

Attitudes regarding the transition towards sustainable heat of general public in the Netherlands

Abstract

To reduce the emissions by 49% by 2030 and by the year 2050 by 95%, one of the aims of the Dutch government is to have 100% of the energy coming from renewables by 2050. To attain this, individuals transitioning to using sustainable heat in their households is necessary. The transition can only succeed if individuals are willing to make these adjustments, as attitudes are an essential predictor for intended actions and actual behaviour. This research focuses on the factors that influence individuals' attitudes regarding the transition towards sustainable heat by surveying 160 participants living in the Netherlands. The survey was set as an online survey in Qualtrics, using the snowball sampling method. The following analyses were done to construct the measurement scales: a factor analysis to test validity and a reliability analysis for internal consistency. The research uncovered a number of factors to influence individuals' attitudes regarding the transition to sustainable heat. The perceived benefits of this transition were found to have the strongest positive influence on people's attitudes regarding the heat transition. Other factors, such as environmental concerns and perceived feasibility, were found to impact people's attitudes positively. Factors such as knowledge of alternatives and policies were found to not significantly impact the attitudes about sustainable heat transition. Age showed to be of importance when considering the transition to sustainable heat. The sources used by individuals to gather information were also researched; the most used sources were found to be online sources. The research concluded that several factors influence individuals' attitudes regarding the transition toward sustainable heat in the Netherlands. These factors, as well as the sources of knowledge utilised by individuals, can be useful in promoting and facilitating the transition towards sustainable heat for businesses and policymakers.

Keywords: transition towards sustainable heat; sustainability; natural gas;

1. Introduction

Climate change represents a pressing topic in present-day society. Following the 2015 Paris agreement, which is a global commitment to turn towards a low-carbon economy, a significant variety of actors are invested in governing this transition, an example of this being the increased political will to promote fast transitions (Haines et al., 2007; Kern & Rogge, 2016). In recent years, climate change has been considered of increased importance, leading the public and the government to consider energy transition (Kern & Rogge, 2016). The 2019 Climate Act sets legally binding targets for reducing greenhouse emissions. In the Netherlands, the goal is to reduce emissions by 49% by 2030 and by the year 2050 by 95%, compared with the emissions from 1990. A way to achieve these goals is by radically transforming the current energy system dominated by fossil fuels into renewable energy systems. In line with this, The Dutch government aims to have 100% of the energy coming from renewables by 2050 (*The Netherlands - Countries & Regions - IEA*, 2021). To attain the goal of transitioning towards sustainable energy sources, serious actions should be taken (Beun, 2022). As the Dutch heating systems rely predominantly on natural gas, sustainable heat can have a significant impact on reducing emissions since the emissions of households are produced mainly by using natural gas, with households accounting for roughly 9% of total emissions (*Nationale Energieverkenning 2016*, n.d.). The concept of sustainable heat involves disconnecting various properties, including residential properties, from the gas grid (Jansma et al., 2020). In the Netherlands, policymakers have set a goal to completely transition from natural gas to sustainable heat for all homes and buildings by 2050 (*Central Government Encourages Sustainable Energy | Renewable Energy | Government.Nl*, n.d.). This involves equipping every property with sustainable heating systems. In order for the transition to sustainable heat to succeed, it is crucial to create acceptance among the involved actors and the general public.

The feasibility and effects of this policy, however, have been met with opposition among the Dutch population (Jansma et al., 2020), particularly considering the fact that the European Union has classified natural gas as a clean energy source (Clifford, 2022; Yadav, 2022). On the other hand, the Russian invasion of Ukraine, resulting in a significant increase in gas prices (*Reducing Dependence on Russia | Less Gas from Russia | Government.Nl*, n.d.), might have

changed the Dutch public opinion in favour of the transition towards sustainable heat. However, little research has been done on the public opinion of Dutch citizens regarding the transition towards sustainable heat, taking into account these recent developments.

In the Netherlands, several technological sustainable heating systems, such as the electric heat pump, hybrid heat pump, and district heating, are currently being developed and implemented. Although these systems differ from each other in terms of technology and communality, they have in common that they require individuals to make certain adjustments to their homes. Hence, the transition can only succeed if individuals are willing to make these adjustments. As attitudes are an essential predictor for intended actions and actual behaviour (Halder et al., 2016; Yazdanpanah et al., 2015; Chen & Chai, 2010), it is relevant to study the attitudes of the Dutch population regarding the transition towards sustainable heat. Furthermore, by gaining insights into the factors influencing these attitudes, the Dutch government can anticipate these in their information and communication strategies. (Halder et al., 2016; Yazdanpanah et al., 2015). Therefore, the following research question will be addressed in this study:

What factors influence individuals' attitudes regarding the transition towards sustainable heat in the Netherlands?

This study does not only contribute to practical insights but is also theoretically relevant. There is a gap in knowledge concerning the attitudes of individuals regarding transitioning towards sustainable heat worldwide (Setton, 2020). The studies that have addressed the transition towards sustainable heat only included a limited number of variables (e.g., governmental trust, concern regarding climate change, costs) and their impact concerning attitudes towards energy transition (Jansma et al., 2020). A more extensive array of factors has the potential to influence individuals' attitudes towards the transition to using sustainable heat (Miedema et al., 2018; van Middelkoop et al., 2017); therefore, it is relevant to research these factors to understand their impact on attitudes. The study will focus on individuals' perceptions, specifically homeowners and renters since this category is the most affected by the transition and the attitudes that influence them to take action regarding climate preservation (van Middelkoop et al., 2017). Researching a more extensive array of factors that impact individuals' attitudes regarding the transition towards sustainable heat offers a more complete overview of the topic, therefore, can

act as starting point for further research on the willingness to transition and implement sustainable heat of individuals. Furthermore, other stakeholders, such as governments and entrepreneurs, can use this research to adjust how they communicate information and plans regarding climate protection actions in the future.

2. Theoretical Framework

2.1 Attitudes about transitioning to sustainable heat.

Past research regarding the transition towards sustainable heat focused mainly on the attitudes or support for the policies set by the government to switch from natural gas (Jansma et al., 2020; Scholte et al., 2020; Steenbekkers, A., & Scholte, 2019). Attitude can be defined as the degree to which a person has a positive or negative opinion of a particular behaviour or action that develops from beliefs regarding a specific behaviour. Specific outcomes are related to each belief (Ajzen, 1991). Attitudes can be used as a determinant of intention, having significant importance in predicting and understanding individuals' behavior and are ingrained in perceived costs, risks and benefits (Ajzen, 2001). Attitudes are one of the most important predictors of intention; therefore, the attitudes of people regarding the transition to sustainable heat must be thoroughly studied and understood to help increase their intention and willingness to use renewable energy (Halder et al., 2016; Yazdanpanah et al., 2015). Attitudes can be perceived as a mediator between different beliefs, such as advantages, awareness, and moral norms, which can significantly affect predicting intentions (Rezaei & Ghofranfarid, 2018). They have an essential role in the transition towards sustainable heat; negative attitudes can potentially decrease the readiness to transition towards sustainable heat (Neofytou et al., 2020). Hence, further research on the attitudes of people living in the Netherlands regarding transitioning towards sustainable heat is relevant for understanding how to influence them better to transition to sustainable heat.

