Enhancing urban heat grid development through improved communication

Exploring communication strategies for better technology adoption among tenants in social housing

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Abstract

The international agreed upon UN COP21 Paris Agreement argues the urgent need of a shift in greenhouse gas emissions. This has been one of the reasons for the Dutch government to establish goals that comply with these agreements. One approach that is being used is the implementation of heat grids. Literature shows the importance of acceptance from tenants, but fails to provide information regarding the effects of communication strategies on the willingness to adopt heat grids. This research explores the current willingness and openness of tenants to adopt new technologies and its barriers to this, as well as the influence of the role of involved stakeholders and its communication strategies. The main research question therefore is: 'How can actively involved stakeholders enhance communication to improve the adoption of heat grids among housing association tenants?' The current gap will be researched through an explorative qualitative study, using literature, (intercept-) interviews, and case studies to identify the key problems. The findings show that a well-tailored narrative, aligned by the views of all stakeholders, helps to lower the social, behavioral and economic barriers related to heat grid adoption, where establishment of trust between tenants and organizations should be the principle for the communication strategy. This research contributes to the already existing literature by providing new insights in organizational barriers among the engaged stakeholders, as well as how certain communication strategies can be enhanced to create a successful project and helps in achieving energy transition goals.

Keywords | Heat grids, communication strategies, technology adoption, social housing, storytelling

Preface

This is the master thesis called 'Enhancing urban heat grid development through improved communication'. It has been written in order to fulfil the requirements necessary to graduation program for Management in the Built Environment (MBE) at the TU Delft. Before continuing this thesis I would like to express my gratitude for some valuable individuals who guided me throughout completing this master's thesis.

It has been quite a challenge, starting from zero and finishing with a product and research to be proud of. This result would not be here without my three mentors who guided and supported me by giving feedback from their expertise. Erwin, Queena and Yu, thank you for encouraging me the past few months. Your insights really helped me to challenge and motivate myself in order to continue and constantly seeking for improvements to make this research even more valuable.

I would also like to thank Astrid, the person responsible for my guidance during the internship. Even though it was a short period of time, it was a very valuable time in which I had the chance to see my interests reflected in a different sector. You gave me the opportunity to be involved in certain tasks which helped to develop my skills and gave me a broader view of the complex task of the energy transition. The guidance on how to tackle certain projects helped me to become more comfortable in doing research, something that reflected during the writing of this thesis. Additionally, I would also like to thank all the interviewees that participated in this research. Your openness, knowledge and interests really helped to visualize and shape this thesis. The willingness to offer support and provide extra insights showed me how valuable your roles are in creating a more sustainable world.

To all the other people who I had conversations related to this thesis, even though you might not realize it, your comments and small conversations helped to get me motivated and get some perspectives on how to write this thesis. For that I will always be very thankful.

Stef Gitzels

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HA – Housing association

EC – Energy company

M – Municipality

CC – Consulting company

Chapter 1 - Introduction

1.1 Background information

It is clear that climate change is happening at global scale. This has been the reason for world leaders to come together and establishing an agreement, known as the UN COP21 Paris Agreement in 2015 (UNFCCC, n.d.). One of the biggest goals mentioned in this agreement is the limitation of the rising temperatures with a maximum of 1.5°C (UNFCCC, n.d.). The UN COP21 Paris Agreement has an international effort to tackle climate change. Nationally determined contributions (NDCs), in which nations mention their plans for cutting greenhouse gas emissions and preparing for the consequences of climate change, are how this commitment has played a significant role for every nation (UNFCCC, n.d.). Various obligations and frameworks have been created by the EU, such as The European Green Deal, which is initiated in 2019. It is the European Union's comprehensive plan to reach carbon neutrality by the year 2050 (Directorate-General for Climate Action, 2021). The plan sets objectives to decrease greenhouse gas emissions by a minimum of 55% by 2030 in comparison to the levels recorded in 1990. The Energy Performance of Buildings Directive (EPBD) and the Renewable Energy Directive (RED) are essential parts of this effort. The EPBD aims to improve the energy efficiency of buildings by implementing an ongoing removal of fossil fuel-based heating systems by the year 2040 (European Commission, n.d.). Meanwhile, the RED establishes a goal of achieving a minimum of 42.5% renewable energy in the EU energy mix by 2030 (European Commission, n.d.)

This agreement has also triggered the Dutch government in establishing goals for the Netherlands in order to comply to these agreements set in the UN COP21. These goals have been written in the 'Klimaatwet', which focus points are towards reducing the CO_2 emissions (Rijksoverheid, 2022). According to the Rijksoverheid (2022), the goal is to reduce the CO_2 emissions by 55% in 2030 and to be climate neutral in 2050. In order to reach this, several financial compensations has been reserved (Rijksoverheid, 2022). Major steps in the energy transition are needed to meet these aims of reducing CO_2 emissions. The heating industry plays a major role in this shift. In the Netherlands, heating accounts for around 40% of the total energy demand, while the built environment provides one-third of the total energy demand (EBN, 2024).
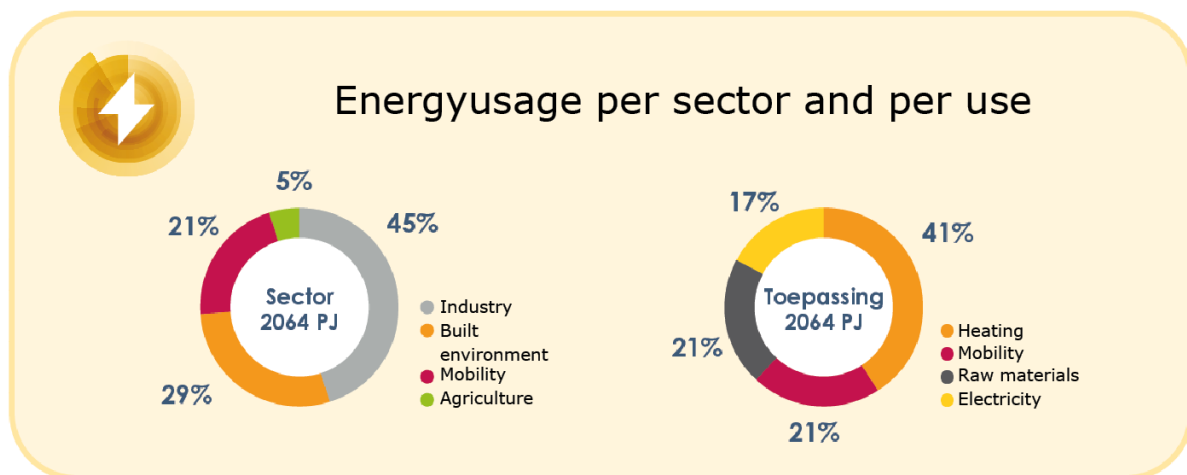
Figure 1: Percentage of energy usage in different sectors in the Netherlands
(Infographic from EBN (2024) based on data from CBS (2023))

Making the switch to sustainable energy sources is essential to reach the high targets given in the Dutch government's Klimaatwet (Rijksoverheid, 2022). In order to go gas-free, the Dutch government established a program called 'Programma aardgasvrije woningen (PAW)', in which it is described how 7 million homes should be gas-free (Rijksoverheid, n.d.). In this PAW it also described the district to district approach, where it is highlighted that governments and other instances decide what measurements are possible in that district and how this impacts the citizens. The Dutch Warmtewet

(Heat Act) regulates the supply of heat to households, ensuring that consumers are protected in terms of price, reliability, and transparency (Overheid.nl, 2024). The introduction of the Warmtewet was in 2014, and has undergone revisions to better align with the Dutch sustainability goals and to support the transition to renewable energy sources. In the construction sector, heating accounts for a significant amount of energy use, therefore identifying new and innovative approaches is essential to accelerate this shift (Schoots et al., 2016). One approach is the use of heat grids. There are several reasons why heat grids are unique among other options (Fischer & Madani, 2017; Marrasso et al., 2018). Heat grids can make use of centralized renewable energy sources, which are more sustainable and efficient than decentralized ones like personal gas or electric heaters. By collecting and reusing waste heat from industrial operations, heat grid infrastructure improves overall energy efficiency (Marrasso et al., 2018). Heat grids, as opposed to individual systems, have the ability to lessen infrastructure stress and peak electricity needs (Baeten et al., 2017). This makes them more appropriate for urban locations where retrofitting buildings for individual renewable energy sources, such as heat pumps or solar panels, may be difficult or expensive.

The existence of heat grids is not something new and is talked about for several years, as seen by the analyses of Ossebaard et al. (1997). These heat grids provide a cost-effective and environmentally responsible alternative for traditional heating methods by distributing heat produced by renewable energy sources like geothermal, solar thermal, or biomass throughout different urban areas (Catrini et al., 2022). Several Dutch examples can be mentioned, such as the geothermal pumps in Agriport Middenmeer, which saves 30.000.000 M^3 of natural gas each year (Geothermie Nederland, 2024). Heat grids have progressed to fourth and fifth-generation systems, which provide improved effectiveness and sustainability. Fourth-generation district heating (4GDH) functions at reduced temperatures, incorporates renewable energy sources, and uses intelligent thermal grids to decrease the loss of heat (Buffa et al., 2020). Fifth-generation district heating (5GDH) is an even newer and more advanced system that distributes heat at temperatures close to the surrounding environment. It uses heat pumps in every building to provide both heating and cooling. This technology also enables the incorporation of leftover heat and intelligent energy management, therefore maximizing the use of energy (Buffa et al., 2020). Municipalities may significantly reduce their reliance on fossil fuels by using heat grids, which will cut CO2 emissions and help them move closer to sustainability objectives. In addition, the use of intelligent technology improves heat grid management and efficiency, ultimately optimizing energy use and reducing operating costs (Wiethe, 2022). Therefore, in order to move the Netherlands towards a greener, more sustainable future, an interesting alternative for fossil fuels is the use of heat grids.

The successful implementation of a heat grid requires a multi-phase procedure involving several stakeholders in its development (Hamdan et al., 2021). Engagement with stakeholders and end-users are essential parts of the process, yet this appears to be one of the most challenging parts (Gramberger et al., 2014). Public gatherings such as seminars, information sessions, and meetings are supposed to encourage communication between companies, residents, and project developers (Gramberger et al., 2014). This involvement promotes openness and guarantees that the end-users' opinions and concerns are taken into account at every stage of the project's lifetime. The development of implementing sustainable energy transitions has a number of complicated obstacles regarding community involvement in initiatives like the installation of heat grids (Rogers et al., 2008; Kalkbrenner & Roosen, 2016).

