on four different choice sets where two questions are asked. The first question is about the preference of a design and the second one about acceptance in someone's personal living environment.

The survey also takes personal characteristics, as well as opinions on SWFs and CC, and the experience with the videos into account. Questions and statements are created, based on the literature, that capture the essence of these variables. The survey is spread by mail, social media, and personal messages to reach as much respondents as possible. A descriptive analysis will be performed with the gathered data to draw the first conclusions. Response options that do not have close to thirty responses will be merged. Multiple MNL and RP-ML models are created with the variables based on the preference data, acceptance data, and combining both datasets. Their performance is based on the ρ^2 value as described by McFadden (1974).

4. Results

The results of the descriptive analysis and the MNL model are discussed in this chapter. The descriptive analysis provides an insight into the gathered data from the participants. The MNL model follows and estimates the relative importance of each of the attributes to predict community acceptance.

4.1. Descriptives

A total of 65 people completed the survey. Responses have been combined to create clusters of close to thirty responses as is needed for reliable analysis. A descriptive analysis of the unchanged data was also performed and can be found in Appendix D.

4.1.1. Personal characteristics

The first descriptives that are discusses are the personal characteristics of the respondents. Respondents were asked about their age, gender, place of residence, level of education, and income.

Age

Initially, there were seven different age categories ranging from 18 to 65+ years as illustrated in Table 3. However, the number of responses in most categories was too small for further research. The categories were, therefore, merged into two categories. The categories are, people below the age of 25 and people over 25. The *p*-value associated with the test statistic indicates that there is significant difference between the sample and population.

Table 3: Descriptive statistics age

Age	Categories	N	%	Merged categories	N	%
$X^2 = 56.97$	18 - 24 Years	26	40%	Under the age of 25	26	40%
$p < .01$	25 - 34 Years	17	26%	Over the age of 25	38	58%
	35 - 44 Years	3	5%	I prefer not to say	1	2%
	45 - 54 Years	4	6%			
	55 - 64 Years	6	9%			
	65+ Years	8	12%			
	I prefer not to say	1	2%			

Gender

38 males and 26 females completed the survey. Only one respondent indicated that they did not want to say their gender as shown in Table 4. These response possibilities did not have to be merged. Next to this, the sample is representative for the population.

Table 4: Descriptive statistics gender

Gender	Categories	N	%	Merged categories	N	%
$X^2 = 2.59$	Male	38	59%	Male	38	58%
$p = .11$	Female	26	40%	Female	26	40%
	I prefer not to say	1	2%	I prefer not to say	1	2%

Residents of Zwolle

Only five respondents lived in Zwolle as shown in Table 5. This attribute can, therefore, not be taken into account for further research. This means that the difference between people familiar with the area and people who are not cannot be researched.

Table 5: Descriptives resident of Zwolle

Resident	Categories	N	%	Merged categories	N	%
	No	53	82%	No	53	82%
	Yes	5	8%	Yes	5	8%
	I prefer not to say	7	11%	I prefer not to say	7	11%

Education

The response possibilities ranged from primary education to PhD as illustrated in Table 6. Responses were merged into two categories. The lower educated category includes the levels of education up to secondary vocational education. The p-value of .08 indicates that there is a significant correlation between the sample and population. The education parameters found for the respondents in the MNL and RP-ML are, therefore, representative for The Netherlands

Table 6: Descriptive statistics education

Education	Categories	N	%	Merged categories	N	%
$X^2 = 3.17$	Primary education	0	0%	Lower educated	31	48%
$p = .08$	Secondary education (VMBO/HAVO/VWO)	17	26%	Higher educated	33	51%
	Secondary vocational education (MBO)	14	22%	I prefer not to say	1	2%
	Higher vocational education (HBO or bachelor degree WO)	22	34%			
	WO master or PhD	11	17%			
	I prefer not to say	1	2%			

Income

20% of the respondents did not want to indicate their income as shown in Table 7. The number of respondents that have a lower income than €10.000 annually is heavenly overrepresented. A reason for this could lie in the personal network of the researcher that mainly consists out of students. Because of this and the small sample size, the responses had to be combined in two categories. Incomes below €20.000 are categorized as lower incomes and the rest as higher incomes.

Table 7: Descriptive statistics income

Income	Categories	N	%	Merged categories	N	%
$X^2 = 42.81$	Less than €10.000	16	25%	Lower income	25	38%
$p < .01$	Between €10.000 and €20.000	9	14%	Higher income	27	42%
	Between €20.000 and €30.000	9	14%	I prefer not to say	13	20%
	Between €30.000 and €40.000	9	14%			
	Between €40.000 and €50.000	6	9%			
	Between €50.000 and €100.000	3	5%			
	I prefer not to say	13	20%			

4.1.2. Climate Change

Alike the data from the personal characteristics, the data about all the statements was combined into two categories. Hereby it was chosen to have the same categories for each variable, namely a disagree/neutral, and a agree category. Dividing them over more than two categories or dividing them differently over two categories would result in merged categories with far less than thirty respondents. The data of three statements cannot be included in the MNL and RP-ML models because even after combining the responses there is a category with far less than 30 responses as shown in Table 8. These findings connect to the findings of Weber & Stern (2011), who also found that most people believe in the existence of CC. Their research was performed in the United States and this research was performed in The Netherlands. Respondents also indicate that they strongly agree that weather extremes are becoming more common. This connects to the findings of Easterling et al. (2000), Guillard et al. (2021), and McMichael et al. (2006), who indicate that weather extremes are a consequence of CC. The findings of this study add that people are aware that this is happening. People are also aware of the fact that the use of pollutants is an important reason for CC. This in line with findings of Olabi & abdelkareem (2022), and Isah (2013).

Table 8: Descriptives climate change statements 1

Statements	Categories	N	%	Merged categories	N	%
Climate change is happening	Strongly disagree	0	0%	Disagree/ neutral	6	9%
	Disagree	2	3%	Agree	59	91%
	Somewhat disagree	2	3%			
	Neither agree nor disagree	1	2%			
	Somewhat agree	1	2%			
	Agree	20	31%			
	Strongly agree	39	60%			
Extremes in the weather, such as heavy showers and long droughts, are becoming more common	Strongly disagree	0	0%	Disagree/ neutral	13	20%
	Disagree	1	2%	Agree	52	80%
	Somewhat disagree	1	2%			
	Neither agree nor disagree	3	5%			
	Somewhat agree	8	12%			
	Agree	24	37%			
	Strongly agree	28	43%			
The use of pollutants, such as fossil fuels, contributes to climate	Strongly disagree	0	0%	Disagree/ neutral	14	22%
	Disagree	0	0%	Agree	51	78%
	Neither agree nor disagree	0	0%			
	Neither agree nor disagree	5	8%			
	Somewhat agree	9	14%			
	Agree	18	28%			
	Strongly agree	33	51%			

On the hand, for the other climate statements, there are differences in the responses as shown in Table 9. Although the majority believes that CC is caused by humans, almost a third does not. Even though there is more and more evidence accumulating that some effects of CC have anthropogenic causes driven (Höök & Tang, 2013; Oldenborgh et al., 2021; Li et al., 2021). This indicates that there is not enough awareness about the causes of CC among the respondents. A similar conclusion can be drawn for the general CC concerns. The majority of people is afraid of the effects of CC. However, almost a third is not afraid of the consequences. Furthermore, close to half of the respondents do not think that CC will have consequences for them personally. A reasoning for this lies in the psychological distance as described by Spence et al. (2012). If people are not concerned about the consequences of CC in general, they are even less likely to be concerned about the consequences for them personally.

Table 9: Descriptives statements on climate change 2

Statements	Categories	N	%	Merged categories	N	%
Climate change is mainly caused by human activities	Strongly disagree	0	0%	Disagree/ neutral	20	31%
	Disagree	2	3%	Agree	45	69%
	Somewhat disagree	2	3%			
	Neither agree nor disagree	5	8%			
	Somewhat agree	11	17%			
	Agree	23	35%			
	Strongly agree	22	34%			
I am concerned about the effects of climate change	Strongly disagree	1	2%	Disagree/ neutral	19	29%
	Disagree	4	6%	Agree	46	71%
	Somewhat disagree	4	6%			
	Neither agree nor disagree	2	3%			
	Somewhat agree	8	12%			
	Agree	23	35%			
	Strongly agree	23	35%			
I think climate change will have negative consequences for me personally	Strongly disagree	1	2%	Disagree/ neutral	31	48%
	Disagree	5	8%	Agree	34	52%
	Somewhat disagree	3	5%			
	Neither agree nor disagree	6	9%			
	Somewhat agree	16	25%			
	Agree	25	39%			
	Strongly agree	9	14%			

4.1.3. Solar and Wind Farms

Looking at the first statement in Table 10, the opinion on the necessity of solar and farms is divided fifty-fifty. This is not in line with the findings of Segreto et al. (2020), who found that there is much support for renewable energy. A possible explanation of this is the fear of such projects, as was researched by Assefa & Frostell (2007). Interestingly, most respondents disagree with the negative impact on the aesthetics of an area. Many studies, including O'Neil (2021), Roddis et al. (2018), and Bell et al. (2013) found that people were concerned by the visual impact. The difference between these findings can be linked to the fact that elderly are more afraid and against SWFs. In this research the younger population is overrepresented. 57% of the respondents indicate that local parties should be included in the decision-making of a SWF. Jobert et al. (2007), and Walker & Devine-Wright (2008) suggest that community acceptance increases when local parties are included. 55% of the respondents are against the development of a SWF in their living environment. This is in line with findings of Huijts et al (2012), and Wüstenhagen et al. (2007). They found that it mainly comes from visual obstruction of SWFs. However, respondents in this study do not deem SWFs as visual obstruction. The majority of respondents do not think that a SWF would have a positive influence on the local economy. However, as stated by IRENA (2012), the implementation of a SWF could increase the number of job opportunities in that area. This means that people might not be aware of this. The influence of this on acceptance and preferences cannot be further researched in this study because the number of respondents that do agree is too low to include in the models. The same counts for the negative impact on people's health. 94% of the respondents do not think that a SWF will lead to personal health problems. This is not in line with Susskind et al. (2022) who found that health concerns are an recurrent argument for opposition against SWFs.

Table 10: Descriptives statements on solar and wind farms

Statements	Categories	N	%	Merged categories	N	%
More solar and wind farms should be built to combat climate change	Strongly disagree	2	3%	Disagree/ neutral	33	51%
	Disagree	4	6%	Agree	32	49%
	Somewhat disagree	3	5%			
	Neither agree or disagree	6	9%			
	Somewhat agree	18	28%			
	Agree	25	38%			
	Strongly agree	7	11%			
Solar and wind farms have a negative impact on the appearance of an area	Strongly disagree	3	5%	Disagree/ neutral	40	62%
	Disagree	9	14%	Agree	25	38%
	Somewhat disagree	4	6%			
	Neither agree or disagree	10	15%			
	Somewhat agree	14	22%			
	Agree	14	22%			
	Strongly agree	11	17%			
Citizens and local companies should be included in the decision-making process of solar and wind farms	Strongly disagree	0	0%	Disagree/ neutral	28	43%
	Disagree	2	3%	Agree	37	57%
	Somewhat disagree	5	8%			
	Neither agree or disagree	3	5%			
	Somewhat agree	18	28%			
	Agree	22	34%			
	Strongly agree	15	23%			
I would not mind a solar or wind farm being built in my living environment	Strongly disagree	5	8%	Disagree/ neutral	36	55%
	Disagree	8	12%	Agree	29	45%
	Somewhat disagree	1	2%			
	Neither agree or disagree	10	15%			
	Somewhat agree	12	18%			
	Agree	25	38%			
	Strongly agree	4	6%			

Solar and wind farms could have a positive impact on the local economy	Strongly disagree	1	2%	Disagree/ neutral	49	75%
	Disagree	4	6%	Agree	16	25%
	Somewhat disagree	2	3%			
	Neither agree or disagree	28	43%			
	Somewhat agree	14	22%			
	Agree	15	23%			
	Strongly agree	1	2%			
I am afraid that a solar and wind farm will have a negative impact on my health	Strongly disagree	16	25%	Disagree/ neutral	61	94%
	Disagree	26	40%	Agree	4	6%
	Somewhat disagree	5	8%			
	Neither agree or disagree	8	12%			
	Somewhat agree	6	9%			
	Agree	1	2%			
	Strongly agree	3	5%			

4.1.4. Visualization of Designs

The final statements are about the presentation of the videos. The descriptive results are shown in Table 11. The majority of the respondents is positive about their experience with the choice sets. The only negative aspect of the videos where most of the respondents agreed on was the length of a video. The majority of the respondents considered the videos to be too long. Each choice set consisted of a two minute video. If the videos were shorter, respondents would potentially be more positive. However, another reason why they indicate this could be that each respondent had to watch similar videos with the same routing but different designs four times. Therefore, there is also the possibility that they got bored. Since the statements about the clear visualization difference in designs and experience of dizziness both have a category with far less than thirty respondents, these will not be taken into account in further research. The conclusion drawn for these statements is that the split screen display does not cause dizziness for the respondents and that the differences in design are clearly visible.