Individuals living in the Netherlands represent the most significant actor in achieving the transition (Beauchampet & Walsh, 2021). Individuals, in this study, homeowners and tenants, have a substantial impact on the transition towards sustainable heat, their implication

and acceptance being indispensable for the transition. Regardless of their different roles and responsibilities, homeowners and tenants seem to have similar views on transitioning to sustainable heat; therefore, they can be approached similarly to influence their attitudes (Jansma et al., 2020). The attitudes of individuals living in the Netherlands regarding transitioning to sustainable heat were found to be divided; a majority of homeowners respectively, 49% of them, seem to have positive attitudes, 27% were found to have negative attitudes, 16% of homeowners were found to be neutral, and 8% were found not to have an opinion (Scholte et al., 2020). Individuals seem to have positive attitudes regarding transitioning to sustainable heat, aiming to decrease emissions; uncertainty regarding the transition is also due to their lack of trust in the national government and policies (Steenbekkers, A., & Scholte, 2019). Further research on the attitudes of people living in the Netherlands is relevant for understanding the attitudes in the connection with the factors that can impact them.

2.2 Attitudes about natural gas

Natural gas is a resourceful fossil fuel highly available on Earth (Balat, 2006; Brown et al., 2011; Xu et al., 2023). The European Union considers natural gas a form of clean energy (Clifford, 2022; Yadav, 2022). Contrary to the European Union, the Netherlands does not consider natural gas to be a clean energy source (Jansma et al., 2020). The policies on natural gas of the Netherlands deviate from other European countries, which makes the Netherlands an interesting case to analyse. Hence, the impact of individuals' attitudes concerning natural gas on their attitudes towards sustainable energy in the Netherlands is relevant to research.

Most homeowners have negative attitudes concerning transitioning from natural gas to alternative ways of house heating due to the increased costs. People in the Netherlands rely on natural gas for heating their houses, which has the potential to influence individuals' attitudes regarding natural gas (*Energy Consumption of Private Households*, n.d.). Individuals were also found to be unsure that the transition to becoming gas-free by 2050 is possible (Jansma et al., 2020). In previous studies, it was also found that citizens of the Netherlands have relatively positive attitudes regarding natural gas, regardless of it being seen as sustainable or not, with natural gas being considered to not negatively impact the environment. Furthermore, individuals in the Netherlands were found to have positive attitudes regarding natural gas, which

is considered to have positive consequences in regard to the Dutch economy and the daily comfort of people (Perlaviciute et al., 2016). Therefore, individuals' perceptions about natural gas should be considered when assessing their attitudes regarding transitioning to sustainable heat since a positive attitude towards natural gas usage can potentially influence their attitudes regarding sustainable heat negatively.

Hypothesis 1: Individuals' perception of natural gas as clean energy negatively relates to their attitude regarding the transition to sustainable heat

2.3 Environmental concerns

Environmental concern is one of the variables that will be considered when discussing general attitudes towards sustainable heat. Environmental concern can be defined as the level of awareness, support and willingness to tackle environmental problems (Dunlap & Jones, 2002). Individuals that are very concerned about the environment are the ones that have higher positive attitudes towards taking environmentally friendly actions; these people are more inclined towards using renewable energy (Chung & Kim, 2018; Jansma et al., 2020; Liobikienė et al., 2021). Citizens of the Netherlands seem to be positively influenced by their acknowledgement of the urgency of acting and taking actions regarding conserving the climate and the need for energy transition (Jansma et al., 2020). Therefore, their acknowledgement of the climate issues and urgency to transition towards sustainable heat was found to positively influences their attitudes towards sustainable heat. Environmental concerns could influence individuals' attitudes towards transitioning to sustainable heat. Past research concluded that individuals tend to be environmentally concerned and are open to transition towards renewable energy. (Broers et al., 2019a). Individuals being concerned about the environment was found to impact their attitudes regarding the transition to sustainable heat positively(Chung & Kim, 2018; Liobikienė et al., 2021); therefore, it should be considered when looking at the attitudes of individuals towards sustainable heat.

Hypothesis 2: Environmental concerns positively relate to the attitude regarding the transition towards sustainable heat

2.4 Knowledge

The topic of climate change has become increasingly important in the past years, with energy transition becoming a goal for the public and the government (Kern & Rogge, 2016). To better understand the attitudes of people in regard to the transition towards sustainable heat in the Netherlands, it is relevant to research their knowledge about energy transition policies and alternatives to not sustainable heat systems to comprehend how their knowledge impacts their attitudes. The sources of information should also be reviewed to understand individuals' knowledge better.

Knowledge about policies

Given the targets of the Netherlands, it can be useful for the public to know the policies installed to help achieve the goals since serious actions should be taken to attain the transition in the aimed timeframe (Beun, 2022). Knowledge of policies has the potential to be relevant since individuals are expected to take action regarding the transition, and knowledge could impact their attitudes and actions. Jansma et al. (2020) found that the individuals' knowledge did not affect their attitudes towards heat transitioning (Jansma et al., 2020). Furthermore, Ebrahimigharehbaghi et al.(2019) and Wilson et al. (2015) concluded that the lack of knowledge negatively influenced attitudes towards heat transition (Ebrahimigharehbaghi et al., 2019; Wilson et al., 2015). Given the irregularities from past research, it is unclear if there is a connection between knowledge of the policies and attitudes regarding transitioning to sustainable heat. Therefore, knowledge of the policies does not clearly influence attitudes regarding the transition towards sustainable heat.

Hypothesis 3: Individuals' knowledge of policies doesn't have an influence on the attitudes regarding the transition to sustainable heat

Knowledge about alternatives

Individuals' knowledge about the alternatives could influence their attitudes regarding the transition towards sustainable heat; therefore, it is relevant to consider (Hainsch et al., 2022). One of the alternatives is transitioning to having a hybrid heat pump, which is suitable for most homes; subsidies are in place to cover additional costs generated by the switch to this technology (Climate and Energy | Government | Rijksoverheid.Nl, n.d.). Electrical heat pumps are very

efficient alternatives, generating more heat or cold than it uses electrical energy, making it an effective way of supplying thermal load with electrical energy (Romanov & Leiss, 2022). House heating could also be done using Infrared (IR)-panels due to their perceived affordability, sustainability and capability to ensure good comfort levels (Supervisor et al., 2020). The solar boiler can be a relevant alternative for heating homes using solar water heaters (*Solar Water Heater as an Alternative to Natural Gas - Zonnepanelen Planet*, n.d.).