A thorough understanding of the complexities of heat grid projects, including their effects on the environment and the economy, requires specific knowledge that the general public may not easily get (Krog et al., 2020). The difficulty in correctly including communities in these activities comes from the information gap that exists between specialists and non-experts (Krog et al., 2020). The wide range of values and interests held by many stakeholder groups in these communities, including local companies, governmental bodies, environmental organizations, and residents, complicates this issue even further. Since every group has different goals and concerns, it can be challenging to deliver

information that sufficiently meets the requirements of every single person. Achieving project goals while managing these sometimes conflicting interests is difficult (Millhollan & Kaarst-Brown, 2016). For example, although some locals could place a higher priority on the environmental advantages of switching to renewable energy sources, others might be more worried about possible interruptions to their daily routines or how affordable energy bills will be. In order to gain an understanding in this, a roadmap and cycle of user experience can be visualized (Kort et al., 2020). An overview of such experience visualized can be seen in Figure 2.
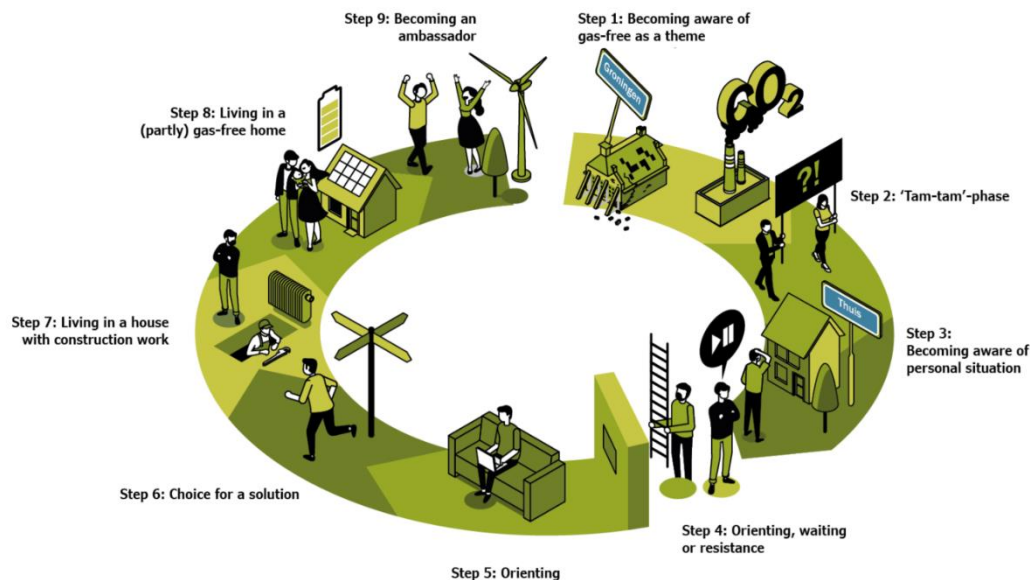
Figure 2: User experience towards gas free living (Kort et al., 2020)

Information is essential to project participation, especially when it comes to energy retrofits for residential buildings (Jia et al., 2021). In order for homeowners to make educated selections during the retrofitting process, information such as building characteristics, advantages of retrofitting, technological specifications, and service options must be provided. Positive information encourages homeowners to cooperate and influences how they perceive risk, which increases their involvement in retrofit initiatives (Jia et al., 2021). Furthermore, the reliability of information sources has a big influence on how cooperative homeowners are (Jia et al., 2021). Therefore, encouraging homeowners to actively participate in and cooperate with energy retrofit initiatives demands making sure that information is easily accessible and well understood.

1.2 Problem statement

Achieving national and international climate targets requires changes in the energy industry. Despite the increasing awareness of the urgent need for alternatives to the current energy providence services, this transition is taking some time and has several challenges. It is suggested that public awareness, knowledge and engagement improves climate change adaptation policies (Khatibi et al., 2021). One of the most prominent alternatives that also has been discussed in the previous paragraph is the use of heat grids, since it is proven that the usage of these heat grids, when implemented correctly, will drastically decrease the reliance on natural gases and therefore will be a more sustainable option. However, there are difficulties in implementing these systems in existing neighborhoods, which will be elaborated on in the next paragraphs.

This research will be particularly be focused on housing associations. The implementation of heat grids in this sector is crucial to research due to its unique complexity. In the Netherlands, a total of three million homes are owned by housing associations and therefore makes social housing a significant sector to research. Its complexity comes partly from the sectors requirement for a tenant approval of

at least 70% before being allowed to execute the project (AEDES, n.d.). This approval rate is implemented to ensure the housing association offers a 'reasonable proposal' to its tenants. Tenant participation is essential, yet tenants often show a lower level of acceptance of energy transitions compared to other sectors and this poses a barrier for successful implementation of these heat grids (Ossokina et al., 2021).

This research focusses on housing associations and tenants in an effort to address these particular issues and provide important new information on the variables affecting societal acceptability. In order to provide easier transitions to heat grids, it will be beneficial to establish strategies that take into account the diverse viewpoints of tenants living in social housing (Madumere, 2016). This tailored approach offers targeted solutions for addressing challenges in the energy transition while promoting a greater awareness of the socio-economic and regulatory complexity specific to the housing sector. Several studies claimed that public awareness has a substantial influence on the adoption and knowledge of climate change policies (Nunn et al., 2013; Khatibi et al., 2021; Madumere, 2016)

Heat grids have complicated social acceptability. Tenants sometimes find it difficult to understand the advantages of switching from gas because they are worried about the financial consequences and the difficulties of construction (Khatibi et al., 2021). Also, tenants are more often hesitant due to it being a change in their lifestyle. Openness to new technology is shaped by education and risk-taking mindsets. Although there is an increasing amount of study on heat grids, little is known about their acceptability. Important factors include independence, financial stability, interior comfort, and knowledge gaps (Khatibi et al., 2021). It is crucial to have trust in stakeholders since mistrust can hinder collaboration and acceptance. The successful adoption of heat-grids relies on the active participation and acceptance of end-users (Madumere, 2016; Skjølsvold & Lindkvist, 2015). However, existing literature falls short in understanding the crucial role that communication has on tenants' technological knowledge, preferences, and barriers towards adopting these innovative heating technologies. Without addressing these user-centric aspects and knowing how to approach this group, efforts to introduce heat-grid adoption are likely to encounter resistance. Researching in how engaging stakeholders approach and communicate with these tenants, will provide insights in how to effectively communicate to tenants to get a higher participation grade.
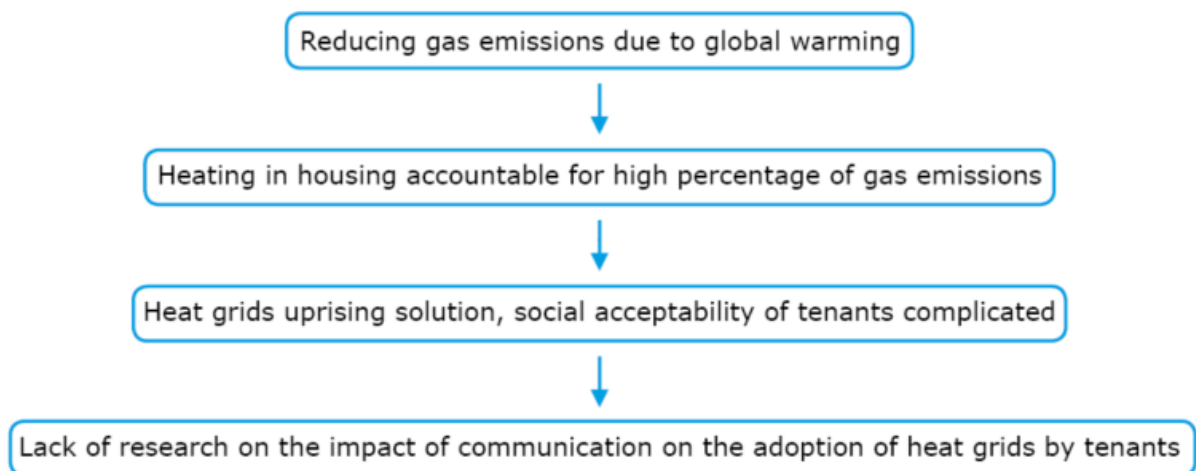
Figure 3: Problem statement, simplified (author)

Chapter 2 - Research

2.1 Main research questions

In order to perform a research based on the problem stated in the introduction, it is important to have sorted out the different components that have to be researched. The main research question in this paper is:

How can actively involved stakeholders enhance communication to improve the adoption of heat grids among housing association tenants?

2.2 Research sub-questions

To be able to answer the main research question, five different sub-questions will be developed.

Sub-question 1: What is the current level of adoption and openness to new technology of tenants in heat grid projects?

Sub-question 2: What are the barriers encountered by tenants in the adoption of heat grids?

Sub-question 3: What role do the actively involved stakeholders have in facilitating and communicating technological knowledge to tenants?

Sub-question 4: What communication methods do stakeholders believe would best improve adoption among tenants in heat grid projects?

Sub-question 5: What communication approaches can be used to overcome the barriers regarding the adoption of heat grids?