Table 11: Descriptives statements on experience choice sets

Variable	Categories	N	%	Merged categories	N	%
The differences in design between the left and right halves of each video were clearly visible	Strongly disagree	0	0%	Disagree/ neutral	15	23%
	Disagree	1	2%	Agree	50	77%
	Somewhat disagree	5	8%			
	Neither agree or disagree	4	6%			
	Somewhat agree	5	8%			
	Agree	25	38%			
	Strongly agree	25	38%			
I experienced dizziness while watching the videos	Strongly disagree	28	43%	Disagree/ neutral	64	98%
	Disagree	24	37%	Agree	1	2%
	Somewhat disagree	2	3%			
	Neither agree or disagree	6	9%			
	Somewhat agree	4	6%			
	Agree	1	2%			
	Strongly agree	0	0%			

I could easily divide my attention between the left and right halves of a video	Strongly disagree	0	0%	Disagree/ neutral	20	31%
	Disagree	0	0%	Agree	45	69%
	Somewhat disagree	5	8%			
	Neither agree or disagree	3	5%			
	Somewhat agree	12	18%			
	Agree	34	52%			
	Strongly agree	11	17%			
The videos showed a credible representation of reality	Strongly disagree	0	0%	Disagree/ neutral	23	35%
	Disagree	0	0%	Agree	42	65%
	Somewhat disagree	3	5%			
	Neither agree or disagree	7	11%			
	Somewhat agree	13	20%			
	Agree	27	42%			
	Strongly agree	15	23%			
The impact of possible developments was clearly visualized	Strongly disagree	0	0%	Disagree/ neutral	20	31%
	Disagree	2	3%	Agree	45	69%
	Somewhat disagree	4	6%			
	Neither agree or disagree	4	6%			
	Somewhat agree	10	15%			
	Agree	29	45%			
	Strongly agree	16	25%			
The video length was good, disagree if they were too long	Strongly disagree	3	5%	Disagree/ neutral	43	66%
	Disagree	5	8%	Agree	22	34%
	Somewhat disagree	19	29%			
	Neither agree or disagree	10	15%			
	Somewhat agree	6	9%			
	Agree	14	22%			
	Strongly agree	8	12%			

4.2. Correlations

To check for correlations between the variables, the mutual spearman rank order correlations were determined. The results are shown in Appendix F and based on the merged categories. There are a number of correlations above the value of .40, indicating a moderate correlation. However, these correlations are not strong enough to consider combining two different variables. The correlation between the general concerns and the human cause of CC, $r_s(65) = .45$, $p < .01$, as well as personal concerns and the human cause of CC, $r_s(65) = .50$, $p < .01$, are connected to the findings of Cooke et al. (2016). The correlation between income and age, $r_s(65) = .48$, $p < .01$, is also expectable since it is likely that a person's income increases when someone is getting older. The correlation between education, and whether or not people mind a solar or wind farm in their area, $r_s(65) = .41$, $p < .01$, was also found by Acheson (2012). On the other side, this also means that for this study, the findings of Ladenburg (2010) cannot be supported. 75.8% of the higher educated respondents would not mind a solar or wind farm in their living area against 48.4% of the lower educated respondents. An argument why higher educated do not mind a solar or wind farm in their area can suggestively be related to the fact that higher educated people do not think that a solar or wind farm will have a negative influence on the appearance of that area $r_s(65) = -.28$, $p = .02$. Hereby it can be suggested that place attachement, as described by Bell et al. (2013), can influence the level of acceptance of a solar and wind farm and that this place attachement differs between education levels. However, since the education data for this research is not representative for The Netherlands, no hard conclusions can be drawn.

Another attribute related to whether or not someone beliefs a solar and wind farm has a negative impact on an area is the age of the respondent, $r_s(65) = .43$, $p < .01$. This is in line with the studies of Ek & Pesson (2014), and Greenberg (2009). 68.4% of the older respondents state that they agree with the statement compared to only 46.2% of the younger respondents. As suggested in the literature of De Vries et al. (2012), young people are more used to seeing solar and wind farms than elderly. For them it is a new technology that they have not seen throughout the majority of their life and, therefore, it might be harder for them to adjust.

4.3. Multinomial Logit Model

A total of three MNL models have been created. One model for preference, one for acceptance, and one for the combined data. The models consist of the design attributes, personal characteristics, and the statements. Variables have been added or removed from the model to work toward a model that only includes significant parameters. A parameter was considered to be significant if P < .10. This is higher than the most commonly used value of P < .05. However, the attributes that have P-values between .10 and .05, can become significant for P < .05 if the sample size is increased in future research. Therefore, it is interesting to include these attributes in the models. The models can be found in Appendix G and have been created with NLOGIT software. With the data from the models, the level partworths have been calculated. Next to this, the rho-squared value was calculated to describe the performance of each model.

4.3.1. Preference

The preference model is created from the question ‘Which design do you prefer?’. Respondents could either indicate which design they preferred or that they had no preference. The no preference option is hereby formulated as preferring both designs equally. It differs from the acceptance question because in the preference scenario, a SWF already was in the area before the respondent, hypothetically, lived there. In the acceptance scenario, the respondent was already living in the area before there was a SWF and could, therefore, choose to leave the area untouched. A respondent is most likely to choose the choice alternative with the highest utility. The utility of the no preference alternative is always zero and the utility of a design alternatives is calculated as the sum of the preference constant, the parameters of a design, and the parameters connected to the attitude of a respondent. At least one utility function of the design alternatives, therefore, has to be higher than zero for a respondent to prefer one design over the other. The performance of the model is based on the ρ^2 value and is calculated as described in equation 3.5. According to McFadden (1974), a ρ^2 value between .20 and .40 represents an excellent model fit. The $LL(0)$ of the model is 65 x 4 x ln(1/3) = -285.64 and the $LL(\beta)$ = -249.93. This results in a ρ^2 value of .13, which indicates a modest fit. The attributes that were found to be significant in predicting preference are shown in Table 12.

Table 12: Results MNL model preference

Attribute	Parameter	Significance
Preference constant	.71141	***
Solar farm	.19418	**
Wind farm	-.19418	**
Far from residential area	.21843	**
Close to residential area	-.21843	**
Over the age of 25 years	-.63768	***
Under the age of 25 years	.63768	***
CC is caused by humans	-.37925	**
CC is not caused by humans	.37925	**
CC will not affect me personally	-.77257	***
CC will affect me personally	.77257	***
More SWFs are needed	-.36343	**
No more SWFs are needed	.36343	**
SWFs have a negative visual impact	.99620	***
SWFs do not have a negative visual impact	-.99620	***

***, **, * ==> Significance at 1%, 5%, 10% level.

A more visual representation of the results is shown in Figure 23. The relative importance of each attribute can be seen in this figure. Two different types of parameters can be distinguished in the model: the first type are the design attributes that influence which and if a design is preferred and the second type are the personal characteristics and attitude of the respondent that only influence if a design is preferred or if the no preference alternative is chosen. The second type of attributes do not change the relative difference in utility between the design choice alternatives.

First looking at the design attributes, it can be seen that only two of the three are significant, namely the type of development and distance. The land use was not found to be significant, indicating that respondents do value farm land and natural areas as equally important. On the other side, does the type of development and distance from the residential area influence their preferences. More specifically, a solar farm and a greater distance increase the utility, and a wind farm and smaller distance decrease the utility of preferring a design. The part worth utilities of type of design and distance are almost equally as large. This means that a solar farm close to a residential area has a comparable utility to a wind farm far from a residential area. Therefore, if a respondent had to choose between these two types of developments, and the total utility is above zero, these two developments had equal probability of being preferred. Moreover, the type of design that is most probable to be preferred is a solar farm far from a residential area and the design least probable is a solar farm close to a residential area.

However, a respondent will only choose to prefer a design alternative if the total utility surpluses zero. From the personal characteristics parameters, only the age of a respondent has a significant influence on if a design is preferred. More specifically, people under the age of 25 are more likely to prefer one design over the other than people over the age of 25. The belief that CC is caused by humans lowers the probability that an individual prefers a design. The belief that CC will have a personal effect on someone increases the probability that a design is preferred over the other by that individual. People that indicate that more SWFs are needed to combat CC are less likely to prefer one design over another.

This suggests that people who are aware of how SWFs can help to combat CC are more interested in the results, like fewer greenhouse emissions, rather than in what a SWF looks like. Contrary to that are the people that indicate that SWFs have a negative visual impact on the appearance of an area. This attributes has the biggest parameter magnitude of all the attributes in the model. People who indicate that SWFs have a negative visual impact on the appearance of an area are much more likely to prefer a design than people who do not. The attitude regarding visual impact of a SWF is, therefore, an important predictor in estimating preference. On the other side, none of the visualization of the design parameters are significant. This indicates that in estimating preferences, the credibility of the design, the length of the video, the ability to focus on both halves of the video, and the level of representation of reality are not significant.

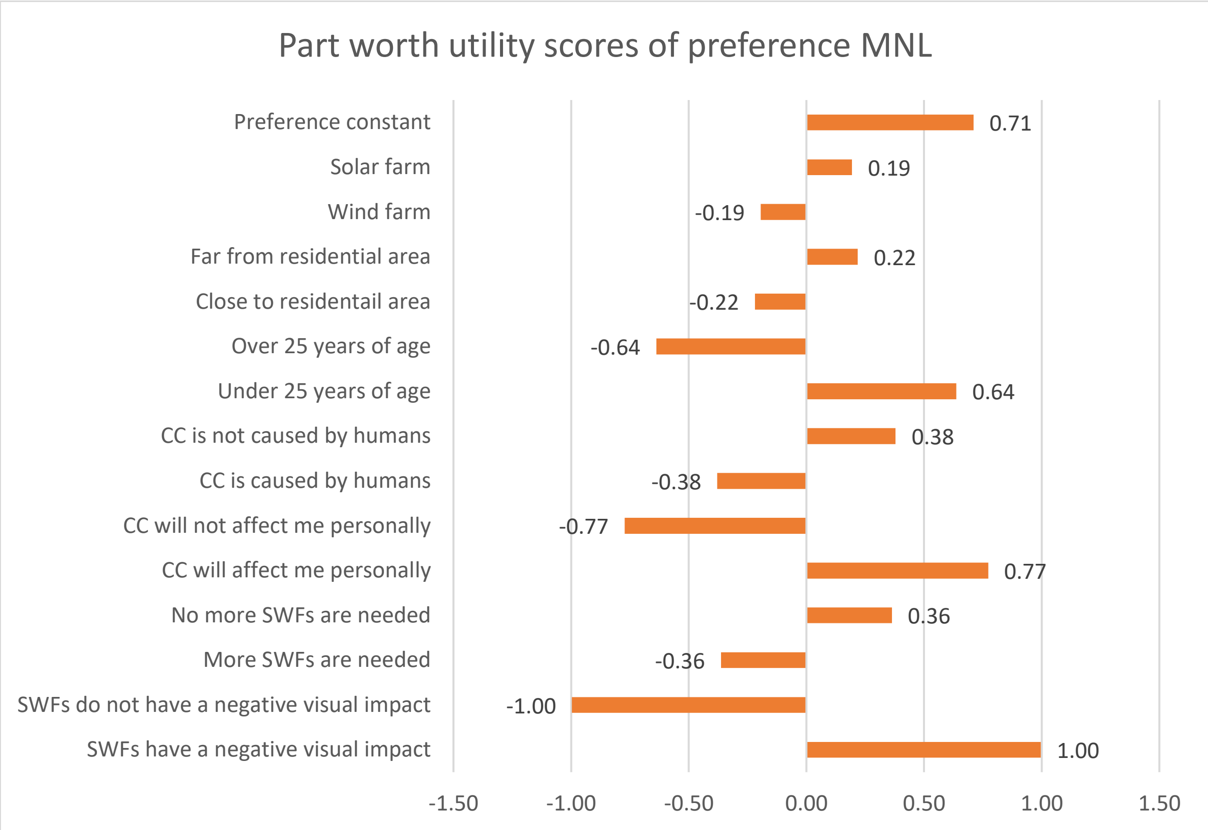

Figure 23: Part worth utility scores of preference MNL model

4.3.2. Acceptance

The acceptance model is based on the question: 'Imagine you lived in one of the residential areas on the map before there was a solar or wind farm. Would you then agree if the design was realized?'. The two scenarios where a respondent could choose between were either with or without the shown SWF development. This differs from the preference question since respondents have the option to have no SWF development. The emphasis of this model lies on if a development is accepted and what kind of development. The utility of not accepting a development is zero, meaning that the utility of a development must surplus zero for it to be accepted. The significant attributes and their parameters are shown in Table 13. The performance of the model is based on the ρ^2 value and is calculated using the $LL(0)$ and $LL(\beta)$. The $LL(0)$ of the model is calculated as 65 x 8 x ln(1/2) = -360.43 and the $LL(\beta)$ is calculated by NLOGIT, and is -275.09. This results in a ρ^2 value of the model is .24, which indicates a good fit.

Table 13: Results MNL model acceptance

Attribute	Parameter	Significance
Acceptance constant	.83244	***
Solar farm	.31568	***
Wind farm	-.31568	***
Far from residential area	.20193	*
Close to residential area	-.20193	*
More SWFs are needed	.31244	***
No more SWFs are needed	-.31244	***
SWFs have a negative visual impact	-.58046	***
SWFs do not have a negative visual impact	.58046	***
Accept SWF in living area	.38750	***
Against SWF in living area	-.38750	***
Can divide attention between both designs shown	-.62324	***
Cannot divide attention between both designs shown	.62324	***
The impact of the SWFs is clearly visualized	.59117	***
The impact of the SWFs is not clearly visualized	-.59117	***
The video length is good	.39084	***
The videos are too long	-.39084	***

***, **, * ==> Significance at 1%, 5%, 10% level.

Figure 24 shows the outcome of the acceptance model in a visual way. A design is more probable to be accepted than not if the sum of the parameters is more than zero, because the utility of not accepting a design is always zero. The acceptance constant has the parameter with the biggest magnitude. It has a value of .83 in the acceptance alternative utility function and zero for not accepting the alternative. The baseline probability that a person accepts a design is, therefore, higher than not accepting a design. Since a solar farm and far distance from a residential area increase the utility of accepting, it is very unlikely that these designs are not accepted. On the other hand, a wind farm decreases the utility of accepting. However, if placed far from a residential area it is still likely to be accepted. If a SWF is located close to a residential area, its probability of being accepted decreases. More specifically, from all the design alternatives, a wind farm close to a residential area is most likely not to be accepted because the relative differences of the utility functions of accepting and not accepting are the smallest.

None of the personal characteristics were found to be significant in predicting acceptance. This means that there is no difference between younger and older people, people with different educational levels, and income classes or gender. The outcome of this model is, therefore, contrary to the findings of Ladenburg (2010), Acheson (2012), and Firestone & Kempton (2007). Namely, in their studies it is suggested that there are differences in the acceptance of renewable energy by people with different personal characteristics. Furthermore, none of the CC statements were found to be significant predictors of acceptance. Cook et al. (2016) stated that communities that have a broader understanding of CC are more likely to accept renewable energy developments. However, that finding does not align with the findings in this model. Next to this, the fear for environmental effects due to CC as described by McMichael et al. (2006) do not significantly influence the acceptance of SWFs.