Positive societal attitudes towards decreasing gas emissions resulted in individuals accepting and being interested in new technologies and transitioning into using them (Hainsch et al., 2022). An example of individuals not having increased knowledge about alternatives is biomass, known as a renewable energy source by just 55% of the population (Devine-Wright, 2011). Individuals also tend to wrongly associate bioenergy with fossil fuel (Butler, n.d.); carbon capture and storage technology are also wrongly judged as a threat to the environment; therefore, the lack of knowledge leads to negative attitudes towards sustainable heat (Wallquist et al., 2010). Based on past research, it can be hypothesised that knowledge about alternatives positively impacts attitudes regarding the transition to sustainable heat.

Hypothesis 4: Individuals' knowledge regarding alternatives positively relates to their attitudes regarding the transition towards sustainable heat

Sources of knowledge

To better understand the knowledge variables, a control variable must be added to research the sources used for gathering knowledge about policies and alternatives. The knowledge sources that will be researched are science, formal governmental campaigns, mainstream media and social media. This aims to provide means for the stakeholders to update their marketing campaigns to reach the general public better.

The public perception of climate change and energy transition could be positively influenced by exposing individuals to scientific information about climate change and individuals knowledge leading to increased perceived feasibility regarding the energy transition (Van Linden et al., 2015). Governments must ensure homeowners have sufficient information available to them for deciding on a particular system; therefore, much attention should be given to formal

governmental campaigns. Homeowners were found to have more trust in the government when it provides support; individuals expect the government to provide them with the needed information about sustainable heat and support; therefore, formal governmental campaigns are essential for transitioning to sustainable heat, having a positive impact on attitudes towards sustainable heat (Scholte et al., 2020).

One of the sources of information is mainstream media. Jansma et al. (2020) found that homeowners and tenants heard about the national transition policy towards sustainable heat in the news media. It was also found that for the attitudes towards sustainable heat to improve, the government should find ways to increase sharing of news via word-of-mouth by encouraging homeowners to promote the idea of heat transition to their friends and family (Ajzen, 1991). Social media has a role in promoting sustainable heat by creating a space for energy debates. Debates are essential since they can support learning and promote individuals' future expectations (Rantala et al., 2020). The sources used for gathering knowledge about the transition towards sustainable heat will be studied to understand individuals preferred sources of information.

What are the main sources of information used by citizens of the Netherlands for gathering knowledge regarding the transition towards sustainable heat?

2.5 Perceived feasibility

The perceived feasibility of this transition will be researched to understand the individuals' attitudes towards sustainable heat. In a study done based on countries from South-Eastern Europe, it was found that the transition from traditional heat to sustainable heat is feasible based on economic, environmental and social criteria (Rutz et al., 2019). People perceive energy transition as more feasible if they consider themselves part of the change (Huijts et al., 2012; G Perlaviciute et al., 2014). In a study by Beauchamp et al. (2021), individuals seem to consider the cost of alternatives and practicalities of citizens' engagement a barrier towards feasible energy transition. Individuals considered that the transition was feasible if the barriers could be overcome. Individuals view heat transitioning as feasible when the costs are

transparent or supported through financial support, which leads to positive attitudes towards transitioning to sustainable heat (Beauchamp & Walsh, 2021). Based on these studies, perceiving the transition towards sustainable heat as feasible positively influences individuals' attitudes towards it.

Hypothesis 5: If Individuals consider the transition to sustainable heat to be feasible, their attitudes towards the transition will be more positive

2.6 Trust in the government

To understand the attitudes of individuals regarding the transition towards sustainable heat is essential to consider the trust they have in stakeholders. One of the most important stakeholders is the Dutch government for this research due to the research being focused on individuals living in the Netherlands; therefore, trust in the Dutch government will be discussed. Trust in the government is essential since it can positively influence attitudes towards energy transitioning policies (Konisky et al., 2008; Steenbekkers, A., & Scholte, 2019). Previous studies also found that having trust in the national government and its capability to support energy transitioning is significant for people to support them (Scholte et al., 2020). Therefore, individual trust in the government and its ability to facilitate the transition towards sustainable heat can positively impact attitudes towards it.

Hypothesis 6: Trust in the national government positively relates with the attitude on the transition towards sustainable heat

2.7 Perceived benefits and costs

The benefits individuals consider they have from transitioning to sustainable heat have the potential to influence their attitudes towards heat transition. Perceived benefits can be categorised into benefits at a personal level, such as cost reduction and personal emission reduction, and collective benefits that affect society (Huijts et al., 2012). For this study, the focus will be on benefits at an individual level. Individuals tend to consider and participate in sustainable energy behaviour when they believe it brings them high personal benefits at low

personal costs because they view the actions as an overall positive. At an individual level, the potential for economic and security gains positively influences the attitudes towards energy-efficient products and energy renovations (Ebrahimigharehbaghi et al., 2019).

Other potential benefits regarding transitioning to sustainable heat are the home's living comfort and the impact transitioning can have on overall home comfort. Individuals have misconceptions about sustainable heat and comfort in the house, especially regarding holding comfortable temperatures in the winter (Jansma et al., 2020). The negative expectations are problematic since having comfort is one of the main factors when switching to a sustainable system (Broers et al., 2019b; Ebrahimigharehbaghi et al., 2019; Gram-Hanssen et al., 2012; Karytsas, 2018; Murphy, 2016). Therefore, it can be hypothesised that people can be positively influenced by perceived benefits and negatively influenced by perceived costs.

Hypothesis 7: Perceived benefits positively influence attitudes regarding transitioning towards sustainable heat

Hypothesis 8: Perceived costs negatively influence attitudes regarding transitioning towards sustainable heat

2.8 Demographics

The following section summarises the impact demographics can have on attitudes towards sustainable heat. The first demographic factor discussed is age; according to past research, motivation towards heat transition decreases with age. Older people tend to be unwilling to transition due to high costs, long payback time, risk aversion, and being pleased with current heating systems (Azizi et al., 2019; März, 2018; Scholte et al., 2020; Weiss et al., 2012). Younger people seem to have a more positive attitude towards heat transition and are more responsible regarding climate change (Scholte et al., 2020). Therefore, it can be hypothesised that ages negatively relate to the attitude towards heat transition.

Hypothesis 9: Ages negatively relate to the attitudes towards heat transition

The next factor that will be discussed is education level. Past research shows that willingness to transition to sustainable heat increases with educational level (Arroyo & Carrete, 2019; Azizi et al., 2019; Scholte et al., 2020; Weiss et al., 2012). Education levels also appear to

increase sustainability and environmental knowledge (Kollmuss & Agyeman, 2010). Therefore, this study hypothesises that education positively influences attitudes towards heat transition.

Hypothesis 10: Higher education level positively relates to the attitudes towards heat transition

2.9 Research model

The research model is presented in Fig. 1. The variables that influence the attitudes about sustainable heat are displayed in the model. Table 1 offers an overview of all the hypotheses.