The research's primary objective is to identify tenants' present level of openness to new technology in order to establish an overview of their knowledge gaps, misunderstandings, and perspectives. Afterwards, it will focus on the roles and responsibilities of engaged stakeholders in developing and communicating technical knowledge to tenants. The research aims to identify which stakeholder roles are essential for good communication and how they might need to be adjusted to increase tenants' understanding by evaluating their impact. Following this, stakeholder perspectives on communication strategies to improve technology awareness and acceptability is being tackled. By looking into current strategies and possible good other initiatives, insights in enhancing communication will be researched. In order to create a communication framework that removes technological barriers, and encourages the use of heat grids, the research will finally combine these results. The research aims to answer the main research question by completing a four step approach to understand the importance of technological awareness. In Figure 4, a simplified model has been given to understand the structure of the various components.
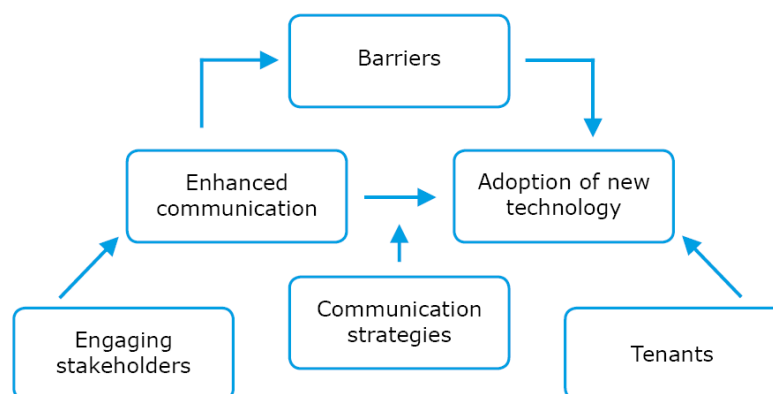
Figure 4: Conceptual model (author)

2.3 Type of study

In order to be able to answer the main research question and the sub-questions, an explorative qualitative study will be done, with some aspects of a quantitative study. The research will start with a literature review. Based on this literature review a framework will be established that shows the main barriers for the importance of communicating technological knowledge to the end-user. Also the importance of tailored communication strategies will be researched upon. The sub-research questions will help validating and providing new insights that will help answer the main research question. A qualitative research is being conducted because of its ability to research the role and the awareness of the stakeholders in relation to tenants. Besides this, a qualitative study is best suited for answering these research questions as it provides elaboration of existing literature, instead of testing theories (Reinecke et al., 2016). This is necessary due to the generation of new information that is currently being generated and can help improving future processes. An overview of this can be seen in Figure 5.
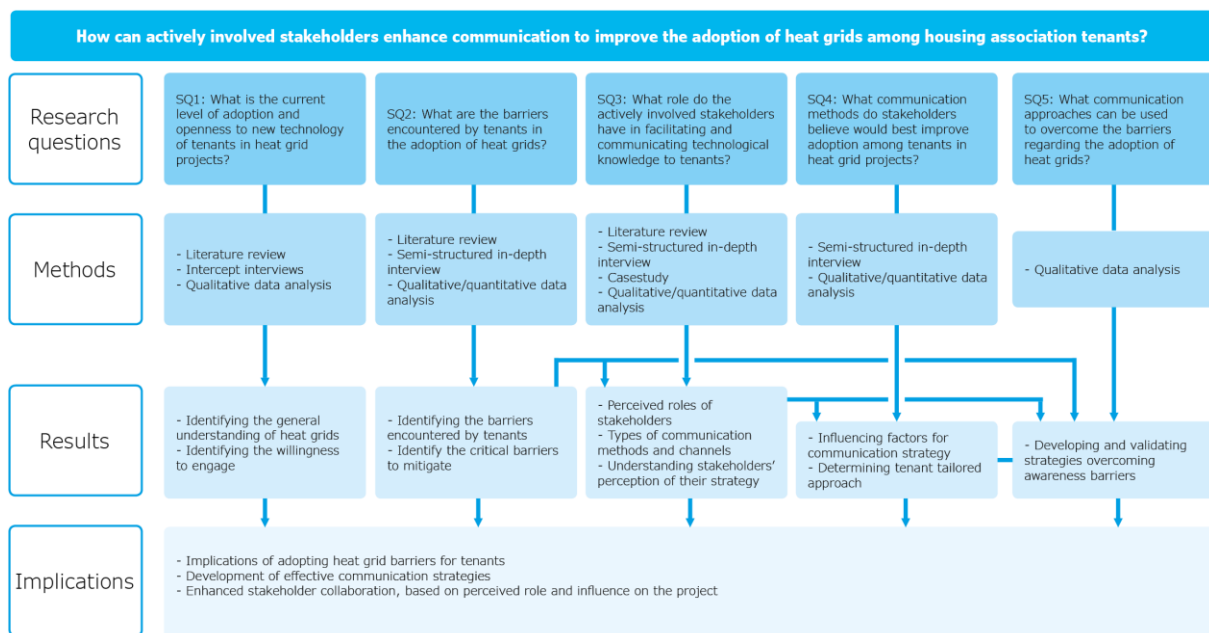
Figure 5: Research overview (author)

The goal of the first sub-question is to examine the current state of tenants' awareness and familiarity with heat grid systems: What is the current level of adoption and openness to new technology of tenants in heat grid projects?'. This involves figuring out how well-informed tenants are about the technology, as well as their views and any possible misunderstandings. In order to identify areas of knowledge and perception gaps, it is important to establish a baseline for new technology. This will determine which components of the technology are well understood and which are not by analyzing the current awareness level. It will highlight areas that need more communication efforts. The data will be gathered via literature review, several intercept interviews, based on responsiveness of tenants, with tenants of housing association who currently experience the process of establishing heat grids and a qualitative data analysis.

When looking to the second sub-question, the barriers will be identified: 'What are the barriers encountered by tenants in the adoption of heat grids?'. This sub-question is critical when it comes to understand how the communication can be improved. When barriers exist in adopting new technologies, tenants are more likely to not cooperate. Acknowledging these barriers can help in mitigating these and lower the resistance towards adopting heat grids. For this sub-question, there will be looked into literature as well as semi-structured interviews with engaged stakeholders which will be defined based on the analyzed cases. A total of eight interviews will be conducted by the four engaged stakeholders over the two cases. The literature will be the foundation on which the interview

protocol will be established. Relevant stakeholders will be asked if they recognize the barriers and how they would address these barriers, which is one of the parts that is being discussed during the interviews. A qualitative and quantitative analysis will be done to provide results on which barriers are encountered, and what the main attention points should be.

The third sub-question: 'What role do the actively involved stakeholders have in facilitating and communicating technological knowledge to tenants?' aims to determine how various stakeholders, such as housing associations, municipalities, and energy companies, have influenced tenants' understanding of heat-grids. Each stakeholder might have a different role to play, a different communication style, and a different engagement goal. It is essential to understand these roles in order to identify any possible overlaps or gaps in responsibilities. Additionally, by examining their strategies and viewpoints by analyzing repetition and emphasize on certain quotes by the interviewees, the research can determine efficient methods of communication as well as the stakeholder groups best suited for particular informative responsibilities. This sub-question acts to explain the division of responsibilities among stakeholders and builds on the adoption of heat grid barriers noted in the previous sub-question. The main methods for this question will be semi-structured in-depth interviews with relevant stakeholders, with a section of the interview being dedicated on identifying their roles in the project. Case studies will be used to compare different strategies within certain projects.

After discovering the roles of the various stakeholders, the goal is to look into stakeholders' perspectives on communication strategies that effectively address tenants' willingness to adopt heat grids, and overcome some of the identified barriers: 'What communication methods do stakeholders believe would best improve adoption among tenants in heat grid projects?'. By collecting data on preferred or used communication methods, the research gives an extensive overview of the communication strategies recommended or used by stakeholders. A framework regarding this communication strategies will be created as a guidance for analyzing the quotes and conversations during the interviews. This will reveal certain stakeholder perspectives and also makes it possible to evaluate which strategies are currently neglected and which have the potential to have a bigger effect. Thus, by matching communication strategies to tenants' desires and preferences, this sub-question directly contributes to increasing tenants' openness to heat grids. This will be done in the same way as the third sub-question, and will be researched upon in the same semi-structured in-depth interviews.

The last sub-question aims to mitigate the barriers related to tenants' openness to heat grids and develop strategies for communication that could tackle this: ' What communication approaches can be used to overcome the barriers regarding the adoption of heat grids?' This sub-question builds on the knowledge gained from the earlier sub-questions by combining all the data to produce helpful recommendations for enhancing communication strategies. It entails matching tenants desires with stakeholder engagement, creating communication strategies that are tailored to certain needs, and using the right channels to establish trust and understanding. By establishing an overview of the findings, the research hopes to provide a framework that stakeholders could apply to overcome or mitigate barriers, which will eventually improve tenants' acceptance and adoption of heat grids.

2.4 Data collection

As seen in the previous section, the research will have different research methods to collect the data necessary to answer the main research question. The research is based on a qualitative study consisting of four components: desk study, expert interviews, case study and intercept interviews. Since it will be a qualitative study, results of a certain methods can be differing and depending on the temporary nature of the situation and therefore the results will be tested and validated based on the other methods. Based on the desk study, a framework and fundament will be created that helps developing the other methods to be more precise and effective in answering its relevant sub-questions. The expert interviews and case studies will help validate or reject the gathered data and

give insights in new situations that the desk study did not show. The case studies will show explicitly what the current status of the implementation of heat grids is and how different approaches and strategies are being done to communicate information to tenants. An important aspect is the use of intercept interviews to capture tenants experiences regarding the topic.

2.4.1 Desk study

The conducted desk study will analyze primarily literature that is already available. It is done to unfold the key concepts in this research and to create a framework of the existing literature that helps establishing interview protocols. Academic papers and documents will be read and reviewed to understand the research gap and how to act on this. In order to find relevant academic papers, databases such as ScienceDirect have been used to ensure credibility and findability. Starting off with a set of keywords related to adoption of new technologies, influence of communication on acceptance and the relation of trust between tenants and housing association helped to find academic papers. These papers were the input for finding other relevant papers due to its references. With the help of AI software such as Research Rabbit helped in organizing related and relevant sources. This is already partly done to elaborate the research gap and also the literature review is done based on desk study.

2.4.2 Case Studies

According to Yin (2017), case studies are a research method that investigates a temporary situation, the case, in-depth and within its real-world context. This is what in this research is necessary, capturing communication strategies by engaging stakeholders to the tenants. The case studies will be the fundament of the research and will decide which stakeholder will be interviewed. In order to have a complete understanding of how stakeholder engagement improves communication and increases tenants' knowledge of technology in housing associations, a case study is used since this is the most fitting research method (Simons, 2020). A comparison will be done by selecting two case studies, which makes it possible to identify trends and variations in the roles of stakeholders, their communication strategies, and how well they work. This is done to identify differences and create conclusions that a single case study could miss. The needed criteria have been met in the selection of these cases to guarantee that the study is both possible and relevant. At first, the cases have to relate to present heat grid projects that directly affect housing association tenants, which is the primary objective of the research. Second, in order to raise technological awareness to tenants, housing associations, local governments, and providers of heat grid services must actively engaging. This guarantees insights on stakeholder viewpoints and strategies. Thirdly, in order to ensure consistency, the cases should take place in similar geographic contexts. This can be seen in Table 1.