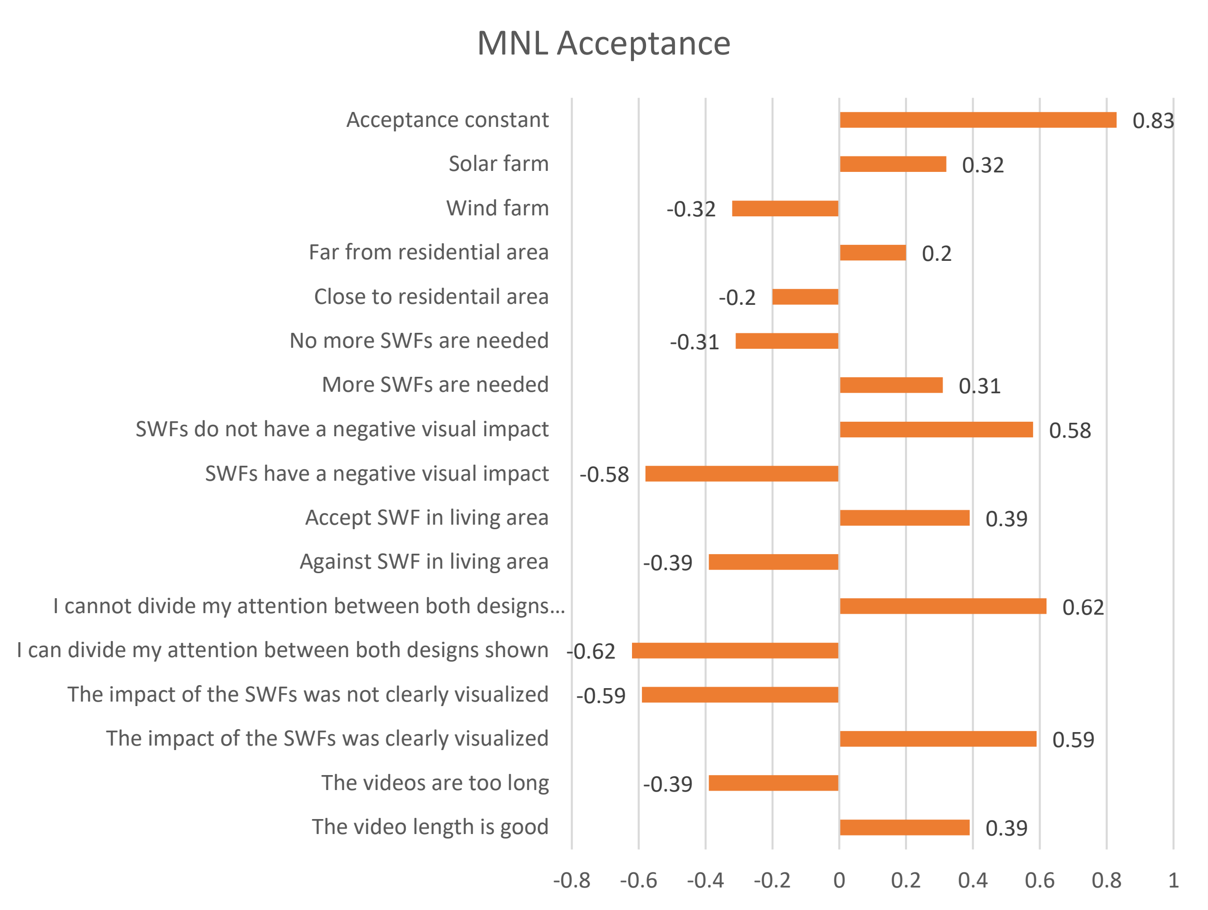

Figure 24: Part worth utility scores of acceptance MNL model

On the other side, there are some statements regarding SWFs that are significant in predicting acceptance. People who indicate that more SWFs are needed are more likely to accept as well as people who indicate that they would accept a SWF in their living area. However, the attribute with the biggest parameter of the SWF statements is about the visual impact of a SWF on the appearance of an area. More specifically, people who think a SWF will have a negative impact on the appearance of an area are much more likely to choose the not accept alternative over the accept alternative. This is in line with the findings of Broekel & Alfken (2015) and Boyle et al. (2019) who also found that visual obstruction often has been brought forward as an argument to not accept a renewable energy project. The perceived visual impact is, therefore, an important contributor to predicating the acceptance of a SWF. The visual impact should, therefore, be communicated in a clear manner.

This can also be related to the final three attributes of the model regarding the presentation of the designs in the DCE. People who indicated that the impact of a SWF on an area was clearly visualized are more likely to choose the accept alternative. This suggests a link between the perceived visual impact before a design is shown and after the designs are shown. This link is also described by Wolsink (2007) whose findings suggest that during the proposal of a design the attitude toward a renewable energy project lowers and post the placement of it rises again. This suggests that proposals of SWFs might not be accurate in communicating the visual impact of a SWF on the appearance of an area. Related to that is the length of the video that is shown to a person. If the video length is not good, in the case of this study too long, people are less likely to choose the accept alternative. However, contrary to this is the finding that people who are not able to divide their attention over both the designs shown on screen are more likely to choose the accept alternative. Table 14 shows that 74.4% of the designs shown to respondents that could not divide their attention were scored as acceptable against 59.2% of the respondents that could divide their attention. No previous research could be found that could be linked to this finding. In depth research is needed to find out why people that are able to divide their attention over the two sides of the screen are less likely to choose the accept alternative.

Table 14: Crosstabulation ability to divide attention and acceptance of a design

			Acceptance		Total
			Unacceptable	Acceptable	
Able to divide attention	Disagree/ Neutral	Count	41	119	160
		% within Divide Attention	25.6%	74.4%	100.0%
	Agree	Count	147	213	360
		% within divide attention	40.8%	59.2%	100.0%
Total		Count	188	332	520
		% within divide attention	36.2%	63.8%	100.0%

4.3.3. Combined Model

The combined model consist of the data of both the preference and acceptance questions. It answers the question: 'Can the preference and acceptance models be merged into one model?'. Combining the data into one model shows to which extend preference and acceptance can be estimated using the same attributes and parameters. The ρ^2 value model is calculated for the performance of the model. The $LL(0)$ of the model is calculated as the sum of the $LL(0)$ of the preference and acceptance model, which results in -646.08. The $LL(\beta)$ is calculated by NLOGIT, and is -593.37. The ρ^2 value of the combined model comes to .09, indicating a poor fit. Combining the models is, therefore, not beneficial compared to the separate models that both had a higher ρ^2 value and are better at predicting preference and acceptance. Therefore, it is advised to use the separate models to predict preference or acceptance levels.

Table 15: Results MNL model combined data

Attribute	Parameter	Significance
Acceptance constant	.67964	***
Solar farm	.22912	***
Wind farm	-.22912	***
Far from residential area	.19350	***
Close to residential area	-.19350	***
Over the age of 25 years	-.16767	**
Under the age of 25 years	.16767	**
CC will not affect me personally	-.24061	***
CC will affect me personally	.24061	***
Accept SWF in living area	.24030	***
Against SWF in living area	-.24030	***
Can divide attention between both designs shown	-.20244	**
Cannot divide attention between both designs shown	.20244	**
The impact of the SWFs is clearly visualized	.27050	***
The impact of the SWFs is not clearly visualized	-.27050	***

***, **, * ==> Significance at 1%, 5%, 10% level.

However, all the other attributes in the model do measure preference and acceptance in the same way. Namely looking at the design attributes, as illustrated in Figure 25, a solar farm and greater distance from a residential area increase the utility. This was also found in both the separate models of preference and acceptance and could here fore have been expected in the combined model. Age was not found to be significant in the acceptance model, but it was in the preference model. Although less prominent than in the preference model, it is still found that people under the age of 25 are found to be more likely to prefer a design. In addition to that, it is also found in this model that they are more willing to accept a development. This is in line with the findings of Krueger et al. (2011), Ek & Persson (2014), and Greenberg (2009). In their studies it was also found that older people are more in favor of coal and natural gas compared to younger people. The fear that CC will affect the respondent was also only found to be significant in the preference model while on the other hand accepting or not accepting can only be found in the acceptance model as well as the clarity of the visualization of the impact of a SWF and the ability to divide attention over both designs shown. This means that although not every attribute of the combined model was found to be significant in both the acceptance and preference models, they can be used to predict both acceptance and preference if put together in a single model. However, as stated before, is the performance of the model not good, but it does offer some insights.

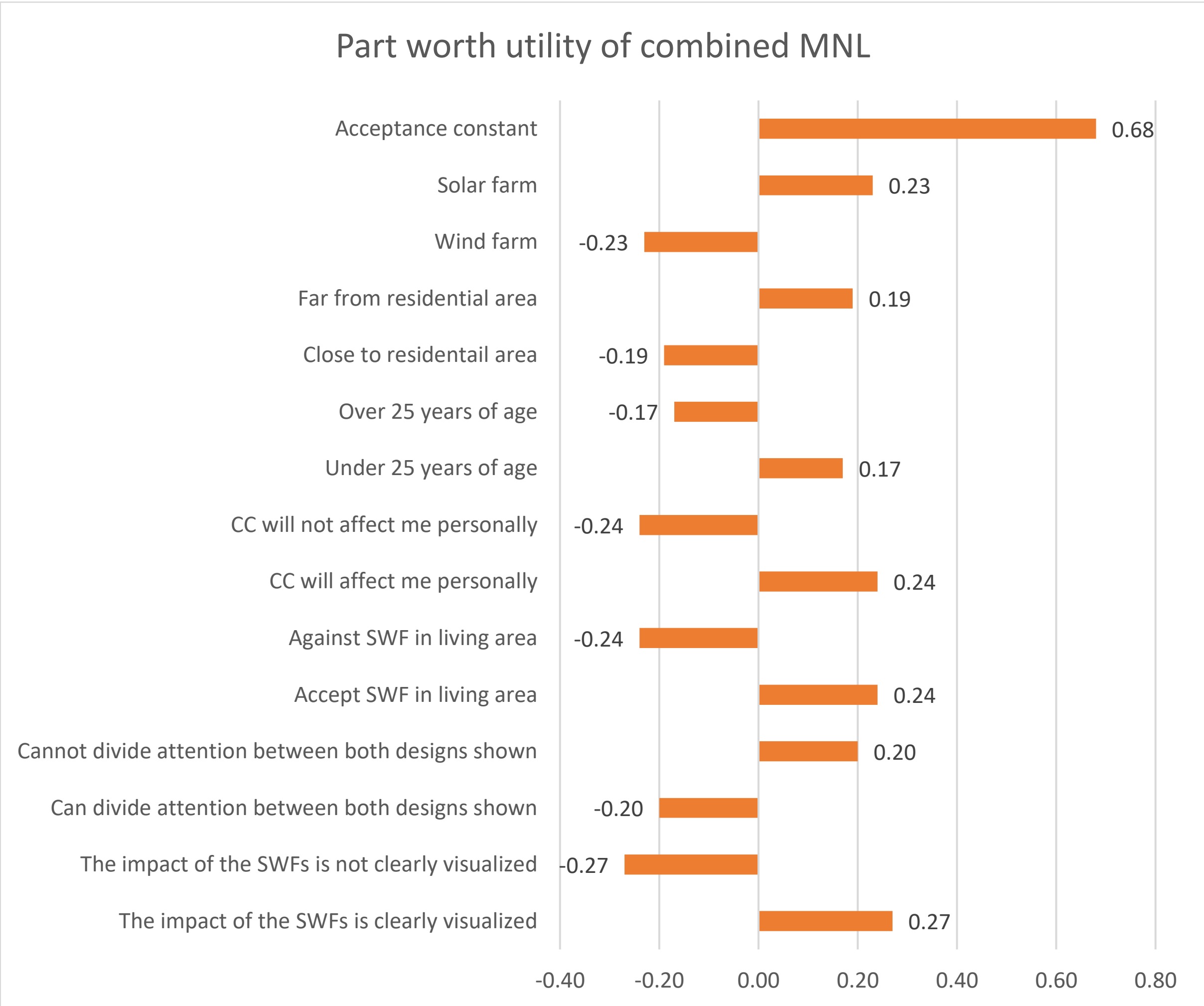

Figure 25: Part worth utility scores of combined data MNL model

4.4. Random Parameter Mixed Logit

The random parameters mixed logit model is used to find heterogeneity amongst the respondents.. A RP-ML model, compared to a MNL model, includes a standard deviation for each parameter, and therefore, addresses differences between respondents. The outcomes of these models can be found in Appendix H. The partworth utility of the different attributes and their levels are compared with the outcomes of the multinomial logit models of chapter 4.3.

4.4.1. Preference

The results of the RP-ML model are shown in Table 16. The ρ^2 of the RP-ML model is .18, which is a significant increase compared to the value of .13 of the MNL model. The heterogeneity found in the location parameter and preference constant are reasons for this increase in model fit. The estimated standard deviation of the preference constant is 2.07, which suggests that there is much heterogeneity between the respondents. This means that some individuals are probable to choose for the preference alternative, which cannot be explained by the parameters in the model. The estimated standard deviation of the location parameter across individuals is .47. This means that for some individuals the effect of the location of a design is more important than for others. A mean value of .24 and a standard deviation of .47 imply that for 95% of the individuals the “far from residential” parameter ranges between -.70 and 1.18. For the “close to residential” parameter the range is between -1.18 and .70. This means that for most respondents an increase in distance results in a higher probability of preferring that design. However, on the other hand, for a small percentage of respondents this means that an increase in distance lowers the probability they choose the preference alternative. No significant standard deviations were found for any other of the attributes which indicates that that there is homogeneity among the impact on the utility of these attributes across individuals with the same attitudes.

Table 16: Results RP-ML model preference

Attribute	Parameter	Significance	Standard deviation	Significance
Preference constant	1.14247	***	2.07058	***
Solar farm	.19533	**		
Wind farm	-.19533	**		
Far from residential area	.24417	**	.47153	**
Close to residential area	-.24417	**	.47153	**
Over the age of 25 years	-.85510	**		
Under the age of 25 years	.85510	**		
CC will not affect me personally	-.89907	**		
CC will affect me personally	.89907	**		
More SWFs are needed	-.62813	*		
No more SWFs are needed	.62813	*		
SWFs have a negative visual impact	1.45082	***		
SWFs do not have a negative visual impact	-1.45082	***		

***, **, * ==> Significance at 1%, 5%, 10% level.

The outcomes of the MNL and RP-ML models of preference are compared in Figure 26. The standard deviation of the preference constant is of a considerable size indicating that there is much heterogeneity in how well the attributes can be used to predict preferences per respondent. For some respondents all the attributes are influential in predicting if they prefer a design and which one, since for them the preference constant is close to zero. However, on the other hand, for the majority of the respondents the probability of preferring a design or having no preference is less subjective to the attributes in the model as the constant has a large influence on the decision making. For them it is much more likely that the outcome of the model will be that they prefer a design than having no preference. Namely, the sum of the attributes must be lower than the preference constant for them to choose the no preference alternative. From the design attributes it can be stated that when both a solar farm and wind farm, at the same distance from a residential area, are shown to respondents, they are more likely to prefer the solar farm. On the other hand, if the solar farm was closer to a residential area, the probability of preferring the wind farm development is slightly higher. However, this difference in utility is neglectable. This means that on average, distance and type of design are valued as the same. However, since there also is a significant standard deviation for the distance parameter, this is not true for all respondents. For some of them, an increase in distance increases the utility of that design more than a change in type of development would do. On the other hand, for other respondents does a change in distance make little difference to the utility of that alternative. For them a change of type of development is more important than a change in distance.

There are also a number of attributes that do not affect the relative utility between the design alternatives, but do affect if the respondent is likely to choose to prefer a design or to have no preference. Younger people have a higher probability of preferring a design as well as people who are afraid that CC will affect them personally. People that think that more SWFs are needed are less likely to prefer a design. The belief that SWFs do have a negative visual impact does increase the probability that a respondent has a preference for a design. From all the attributes in the model is this the most important contributor to predicting if a respondent has a preference for a design. The difference in utility between someone who does think a SWF has a negative influence on the appearance of an area and someone who does not is 2.90 which is a big part of a utility function of each design. Furthermore, none of the parameters related to the visualization of the designs are significant. This indicates that alike what was found in the MNL model for estimating preferences, the credibility of the design, the length of the video, the ability to focus on both halves of the video, and the level of representation of reality are not significant. Differences in attitude towards how the choice sets were experienced, therefore, do not affect the probability of preferring a design.