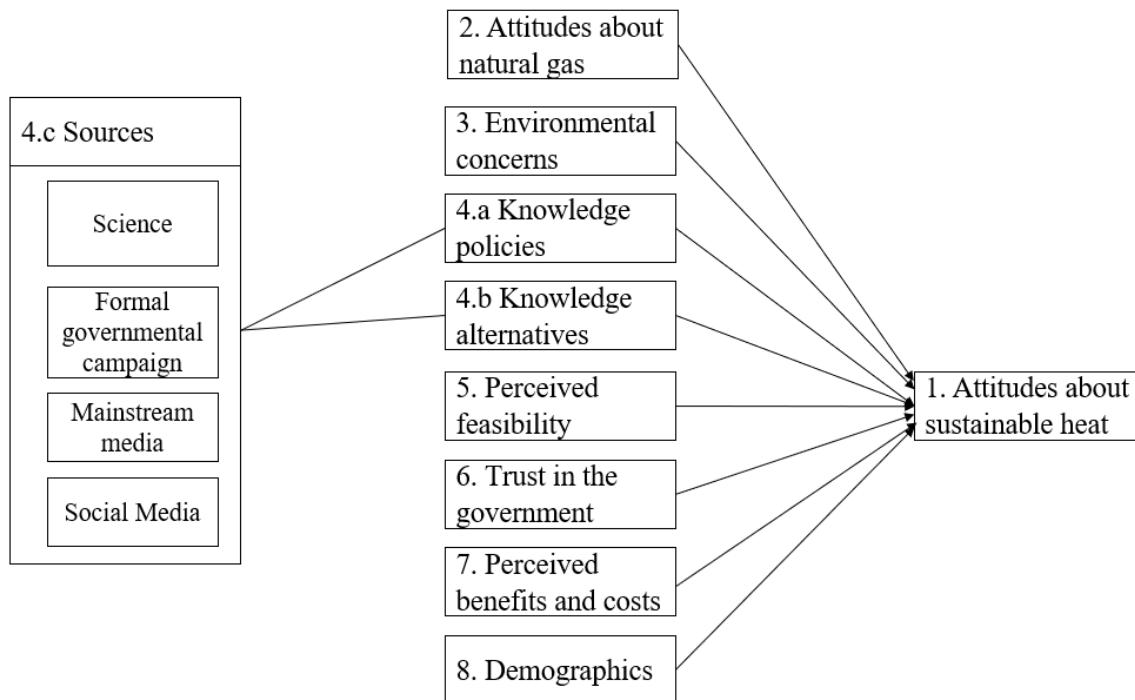


Figure 1: Research model

Table 1: Hypotheses

Number	Hypothesis
H1	Individuals' perception of natural gas as clean energy negatively relates to their attitude regarding the transition to sustainable heat
H2	Environmental concerns positively relate to the attitude regarding the transition towards sustainable heat
H3	Individuals' knowledge of policies doesn't have an influence on the attitudes regarding the transition to sustainable heat
H4	Individuals' knowledge regarding alternatives positively relates to their attitudes regarding the transition towards sustainable heat
H5	If Individuals consider the transition to sustainable heat to be feasible, their attitudes towards the transition will be more positive
H6	Trust in the national government positively relates with the attitude on the transition towards sustainable heat
H7	Perceived benefits positively influence attitudes regarding transitioning towards sustainable heat
H8	Perceived costs negatively influence attitudes regarding transitioning towards sustainable heat
H9	Ages negatively relate to the attitudes towards heat transition
H10	Higher education level positively relates to the attitudes towards heat transition

3. Method

3.1. Research design

This study used an online survey to assess the relationships between the independent and dependent variables. The survey focused on the attitudes of individuals living in the Netherlands regarding transitioning towards sustainable heat. The survey was set as an online survey in Qualtrics to make it easier to distribute and get a large sample of respondents. The approval of the ethics committee of the University of Twente was obtained before distributing the survey; the BMS form number for this research project is 230117.

3.2. Selection and procedure

The participants were selected based on the following criteria to be suitable for participating in this research. (1) participants must understand the concept of energy transition and climate change, (2) are above 18 years old, (3) understand English, and (4) live in the Netherlands. The participants were notified that the survey assesses their attitude regarding transitioning towards sustainable heat. To begin the data collection, the survey was transmitted directly to people from the personal network of the researcher; after that, the snowball sampling

method was utilised. Research participants used the snowball sampling method to help the researcher gain more responses that followed the selection requirements(Naderifar et al., 2017).

The snowball sampling method was chosen since it is considered to help gather the most relevant persons for the study(Khan, 2022). The survey was also posted on platforms such as Facebook and Instagram. The survey was completed by 202 people, out of which 160 live in the Netherlands, respected the requirements and finished the survey; therefore, 160 responses were used in the research.

3.3 Participants

The sample of people who participated in the study has the following characteristics: 53.1% male, 43.1% female and 3.8% chose not to disclose their gender. The respondents' ages are between 18 and 67, with the mean age being 27; 48.8% of the participants are from the Netherlands, 62.5% of respondents live in rental properties, and the other 37.5 live in owner-owned houses. The respondents have various levels of education. Table 2 offers a complete overview of the respondents' background characteristics.

Table 2: Background characteristics

Demographics	Frequency	Percentage
<i>Gender:</i>		
Male	85	53.1
Female	69	43.1
Prefer not to say	6	3.8
<i>Age:</i>		
18 - 24	95	59.4
25 – 34	38	23.7
35 – 44	10	6.3
45 – 54	12	7.5
55 – 64	3	1.9
65+	2	1.2

<i>Nationality:</i>		
Dutch	78	48.8
Other	82	51.2
<i>Education:</i>		
Primary education/Primary school	2	1.3
IBO/VBO/VMBO	4	2.5
Senior secondary vocational education (MBO)	12	7.5
Higher secondary education (HAVO or VWO)	48	30.0
Higher vocational education (HBO)	18	11.3
Scientific education (university)	76	47.5
<i>Property type:</i>		
Rental home	100	62.5
Owner occupied home	60	37.5

3.3. Measurement

A questionnaire was created to analyse the constructs of this study. The measurement items of the questionnaire are regarding demographics, attitudes about sustainable heat, general attitudes about natural gas, knowledge, environmental concerns, perceived feasibility, and perceived benefits. They were measured using a 7-point Likert scale, ranging from 1 - strongly disagree to 7 – strongly agree. The survey started with questions about the demographics of the participants, followed by statements concerning the attitudes about transitioning to sustainable heat, such as "I have a positive feeling towards switching to natural gas-free heating for my home", and statements concerning attitudes regarding natural gas, such as " Natural gas is a sustainable source for heating". Statements regarding environmental concern were used to gain understanding of individuals' perceived environmental concern and pro-environmental behaviour. The perceived knowledge of individuals was measured using statements regarding the knowledge of policies and alternatives. Furthermore, statements regarding perceived feasibility were used to understand the individuals' opinion of the topic using statements such as "I am positive about the idea that the Netherlands will be completely natural gas free in 2050" The trust in national government was measured using statements such as "The national government will

adhere to promises to be natural gas-free by 2050". The perceived benefits were measured with items regarding the financial benefits, personal emission reduction, positive outcomes and perceived costs. The survey was regarding the impact of the items on the individuals' attitudes regarding transitioning towards sustainable heat. Table 3 gives a complete overview of the constructs and items.