	Case selection criteria	Criteria because
Needed	Heat grid project	Scope of the project
	Project in the Netherlands	Scope of the project
	Project in which housing association is involved actively	Scope of the project
	Project with multiple engaging stakeholders	Scope of the project
Wanted	Multiple stakeholders engaging in different phases	Mulitple stakeholders acting as the leading communincator could cause distrust or cause double communication, interesting to see its effect on tenants
	Variation in communication strategy	Allows for comparative analysis of stakeholder approaches, addressing Subquestion 4 on effective communication methods
	Project with residents committee	Residents committees can be effective and really show the voices of the tenants, who otherwise would be reluctant

Table 1: Case selection criteria (author)

These criteria are essential because they guarantee that the cases that are chosen are directly relevant to the research topic and that the information gathered will be useful and comparable. Following these criteria will allow the research to investigate the dynamics of stakeholder communication strategies and how they impact tenant awareness, therefore making a significant contribution to the field and providing useful insights for future projects.

2.4.3 Interviews

Building on the literature review and desk study, a semi-structured interview protocol will be established. The goal of these interviews are to recognize the communication strategies currently used by stakeholders and confirm or add to the information already known about the factors that encourage and hinder tenants in housing associations from not knowing how heat grids could change their way of living. The purpose of the interviews is to learn more about the roles that actively engaged stakeholders play when encouraging and informing tenants about developments in technology. In accordance with the case selection criteria, appropriate stakeholders will be identified and invited to take part in the interviews. Because this study is qualitative in character and compares two case studies, a sample size of eight interviewees is considered appropriate.

2.4.4 Intercept interviews

Intercept interviews were used to try to facilitate tenants' sharing their opinions. Intercept interviews are short conversations conducted in casual, familiar environments, which encourages participation (DJS Research, n.d.). This reason for intercept interviews was influenced by privacy concerns and anticipated difficulties in contacting tenants. The research aimed to get more direct, honest input by meeting residents where they are, such as at the market in their neighborhood. The purpose of these interviews was to learn more about the general views of tenants regarding heat grids, their understanding of the information presented, and their suggestions for improvement. This eventually will help to validate sub-question 1 and will help to provide answers in how the communication strategy can be enhanced.

2.5 Data management

2.5.1 Data analysis

The goal of data analysis is to categorize, analyze and summarize data into useful information that can be used to answer the research questions. Data processing is the systematic gathering, transforming,

cleaning, and structuring of data with the objective of discovering the necessary information. There is a difference between qualitative and quantitative data analysis. Whereas quantitative data analysis focuses on numbers and statistics, qualitative data will derive from analyzing and categorizing the results from interviews and the intercept interviews.

The data collected from the desk study will be used to create a framework and an overview of the current literature covering this topic and relevant information necessary to take in consideration when conducting the other parts of the research. The data acquired during the stakeholder interviews and intercept interviews will be more important to analyze. This will be done by organizing and categorizing quotes stated by the interviewees in thematic categories to identify recurring themes. The interviews will be transcribed and saved using Atlas TI. This software program will help the categorizing and coding of the transcriptions. It will help to understand the story that will be told and pinpoint the important messages stated by the interviewee and help answering the questions. The intercept interviews will be analyzed via an inductive content analysis to evaluate the most common answers.

This will be the same for the case studies. Based on the earlier mentioned criteria for case study selection various cases will be explored. Since these cases will be all in the early stages of implementing heat grids, it will provide an overview of the strategies used and the factors influencing the project most. This information will be later on categorized in themes relevant to the research to recognize patterns and confirming or denying earlier research. Eventually this will be used to answer the research questions.

2.5.2 Data plan

All data that will be collected during this research will follow the FAIR guiding principles of scientific data management, based on the principles stated by Wilkinson et al. (2016). This will guarantee its Findable, Accessible, Interoperable, and Reusable (FAIR). The objective of these principles is to improve the network that facilitates the reuse of academic data (Wilkinson et al., 2016). Complete data will be given to facilitate automated identification of datasets and interaction with services, and this metadata will be organized and made searchable, adhering to the principle of the data being findable (Wilkinson et al., 2016). Accessibility will be guaranteed by using established communication protocols. The results of this research will also be published on the TU Delft repository which is accessible for every individual interested in the results of this research. To keep it findable, relevant key-words will be provided that will link to this research. Interoperability will be achieved by the utilization of formal, easily accessible, and shared languages for describing knowledge, which means this research will comply with the use of formal English, with the exception of the not published interview transcripts, quotes will be translated to English as accurate as possible. The use and documentation of other papers will be clearly given. This follows I1 and I3: "(meta)data use a formal, accessible, shared, and broadly applicable language for knowledge representation" and "(meta)data include qualified references to other (meta)data respectably" (Wilkinson et al., 2016). For optimal reusability, it is necessary to characterize the data and metadata, ensuring it corresponds to standards. This is also done by being published at the TU Delft repository and ensures the research meets the level necessary for being published by a university. The data management plan will be included in the appendix.

2.5.3 Ethical consideration

In this research, ethical considerations are strictly followed to maintain the integrity of the research and protect the participants. All acquired data is securely kept and may only be accessed by authorized individuals. In order to ensure security, the HREC (Human Research Ethics Committee) application procedure from the TU Delft has been completed. During this progress it had to be shown how the data will be obtained, anonymized and stored to obtain as much security as possible. Once this form was completed, it had to be signed by both the main mentor and a member of the HREC. Participants' personal information is anonymized to ensure their privacy remains secure and to avoid

revealing their identities. Obtaining informed consent is necessary when individuals are involved in the research. This involves ensuring that participants have a complete understanding of the research objectives, methods, potential risks, and their right to withdraw from the study without facing any negative consequences. Prior any interactions and interviews which involves individuals, a consent form will be provided which is mandatory to complete before continuing the interaction. In this consent form it will be described what will be done with the data and why this research is being conducted. Attention will be placed on voluntary engagement, without any kind of force. The intercept interviews all have been done anonymously and prior the short interview it purpose of the interview was explained to provide tenants clarity and the possibility to not participate. It is guaranteed that data management is transparent and study findings are reported ethically. These factors are essential to the research process, guaranteeing the protection of participants' identity.

2.6 Research output

2.6.1 Research goal

The goal of this research is to enhance the adoption of heat grids by looking into communication strategies. In order to do this, the thesis seeks to develop methods that enhance information accessibility and communication, enabling these communities to engage in better group decision-making processes.

Evaluating the existing communication strategies used to encourage heat grid adoption by tenants is the main objective of this study. In order to facilitate the integration of these systems into the built environment, a thorough evaluation of current strategies and guidelines is required. The objective is to comprehend the efficacy of these tactics and to identify any weaknesses or gaps that could prevent them from succeeding. Finding the exact kinds of technical knowledge hurdles that tenants in these neighborhoods face is a different objective. This will involve investigating how these barriers influence how heat grids are perceived and accepted as well as how they affect the processes associated with making decisions about energy transitions. The study will concentrate on personalized communication techniques that address and minimize these problems when these barriers have been identified.

2.6.2 Deliverables

The goal, as stated in the previous paragraph, is to enhance the communication and the ways in which communication influences tenants desire to participate in the heat grid projects. A verified framework emphasizing the critical role that communication and information facilities play in influencing tenants willingness to actively participate will be the final deliverable. The purpose of this research is to raise awareness of the challenges people have when it comes to technical expertise, how to get beyond these barriers, and when engagement and involvement will likely increase. With this, a set of recommendations will be given to the engaged stakeholders. Besides this, an overview of current working strategies will be provided that can be implemented by different stakeholders to get tenants more familiar and willing to engage in heat grid projects. By taking care of these things, it will promote better cooperation and agreement while creating a solid project plan for the heat transition.

2.6.3 Dissemination and audiences

The conducted research will be published under the terms and conditions of TU Delft and will be publicly available for those interested. Short articles and other publications can be derived from this thesis in or-der the broaden the knowledge for those directly involved and interested in the researched topic. The significance of this research can be especially interesting for policymakers, energy transition practitioners and project leaders who seek effective strategies for sustainable community engagement. It will give relevant information regarding the adoption of heat grids, effective strategies to overcome these barriers and the role and importance of the directly involved stakeholders communicating with the tenants. Organizations who take part in establishing heat grids might find this research valuable to gain insights in what strategies should be utilized for better communication and higher participation in the initiation phase.

2.6.4 Societal and scientific relevance

This research addresses the urgent need for sustainable energy solutions as well as the challenges of social acceptance and policy implementation, making it highly relevant from both a scientific and societal standpoint. The findings will have societal importance as it addresses the shift to renewable energy sources in heating systems. Since its emphasis is on tenant perspectives and the overcoming of barriers, this study improves neighborhood involvement and engagement. It contributes to the existing knowledge by examining the different relationships. It provides perceptions on how various stakeholder views and degrees of acceptance could affect how heat grid technologies are implemented. The study will provide insights in the development of more effective communication plans that are aware of the desires and barriers from the community by identifying and analyzing the obstacles. In conclusion, this research contributes to closing the gap between technology potential and practical implementation by providing suggestions that might help housing associations and other stakeholders towards sustainable energy transitions.

The scientific relevance of this research is related to the problem statement. This problem statement mentioned the gap in research on how communication can tackle the barriers of technological knowledge regarding the implementation of heat grids. This element is essential for the societal relevance regarding the transition to greener alternatives. Research has been done on the importance of tenant involvement and the importance of active participation of the tenants in projects. However, research has to be done on how adopting new technology barriers can be overcome by the providence and accessibility of information for this vulnerable group. Heat-grid projects will benefit highly when research towards this topic is conducted given the pressure and difficulty of user participation in these heat grid projects.