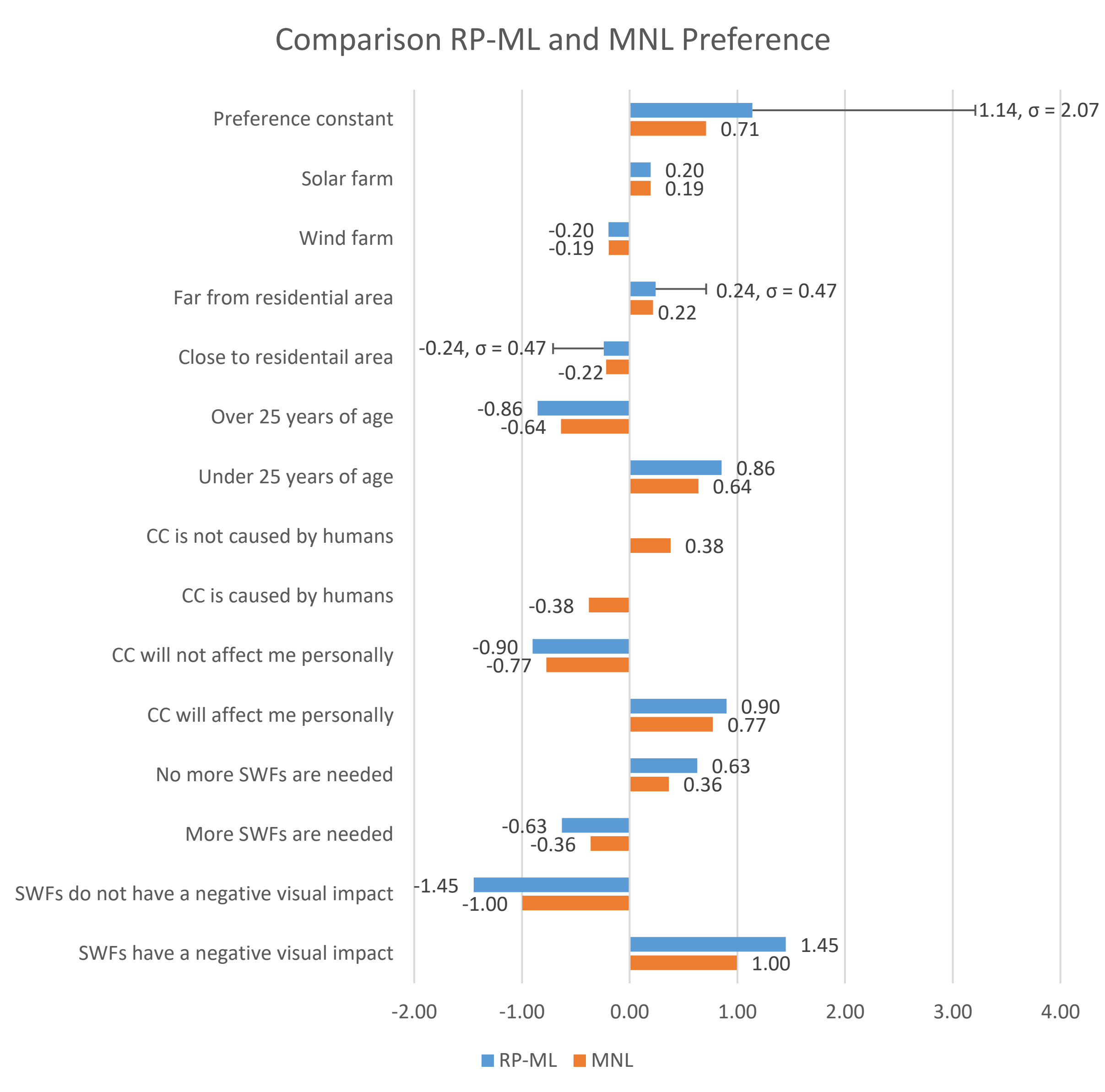

Figure 26: Comparison MNL and RP-ML models preference

4.4.2. Acceptance

The RP-ML model of acceptance alike the MNL models answers the question if a design is acceptable or not. Respondents can choose from two hypothetical scenarios and have to imagine that they live in the area where the SWF is located. They can choose for the scenario where a SWF is located in their living area and, therefore, accept a development, or they can choose to have no development and reject it, and hereby leaving the area untouched. The utility of not accepting a design is zero and a design is, therefore, probable to be accepted if its utility is more than zero. The results of the RP-ML model are shown in table 17. The ρ^2 value of the RP-ML model is .27 which is a small increase compared to the value of .24 of the MNL and represents an excellent model fit. The location parameter has a significant standard deviation. This indicates that for a subgroup of the respondents, the distance from a residential area is more valuable than for others. They are more likely to accept a design if it is placed further away from the residential area. This also means that for a subgroup of the respondents, it is much more likely that they do not accept a design if it is placed close to a residential area. Furthermore, the length of the video attribute also has a significant standard deviation of 1.30. This means that there is much heterogeneity amongst the respondents about the influence of the length of the video on the probability of choosing the accept alternative. For a subgroup of the respondents, the probability of them accepting a design decreases significantly if they found that the videos were too long. However, on the other side does a good video length increase the utility of accepting a design as well. The experience of the length of the video is, therefore, important in predicting acceptance of a design.

Table 17: Results RP-ML model acceptance

Attribute	Parameter	Significance	Standard deviation	Significance
Acceptance constant	.91989	***		
Solar farm	.36316	***		
Wind farm	-.36316	***		
Far from residential area	.30002	*	.70707	***
Close to residential area	-.30002	*	.70707	***
SWFs have a negative visual impact	-1.14025	***		
SWFs do not have a negative visual impact	.1.14025	***		
Can divide attention between both designs shown	-1.05425	***		
Cannot divide attention between both designs shown	1.05425	***		
The impact of the SWFs is clearly visualized	.97239	***		
The impact of the SWFs is not clearly visualized	-.97239	***		
The video length is good	.30870		1.30118	***
The videos are too long	-.30870		1.30118	***

***, **, * ==> Significance at 1%, 5%, 10% level.

The results of the RP-ML and MNL models of acceptance are compared in Figure 27. The parameters of support of SWFs and acceptance of a SWF in the living environment are not significant in RP-ML model. This means that there is no difference between probability of acceptance of a design by people who have different opinions on these statements. This is noteworthy since it could have been expected that people who indicate that more SWFs are needed and would not mind them in their living environment would be more likely to choose the accept alternative. However, this can be related to the studies of Bell et al. (2013), Tidwell et al. (2018), and Wüstenhagen et al. (2007) that described the social-gap of renewable energy. They explain that on the one hand people are advocates of increasing the number of SWFs but when it comes to the actual implementation, they are more reluctant. This suggestively, could be the case in this study as well. People were asked prior to the DCE to indicate their opinions on these statements and acted as supporters of SWFs but when the real designs were shown, their support decreased. This could also be linked to Wolsink (2007) who found that support decreases in the implementation phase.

The partworth utility of the negative visual impact of a SWF, on the other hand, has doubled in magnitude, although there is no heterogeneity amongst individuals. The relative importance of the perceived visual impact, therefore, has risen significantly compared to the MNL. People indicating that they think a SWF will have a negative influence on the appearance of an area are more probable to choose the not accept alternative in the RP-ML than in the MNL. A comparable increase can also be observed for the visualization of the impact of the SWFs and ability to divide attention attributes. The influence of these attribute have also increased significantly. This suggests that the visualization of a development is a more important contributor of acceptance of SWF compared to the design attributes, personal characteristics, and other statements.

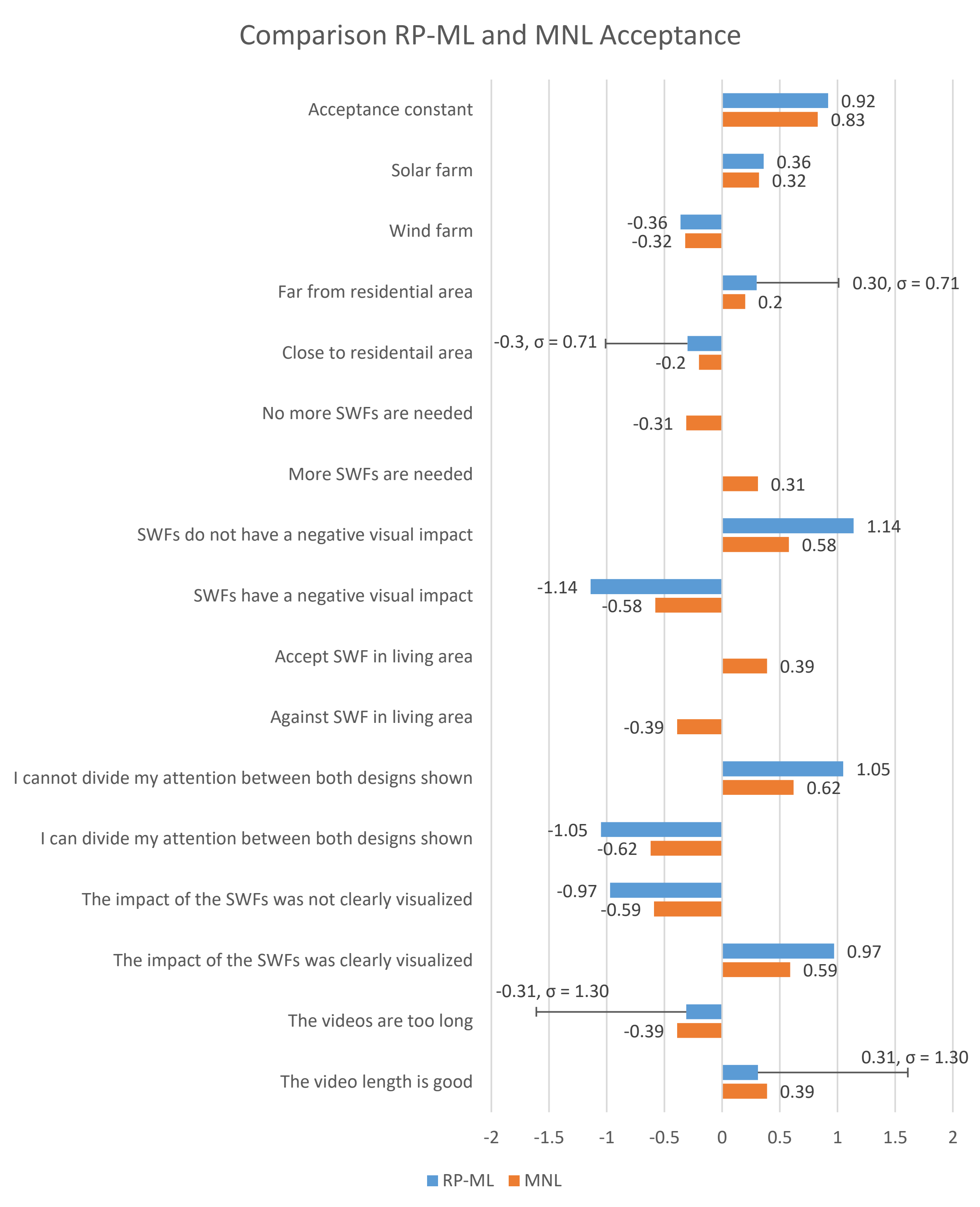

Figure 27: Comparison MNL and RP-ML models acceptance

4.4.3. Combined Model

The combined RP-ML model consists of both the preference and the acceptance data from the DCE and the results are shown in Table 18. The $LL(0)$ of the model is calculated as the sum of the $LL(0)$ of the RP-ML of preference and acceptance. This results in the following equation: -285.63920 + -360.43653 = -646.08. The $LL(\beta)$ of the model is -505.66 and the ρ^2 value, therefore, becomes .22 which implies a good fit. Still, as the performance of the acceptance model is better than the performance of the combined model, it is better to use the separate models to predict probabilities. However, the performance did rise significantly compared to the MNL. There are four parameters with a significant standard deviation. The preference constant has a substantial standard deviation of 4.28 which indicates that there is much heterogeneity amongst respondents regarding preference that is not described by the parameters in the model. There is a large group of respondents that are very likely to prefer a design which is not explained by the parameters in the model. On the other side, there is also a considerable group that has no preference which also cannot be explained by the model. Namely, if the standard deviation is subtracted from the preference constant, the utility of the design alternatives is likely to be less than zero, indicating that the no preference option is most probable to be chosen. The same counts for the acceptance constant, although its standard deviation is smaller, it is still of a considerable size to conclude that there is much heterogeneity for acceptance not explained by the parameters. The probability that majority of respondents accepts a design is higher than that they do not accept it based on the acceptance constant and standard deviation. For the respondents that are one standard deviation added from the acceptance constant, the sum of the parameters must be greater than -2.21 for them to not accept a design. Since multiple negative parameters have to be summed to equal this number, it is unlikely that the outcome of the model for these respondents would be that they do not accept a design.

Table 18: Results RP-ML model combined data

Attribute	Parameter	Significance	Standard deviation	Significance
Preference constant	.80152		4.28249	***
Acceptance constant	.82354	***	1.39163	***
Solar farm	.24433	**	.48909	***
Wind farm	-.24433	**	.48909	***
Far from residential area	.28501	*	.88775	***
Close to residential area	-.28501	*	.88775	***
SWFs have a negative visual impact	-.86082	***		
SWFs do not have a negative visual impact	.86802	***		
Can divide attention between both designs shown	-.72299	***		
Cannot divide attention between both designs shown	.72299	***		
The impact of the SWFs is clearly visualized	.77933	***		
The impact of the SWFs is not clearly visualized	-.77933	***		

***, **, * ==> Significance at 1%, 5%, 10% level.

Next to this, there are also two parameters in the model that have a significant standard deviation that are related to the researched attributes. Namely, the type of development has a standard deviation of .49. The parameter of the solar farm attribute is .24 and for the wind farm attribute -.24. This means that for the majority of the respondents a solar farm development increases the probability they choose the accept alternative and for most of the respondents the opposite counts for wind farms. However, since the standard deviation is twice as big as the parameter, there is also a group of respondents for who the opposite is true. They are more likely to accept a wind farm than a solar farm. For them the part worth utility of a wind farm could be .25 and for a solar farm -.25, which means that they are more probable to accept a wind farm. However, this is only the case for a small subgroup of the respondents. For the majority of the respondents, a solar farm is more likely to be accepted. Next to this, an increase in distance also results in a higher probability of a design being accepted for the majority of the respondents. However, since the standard deviation is bigger than the parameter, for a small subgroup the opposite is true. They are more probable to accept a design closer to a residential area. Both the parameters of the type of SWF and distance to a residential area can be zero for a respondent, which indicates that for a small group of respondents neither one of these attributes can be used to predict the acceptance of a design. However, this is only the case for a very small subgroup of the respondents. The design attributes can always be used, but their effects may be negligible for some individuals.