Table 3: Instrument questionnaire

Construct	Items	Scale
Attitudes about transitioning to sustainable heat	1) I have a positive feeling towards switching to natural gas-free heating for my home. 2) Sustainable heating for my home is a good idea. 3) It is desirable to get sustainable heating for my home. 4) I find it appealing to invest in sustainable heating for my home.	1=strongly disagree 7=strongly agree
Attitudes about natural gas	1) Natural gas is a sustainable source for heating. 2) Using natural gas does not harm the environment. 3) Among the different alternatives, natural gas is the best one to use for heating. 4) Natural gas is the best option to use for heating.	1=strongly disagree 7=strongly agree
Environmental concerns (Environmental concerns)	1) I am worried about climate change. 2) I want to do something against climate change. 3) Society needs to do something about climate change. 4) I find it important to use sustainable energy.	1=strongly disagree 7=strongly agree
Environmental concerns (Pro environmental behavior)	1) Acting environmentally friendly is an important part of who I am. 2) I am the type of person who acts environmentally friendly. 3) I see myself as an environmentally friendly person.	1=strongly disagree 7=strongly agree
Knowledge (Policies)	How familiar are you with... 1) the plans of the national government regarding the transition towards sustainable heat. 2) the municipality's plans regarding the transition towards sustainable heat. 3) the specific measures national government proposes regarding the transition towards sustainable heat. 4) the specific measures the municipality proposes regarding the transition towards sustainable heat. 5) National policies regarding sustainable heating.	1=strongly disagree 7=strongly agree

	6) Local policies (from your municipality) regarding sustainable heating.	
Knowledge (Alternatives)	How familiar are you with: 1) the possible alternatives other than natural gas to heat houses in a sustainable way. 2) the adjustments needed in houses to make them suitable for sustainable heat. 3) the electrical heat pump as an alternative for gas-based heating. 4) net district heating as an alternative for gas-based heating. 5) geothermal energy as an alternative source for natural gas. 7) the availability of alternatives for natural gas. 8) the capacity of alternatives to replace the usage of natural gas for heating houses. 9) the cost of installing an alternative heating system in houses.	1=strongly disagree 7=strongly agree
Knowledge (Heat pump as an alternative)	1) the adjustments needed in houses for installing and using an electrical heat pump. 2) the availability of electrical heat pumps for households. 3) the capacity of electrical heat pumps to replace gas-based heating system. 4) the costs of installing an electrical heat pump in houses.	1=strongly disagree 7=strongly agree
Perceived feasibility	1) I am positive about the idea that the Netherlands will be completely natural gas free in 2050. 2) It is realistic that the Netherlands will be free of natural gas by 2050. 3) I think transitioning towards sustainable heat is feasible on a household level. 4) I think transitioning towards sustainable heat is feasible on a district level. 5) There is enough capacity to make households natural free by 2050. 6) There are enough resources to replace natural gas by 2050. 7) There are enough financial means to replace natural gas based heating systems in houses by 2050.	1=strongly disagree 7=strongly agree
Trust in national government	1) The national government will adhere to promises to be natural gas-free by 2050. 2) Future governments will stand behind the transition to be natural gas-free.	1=strongly disagree 7=strongly agree

	3) The national government is decisive enough to facilitate the transition to being natural gas-free by 2050.	
	4) The Netherlands will succeed and will be natural gas-free by 2050.	
	5) The national government is determined to be natural gas-free in 2050.	
Perceived benefits (Financial)	1) Natural gas-free heating leads to cost savings on my utility bill.	1=strongly disagree 7=strongly agree
Perceived benefits (Personal emission reduction)	1) By investing in sustainable heat, I do something good for the environment. 2) Sustainable heating leads to less air pollution. 3) Through sustainable heat I will lower my CO2 emissions. 4) By investing in sustainable heat, I do something against global warming.	1=strongly disagree 7=strongly agree
Perceived benefits (Positive outcomes)	1) Investing in sustainable heat increases the value of home. 2) Sustainable heat makes my home safer. 3) Sustainable heat is future proof.	1=strongly disagree 7=strongly agree
Perceived costs (Negative changes in the comfort of living)	1) Sustainable heat heats homes comfortably. 2) Sustainable heat takes up a lot of space. 3) Sustainable heat produces a lot of noise. 4) Air quality in homes will decrease due to sustainable heat.	1=strongly disagree 7=strongly agree

3.4. Scale construct

In order to construct the measurement scales, the following analyses were done: a factor analysis to test validity and reliability analysis for internal consistency. First, negatively formulated items were recalculated to match the others; only three items needed to be recalculated. Factor analysis (rota varimax factor analysis) was executed to determine if the items matched the construct to test the validity of the construct using all the items that were measured for the constructs. This led to the splitting of the following variables: the variable knowledge has been split into two new variables: knowledge policies and knowledge alternatives. Based on the factor analysis results, three statements needed to be removed from the construct environment concern. Furthermore, the perceived benefits variable could not be divided into perceived benefits and perceived costs; therefore, it was combined into one construct, perceived benefits; this construct will be used further in this research. Attitudes about

sustainable heat, attitudes about natural gas, feasibility, trust in the government, and environmental concern remained as constructs. The research model after the factor analysis can be seen in Fig. 2. The reliability of the constructs was considered; for this, Cronbach alpha was calculated. This showed that all the constructs have a Cronbach's alpha higher than 0.7. All constructs can be considered reliable and therefore were maintained for further study. The results of the reliability test can be found in Table 4.