Chapter 3 – Literature review

In this chapter, different literature is being analyzed in order to establish models which will be used later in the analysis part. Each sub-question is being dissected to identify its main themes and what information would be necessary in order to provide answers for these questions. There will be started by looking into tenure typologies, how this affects the willingness to adopt new technology, what percentage of the population in the Netherlands can be related to this. This will provide a basic structure to answer sub-question 1. After this, the general technology related to heat grids will be discussed, and which stakeholders are related to these processes. This provides an overview of which stakeholders should be approached in this research in order to enhance communication and is necessary to identify for sub-question 3. The next step is looking at the communication, what parts of communication is important, who is responsible for the communication in heat grid projects and what strategies should be used that could improve the willingness to adopt new technologies. It is therefore related to sub-question 3 as well. To conclude, there will be looked into the barriers of heat grid adoption. This information is necessary in order to identify the challenges encountered in heat grid projects and how this influences the tenants' willingness to adopt, and is related to sub-question 2, since it will identify the barriers encountered. This literature review will provide an overview of several analysis models that will be the foundation for the interview protocol. Sub-questions 4 and 5 will not be discussed via literature since with these two questions will be answered via the analysis part of this research.

3.1 Tenure typologies

3.1.1 Differences between homeowners and tenants

In order to understand how tenants should be approached compared to homeowners, it is important to understand the different tenure typologies. There are several tenure typologies, which can be divided in residential, consisting of homeowners, private renting and social housing, and commercial. They show a variance of types of ownership that should be considered throughout the area. They are designed to create varying and lasting communities, making them a fitting approach for urban development (Arthurson, 2013). These tenure typologies bring together different tenures into a single, pleasant environment, encouraging interaction between residents, financial stability, and environmental sustainability (Arthurson, 2013). These neighborhoods also have issues. One issue is the possibility of social disagreement and tensions between different communities. While homeowners might focus on property values and stability, tenants, especially in social housing, may have different views (Van Den Nouwelant & Pawson, 2017). Investments needed for repairs or higher sustainability may be less important compared to the current standard of living. Successfully managing different expectations and demands requires the implementation of complex and flexible governance structures.

In the Netherlands, mixed tenure neighborhoods are not new and have been used for many years, thus gathering significant experience. They demonstrate a balanced mix of residential, commercial, and social areas, reflecting modern urban planning principles (Smets & Sneep, 2015). These neighborhoods show complex dynamics that impact the unity and inclusion of the community. The effectiveness of tenure mix in the Netherlands depends on managing commercial and common areas. Class and ethnicity influence social relationships and the feeling of belonging in a neighborhood. Urban planning that includes everyone and is well-managed is essential for creating a sense of belonging and social unity (Smets & Sneep, 2015). This ensures that the benefits of diverse housing options are fully utilized by all inhabitants.

3.1.2 Tenants of social housing

Tenants bring a lively and diverse element to the community. The Dutch social housing system is quite large, with housing associations owning around 30% of the entire housing stock (Boelhouwer, 2017; Smets & Sneep, 2015). These groups have an impact on affordability and maintaining affordability in

the Netherlands. This guarantees inclusiveness and reduces displacement, as mentioned earlier. This diversity encourages a dynamic neighborhood and strengthens the local economy (Arthurson, 2013; Khor et al., 2023). This is different compared to home-owners and can cause problems, especially in hindering collective decision-making due to the contrasting interests and financial commitments of homeowners, renters, and businesses (Van Den Nouwelant & Pawson, 2017). While homeowners

PERCENTAGE OF HOUSING STOCK

■ Housing associations ■ Private and commercial renters ■ Owners
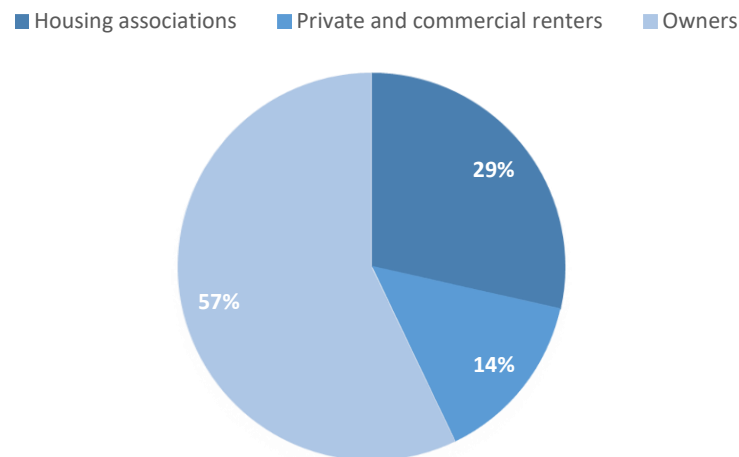
Figure 6: Percentage of houses owned by Housing associations (author, derived from Aedes (2023))

have significant long-term financial interests in their houses and therefore prioritize choices that improve property values and neighborhood stability, this is not the case for renters. Homeowners tend to support investments in existing infrastructure and improvements of social common areas and facilities that attract new homeowners (Arthurson, 2013; Smets & Sneep, 2015). Tenants, particularly in social housing, place more importance on their current living circumstances and affordability rather than long-term property investments (Khor et al., 2023). The temporary nature of renting leads to an emphasis on immediate enhancements such as better maintenance or increased availability of rental options, tenants might argue for measures that enhance their current standard of living, which can conflict with the priorities of property owners (Van Den Nouwelant & Pawson, 2017). Effective governance in neighborhoods with a mix of property ownership needs careful management, ensuring that the opinions of all parties involved are taken into account and that decisions are made via a compromise that can match the varied interests of both homeowners and tenants.

Tenants are important to the housing industry since they are not just tenants but are actively involved in determining their neighborhood and living circumstances. The significance of including tenants' viewpoints while developing housing regulations and decisions is emphasized by recent research. Involving tenants in decision-making processes improves performance because, especially in social housing, they offer invaluable perspectives based what the tenants need for better living conditions (Suszyńska, 2015). This approach illustrates a developing pattern that views tenants as partners instead of just users receiving assistance. Establishing trust and keeping open channels of communication are crucial for engaging tenants in a successful way (Madumere, 2016, Marandet, 2017). This requires frequent meetings, open procedures, and making sure that the opinions of the tenants are taken into consideration. Furthermore, it is essential for housing associations to understand the varied requirements of tenants, including health, safety, and community involvement. This perspective enhances the general sustainability and resilience of housing complexes in addition to increasing tenant happiness. Tenants' responsibilities have grown increasingly significant as the rental market continues to change. They are more proactive and well-informed, looking for residences that fit their budgets and lifestyles. For housing developments to be successful over the long term, a tenant-centered strategy is therefore not just advantageous but also necessary for the housing sector.

3.1.3 Energy poverty

Concern over energy poverty in the Netherlands is growing, especially in the context of rising energy prices and a growing movement toward sustainability. When a household cannot afford enough energy to meet its basic needs such as heating, lighting, and appliance power, it is considered to be living in energy poverty. Because tenants in social housing are frequently from lower-income groups and have less financial flexibility, this problem is especially common here. Table 2 shows energy poverty based on the housing characteristics and it can be seen that around 75% of households who live in energy poverty comes from social rent.

House characteristics (I).

	Type of house				Ownership		
	Detached house	Semi-detached house	Terraced house	Apartment	Privately owned	Social rent	Other[a]
Sample	%	%	%	%	%		
All households	10	25	35	30	60	30	10
Energy poor households							
High Energy Quote (HEQ)	14	25	26	34	31	56	13
Low Income & High Energy Costs (LIHC)	5	28	34	33	11	75	13
Low Income & house with Low Energetic Quality (LILEQ)	7	48	41	3	14	75	12
Owners of house with Low Energetic Quality & inability to invest in renovation (oLEQ)	16	41	41	1	100	–	–
Tenants of house with Low Energetic Quality & inability to invest in renovation (tLEQ)	6	46	44	4	–	75	25

[a] Private rent, unknown.

Table 2: House characteristics where energy poverty occurs (Mulder et al., 2023)

This stresses and shows that many houses are not meeting the current preferred energy efficiency and renovation is necessary to solve this issue. Whereas homeowners might renovate their homes with their savings, and therefore saving on energy costs, this might not be possible due to related costs for tenants in social housing. This shows that in this research the focus group are vulnerable people and causes extra attention on being careful with communication regarding the implementation of heat grids.

Figure 7: Map of pilot projects regarding district heating in The Netherlands (NPLW, n.d.)

3.2 Heat grids

3.2.1 Challenges for stakeholders

Stakeholders face a number of difficulties in the development and management of heat grids. Urban heat grid integration is technically challenging and frequently requires modifying older buildings and systems (Hoetz et al., 2024).. An issue is scalability, as heat grids need to be built to handle future growth and the incorporation of renewable energy sources, which requires adaptable and innovative approaches. Financial difficulties are also significant as heat grids need large upfront investments for building retrofitting and infrastructure construction, which makes securing finance a barrier (Hoetz et al., 2024). Although government subsidies, including those for pilot projects ('proeftuinen') as seen in Figure 7, are essential for funding, long-term sustainability must be guaranteed without a disproportionate dependence on additional funding (NPLW, n.d.; Hoetz et al., 2024). Because stakeholders must ensure customer affordability, operational costs add even more complexity to the financial equation. These economic factors are crucial in a the energy market because the viability of centralized heat grids is challenged by alternatives such as electric heat pumps, which frequently need more significant changes to the current dwelling stock, as seen in Figure 8 (Hoetz et al., 2024).
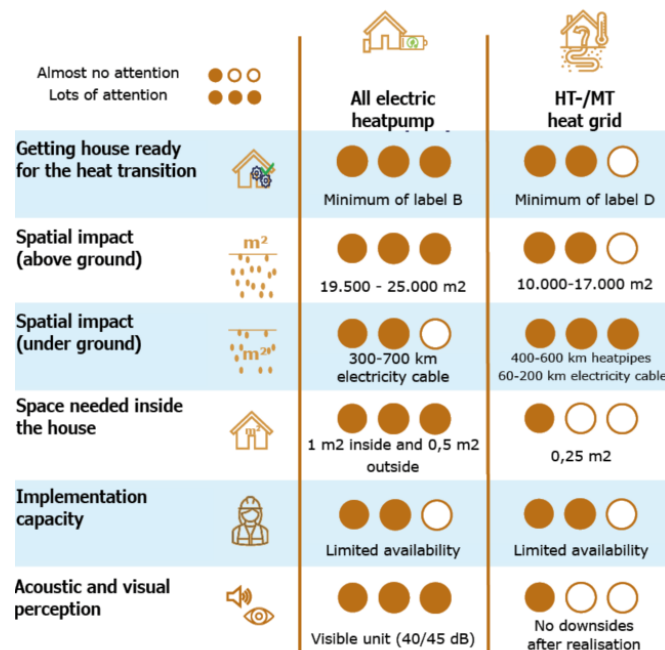
Figure 8: Impact of heat pump compared to heat grid on living situation (Hoetz et al., 2024)