Regarding the preference alternatives, if the majority of respondents has to choose between a solar and wind farm, they are more probable to prefer the solar farm. However, the standard deviation of the parameter could also lead to the opposite. On the other hand, the part worth utility of both a solar farm and wind fam could be negative. If this is the case for a respondent, he is more likely to choose the no preference alternative. The same can be said for the distance attributes. An increase in distance will lead to a higher probability of a design being preferred by a respondent, although again the opposite is true for a small subgroup.

Figure 28 shows the comparison between the MNL and RP-ML models. The preference constant is not significant in the RP-ML model but has a significant standard deviation as priorly discussed. Next to this, the acceptance constant and design attributes behave in the same way as they did in the MNL but include a standard deviation in the RP-ML. Noticeably, the age attributes are no longer significant. This means that the found heterogeneity in the other attributes covers the part worth utility of the age attributes. The same can be said for the attributes about the fear that CC will affect the respondent personally and if a respondent is supportive of a SWF in his living area. These three statements are significant in the MNL model but not in the RP-ML model. On the other hand, the statement about the beliefs on the visual impact of a SWF on an area did become significant. People that do not belief that a SWF has a negative visual impact are more likely to accept a design. In addition to that, they are also more likely to prefer a design over another. Noteworthy is that this is in line with the acceptance models but opposite of what was found in the preference models. In the preference models, namely, it was found that a negative visual impact increases the probability that a respondent chooses to prefer a design compared to having no preference. Finally, there are two visualization parameters that are significant in predicting both preference as well as acceptance. Respondents that cannot divide their attention between both designs shown are more likely to choose to prefer a design. This can be due to them being drawn towards one design and, therefore, being less able to look at another. However, for accepting a design this is also the case. Respondents that could not divide their attention and, therefore, did not look at both designs equally as much time, are more likely to accept a design. Finally, if the impact of a design was perceived to be clearly visualized, a respondent is more likely to choose to prefer a design as well as to accept it. Clearly visualizing a design, therefore, helps to increase the acceptance of a design and increase the informed decision-making about which design is preferred.

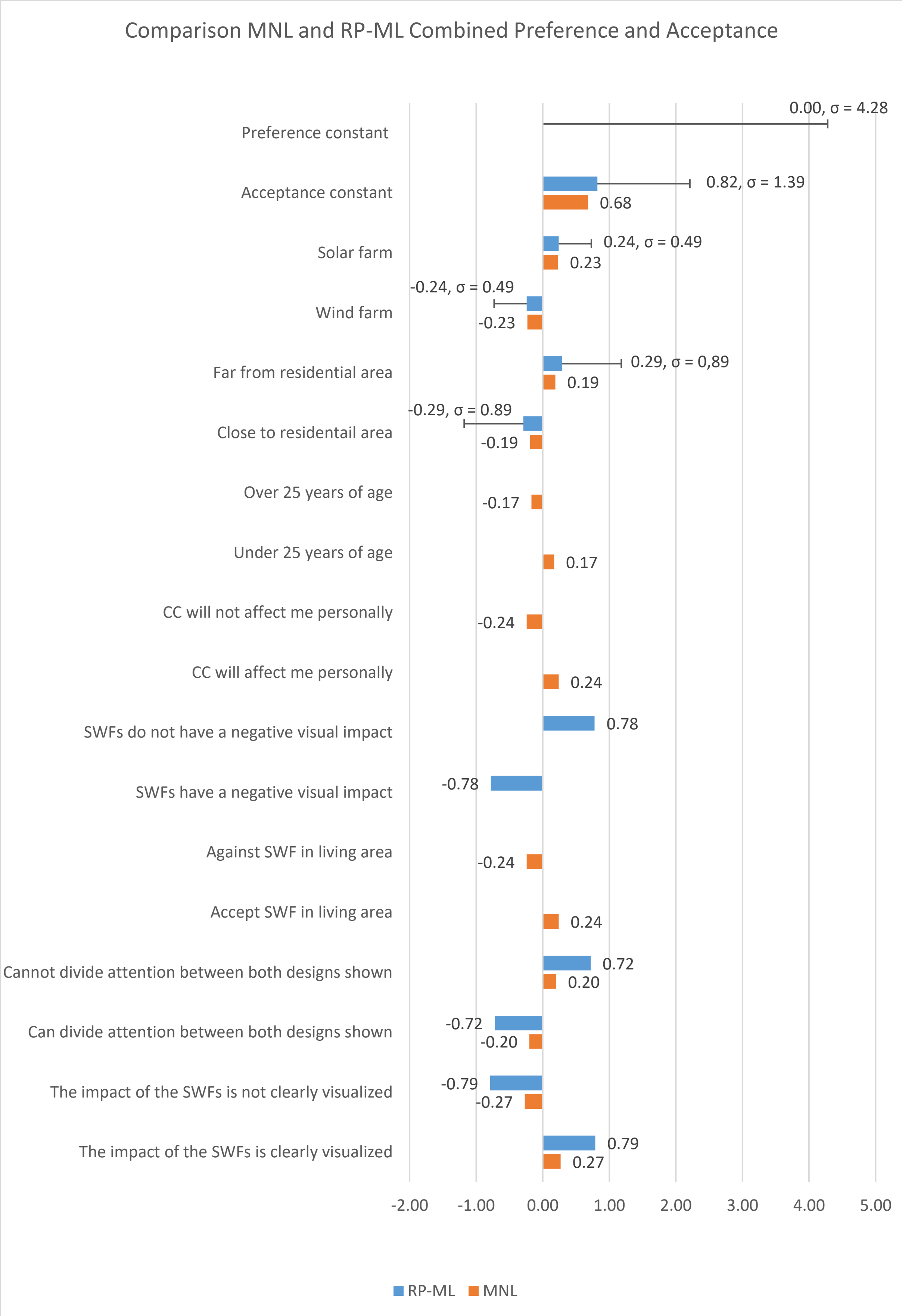

Figure 28: Comparison RP-ML and MNL models combined data

4.5. Discussion and Conclusion

In this chapter the results of the survey have been discussed. The survey was completed by 65 people. Some of the answer categories had to be merged to create groups of close to thirty respondents with similar answers. The ratios of the level of income and age of the respondents were found to be different than that of the population of The Netherlands. The sample is, therefore, not a good representation of the population for these characteristics. The gender and education characteristics on the other hand are comparable to The Netherlands. The findings for these characteristics can, therefore, be seen as representative for The Netherlands. Only a small number of the respondents lived in Zwolle, and therefore, could this variable not be taken into account in further research in this study. This means that the differences or resemblances between the residents of the area and the people that do not, could not be analyzed. The NIMBY concerns that are related to the development of the development of SWFs, therefore, are only tested in hypothetical situations based on the empathy of respondents. On the other hand, the age, income, level of education, and gender variables could be used for further analysis and included in the MNL and RP-ML models.

Most respondents agreed to the statements that CC is happening, that weather extremes are becoming more common, and that the use of pollutants is a contributor to CC. This means that people are generally aware of CC and its effects. A lack of awareness could be a potential burden for the acceptance of a SWF, as was suggested by Cook et al. (2016). Since, the level of agreement with the statements was high, this means that in general there is no lack in awareness. Furthermore, for these statements the group that disagreed with the statements was too small to include in the models and have reliable results. However, for the other CC statements, there is a group that does not agree with the statements. A significant part of the respondents does not belief that CC is caused by humans whilst there is much scientific evidence that some CC effects are human-driven (Höök & Tang, 2013; Oldenborgh et al., 2021; Li et al., 2021). Moreover, some respondents are not afraid of the consequences of CC either for the world as for them personally. This can be linked the findings of Spence et al. (2012), who investigated the psychological distance. Although many respondents are aware of the effects of CC they are not afraid that it will have consequences for them. This means that some respondents show a significant psychological distance from the effects of CC. They indicate that they are aware that it is happening but still deem themselves safe.

Regarding the statements on SWF in general, respondents agreed that a SWF would not have a negative impact on their health. This is beneficial since Susskind et al. (2022) found that opposition against SWFs often originated from health and safety concern. Although the findings of Susskind still can be true, the relative importance of this is neglectable compared to other elements. The majority of the respondents do not believe that a SWF would have a positive impact on the local economy. Providing communities with information about the process and involving them in the decision-making could help mitigate this problem and results in a higher level of acceptance and a change of attitude (Jobert et al., 2007). This could also increase the beliefs of people that local parties should be included which is also not high. Not many people are aware how inclusion of local parties can increase the understanding and support of SWF developments. Next to this, the ratio between people minding a SWF in their living environment or not is evenly divided. This means that about half of the respondents state that they would not want a SWF in their living area regardless of its design. The same counts for the general support for more SWFs. about half of the respondents do think that more SWFs are needed to combat CC. A reason for the low acceptance of a SWF in a living environment lies in the perceived negative visual impact. A substantial part of the respondents indicate that a SWF has a negative influence on the appearance of an area regardless of its design.

The scoring on the statements about the experience with the videos are positive in general. Participants indicate that the differences in design are clear, which is beneficial in making informed decisions. Next to that, the virtual environments were perceived as credible representations of reality. If the virtual environment were not considered to be credible, the impact of the designs on an area could possibly be misjudged. A concern of showing two videos at once in a split screen is that respondents are unable to divide their attentions and experience cyber sickness. However, respondents indicate that they could easily divide their attention without feeling dizzy. The only aspect of the videos that respondents did not like was the length of the video. The videos had a length of two minutes, and four videos were shown to each participant. Shortening the videos or reducing the number of videos shown to each participant could improve the presentation of the designs. However, this would also have been the case if the designs were shown in two videos in sequence. Therefore, in general it can be concluded that showing designs in split screen is a good way to present them and could help to increase the ease of understanding differences of designs and the decision making between them.

MNL and RP-ML models have been created with the data of the preference and acceptance questions. The MNL model of preference has a low performance to predict the choices made. The acceptance model has a reasonable performance and combining both preference and acceptance results in a very poor performing MNL model. The RP-ML models perform much better than the MNL models. The preference model performs reasonably well, and the acceptance model performs good. The combined model does not outperform the separate models, therefore, the separate models should be used to predict preferences and acceptance. The findings of the combined data models were to compare the two types of questions. Some parameters were found to be significant in estimating both preference and acceptance. It was found in all the MNL as well as the RP-ML models that a solar farm and larger distance increase the utility of a choice alternative whereas a wind farm and smaller distance decrease the utility. However, the relative importance of the perceived visual impact of a SWF is more influential in predicting acceptance than the actual design attributes. Therefore, clearly and understandably communicating a design might be more beneficial to community acceptance than differences in the design itself.

5. Conclusion and Discussion

CC and global warming one of the main challenges the world faces today. Their effects are becoming increasingly noticeable and the need for counteracts are becoming more urgent. Related to CC are the use of fossil fuels to generate energy. Namely, the carbon dioxide emitted by producing energy from fossil fuels leads to an increase in CC. Therefore, the energy transition takes place from polluting sources to green, renewable, sources like solar and wind. However, the implementation of renewable energy farms has proven to be subjected to many obstacles. One of these obstacles is the opposition of local communities against the allocation of a utility scale SWF in their living environment. Therefore, a clash arises between the need for renewable energy on the on hand and the opposition against the allocation on the other hand. However, what exactly shapes this opposition is unclear. Therefore, in this study, the following main question is answered. *What factors affect acceptance and preferences regarding solar and wind farm developments near urban areas?* Several sub questions will first be discussed that together answer the main question.

5.1. Research Questions

The first sub question is: How do different design attributes affect community acceptance of SWFs? First of all, land use is insignificant in all of the models. This indicates that people do not value agricultural fields and natural areas differently. On the other hand, the type of SWF is significant. The probability of acceptance of a wind farm is generally lower than that of a solar farm. Next to that, if both a solar and wind farm are shown, the probability of preferring a solar farm is also higher, if the other attributes are the same for both designs. No significant standard deviation for the type of design parameters was found in both the acceptance and preference models. This means that there is no heterogeneity between respondents about how these parameters effect the utility in these models. The final design attribute is the distance from a residential area. The probability of preferring a design located further from a residential area is higher than one that is located closer. Next to that, the acceptance of a designs located further away is also better. For all RP-ML models does the distance have a significant standard deviation. The magnitude of this parameter, therefore, differs per individual. Moreover, the standard deviation is larger than the magnitude of the parameters. This indicates that for the majority of respondents an increase in distance results in a higher preferability and acceptance, but the opposite is also true for a small part of the respondents. They prefer a SWF closer to a residential area and are more likely to accept it.

The second sub question is: How can videos be used to visualize design alternatives and predict community acceptance? Respondents indicate that the differences in the designs that were shown are clearly visible, they were credible, and their impact was understandable. The only point of improvement is the length of the video. The majority of the participants indicate that the videos were too long. However, other expected negativities like the feeling of dizziness or not being able to divide attention over the screen did only occur for a few people. The latter of these two can be linked to the age of the participant. Mainly older people struggled to divide their attention. Therefore, in general it can be concluded that this is a good way to visualize differences in SWFs design. Some of the variables can also be used to predict acceptance, however none were significant in the preference models. The experience of how the designs are presented is, therefore, not significant in predicting if a respondent is probable to prefer a design or have no preference. In the acceptance models on the other side, especially the clear visualization of the differences between designs and the ability to focus on both were found to be influential. More specifically, respondents that indicated that the differences were clearly visualized were much more probable to accept a design. Noteworthy is that respondents that were not able also had a higher probability of accepting a design.

The third sub question is: How do personal characteristics relate to the determinants of community acceptance of solar and wind farms? The first findings are that older people believe more that a SWF would have a negative impact on the appearance of an area, and they are less positive about having a SWF in their living environment. However, in the MNL and RP-ML models of preference, the part worth utility of older people is lower than that of younger people. This indicates that younger people are more likely to prefer one design over the other than to have no preference compared to people over the age of 25. In the models estimating acceptance and the combined data, age is not a significant parameter. This means that there is a difference between preference and acceptance. The second personal characteristic tested was the gender of the respondent. In none of the models gender was found to be statistically significant, opposed to findings of Ladenburg (2010). This indicates that there is no difference between male and females regarding SWFs. Since Zwolle was chosen as a case study, the next personal characteristic was about the place of residence of a participant. Unfortunately, the number of resident of Zwolle that participated was too low to be considered in the logit models. Therefore, hard conclusions on the differences or similarities between people that are familiar with the area and people who are not cannot be made. Education was found to be related to two statements. The group of higher educated participants have less of an aversion of a SWF in their living environment and also do not think as much as the lower educated group that a SWF has a negative effect on the appearance of an area. However, in none of the models, education was found to be significant. This indicates that even though higher educated people indicate that they are more prone to accept SWFs, this does not show in the outcome of the experiment. Income of a participant did not have a significant relation with any of the statements and can also not be found in any of the models. However, it must be noted that the conclusions drawn for the personal characteristics of the respondents only represent the rest of The Netherlands for the gender and education characteristics. The divisions of age and income are not representative for The Netherlands.