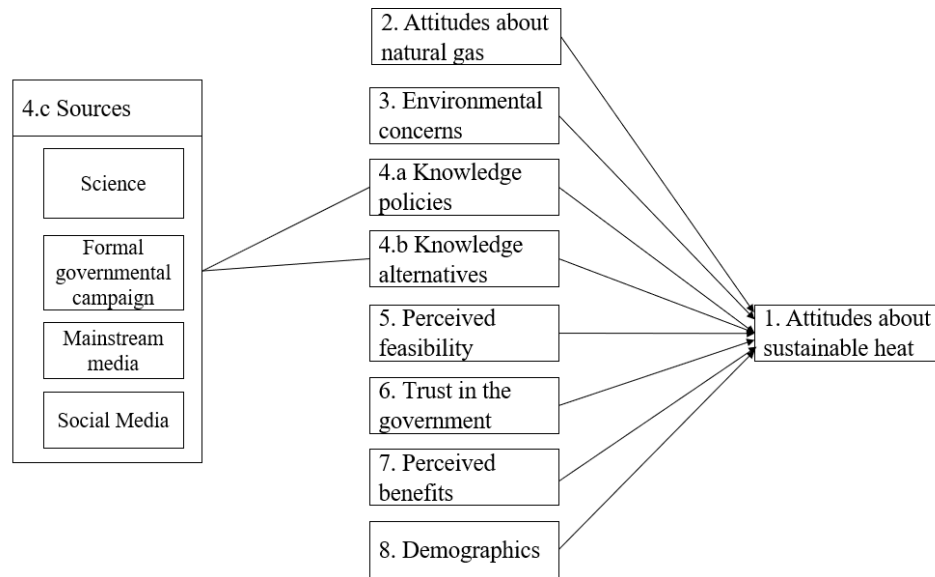


Figure 2: Research model

Table 4: Reliability analysis

Factor	Cronbach's alpha
Attitudes about sustainable heat	0.90
Attitudes about natural gas	0.90
Environmental concerns	0.92
Perceived feasibility	0.92
Knowledge policies	0.95
Knowledge alternatives	0.96
Trust in the government	0.91
Perceived benefits	0.82

4. Results

The results section begins with descriptive statistics presenting an overview of the mean results. Next, correlations were calculated to test for relationships between variables. Lastly, a multiple regression analysis was effectuated to analyse the effects of the independent variables on the dependent variable. In this section, the initial hypotheses will be challenged based on the results to better understand the independent variable's impact on the dependent variable.

4.1 Descriptive statistics

Table 5 shows the means and standard deviation of the variables obtained by recalculating the constructs into new variables, the means and standard variables being analysed on a construct level. The means range between 3 and 6, based on a 7-point Linkert scale. The respondents' attitudes regarding the dependent variable, the transition towards sustainable heat, were generally positive, with a mean score of 5.38. The scores of the independent variables will be analysed next. The respondents seemed interested in acting environmentally conscious and perceiving themselves as having pro-environmental behaviours, as they scored high on environmental concerns. In line with the positive attitude towards transition, the public indicated to perceive the benefits of it. The respondents seemed to be slightly positive regarding the feasibility of the transition to sustainable heat. Furthermore, their trust in the government was slightly positive. The respondents' knowledge of the alternatives is also slightly positive, showing they are informed about alternatives and are interested in this topic, but their knowledge is limited. The knowledge of policies can be considered neutral with negative tendencies, with the trust in shareholders beginning slightly higher than the perceived knowledge of policies. The respondents seem not to have a strong opinion and interest regarding the policies and the stakeholder considered in this research, the national government. Therefore, the national policies seem to be not given much attention by the public. The lowest mean was noticed for the attitudes toward natural gas, showing slightly negative attitudes regarding natural gas; since natural gas is not considered sustainable in the Netherlands, the negative attitude regarding natural gas can be considered positive regarding attitudes about sustainable heat. The means indicate that the public has a positive attitude regarding the topic portrayed by variables.

Table 5: Mean scores

Construct	Mean	SD
Attitudes about sustainable heat	5.38	1.23
Attitudes about natural gas	3.75	1.58
Environmental concerns	5.78	1.08
Perceived feasibility	4.54	1.28
Knowledge policies	3.76	1.53
Knowledge alternatives	4.24	1.41
Trust in the government	4.26	1.24
Perceived benefits	4.81	0.83

To further understand the attitudes regarding the transition towards sustainable heat of the general public in the Netherlands, the public's sources to collect information should also be researched. The most prominent source of information about sustainable heat used by the participants was noticed to be governmental sources, the individual using means offered by the government to gain information about sustainable heat. Many individuals consider friends and family as a source of information. Social media is another source of information used by the general public. Companies represent a leading source of information for individuals, proving that companies' marketing campaigns are significant for informing individuals about sustainable heat. Mainstream media was also used as a source of information. Scientific sources were considered the least used source of information. The sources used by the individual are mainly online sources showing digital marketing strategies need to be considered when trying to inform people about sustainable heat.

Table 6: Frequency sources

Sources	Frequency	Percentage of total sample
Scientific sources	66	41%
Governmental sources (websites, brochures)	96	60%
Mainstream media	72	45%
Social media	86	54%
Companies (websites, brochures)	67	42
Friends and family	87	54%

4.2 Correlations

Table 7 showcases the Pearson correlations between the variables. The Pearson correlation was calculated to analyse the relationship between the variables. A weak correlation is considered a correlation between 0 and 0.3, a correlation between 0.3 and 0.5 is considered moderate, and correlations over 0.5 are considered strong (Laerd Statistics, 2020). As seen in the table, the strongest positive correlation between the variable perceived benefits and the attitudes about sustainable heat; people considering the transition to sustainable heat as beneficial lead to positive attitudes about transitioning to sustainable heat. Furthermore, there is a strong positive correlation between attitudes about sustainable heat and environmental concern; therefore, being concerned about the environment positively impacts attitudes about sustainable heat. A strong positive correlation can also be noticed between perceived feasibility and attitudes about sustainable heat; therefore, people who consider the transition to sustainable heat feasible feel optimistic about transitioning to sustainable heat. A weak positive relationship can be noticed between attitudes about sustainable heat and trust in the government; therefore, trust in the government influences the attitudes about sustainable heat. A weak positive relationship can also be noticed between the attitudes about sustainable heat and the knowledge of policies, knowledge of alternatives, and education. Weak negative relations can be noticed between attitudes about sustainable heat and natural gas, as well as between attitudes about sustainable heat and the demographic component age.

Table 7: Correlation coefficients

Constructs	1	2	3	4	5	6	7	8	9	10
1. Attitudes about sustainable heat	1									
2. Attitudes about natural gas	-.06	1								
3. Environmental concerns	.56**	-.12	1							
4. Perceived feasibility	.54**	0.01	.39**	1						
5. Knowledge policies	.04	.21**	.14	.23**	1					
6. Knowledge alternatives	.18*	.07	.23**	.30**	.73**	1				
7. Trust in the government	.29**	.21**	.30**	.60**	.35**	.36**	1			
8. Perceived benefits	.63**	-.29**	.60**	.56**	.13	.22**	.39**	1		
9. Age	-.20**	.20*	-.04	-.04	.33**	.27**	.11	-.06	1	
10. Education level	0.21**	-.09	0.33**	0.15	.20*	-.19*	.11	.18*	.07	1

** Correlation is significant at the level 0.01 level (2-tailed)

*Correlation is significant at the level 0.05 level (2-tailed)

4.3 Regression analysis

The regression analysis was conducted to add insights into the attitudes regarding the transition towards sustainable heat of the general public in the Netherlands. Attitude about sustainable heat was used as the dependent variable, and the attitudes about natural gas, environmental concerns, perceived feasibility, knowledge policies, knowledge alternative, trust in the government, perceived benefits, education level and age were used as predictors. The percentage of explained variance is high (56%), indicating a good fit and high predictability; therefore, the dependent

variable attitude about sustainable heat is 56% explained by the independent variables. The results of this analysis are summarised in the table below. A number of independent variables proved to be statistically significant, having a p-value of 0.05 or lower. The independent variables that were proven statistically significant are attitude about natural gas, environmental concern, perceived feasibility, perceived benefits and age. The variables that proved insignificant are knowledge policies, knowledge alternatives, trust in the government and education level. The perceived benefits showed to be the most important predictor of the attitude about sustainable heat and influence it positively. The second most important variable that positively influences attitudes about sustainable heat was environmental concerns, followed by perceived feasibility and attitudes about natural gas. The predictor that influences attitude negatively is the age, showing that age negatively influences attitudes about sustainable heat.