3.2.2 Different technologies

As mentioned in the introduction, implementing heat grids in an area, brings new technologies. These technologies range from changes inside the homes and different heating solutions. In this chapter it will be discussed what heat grids typologies exist, the sources of the heat, and the necessary changes in homes. Heat grids have developed across several generations, beginning with steam-based systems that operated at high temperatures and evolving to more sustainable and efficient designs. Heat was distributed using steam in the first generation of district heating systems, but these systems were energy-intensive and vulnerable to heat loss (Interreg North-West Europe, n.d.). Pressurized hot water was used in second-generation systems, which allowed for more effective heat transmission and the incorporation of waste heat from power plants. By decreasing heat losses and allowing the integration of more environmentally friendly, renewable energy sources like biomass and geothermal energy, third-generation systems dropped the temperature below 100°C. Fourth- and fifth-generation systems feature the most recent advancements (Buffa et al., 2020). In order to minimize energy loss, fourth-generation systems (4GDH) concentrate on combining intelligent energy management with renewable energy sources like solar thermal and geothermal energy. They also lower the distribution temperature even more. Fifth-generation (5GDH) systems use localized heat pumps in each building to provide both heating and cooling while operating at room temperature. Because of their great flexibility, low-temperature sources may be used effectively and leftover heat can be recovered and reused (Buffa et al., 2020). Figure 9 shows a visualized overview of the different generations of heat grids.
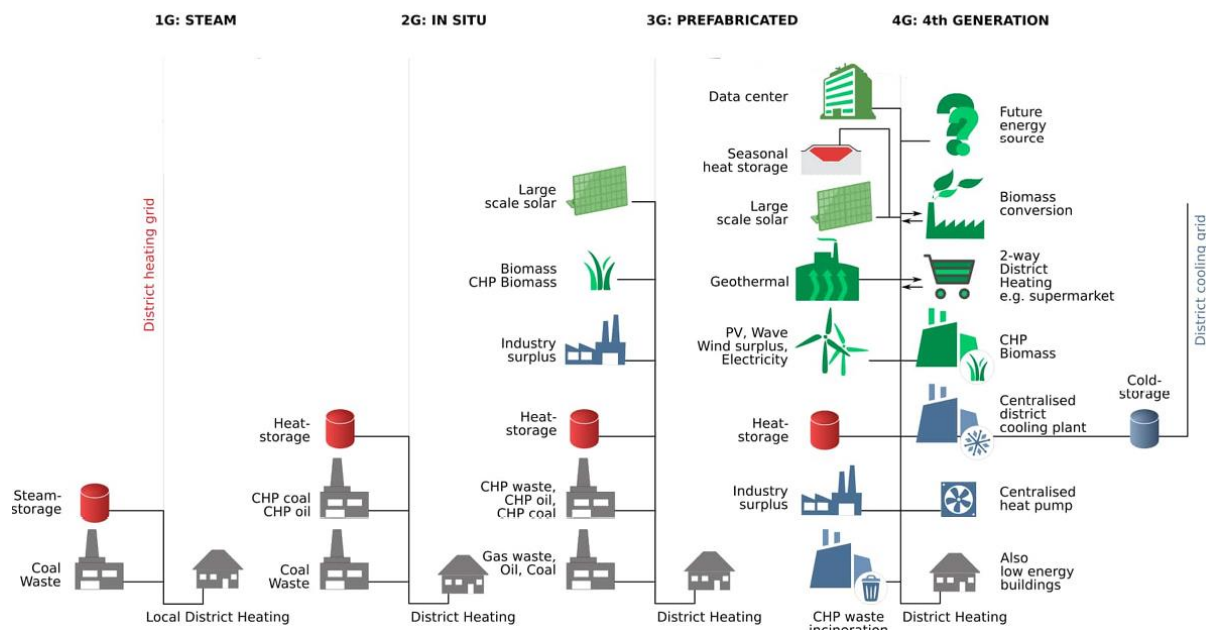
Figure 9: Four generations of district heating (Interreg North-West Europe, n.d.)

Several low-emission or renewable energy sources operate district heating networks. The shift to more sustainable energy sources has allowed modern grids to capture energy from biomass, geothermal energy, solar thermal collectors, and even waste heat from industrial operations, as seen in Figure 9 (Interreg North-West Europe, n.d.). Traditionally, systems depended mostly on coal or natural gas, while after developments urban areas are sometimes heated by collecting excess energy from power plants and data centers. The choice for which source will be used is dependent on the availability in the neighborhood and each has its benefits and downsides.

Not only implementing the grid is necessary, also changing and renovating homes is part of the process. The transition to heat grids requires improvements in residential buildings. Modernizing the current heating systems to connect with heating networks is one of the main modifications. Buildings might have to switch from gas-based systems to electric heat pumps, underfloor heating, or low-

temperature radiators. The infrastructure of the building may need to be modified in order to install these systems, including installing smart controls to efficiently regulate energy flow. Increasing building insulation is a crucial adjustment for ensuring energy efficiency. Buildings with poor insulation could lose heat, which would limit the effectiveness of district heating. Renovating the walls, windows and roof of a building is essential to keep the heat inside, lowering energy use, and preventing heat loss. Retrofitting older buildings may be necessary, which can be expensive and inconvenient for tenants but will eventually useful. These alterations can result in both short-term disadvantages and long-term advantages for tenants. Retrofitting can result in temporary relocation and inconvenience, but tenants will benefit from lower heating expenses, increased energy efficiency, and a more sustainable heating system.

3.2.3 Stakeholders

The energy transition is quite a complex project that requires good analysis of all the involved stakeholders (Maqbool et al., 2022). It is an ongoing process that involves various different factors. To ensure that the project results are successful depends on effectively addressing the requirements of these stakeholders. This shows the importance of including stakeholders throughout the entire scope of the project (Maqbool et al., 2022).

The various stakeholders involved in energy transition projects include a range of individuals, such as the contractors, governmental bodies, investors and end-users, each bringing different points of view and goals regarding the project (Rubio Agulló, 2024). Primary stakeholders involved in the project, such as the developers and contractors, have a direct influence on the economical and operational aspects of the project. On the other hand, the secondary stakeholders such as local authorities, provide assistance that is deemed necessary throughout the project (Hamdan et al., 2021). An overview of the stakeholders involved in sustainable neighborhoods, as stated by Hamdan et al. (2021), can be seen in Table 3.

Stakeholders		
Central governments	Local authoroties	Nonprofit housing developers
Philanthropic organizations	R&D institutions	Private housing developers
Consulting companies	Design companies	Construction companies
Material suppliers	Financial institutions	

Table 3: Stakeholders involved in sustainable neighborhood projects (Hamdan et al., 2021)

The overview created by Hamdan et al. (2021) is not complete since it mainly focusses on the providing side, not the receiving side. Other important stakeholders in heat grid projects are energy suppliers, energy cooperatives and end-users, since these stakeholders have quite a big influence and impact on how the project will shape over time and how the project will be received. An overview of the revised stakeholders can be seen in Table 4

Stakeholders		
Central governments	Local authoroties	Nonprofit housing developers
Philanthropic organizations	R&D institutions	Private housing developers
Consulting companies	Design companies	Construction companies
Material suppliers	Financial institutions	Energy cooperatives
Energy suppliers	End-users	

Table 4: Stakeholders involved in sustainable neighborhood projects, expanded. (author, derived from Hamdan et al. (2021)

Not every stakeholder is as relevant in heat grid projects and their importance depends on the specific role they have in the project. The roles of the various stakeholders will be discussed later in the research. The stakeholder who directly influences critical and important aspects such as policies and

implementation are more crucial. Not only are they responsible for creating the physical heat grid, also the communication to and participation of end-users is related to their actions. The relevance is dynamic and can shift over time in depending on the phase of the project. The aspects crucial during the planning phase, can and will be different in the executing phase. Effective stakeholder engagement therefore requires prioritizing the stakeholders whose roles are crucial to project success.

Community participation is essential because the acceptance and support of the local community may decide whether a project is feasible and can be maintained over time (Hamdan et al., 2021; Hanke & Lowitzsch, 2020). Ensuring inclusion in stakeholder participation is crucial for promoting beneficial outcomes, particularly in vulnerable areas that are disproportionately impacted by energy transitions (Hanke & Lowitzsch, 2020). By using a comprehensive strategy and including every relevant stakeholder, the project could manage the complex obstacles, minimizing any risks and optimize social benefits for the neighborhood (Hanke & Lowitzsch, 2020). To encourage the shift to a more sustainable alternative, it is important to recognize and involve all these earlier mentioned parties and tenures with its different views and interests. This shows that their requirements are taken into consideration at every stage of the project.