The fourth sub question is: How aware are people of the causes and effects of CC and how does this affect community acceptance of solar and wind farms? Most respondents agreed to the statements that CC is happening, that weather extremes are becoming more common, and that the use of pollutants is a contributor. Therefore, it can be concluded that people are generally aware of CC. However, since the group disagreeing with these statements was too small to include in the models, the differences between the groups could not be researched. Therefore, it cannot be researched if lack of belief in CC leads to a higher opposition against SWF with these statements. On the other hand, the opinions on whether CC is caused by humans, and the general and personal concerns were more divided. This suggests that there is a significant physiological distance between the respondents and CC, which could result in less motivation to act. Beliefs that CC is caused by humans is only significant in MNL preference model. More specifically, people who believe CC is caused by humans have a lower utility resulting in a lower probability of them to prefer one design over another. A reason for this might be that they are more concerned about combating CC than what a SWF looks like. The fear of personal impact of CC is only significant in the preference models. Individuals that believe that CC will have negative consequences for them personally, have a higher utility of preferring a design. Thus they are both concerned about personal effects of CC but also have differences in preference for types of design. The general concern about CC is not a significant in any of the models. Therefore, it cannot be used as a predictor to estimate acceptance or preference in design. Respondents that indicate that they are afraid of the consequences of CC are as likely to accept a SWF as people who are not. This indicates that there is a lack of understanding of how SWFs can be used to combat CC and global warming. Namely, if there was sufficient understanding, people that are afraid of CC would be more willing to accept a SWF.

The fifth and final sub question is: How do beliefs on solar and wind farms affect community acceptance? The results of the survey indicate that only a small percentage of the participants believes that a SWF will harm their health. This is beneficial for the acceptance of SWFs since it was found that projects often faced opposition if health concerns were not taken into account. Half of the respondents want local parties to be included in the decision-making process of a SWF. This also means that half of the respondents are not aware of that or not wanting to be included. However, the parameters related to this statement were not significant in predicting either preference or acceptance. The same is concluded for the believe that a SWF would have an influence on the local economy. The majority of people disagrees that there will be a positive impact on the local economy. If more local parties are involved, the belief in improvement for the local economy, and therefore acceptance, could also rise. However, the parameters related to this statement are also is not significant in any of the models. On the other side, the remaining three statements are significant in some of the models. People supporting the development of more SWFs are less probable to have a preference in design and are also more likely to accept a design. However, the part worth utility of these parameters is small compared to other parameters. This means that even if people state that they are supportive of SWFs this barely shows in the results of the models. This means that there is a difference between what these respondents indicate and what they actually accept. The same counts for people stating that they would accept a SWF in their living environment. Compared to people that state the opposite, their probability of accepting a design is only a little higher. The negative visual impact on the other hand is the most influential on the utility of preference and acceptance of all the parameters. People that indicate that a SWF has a negative influence on the appearance of an area are much more likely to prefer a design and, therefore, also much more likely not to prefer another design. In the acceptance models, people stating that there is a negative influence are much more likely not to accept a design. The relative importance of the design attributes is much more important to people that perceive the visual effects of SWFs as negative.

Finally, to answer the main question: The personal characteristics of a person are only a small contributor and are not really significant in predicting acceptance or preferences. From the general beliefs about CC it was found that most people do believe in CC and believe that humans cause it by using pollutants. However, the only significant parameter within this subsection is the personal impact. The awareness of the personal consequences of CC affect acceptance and preference the most. The design attributes are significant predictors of acceptance and preference. Namely, solar farms are preferred over wind farms and an increase in distances also increases the acceptance of a design and the probability it is preferred. However, the parameter with the biggest contribution to predicting both acceptance and preference is the perceived visual impact on the appearance of an area. If respondents indicated that a SWFs do have a negative influence, they are much less probable to accept a design.

5.2. Recommendations

In this study models have been created to estimate community acceptance. A difference is made between a preference model and an acceptance model. For both of these models, the alternative specific constants are of considerable size. This could indicate that there are unidentified parameters that could help to predict preference or acceptance. However, the aim of this research was to include all parameters. Because of the sample size, not all potential parameters could be taken into account. The first recommendation is, therefore, to increase the sample size. This could potentially lead to new outcomes with smaller constants and more significant parameters. However, none the less sample size, good performing models could be created. With these models recommendations for policy makers will be described.

The utility of preference and acceptance is subjective to beliefs on the visual impact on the area and some design attributes. The results of the models of both preference and acceptance indicate that solar farms are preferred over wind farms, as well as a larger distance from a residential area. The coefficients of the distance parameter also have a significant standard deviation. This means that the type of development or distance are much more relevant in predicating acceptance for some groups than for others. The recommendation, therefore, is to identify the target groups that do value the extreme values of these coefficients and identify why they value them as much. With that information a strategy can be developed to decrease the chance of opposition of projects and enhance community acceptance as a whole. Next to this, there is also the perceived negative visual impact on the area. This parameter does not have a significant standard deviation which indicates that there is no heterogeneity amongst individuals. The belief that a SWF will have a negative impact on the appearance of an area has a significant negative effect on utility. The probability of acceptance of a design decreases when negative visual impacts are perceived. Therefore, it is a must to accurately visualize the impact of a SWF development on an area. A way of doing this is by showing the designs like the videos created for this study. The results of the new created visualization technique indicate that the impact shown by the designs and the credibility of these designs are generally reviewed as good. Next, there are the alternative specific constants of preference and acceptance. These both have a significant value and a large standard deviation. This indicates that the probability of preferring a design and accepting it are higher than not doing so but is not explained by the parameters in the models. To finalize the conclusions and recommendations, this research provides insights in that good performing models to predict acceptance and preferences can be made. The results of these models can be used by policy makers to create target groups to increase the acceptance of solar and wind farms.

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Appendix

Appendix A – Experimental Design

Suggesting Design Size

```
         Design Summary
    Number of
    Levels        Frequency
         2             3
```

Suggesting Design Size

```
Saturated       = 4
Full Factorial = 8
Some Reasonable                            Cannot Be
   Design Sizes          Violations        Divided By
              4 *S                 0
              8 *                  0
              6                    3      4
              5                    6      2 4
              7                    6      2 4
* - 100% Efficient design can be made with the MktEx macro.
S - Saturated Design - The smallest design that can be made.
```

Obs	x1	x2	x3
1	1	1	1
2	1	1	2
3	1	2	1
4	1	2	2
5	2	1	1
6	2	1	2
7	2	2	1
8	2	2	2

Appendix B – Survey

B.1 Page 1 – Introduction

Dear participant,

First of all, I would like to thank you for participating in this survey for my graduation research at Eindhoven University of Technology. I would like to emphasize that filling in this survey is voluntary. The purpose of this survey is to find out people's preferences regarding large-scale renewable energy farms.

The survey starts with a few questions about yourself, followed by a number of statements about climate change, and solar and wind farms. You then watch a number of videos showing different designs created for South of Zwolle around the IJssel River. After each video, we will ask you what you think. The survey takes about 15 minutes to complete. Your answers will be stored and processed anonymously. If you have any further questions, please contact me at: m.i.j.bouwmans@student.tue.nl

Kind regards,

Michel Bouwmans

Before starting the survey, the law requires you to accept the privacy terms. For more information: click on Show policy.

By clicking the box below, I acknowledge the following:

I am sufficiently informed about the research project through a separate information sheet. I have read the information sheet and have had the opportunity to ask questions. These questions have been answered satisfactorily. I take part in this research project voluntarily. There is no explicit or implicit pressure for me to take part in this research project. It is clear to me that I can end participation in this research project at any moment, without giving any reason. I do not have to answer a question if I do not wish to do so. I consent to processing my personal data gathered during the research in the way described in the information sheet.

☐ **To continue please first accept our survey privacy policy.**
Show policy

Next

B.2 Page 2 – Personal details

Personal details

This part of the survey asks for some of your personal details. It is important to note that the data collected cannot be used to find out who answered the questions.

*What is your age?

- 18 - 24 Years
- 25 - 34 Years
- 35 - 44 Years
- 45 - 54 Years
- 55 - 64 Years
- 65+ Years
- I prefer not to say

*What is your gender?

- Male
- Female
- Other/ I prefer not to say

*What is your gross annual income?

- Less than €10.000
- Between €10.000 and €20.000
- Between €20.000 and €30.000
- Between €30.000 and €40.000
- Between €40.000 and €50.000
- Between €50.000 and €100.000
- Between €100.000 and €200.000
- over €200.000
- I prefer not to say

What are the four digits of your postcode?

If you do not wish to share this, you can skip this question

Only numbers may be entered in this field.

*What is the highest level of education you have completed?

- Primary education
- Secondary education (VMBO/HAVO/VWO)
- Secondary vocational education (MBO)
- Higher vocational education (HBO or bachelor degree WO)
- WO master or PhD
- I prefer not to say

B.3 Page 3 – Statements on CC

Statements on climate change

*Please indicate the extent to which you agree with the following statements.

	Strongly disagree	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree	Strongly agree
Climate change is happening	○	○	○	○	○	○	○
Climate change is mainly caused by human activities	○	○	○	○	○	○	○
I am concerned about the consequences of climate change	○	○	○	○	○	○	○
I think climate change will have negative consequences for me personally	○	○	○	○	○	○	○
Extremes in the weather, such as heavy showers and long droughts, are becoming more common	○	○	○	○	○	○	○
The use of pollutants, such as fossil fuels, contributes to climate change	○	○	○	○	○	○	○

B.4 Page 4 – Statements on solar and wind farms

Statements on solar and wind farms

*Please indicate the extent to which you agree with the following statements.

	Strongly disagree	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree	Strongly agree
More solar and wind farms should be built to combat climate change	○	○	○	○	○	○	○
Solar and wind farms have a negative impact on the appearance of an area	○	○	○	○	○	○	○
Citizens and local companies should be included in the decision-making process of solar and wind farms	○	○	○	○	○	○	○
I would not mind a solar or wind farm being built in my area	○	○	○	○	○	○	○
Solar and wind farms could have a positive impact on the local economy	○	○	○	○	○	○	○
I am afraid that a solar and wind farm will have a negative impact on my health	○	○	○	○	○	○	○

B.5 Page 5 – Explanation choice sets

Solar and wind farms in the South of Zwolle

The next part of the Survey consists of four short videos. Each video will be split into two clips. Each clip shows where solar and wind farms could be placed and what that would look like, in this case, in the South of Zwolle. Then we ask some questions about what you have seen. To be clear, these are imaginary designs.

For each video a map is first shown, like the one below, showing where the solar and wind farms are placed. The route traveled in the area is also shown. If you want, you can watch the videos several times. Now click on 'next'.

B.6 Page 6 - Choice set (repeated four times)

Solar and wind farms in the South of Zwolle

Where would you rather live, in the residential areas of the left or the right design?

(If it doesn't matter to you, you can choose 'No preference')

- The left design
- The right design
- No preference

*Imagine you lived in one of the residential areas on the map before there was a solar or wind farm. Would you then agree if the designs were realized?

- Yes, both designs
- Only the left design
- Only the right design
- No, neither designs

B.7 Page 7 - Statements on experience of the videos

Statements about your experience with the videos

You have watched some videos about possible design ideas for solar and wind farms in the south of Zwolle. Now follow some statements about how you observed these videos.

*Please indicate the extent to which you agree with the following statements.

	Strongly disagree	Disagree	Somewhat disagree	Neither agree or disagree	Somewhat agree	Agree	Strongly agree
The differences in design between the left and right halves of each video were clearly visible	○	○	○	○	○	○	○
I experienced dizziness while watching the videos	○	○	○	○	○	○	○
I could easily divide my attention between the left and right halves of a video	○	○	○	○	○	○	○
The videos showed a credible representation of reality	○	○	○	○	○	○	○
The impact of possible developments was clearly visualised	○	○	○	○	○	○	○
The videos took too long to stay focused	○	○	○	○	○	○	○

B.8 Page 8 – Comments

End of survey

You have reached the end of the survey. If you have any comments about the survey, please write them here. When you are sure of all your answers, you can press submit.

B.9 Page 9 – Thank you page

Thank you very much for taking part in the survey.

Appendix C – Informed Consent Form

Information sheet for research project "Community acceptance of Solar and Wind farms"

Introduction

You have been invited to take part in research project community acceptance of solar and wind farms, because you have been approached by the researcher or because you found a link to this research on an online platform

Participation in this research project is voluntary: the decision to take part is up to you. Before you decide to participate we would like to ask you to read the following information, so that you know what the research project is about, what we expect from you and how we deal with processing your personal data. Based on this information you can indicate via the consent declaration whether you consent to take part in this research project and the processing of your personal data.

You may of course always contact the researcher via m.i.j.bouwmans@student.tue.nl if you have any questions, or you can discuss this information with people you know.

Purpose of the research

This research is led by Michel Bouwmans BSc.
The purpose of this research is to find out what people's preferences are regarding the development of solar and wind farms. This examines your position on CC in general and whether you think solar and wind farms offer a solution to this. In addition, it is investigated whether there is a difference in the results of the research between different personal characteristics groups. The last thing that is also examined is to what extent the videos created are comparable to what people expect to experience in reality. The findings will be incorporated into a report that will be used as a master's graduation project by the aforementioned researcher.

Controller in the sense of the GDPR

TU/e is responsible for processing your personal data within the scope of the research. The contact details of TU/e are:
Technische Universiteit Eindhoven
De Groene Loper 3
5612 AE Eindhoven

What will taking part in the research project involve?

You will be taking part in a research project in which we will gather information by:
Submit a questionnaire to you about your personal characteristics data and your opinion on CC and solar and wind farms. In addition, you will be shown every few videos where you will be asked to make a choice about which situation you prefer. The last part of the questionnaire consists of a number of questions about how you experienced the videos shown.

For your participation in this research project you will not be compensated.

Potential risks and inconveniences

Your participation in this research project does not involve any physical, legal or economic risks. You do not have to answer questions which you do not wish to answer. Your participation is voluntary. This means that you may end your participation at any moment you choose by letting the researcher know this. You do not have to explain why you decided to end your participation in the research project.