Table 8: Regression analysis

Construct	β	t	Sig.
Attitudes about natural gas	.13	2.72	.01
Environmental concerns	.27	3.40	<.001
Perceived feasibility	.25	3.35	.001
Knowledge policies	-.12	-1.82	.07
Knowledge alternatives	.11	1.50	.14
Trust in the government	-.10	-1.41	.16
Perceived benefits	.61	5.12	<.001
Education level	.07	1.13	.26
Age	-.02	-2.86	.01
R ²	0.56		
F	20.60		
df	9		

Dependent Variable: Attitudes about sustainable heat

The analysis of the results showed that a number of hypotheses were accepted. Environmental concern was found to positively influence the attitude regarding the transition towards sustainable heat, having a significant impact on the dependent variable. Individuals' knowledge of policies was shown not to clearly influence the attitudes regarding the transition to sustainable heat, proving to be insignificant in the regression analysis; therefore, the initial hypothesis is accepted. Individuals considering the transition to sustainable heat feasible were found to have a significant positive influence on their attitudes towards sustainable heat. Perceived benefits were found to have the highest positive influence on the dependent variable; therefore, the initial hypothesis was accepted. Age was found to have a significant negative influence on attitudes towards heat transition; therefore, the initial hypothesis is accepted. Table 9 provides an overview of the hypotheses and whether they were accepted.

Table 9: Overview of the hypotheses

Number	Hypothesis	Accepted	Rejected
H1	Individuals' perception of natural gas as clean energy negatively relates to their attitude regarding the transition to sustainable heat		X
H2	Environmental concerns positively relate to the attitude regarding the transition towards sustainable heat	X	
H3	Individuals' knowledge of policies doesn't have an influence on the attitudes regarding the transition to sustainable heat	X	
H4	Individuals' knowledge regarding alternatives positively relates to their attitudes regarding the transition towards sustainable heat		X
H5	If Individuals consider the transition to sustainable heat to be feasible, their attitudes towards the transition will be more positive	X	
H6	Trust in the national government positively relates with the attitude on the transition towards sustainable heat		X
H7	Perceived benefits positively influence attitudes regarding transitioning towards sustainable heat	X	
H9	Ages negatively relate to the attitudes towards heat transition	X	
H10	Higher education level positively relates to the attitudes towards heat transition		X

5. Discussion

This study aimed to understand the attitudes regarding the transition towards sustainable heat of the general public in the Netherlands and the information sources that influence them. A survey was conducted to understand the factors that impact attitudes on the transition towards sustainable heat. In this chapter, the findings of the study are summarised and interpreted. This study's limitations are discussed, followed by the practical implications of the study.

5.1 Main findings

This research focused on the factors that influence individuals' attitudes regarding the transition towards sustainable heat in the Netherlands. The findings of this research showed that there are factors that could influence the general public's attitudes towards sustainable heat. The regression analysis uncovered differences in the impact of the factors that predict attitudes. The research confirmed a number of hypotheses; this will be outlined in the following parts.

This study found a weak positive influence of natural gas on attitudes about sustainable heat. Even though there is a relationship between the variables, it is weak, considering natural gas as sustainable and having a weak positive impact on sustainable heat. The finding contradicts previous research (Jansma et al., 2020), with the results of this study showcasing natural gas as a factor that positively influences attitudes towards sustainable heat. The variable is therefore found to impact people's attitudes regarding natural gas. This may be explained by the fact that a number of the respondents are not from the Netherlands, even though they currently live here; in the Netherlands, natural gas is not considered sustainable, but in other countries, natural gas is associated with sustainability, which might lead to confusion. Therefore, a previous view of natural gas as sustainable might positively influence individuals' attitudes towards sustainable practices, in this case, sustainable heat.

Environmental concern was the variable that most individuals were interested in, with the most favourable opinion regarding it; the respondents seemed interested in acting environmentally conscious and perceiving themselves as having pro-environmental behaviours.

A strong positive correlation was found between attitudes about sustainable heat and environmental concern, as well as environmental concern having a positive impact on the dependent variable. This could be explained by the fact that sustainable heat is an environment-friendly measure; therefore, people who affiliate themselves with pro-environmental behaviour are predisposed to have positive attitudes towards sustainable heat transition. Therefore, being concerned about the environment positively impacts attitudes about sustainable heat. This research, therefore, confirms the hypothesis since in past research, environmental concerns were previously found to positively influence the attitude regarding the transition towards sustainable heat (Broers et al., 2019a; Chung & Kim, 2018; Jansma et al., 2020; Liobikienė et al., 2021).

Individuals' knowledge of policies was presumed not to have an evident influence on the attitudes regarding the transition to sustainable heat. This will be discussed in rapport to trust in the national government due to the variables being intertwined. Individuals were found to have limited but slightly existing knowledge of policies. Individuals were found to have slightly more trust in the national government. A weak positive relationship was noticed between the attitudes about sustainable heat and the knowledge of policies and between attitudes about sustainable heat and trust in the government, showing that there is a relationship between the dependent variable and the knowledge of policies as well as the trust in the government. Unfortunately, both predictors had an insignificant, weak negative influence on attitudes regarding sustainable heat. The findings regarding knowledge of policies correspond with previous research, showcasing the knowledge of policies to not have a clear influence on attitudes. The finding regarding trust contradicts previous research (de Kluizenaar et al., 2020; Konisky et al., 2008; Steenbeekers & Scholte, 2019) due to trust in the stakeholders being found to have an insignificant influence on attitudes regarding the transition to sustainable heat, this can be due to individuals considering other aspects more when thinking about heat transition such as financial costs.

The respondents were found to consider that they are informed about alternatives and are interested in this topic, but their knowledge is limited. A weak positive relationship was noticed between the attitudes about sustainable heat and knowledge. The knowledge of alternatives proved to have an insignificant impact on the dependent variable. The research contradicts previous studies (Wallquist et al., 2010) with knowledge of alternatives not impacting the

attitudes towards transitioning towards sustainable heat; this could be due to individuals considering the alternatives as not being suitable for their homes.