3.2.4 Process of establishing heat grids

The implementation of heat grids can be visualized in a series of steps with the ultimate goal of transferring neighborhoods from gas to other heating alternatives. This effort is part of the larger national program, called the National Program for Local Heat Transition (NPLW, 2024), and starts with thorough preparation and active participation of the neighborhood. The first step is done by the governmental bodies or municipalities. Municipalities select appropriate neighborhoods for the implementation and installation of heat grids by taking into account various aspects such as the existing infrastructure, the building typologies, and resident demographics (NPLW, 2024). A total of five stages can be identified and visualized, as seen in Figure 10.
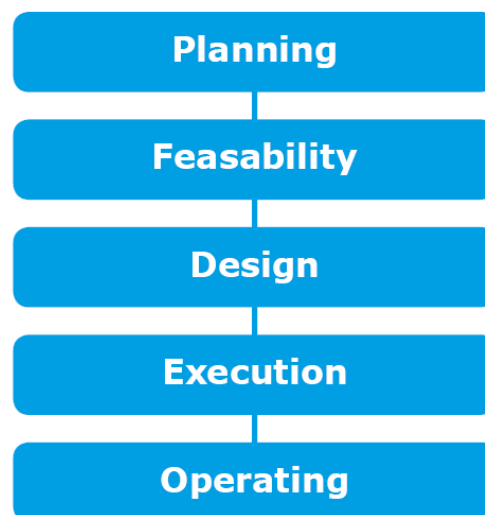
Figure 10: Stages of heat grid implementation (author)

Understanding the process is important to see the relations between the roles of the stakeholders, and their responsibilities, and how this changes throughout the project. Once the steps of the process is clear, it can be explained why certain stakeholders act in a certain way, and how this could or should be improved for better communication and heat grid adoption. The process starts with an in-depth analysis of the existing energy requirements and the possible sources of the earlier mentioned renewable energy available in the region, which can be excess heat from industry. Municipalities try to engage various stakeholders who are involved in the process, such as citizens, housing associations, and energy companies in order to develop a vision (NPLW, 2024; Rubio Agulló, 2024). In this vision,

the ultimate goals and objectives are mentioned, as well as deadlines, dates, and approaches towards the implementation of the heat grid. After this, a feasibility study will be conducted in which the technical, economic, and social elements of the implementation of heat grids will be reviewed (Lund et al., 2014). This is done to identify the optimal heat grid technology or method for the appointed neighborhood, which can be district heating, geothermal energy, or a mix (hybrid) of those systems. The research also further evaluates the adjustments necessary to ensure compatibility with the new heating systems, such as the required insulation levels and other renovations (Lund et al., 2014). This feasibility study is conducted by various stakeholders such as the local authorities, housing associations, energy companies and consultancy bureaus. The stakeholder responsible for the feasibility study is often the stakeholder who initiates the project and is responsible for the costs related to this.

Involving the community and neighborhood is crucial at every stage of the process. Residents and other property owners are kept informed and engaged throughout the process by a variety of methods, including meetings, informative brochures, and internet portals (NPLW, 2024; Gramberger et al., 2014). This involvement ensures that the final design includes all the needs and preferences. According to several sources, this is a crucial but difficult to implement step. After the completion of the planning and feasibility stages, the next steps are the design and execution phase (NPLW, 2024). This includes the complete technical design for the implementation of the heat grid infrastructure, procurement of the essential technology and materials, and the physical construction of the heat grid. During these stages, it is essential to have effective collaboration among the earlier mentioned stakeholders to ensure collaboration and guarantee the project is finished in time (Rubio Agulló, 2024).

The last step of the process involves the need for commissioning and monitoring the newly installed heat grid. The system undergoes thorough evaluation to ensure it meets the performance criteria on reliability, effectiveness, and sustainability (Nazarychev et al., 2019). Monitoring frameworks should be created by the municipality to consistently evaluate the system's effectiveness and performance and implement necessary changes. Regular maintenance and adjustments are scheduled to meet any further future improvements and changing energy requirements. These processes have been tested according to the PAW (n.d.) (programma aardgasvrije wijken) via pilot projects, called the 'proeftuinen', as seen in Figure 7. Lessons learned from these pilot projects are utilized to enhance efficiency and effectiveness in new projects and provide insights into overcoming technological challenges and optimizing neighborhood engagement strategies.

3.3 Communication

3.3.1 General information

Projects involving complex systems such as heat grids, require effective communication to guarantee that all stakeholders, and thus also end users, are aware of the project's goals and their part in it. Tenant engagement is crucial for the success of the project, and good communication helps to resolve issues, promotes collaboration, and decreases disagreement from tenants. In addition to aligning interests and improving transparency, clear communication from authorities, housing associations, and energy suppliers also drives behavior change and leads to more sustainable results (Morales-Guerrero & Karwat, 2020; Jia et al., 2021). As seen, communication is important, can be executed in various ways and has different stakeholders in different phases of the project who are actively involved.

3.3.2 Communication of stakeholders

This research primarily focusses on the influence communication towards the end-users, in this case the tenant. Therefore, not all stakeholders from Table 4 will be elaborated on. Figure 11 shows which of the stakeholders have a roll in communicating to tenants in order to succeed the project on district level. The stakeholders responsible for communication are the local authorities (municipalities),

housing associations, consulting companies, energy cooperatives, energy suppliers and the end-users themselves.

Stakeholders (communication to tenants on district level)

Central governments		Design companies			
Local authorities		Construction companies		Likely	
Nonprofit housing developers		Material suppliers			
Philanthropic organizations		Financial institutions		Rahter	
R&D institutions		Energy cooperatives		unlikely	
Private housing developers		Energy suppliers			
Consulting companies		End-users			

Figure 11: Overview of stakeholders involved in communication to tenants on district level (author)

Local authorities such as the municipalities are responsible for setting the regulations, offering guidance and providing information on the benefits and downsides. The housing associations are directly responsible since they will have to execute the project in their stock. They will engage the tenants, address concerns and ensure that the tenants understand what will happen during the project. Consulting companies make a contribution by creating communication plans and offering their knowledge to help stakeholders synchronize their communication. Energy cooperatives frequently serve as the mediator, promoting the rights of tenants and promoting open discussion. In order to get tenant participation, energy providers are crucial in providing technical specifics and the costs. Lastly, the tenants actively participate in the communication process as recipients and contributors, offering suggestions and holding discussions that help to shape the project's final results. By working together, these stakeholder may guarantee that tenants are informed, which lowers resistance and facilitates smoother transition.

3.3.3 The RASCI-model

As mentioned, participation from users is an essential component in the development of heat grids, but also creates considerable problems. By actively engaging users in the design and decision-making processes, more knowledge and incorporation of their requirements and preferences can be achieved, leading to the development of energy systems that are more user-friendly and efficient (Jia et al., 2021; Liu et al., 2015). Moreover, participation could encourage a feeling of inclusion and responsibility of the project, creating changes in behavior towards energy consumption and increasing the efficacy of so said projects (Morales-Guerrero & Karwat, 2020).

Nevertheless, getting the involvement of tenants is a complex task. A significant obstacle are the different views and preferences (Van Den Nouwelant & Pawson, 2017). The complex structure of heat grids creates challenges for the tenures in understanding and therefore participating in the project, resulting in disinterest or resistance (Morales-Guerrero & Karwat, 2020). Also the alignment of stakeholder interest is an issue, since all the different stakeholders and tenures wish different outcomes, and have different knowledge regarding the projects complexity. This shows the importance of good communication between the active engaging stakeholder and the end-user.

Information and communication by stakeholders is important. In Figure 11 an overview of stakeholders who communicate with tenants is given. It is known that the role of the stakeholder can differ over time, and therefore an overview of what role the stakeholder has at which phase is necessary. In Figure 12 an example of a RASCI-model can be seen. A RASCI-model is an extension of the traditional RACI framework, used to clarify roles and responsibilities in projects (Smith & Erwin, 2005). In the RASCI model, the following roles are used (Smith & Erwin, 2005; Cabanillas et al., 2012).

- Responsible (R): The person or people carrying out the assignment. They are in charge of finishing the task and making sure it progresses. To preserve clarity, there should ideally only be one "Responsible" for each activity.

- Accountable (A): The one with the final say and task accountability. They confirm that the work satisfies quality requirements and approve its completion. Each job should only have one accountable party.
- Support (S): People who lend extra resources or assistance to the Responsible party. They play a supporting role, and the Responsible person coordinates their participation.
- Consulted (C): Individuals who provide knowledge and counsel but do not carry out the task. They play a two-way communication function that influences task direction by offering both input and feedback.
- Informed (I): Those who require regular updates on the status and results of a task are considered informed. Although they don't participate in decision-making, they receive status updates to be informed about developments.
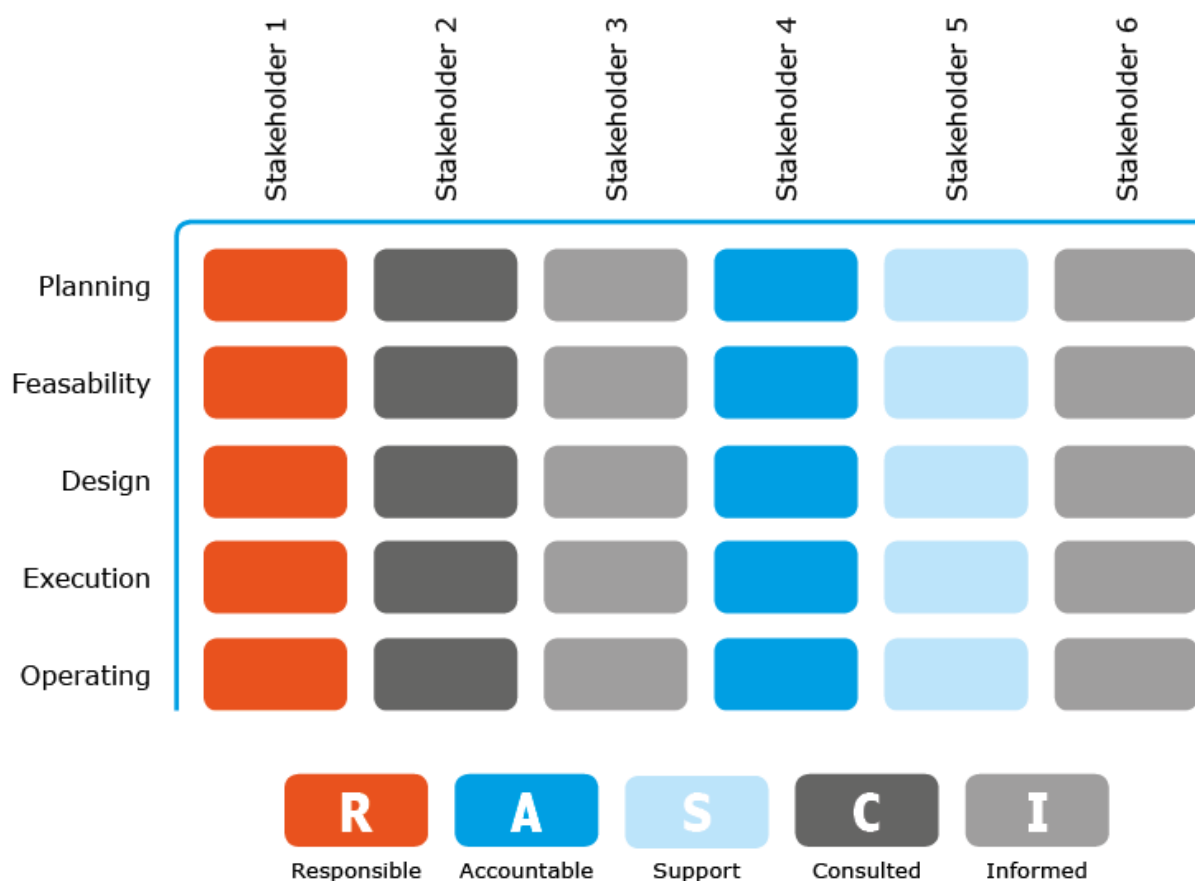
Figure 12: Example of a RASCI framework (author)