Withdrawing your consent and contact details

Participation in this research project is entirely voluntary. You may end your participation in the research project at any moment, or withdraw your consent to using your data for the research, without specifying any reason. Ending your participation will have no disadvantageous consequences for you.

If you decide to end your participation during the research, the data which you already provided up to the moment of withdrawal of your consent will be used in the research.

Do you wish to end the research, or do you have any questions and/or complaints? Then please contact the researcher via m.i.j.bouwmans@student.tue.nl

If you have specific questions about the handling of personal data you can direct these to the data protection officer of TU/e by sending a mail to functionarisgegevensbescherming@tue.nl. Furthermore, you have the right to file a complaint with the Dutch data protection authority: the Autoriteit Persoonsgegevens.

Finally, you have the right to request access, rectification, erasure or adaptation of your data. Submit your request via privacy@tue.nl.

Legal ground for processing your personal data

The legal basis upon which we process your data is consent.

What personal data from you do we gather and process?

Within the framework of the research project we process the following personal data:

Category	Personal data
Personal characteristics data	*Age, gender, 4-digit postcode, level of education, income*

Within the framework of the research project your personal data will be shared with:

Storage solution: SURFdrive, storage of data

Survey tool: LimeSurvey (Germany or Finland), creating and administering survey

Data analysis tool: IBM Corp. SPSS (The Netherlands), analyzing data, performed on the laptop of the researcher run locally.

Confidentiality of data

We will do everything we can to protect your privacy as best as possible. The research results that will be published will not in any way contain confidential information or personal data from or about you through which anyone can recognize you, unless in our consent form you have explicitly given your consent for mentioning your name, for example in a quote.

The personal data that were gathered via the online survey and other documents within the framework of this research project, will be stored on SURFdrive.

The raw and processed research data will be retained for a period of 10 years. Ultimately after expiration of this time period the data will be either deleted or anonymized so that it can no longer be connected to an individual person. The research data will, if necessary (e.g. for a check on scientific integrity) and only in anonymous form be made available to persons outside the research group.

This research project was assessed and approved on 16-10-2023 by the ethical review committee of Eindhoven University of Technology.

Consent form for participation by an adult

By signing this consent form I acknowledge the following:

I am sufficiently informed about the research project through a separate information sheet. I have read the information sheet and have had the opportunity to ask questions. These questions have been answered satisfactorily.

I take part in this research project voluntarily. There is no explicit or implicit pressure for me to take part in this research project. It is clear to me that I can end participation in this research project at any moment, without giving any reason. I do not have to answer a question if I do not wish to do so.
Furthermore, I consent to the following parts of the research project:
I consent to processing my personal data gathered during the research in the way described in the information sheet.

YES ☐ NO ☐

Appendix D – Extensive Descriptive Analysis

Median and mode

The tables in this chapter show the median and mode of all the personal characteristics data and data of the statements. The median is found by choosing the middle number after ordering all the data in a variable and the mode is the option that is chosen the most (Khan Academy, 2023). Full frequency tables covering all the gathered data can be found in Appendix.

Personal characteristics

As could be expected from the conclusions of the Chi-Square goodness-of-fit test of the sample and population, the mode and median of age are the younger age groups. The medians and modes of gender, education, and income could be deducted from the same reasoning as well. Next to this, the number of respondents who are not residents of Zwolle is much bigger than the group that are residents of Zwolle resulting in a median and mode of 'No' as shown in Table 19.

Table 19: Median and mode personal characteristics variables

	N		Median	Mode
	Valid	Missing		
Age	64	1	25-34 Years	18-24 Years
Gender	64	1	Male	Male
Resident Zwolle	58	7	No	No
Education	64	1	Higher vocational education	Higher vocational education
Income	52	13	Between €20.000 and €30.000	Below €10.000

Statements about CC

Looking at Table 20 it can be seen that the median and mode of the statements are either 'agree' or 'strongly agree'. Most respondents, therefore, confirm that they are aware of CC and indicate that it is mainly caused by human activities. Next to this, they indicate that they are concerned about the consequences of CC and that using pollutants contributes to the problem.

Table 20: Median and mode statements CC

	N		Median	Mode
	Valid	Missing		
CC is happening	65	0	Strongly agree	Strongly agree
CC is mainly caused by human activities	65	0	Agree	Agree
I am concerned about the consequences of CC	65	0	Agree	Agreea
I think CC will have negative consequences for me personally	65	0	Agree	Agree
Extremes in the weather, such as heavy showers and long droughts, are becoming more common	65	0	Agree	Strongly agree
The use of pollutants, such as fossil fuels, contributes to CC	65	0	Strongly agree	Strongly agree

a: Multiple modes exist. The smallest value is shown

Statements about solar and wind farms

The median of the statement; more solar and wind farms should be built is 'somewhat agree' and the mode is 'agree', as shown in Table 21. The general opinion, therefore, is positive towards creating more solar and wind farms. On the other hand respondents also state they 'somewhat agree' that solar and wind farms have a negative impact on the appearance of an area. This might indicate a clash resulting in a trade-off of interests. On the one hand preservation of an area and on the other hand the awareness that solar and wind farms are needed to combat CC. This is something that came forth in the literature study as well and is now confirmed for this study. However, respondents also state they would not mind a solar and wind farm in their area. This presumably indicates that building solar and wind farms to combat CC is perceived as more important than preserving the appearance of an area where people live. Increasing the local influence in the decision-making of solar and wind farms could be used as a possible catalysator to increase the importance of combating CC over preserving the appearance of an area. Namely, respondents indicate that local parties should be included in the decision-making process. Including these parties in the early process of creating a solar and wind farm could, therefore, be beneficial for progression of a project. Including them could also improve the opinion on the impact of solar and wind farms on the local economy. Local parties could be included in for instance the building or maintenance of a farm. Regarding the health concerns that could potentially form a reason to not accept a solar or wind farm, most respondents disagree that these farms would have a negative on their health. Acceptance of the designs, therefore, is not based on health concerns.

Table 21: Median and mode statements solar and wind farms

	N		Median	Mode
	Valid	Missing		
More solar and wind farms should be built to combat CC.	65	0	Somewhat agree	Agree
Solar and wind farms have a negative impact on the appearance of an area	65	0	Somewhat agree	Somewhat agree[a]
Citizens and local companies should be included in the decision-making process of solar and wind farms	65	0	Agree	Agree
I would not mind a solar or wind farm being built in my area	65	0	Somewhat agree	Agree
Solar and wind farms could have a positive impact on the local economy	65	0	Neither agree or disagree	Neither agree or disagree
I am afraid that a solar and wind farm will have a negative impact on my health	65	0	Disagree	Disagree

a: Multiple modes exist. The smallest value is shown.

Statements about the experience with the videos

Respondents are generally positive about their experience with the videos as is shown in Table 22. They indicate that they agree with the statements that positively ask about their experience. Therefore, it can be concluded that differences between both sides of the videos were clearly visible and showed a credibly representation of reality. Respondents also indicate that they did not experience dizziness while watching the videos. Something that is contrary to what was expected. Namely, the split screen and rapid movement through the area was expected to cause some level of dizziness. The length of the videos is somewhat agreed on to be too much. This could potentially influence if the respondent accepted a design or not. However, the chances of respondents losing focus during the last videos is higher than during the first videos. Since the order of the choice sets was randomized, this impact is minimized.

Table 22: Median and mode statements experience with the videos

	N		Median	Mode
	Valid	Missing		
The differences in design between the left and right halves of each video were clearly visible	65	0	Agree	Agree[a]
I experienced dizziness while watching the videos	65	0	Disagree	Strongly disagree
I could easily divide my attention between the left and right halves of a video	65	0	Agree	Agree
The videos showed a credible representation of reality	65	0	Agree	Agree
The impact of possible developments was clearly visualized	65	0	Agree	Agree
The videos took too long to stay focused	65	0	Neither agree or disagree	Somewhat agree

a: Multiple modes exist. The smallest value is shown.

Acceptance

63.8% of times a design was shown to a respondent it was accepted as shown in Table 23. Alternative 3 was percentual the most acceptable with it being accepted 74.6% of times as shown in Table 23. This alternative showed a solar farm placed on agricultural land far from a residential area. The least accepted alternative with an acceptance score of 48.5% is alternative 6. This alternative showed a design of a wind farm on agricultural land close to a residential area.

Table 23: Acceptance of alternatives

	Unacceptable		Acceptable		Total
Alternative	Count	% within Alternative	Count	% within Alternative	Count
1	26	41.90%	36	58.10%	62
2	24	37.50%	40	62.50%	64
3	18	25.40%	53	74.60%	71
4	24	33.80%	47	66.20%	71
5	28	29.50%	67	70.50%	95
6	50	51.50%	47	48.50%	97
7	9	30.00%	21	70.00%	30
8	9	30.00%	21	70.00%	30
Total	188	36.20%	332	63.80%	520

Appendix E – Chi-Square Test Statistics

Table 24: Chi-square test gender

	Percentage		Sample of 64				
Gender	Expected	Observed	Expected	Observed	Observed - Expected	Square difference	Square difference/ Expected
Male	49.3	59.4	31.6	38.0	6.4	41.5	1.3
Female	50.7	40.6	32.4	26.0	-6.4	41.5	1.3
Total	100.0	100.0	64.0	64.0			
					Test statistic		2.6
					Chi-square value		3.8
					Degrees of freedom		1

Table 25: Chi-square test age

	Percentage		Sample of 64				
Age	Expected	Observed	Expected	Observed	Observed - Expected	Square difference	Square difference/ Expected
Younger	11.0	40.6	7.1	26.0	18.9	358.3	50.7
Older	89.0	59.4	56.9	38.0	-18.9	358.3	6.3
					Test statistic		57.0
					Chi-square value		3.8
					Degrees of freedom		1

Table 26: Chi-square test education

	Percentage		Sample of 64				
Education	Expected	Observed	Expected	Observed	Observed - Expected	Square difference	Square difference/ Expected
Lower	59.4	48.4	38.0	31.0	-7.0	49	1.3
Higher	40.6	51.6	26.0	33.0	7.0	49	1.9
					Test statistic		3.2
					Chi-square value		3.8
					Degrees of freedom		1

Table 27: Chi-square test income

	Percentage		Sample of 52				
Income	Expected	Observed	Expected	Observed	Observed - Expected	Square difference	Square difference/ Expected
Lower	15.4	48.1	8.0	25.0	17.0	289.4	36.2
Higher	84.6	51.9	44.0	27.0	-17.0	289.4	6.6
					Test statistic		42.8
					Chi-square value		3.8
					Degrees of freedom		1

Appendix F – Spearman Correlation

Table 28: Spearman correlation

		Age	Gender	Education	Income	CC Human Causes	CC General Concerns	CC Personal Concerns	SW More	SW Impact Area	SW Local Inclusion	SW Would Not Mind	SW Local Economy	V Divide Attention	V Representation Reality	V Visualization Impact	V Length Reversed
Age	Cor.	1.000	0.083	0.026	0.484	0.028	0.126	0.184	-0.032	0.430	0.327	-0.236	0.186	-0.109	0.012	-0.109	0.067
	Sig.		0.510	0.836	0.000	0.825	0.317	0.143	0.803	0.000	0.008	0.058	0.137	0.389	0.924	0.389	0.598
	N	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
Gender	Cor.	0.083	1.000	-0.040	-0.010	0.217	-0.016	0.106	-0.069	0.180	-0.098	-0.055	0.003	0.012	0.027	0.040	-0.094
	Sig.	0.510		0.754	0.934	0.082	0.901	0.400	0.586	0.152	0.435	0.665	0.979	0.922	0.831	0.749	0.457
	N	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
Education	Cor.	0.026	-0.040	1.000	0.140	0.257	0.362	0.279	0.310	-0.280	-0.192	0.408	0.055	-0.147	0.024	-0.147	-0.153
	Sig.	0.836	0.754		0.267	0.039	0.003	0.025	0.012	0.024	0.126	0.001	0.666	0.244	0.852	0.244	0.224
	N	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
Income	Cor.	0.484	-0.010	0.140	1.000	-0.013	0.138	0.069	0.104	-0.065	0.167	-0.028	0.139	-0.050	-0.151	-0.271	0.160
	Sig.	0.000	0.934	0.267		0.916	0.274	0.586	0.409	0.605	0.182	0.822	0.268	0.694	0.229	0.029	0.202
	N	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
CC Human Causes	Cor.	0.028	0.217	0.257	-0.013	1.000	0.451	0.498	0.056	-0.090	0.093	0.263	0.071	-0.011	0.134	0.206	0.054
	Sig.	0.825	0.082	0.039	0.916		0.000	0.000	0.655	0.478	0.460	0.034	0.572	0.930	0.287	0.100	0.668
	N	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
CC General Concerns	Cor.	0.126	-0.016	0.362	0.138	0.451	1.000	0.538	0.362	-0.257	0.124	0.305	0.132	-0.062	0.020	0.011	0.031
	Sig.	0.317	0.901	0.003	0.274	0.000		0.000	0.003	0.039	0.325	0.014	0.296	0.624	0.877	0.929	0.808
	N	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
CC Personal Concerns	Cor.	0.184	0.106	0.279	0.069	0.498	0.538	1.000	0.016	-0.068	0.102	0.113	0.045	0.031	0.260	0.098	0.162
	Sig.	0.143	0.400	0.025	0.586	0.000	0.000		0.899	0.589	0.417	0.368	0.721	0.808	0.037	0.440	0.197
	N	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
SW More	Cor.	-0.032	-0.069	0.310	0.104	0.056	0.362	0.016	1.000	-0.209	-0.138	0.354	0.295	-0.277	-0.172	0.056	-0.184
	Sig.	0.803	0.586	0.012	0.409	0.655	0.003	0.899		0.094	0.274	0.004	0.017	0.026	0.170	0.655	0.142
	N	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
SW Impact Area	Cor.	0.430	0.180	-0.280	-0.065	-0.090	-0.257	-0.068	-0.209	1.000	0.241	-0.519	-0.158	0.047	0.188	0.116	0.036
	Sig.	0.000	0.152	0.024	0.605	0.478	0.039	0.589	0.094		0.053	0.000	0.208	0.707	0.133	0.358	0.776
	N	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
SW Local Inclusion	Cor.	0.327	-0.098	-0.192	0.167	0.093	0.124	0.102	-0.138	0.241	1.000	-0.344	-0.008	-0.109	0.071	-0.243	0.360
	Sig.	0.008	0.435	0.126	0.182	0.460	0.325	0.417	0.274	0.053		0.005	0.951	0.389	0.574	0.051	0.003
	N	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
SW Would Not Mind	Cor.	-0.236	-0.055	0.408	-0.028	0.263	0.305	0.113	0.354	-0.519	-0.344	1.000	-0.082	-0.139	-0.177	0.062	-0.250
	Sig.	0.058	0.665	0.001	0.822	0.034	0.014	0.368	0.004	0.000	0.005		0.517	0.269	0.158	0.624	0.045
	N	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
SW Local Economy	Cor.	0.186	0.003	0.055	0.139	0.071	0.132	0.045	0.295	-0.158	-0.008	-0.082	1.000	-0.083	-0.100	0.071	-0.107
	Sig.	0.137	0.979	0.666	0.268	0.572	0.296	0.721	0.017	0.208	0.951	0.517		0.509	0.428	0.572	0.397
	N	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
V Divide Attention	Cor.	-0.109	0.012	-0.147	-0.050	-0.011	-0.062	0.031	-0.277	0.047	-0.109	-0.139	-0.083	1.000	0.273	0.350	0.336
	Sig.	0.389	0.922	0.244	0.694	0.930	0.624	0.808	0.026	0.707	0.389	0.269	0.509		0.028	0.004	0.006
	N	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
V Representation Reality	Cor.	0.012	0.027	0.024	-0.151	0.134	0.020	0.260	-0.172	0.188	0.071	-0.177	-0.100	0.273	1.000	0.413	0.393
	Sig.	0.924	0.831	0.852	0.229	0.287	0.877	0.037	0.170	0.133	0.574	0.158	0.428	0.028		0.001	0.001
	N	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
V Visualization Impact	Cor.	-0.109	0.040	-0.147	-0.271	0.206	0.011	0.098	0.056	0.116	-0.243	0.062	0.071	0.350	0.413	1.000	0.125
	Sig.	0.389	0.749	0.244	0.029	0.100	0.929	0.440	0.655	0.358	0.051	0.624	0.572	0.004	0.001		0.323
	N	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65
V Length Reversed	Cor.	0.067	-0.094	-0.153	0.160	0.054	0.031	0.162	-0.184	0.036	0.360	-0.250	-0.107	0.336	0.393	0.125	1.000
	Sig.	0.598	0.457	0.224	0.202	0.668	0.808	0.197	0.142	0.776	0.003	0.045	0.397	0.006	0.001	0.323	
	N	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65	65