The topic of perceived feasibility will further be discussed; the general public seemed to be optimistic regarding the feasibility of the transition. A strong correlation was found between feasibility and attitudes about sustainable heat; perceived feasibility also positively influences attitudes. Therefore the study supports previous studies (Beauchamp & Walsh, 2021), proving that perceiving the transition as feasible positively influences one's attitudes toward it. The results may be due to respondents' positive attitudes towards changes they perceive as feasible.

The perceived benefits were shown to be the most important predictor of the attitude about sustainable heat and influence it positively. This is understandable because the public perceives benefits regarding the transition to sustainable heat, and there is a strong positive correlation between benefits and attitudes. The findings support previous research (Ebrahimigharehbaghi et al., 2019). It was found that when the general public understands the benefits, they have a positive attitude towards the transition. The results could be due to people aiming to make the changes that benefit them in the long run and therefore perceived benefits leading to positive attitudes.

The demographics factor, age and levels of education will be further discussed. Age was previously seen as negatively influencing attitudes towards heat transitioning, with older people not supporting the transition towards sustainable heat (Scholte et al., 2020). The findings of this research coincide with the hypothesis, a weak negative correlation being noticed between age and sustainable heat, as well as a significant negative impact on the dependent variable. This may be due to older people not having the means to gain knowledge and being less adaptive to change. Previous studies found higher levels of education positively influence attitudes towards heat transition (Azizi et al., 2019; Scholte et al., 2020; Weiss et al., 2012). The findings of this research are not in line with the hypothesis; education levels proving to have an insignificant impact on the heat transition; this could be due to individuals not considering the heat transition as something they are willing to do.

The sources the public uses to collect information were also researched. The sources used by the individuals were found to mainly be online sources, showing digital marketing strategies need to be considered when trying to inform people about sustainable heat to positively influence

their attitudes regarding transitioning to sustainable heat. The marketing campaigns and strategies of the stakeholders to promote sustainable heat have the potential to influence the general public attitudes regarding sustainable heat positively.

Based on the finding of this research, the factors that influence individuals' attitudes regarding the transition towards sustainable heat in the Netherlands are attitudes about natural gas, perceived feasibility, perceived benefits, sources of information, environmental concern and age; therefore, there are an array of factors that need to be taken into consideration when trying to promote the transition towards sustainable heat.

5.2 Limitations and future research

This study has the following limitations. That sample size of 160 is not large enough to fully represent the entire population of the Netherlands. Hence, the results need further investigation in further studies using a larger population sample. Individuals' lack of knowledge or misunderstanding of the topic threatens the reliability and validity because the answers are due to individuals responding without a clear understanding of the topic, leading to biased results. The research did not only include Dutch citizens; it included all people living in the Netherlands, which can be seen as a limitation given that their knowledge of Dutch policies and plans could be very limited. People being in the Netherlands for a short period of time could also impact their attitudes regarding heat transition, which can be seen as a limitation of this research.

The dependent variable in this study was attitudes about sustainable heat; this variable can be used as an indicator of individuals' opinions of transitioning towards sustainable heat but does not measure behavioural patterns, intentions or actual behaviours. The theoretical implications of this study will be discussed further. The study can act as a stepping point into influencing people's behaviour by offering a glimpse into the current attitudes of individuals regarding transitioning towards sustainable heat. This research outlines a more complex array of factors that influence attitudes regarding the transition towards sustainable heat. Attitude can be seen as an initiator of behaviours, but future studies should focus on actions and behaviour. Future research could complete this study by researching a larger sample of people and by analysing

their attitudes in combination with their intention and actual behaviour. This can be done qualitatively by using a more in-depth version of the current questionnaire by adding questions targeting current behaviour and intentions regarding the transition to sustainable heat.

5.3 Practical implications

The results provide a look into the variables that impact the attitudes. They can be used as a baseline to understand the general public's attitudes towards transitioning to sustainable heat and the factors that influence them, as well as the means used by the public to form opinions; this can be useful for both government and companies providing sustainable heat technologies. The government can customise the information and information channels to better target and inform people by using the knowledge channels they prefer. The most relevant one was found to be online sources, which can be used to create digital marketing strategies that can help them inform and motivate people into transitioning in order to attain the goal of having 100% of the energy coming from renewables by 2050 (*The Netherlands - Countries & Regions - IEA, 2021*). The information can also be helpful for companies providing sustainable heat technologies in creating digital marketing strategies to better target and inform their audience.

People being concerned about the environment proved to positively relate to the attitude regarding the transition towards sustainable heat; therefore, both policymakers and businesses could use this to better promote and facilitate the transition to sustainable heat by targeting people that are an environmental concern and by aiming to inform people with online campaigns that explain how the transition to sustainable heat is beneficial for the environment. The perceived feasibility also proved to impact people's attitudes regarding the transition positively. Businesses can use this information and aim to showcase their products' feasibility to individuals; this can be done by promoting the feasibility of their products through digital marketing campaigns since online sources were found to be the ones most used by individuals. Policymakers can use the results of this study and apply them by showcasing the feasibility of their plans to individuals in order to positively impact individuals' attitudes regarding the transition to sustainable heat. Perceiving the transition to sustainable heat as having benefits was also found to positively impact individuals' attitudes towards it; therefore, both businesses and policymakers would benefit from promoting the benefits of the transition to individuals. This can be done using digital marketing campaigns that showcase the benefits of the transition.

Ages were found to negatively relate to the attitudes towards heat transition; therefore, both businesses and policymakers should look into ways to better target older people. This could be done online using targeted ads as well as offline since older people might not use the internet as much as younger people. Older people might also not see the value of changing their heating systems; therefore, the benefits of the transition and the easiness of applying it should be better showcased in order to improve their attitudes.

Actors that aim for the transition should look at the factors that prove to positively impact the attitudes of individuals regarding the transition towards sustainable heat and use them to increase individuals' willingness to transition to sustainable heat.

5.4 Conclusion

Transitioning to sustainable heat is essential to attain the goal of becoming natural gas free, for this is necessary to understand the factors that impact individuals' attitudes regarding the transition towards sustainable heat to better facilitate it. This study analysed factors researched in past studies in order to test their impact on the attitudes of individuals living in the Netherlands regarding the heat transition. A number of factors were found to have significant impact on the attitudes regarding sustainable heat transition; these factors can be helpful in promoting and assisting the transition towards sustainable heat. The factors that proved to significantly impact the attitudes positively were environmental concern, perceived feasibility, and perceived benefits. The sources most used to gain knowledge were also analysed to understand the information channels used by individuals, most sources used by individuals proved to be online sources. Policymakers and businesses that sell sustainable heating systems can use the results of this study to facilitate and promote the transition towards sustainable heat.

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