Appendix G – Multinomial Logit Models

G.1 Preference

```
Discrete choice (multinomial logit) model
Dependent variable                  Choice
Log likelihood function         -249.92757
Estimation based on N =     260, K =    8
Inf.Cr.AIC  =     515.9 AIC/N =     1.984
```

```
            Log likelihood R-sqrd R2Adj
ASCs  only  model must be fit separately
               Use NLOGIT ;…;RHS=ONE$
Note: R-sqrd = 1 - logL/Logl(constants)
Warning:  Model does not contain a full
set of ASCs. R-sqrd is problematic. Use
model setup with ;RHS=one to get LogL0.
```

```
Response data are given as ind. Choices
Number of obs.=   260, skipped    0 obs
```

CHOICE	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
C1	.71141***	.20340	3.50	.0005	.31275	1.11007
TTYPE	-.19418**	.07768	-2.50	.0124	-.34644	-.04193
TLOCATIO	.21843**	.08548	2.56	.0106	.05088	.38597
TAGE	-.63768***	.17712	-3.60	.0003	-.98483	-.29052
THUMANAC	-.37925**	.18764	-2.02	.0433	-.74701	-.01149
TPERSCON	.77257***	.18246	4.23	.0000	.41495	1.13019
TBLTMORS	-.36343**	.15288	-2.38	.0174	-.66306	-.06379
TNEGAPPE	.99620***	.19507	5.11	.0000	.61388	1.37853

```
***, **, * → Significance at 1%, 5%, 10% level.
Model was estimated on Jun 27, 2024 at 11:55:41 AM
```

G.2 Acceptance

```
-----------------------------------------------------------------------
Discrete choice (multinomial logit) model
Dependent variable               Choice
Log likelihood function      -275.09430
Estimation based on N =     520, K =    9
Inf.Cr.AIC  =     568.2 AIC/N =    1.093
---------------------------------------
            Log likelihood R-sqrd R2Adj
ASCs  only  model must be fit separately
               Use NLOGIT ;...;RHS=ONE$
Note: R-sqrd = 1 - logL/Logl(constants)
Warning:  Model does not contain a full
set of ASCs. R-sqrd is problematic. Use
model setup with ;RHS=one to get LogL0.
---------------------------------------
Response data are given as ind. choices
Number of obs.=   520, skipped    0 obs
--------+--------------------------------------------------------------
        |                Standard            Prob.      95% Confidence
  CHOICE|  Coefficient     Error       z    |z|>Z*         Interval
--------+--------------------------------------------------------------
      C2|      .83244***     .14570     5.71  .0000       .54687   1.11800
   TTYPE|    -.31568***     .10519    -3.00  .0027     -.52185   -.10951
TLOCATIO|      .20193*       .10999     1.84  .0664     -.01365    .41751
TBLTMORS|      .31244***     .11183     2.79  .0052      .09326    .53161
TNEGAPPE|    -.58046***     .12396    -4.68  .0000     -.82341   -.33750
TWLDNTMN|      .38750***     .13132     2.95  .0032      .13012    .64489
TDIVATTE|    -.62324***     .14191    -4.39  .0000     -.90137   -.34510
TVISIMPA|      .59117***     .13216     4.47  .0000      .33214    .85019
TLENGTHV|      .39084***     .11992     3.26  .0011      .15581    .62587
--------+--------------------------------------------------------------
***, **, * ==>  Significance at 1%, 5%, 10% level.
Model was estimated on Jun 27, 2024 at 00:02:54 PM
-----------------------------------------------------------------------
```

G.3 Combined data

```
-----------------------------------------------------------------------------
Discrete choice (multinomial logit) model
Dependent variable               Choice
Log likelihood function      -593.37416
Estimation based on N =     780, K =   8
Inf.Cr.AIC  =    1202.7 AIC/N =    1.542
---------------------------------------
            Log likelihood R-sqrd R2Adj
ASCs  only  model must be fit separately
               Use NLOGIT ;...;RHS=ONE$
Note: R-sqrd = 1 - logL/Logl(constants)
Warning:  Model does not contain a full
set of ASCs. R-sqrd is problematic. Use
model setup with ;RHS=one to get LogL0.
---------------------------------------
Response data are given as ind. choices
Number of obs.=   780, skipped    0 obs
--------+--------------------------------------------------------------------
        |                 Standard            Prob.       95% Confidence
  CHOICE|  Coefficient      Error       z    |z|>Z*          Interval
--------+--------------------------------------------------------------------
      C2|     .67964***      .10570     6.43  .0000       .47248    .88681
   TTYPE|    -.22912***      .06070    -3.77  .0002     -.34809   -.11014
TLOCATIO|     .19350***      .06515     2.97  .0030       .06581    .32119
    TAGE|    -.16767**       .08388    -2.00  .0456     -.33207   -.00327
TPERSCON|     .24061***      .08049     2.99  .0028       .08285    .39837
TWLDNTMN|     .24030***      .08314     2.89  .0038       .07735    .40325
TDIVATTE|    -.20244**       .09179    -2.21  .0274     -.38235   -.02253
TVISIMPA|     .27050***      .08867     3.05  .0023       .09671    .44430
--------+--------------------------------------------------------------------
***, **, * ==>  Significance at 1%, 5%, 10% level.
Model was estimated on Jun 27, 2024 at 00:11:08 PM
-----------------------------------------------------------------------------
```

Appendix H – Random Parameter Mixed Logit

H.1 Preference

```
-----------------------------------------------------------------------------
Random Parameters Multinom. Logit Model
Dependent variable               CHOICE
Log likelihood function      -234.48959
Restricted log likelihood    -285.63920
Chi squared [   9](P= .000)   102.29921
Significance level               .00000
McFadden Pseudo R-squared      .1790707
Estimation based on N =    260, K =   9
Inf.Cr.AIC  =    487.0 AIC/N =    1.873
---------------------------------------
            Log likelihood R-sqrd R2Adj
No coefficients  -285.6392  .1791 .1646
Constants only can be computed directly
               Use NLOGIT ;...;RHS=ONE$
At start values  -252.0429  .0696 .0533
Note: R-sqrd = 1 - logL/Logl(constants)
Warning:  Model does not contain a full
set of ASCs. R-sqrd is problematic. Use
model setup with ;RHS=one to get LogL0.
---------------------------------------
Response data are given as ind. choices
Replications for simulated probs. =1000
Used Halton sequences in simulations.
RP-ML  model with panel has      65 groups
Fixed number of obsrvs./group=        4
Number of obs.=   260, skipped    0 obs
--------+--------------------------------------------------------------------
        |                Standard            Prob.      95% Confidence
  CHOICE|  Coefficient     Error       z    |z|>Z*         Interval
--------+--------------------------------------------------------------------
        |Random parameters in utility functions.............................
      C1|    1.14247***     .42282      2.70  .0069      .31377   1.97118
TLOCATIO|     .24417**      .11472      2.13  .0333      .01932    .46902
        |Nonrandom parameters in utility functions..........................
   TTYPE|    -.19533**      .08455     -2.31  .0209     -.36104   -.02961
    TAGE|    -.85510**      .39228     -2.18  .0293    -1.62396   -.08623
TPERSCON|     .89907**      .36488      2.46  .0137      .18391   1.61423
TBLTMORS|    -.62813*       .35787     -1.76  .0792    -1.32955    .07329
TNEGAPPE|    1.45082***     .43150      3.36  .0008      .60509   2.29655
        |Distns. of RPs. Std.Devs or limits of triangular...................
    NsC1|    2.07058***     .45929      4.51  .0000     1.17038   2.97078
NsTLOCAT|     .47153**      .18565      2.54  .0111      .10767    .83540
--------+--------------------------------------------------------------------
***, **, * ==>  Significance at 1%, 5%, 10% level.
Model was estimated on Jun 27, 2024 at 11:58:49 AM
-----------------------------------------------------------------------------
```

H.2 Acceptance

```
-----------------------------------------------------------------------------
Random Parameters Multinom. Logit Model
Dependent variable                 CHOICE
Log likelihood function        -264.75266
Restricted log likelihood      -360.43653
Chi squared [   9](P= .000)     191.36775
Significance level                 .00000
McFadden Pseudo R-squared        .2654666
Estimation based on N =     520, K =    9
Inf.Cr.AIC  =     547.5 AIC/N =     1.053
---------------------------------------
            Log likelihood R-sqrd R2Adj
No coefficients  -360.4365  .2655 .2525
Constants only can be computed directly
               Use NLOGIT ;...;RHS=ONE$
At start values  -285.8510  .0738 .0575
Note: R-sqrd = 1 - logL/Logl(constants)
Warning:  Model does not contain a full
set of ASCs. R-sqrd is problematic. Use
model setup with ;RHS=one to get LogL0.
---------------------------------------
Response data are given as ind. choices
Replications for simulated probs. =1000
Used Halton sequences in simulations.
RPL model with panel has       65 groups
Variable number of obs./group =NSET
Number of obs.=   520, skipped    0 obs
--------+--------------------------------------------------------------------
        |                  Standard            Prob.      95% Confidence
  CHOICE|  Coefficient       Error       z    |z|>Z*         Interval
--------+--------------------------------------------------------------------
        |Random parameters in utility functions...........................
TLOCATIO|      .30002*        .16291      1.84  .0655     -.01927    .61931
TLENGTHV|      .30870         .22983      1.34  .1792     -.14176    .75916
        |Nonrandom parameters in utility functions........................
      C2|      .91989***      .27231      3.38  .0007      .38617   1.45361
   TTYPE|     -.36316***      .12449     -2.92  .0035     -.60715   -.11916
TNEGAPPE|    -1.14025***      .23212     -4.91  .0000   -1.59520   -.68530
TDIVATTE|    -1.05425***      .28473     -3.70  .0002   -1.61231   -.49619
TVISIMPA|      .97239***      .26546      3.66  .0002      .45209   1.49268
        |Distns. of RPs. Std.Devs or limits of triangular.................
NsTLOCAT|      .70707***      .21741      3.25  .0011      .28096   1.13318
NsTLENGT|     1.30118***      .24168      5.38  .0000      .82749   1.77487
--------+--------------------------------------------------------------------
***, **, * ==>  Significance at 1%, 5%, 10% level.
Model was estimated on Jun 27, 2024 at 00:59:14 PM
-----------------------------------------------------------------------------
```

H.3 Combined data

```
-----------------------------------------------------------------------------
Random Parameters Multinom. Logit Model
Dependent variable               CHOICE
Log likelihood function      -505.65366
Restricted log likelihood    -856.91759
Chi squared [ 11](P= .000)    702.52784
Significance level               .00000
McFadden Pseudo R-squared      .4099156
Estimation based on N =    780, K =  11
Inf.Cr.AIC  =   1033.3 AIC/N =    1.325
---------------------------------------
            Log likelihood R-sqrd R2Adj
No coefficients  -856.9176  .4099 .4036
Constants only can be computed directly
               Use NLOGIT ;...;RHS=ONE$
At start values  -599.9098  .1571 .1481
Note: R-sqrd = 1 - logL/Logl(constants)
Warning:  Model does not contain a full
set of ASCs. R-sqrd is problematic. Use
model setup with ;RHS=one to get LogL0.
---------------------------------------
Response data are given as ind. choices
Replications for simulated probs. =1000
Used Halton sequences in simulations.
RPL model with panel has      65 groups
Fixed number of obsrvs./group=       12
Number of obs.=   780, skipped    0 obs
--------+--------------------------------------------------------------------
        |                  Standard            Prob.      95% Confidence
  CHOICE|  Coefficient       Error       z    |z|>Z*         Interval
--------+--------------------------------------------------------------------
        |Random parameters in utility functions..........................
      C1|     .80152         .68039     1.18  .2388     -.53201   2.13506
      C2|     .82354***      .25630     3.21  .0013      .32119   1.32588
   TTYPE|    -.24433**       .10308    -2.37  .0178     -.44637   -.04230
TLOCATIO|     .28501*        .14700     1.94  .0525     -.00310    .57311
        |Nonrandom parameters in utility functions.......................
TNEGAPPE|    -.86082***      .23360    -3.68  .0002    -1.31868   -.40297
TDIVATTE|    -.72299***      .25281    -2.86  .0042    -1.21849   -.22750
TVISIMPA|     .77933***      .25135     3.10  .0019      .28669   1.27197
        |Distns. of RPs. Std.Devs or limits of triangular................
    NsC1|    4.28249***      .86038     4.98  .0000     2.59619   5.96880
    NsC2|    1.39163***      .25177     5.53  .0000      .89816   1.88509
 NsTTYPE|     .48909***      .14094     3.47  .0005      .21284    .76533
 NsTLOCAT|    .88775***      .16192     5.48  .0000      .57039   1.20511
--------+--------------------------------------------------------------------
***, **, * ==>  Significance at 1%, 5%, 10% level.
Model was estimated on Jun 27, 2024 at 07:15:27 PM
-----------------------------------------------------------------------------
```