The RASCI model has clear benefits by ensuring that each role is well-defined, which helps prevent overlaps in responsibilities and avoids confusion (Smith & Erwin, 2005; Cabanillas et al., 2012). This model fosters effective communication and improves collaboration. By clearly outlining who needs to be involved in which phase of the project, the RASCI model helps to improve processes and reduce potential delays. The use of a RASCI model improves better communication channels and clarifies stakeholder relationships (Mrzyglocka-Chojnacka et al., 2019). A RASCI-based communication model could optimize information flow and guarantee that technical, management, and community stakeholders have well-defined responsibilities throughout the project lifecycle in the context of projects (Mrzyglocka-Chojnacka et al., 2019). The RASCI model has some limitations but is useful for planning and managing communication-related tasks. Roles within the matrix may be changed without affecting communication, which makes it sensitive to changes in stakeholders. Because of the differences in organizational systems, it is best suited for projects that are conducted within an organization (Mrzyglocka-Chojnacka et al., 2019). Large-scale projects and a complicated environment

reduce its usefulness, and it frequently leaves out non-design tasks, which narrows the scope of its use. Therefore, in order for the RASCI model to be effective it must be carefully tailored to each project's unique environment and objectives.

This RASCI model is helpful for this research as it offers a methodical way to arrange and oversee communication responsibilities, which is essential in complex projects such as the implementation of heat grids. The approach guarantees that all stakeholders are aware of what their role and responsibilities are by clearly outlining who is responsible, accountable, consulted, supportive and informed. Maintaining clarity in communication is crucial when interacting with many stakeholder groups as it may minimize misunderstandings and inefficiencies. Furthermore, the RASCI model is consistent with the research's emphasis on enhancing information distribution, which supports the development of clear communication strategies. It is expected that when stakeholders know their position in the project better, an enhanced communication strategy can be developed that aligns with the various stakeholders and ensures smooth communication to the tenants to improve their technological awareness.

3.3.4 Communication strategies

In order to understand what communication methods are used, it is important that it is known how communication strategies work to identify the logic behind them. Communication strategies is a term used often and something that has been discussed for years (Tarone, 1981; Downs and Hazen, 1977). It is suggested that communication strategies describe how individuals attempt to communicate with speakers of the target group by using what they know in a predictable way (Tarone, 1981). This means, creating targeted customized strategies based on the stakeholders involved, to create information that is understandable and is being perceived as logical.

The essence of communication strategies is to translate knowledge into understandable information for different stakeholders (Tarone, 1981). This research will focus on three elements of communication towards tenants: Information delivery, information adequacy and information feedback. These three elements stem from research done by Downs and Hazen (1977) and help forming an effective and appropriate communication strategy to the tenants. Recent studies also used these three categories to determine how communication can be characterized and used as a strategy to improve this communication (Ma, 2022).
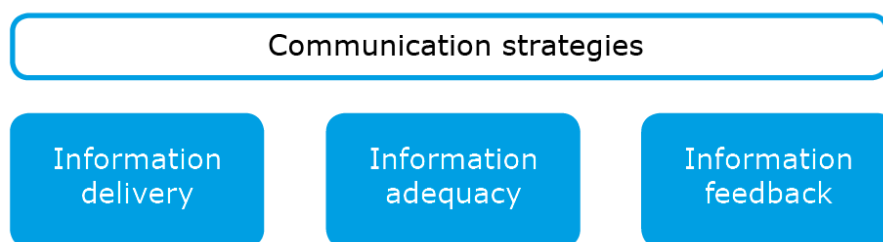
Figure 13: The three elements within communication strategies (author)

The delivery of information from stakeholders, such as housing associations and technical experts, to tenants is critical. Messages are delivered through the proper channels and reach at the tenants at the appropriate time are components of this (Addimando, 2024). Communication methods are part of this, consisting of the ways of communication to the tenants. It is essential to address this since a poor delivery might lead to miscommunication, delays, or limited participation (Addimando, 2024; Jia et al., 2021). This element is divided into two categories, methods and timing, as seen in Figure 14. In the method it is further explained how the way of information delivery can be done on certain levels: participation, communication and channels, which can also be seen in Figure 14 . These levels are created based on the literature and are created specifically for this research. In the participation section a distinction can be made between an engaging strategy or a informing strategy. For the communication section a distinction is made between physical and virtual communication. Lastly, in

the channel section, a difference is made between mass media, personal attention and social media. Each of these three has various ways of delivering, for example brochures, meetings, e-mails etc. The timing category focusses more on when the information is delivered (NPLW, 2022). This impacts the awareness of tenants, but also trust in when certain work is being executed. It also is mentioned because of participation fatigue (NPLW, 2022).

Information adequacy addresses the quality and comprehensiveness of the information offered. It guarantees that the information is supplied in a way that makes sense, is accurate, and provides enough information for tenants to make an adequate choice (Jia et al., 2021). Effective communication requires language that is both understandable and appropriate for the demands and comprehension level of the audience. This means staying away from unnecessary technical language that could confuse tenants or cause misunderstanding (Al-Kurdi et al., 2018; Hirst, 2003). Adequate information should cover possible costs, delays, and interruptions in addition to the advantages of using new technology. Research indicates that tenants are more likely to become engaged and support the initiative when the information is clear and comprehensive (Jia et al., 2021). Adequate information is essential because it assists in reducing the concerns and uncertainty that come with implementing new technology, which frequently act as barriers to acceptance (Al-Kurdi et al., 2018; Hirst, 2003)
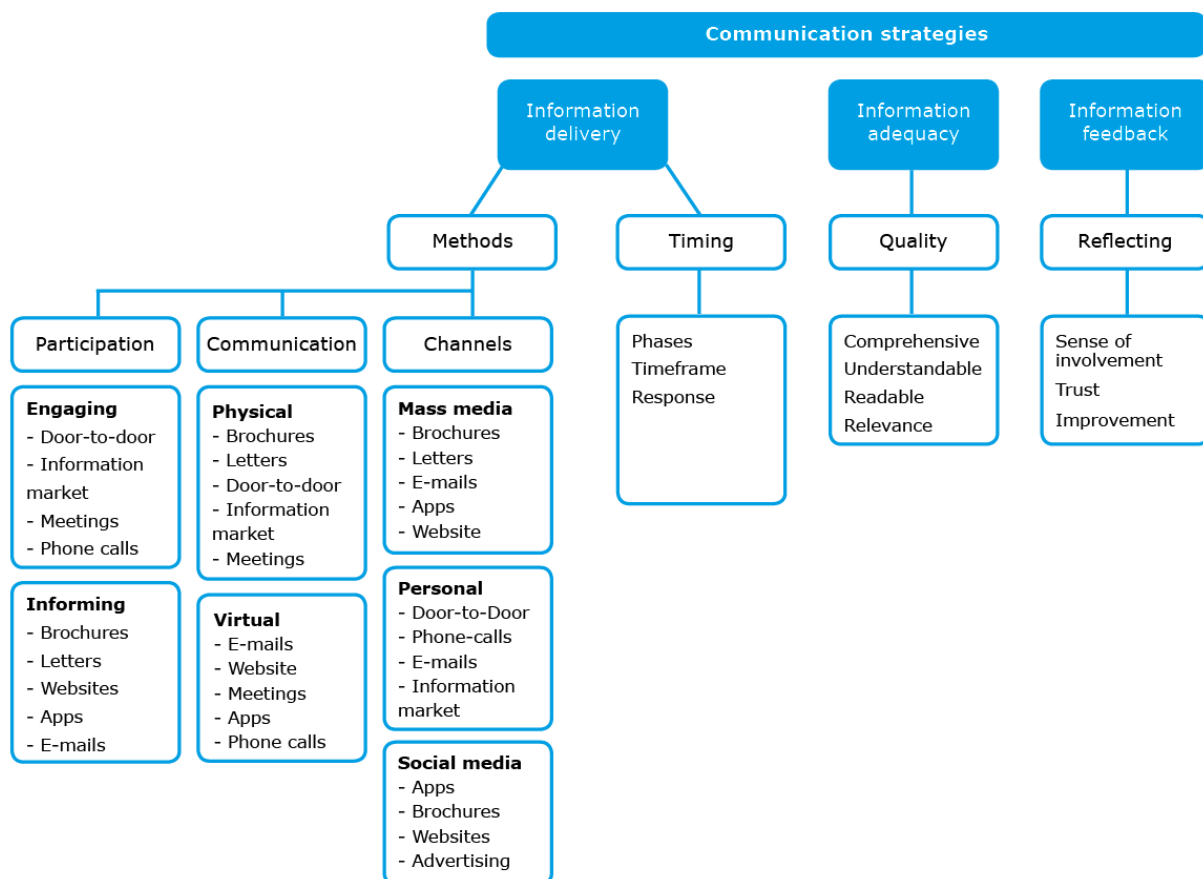
Figure 14: Framework for communication strategies (author)

Information feedback enables tenants to communicate in both directions and ask questions. Since information feedback allows tenants and stakeholders to engage in two-way communication, it is essential in good communication (Downs & Hazen, 1977). Tenants can ask questions, express concerns, or offer comments through this feedback loop, which promotes conversation rather than a one-way communication channel (Downs & Hazen, 1977). Stakeholders can adjust their communication strategy to better suit tenants' demands and address any misunderstandings by taking into account tenants' comments. Research has indicated that responsiveness to input from

stakeholders enhances perceived transparency and trustworthiness, both of which are important factors in the adoption of new technologies (Torma & Aschemann-Witzel, 2024). Additionally, feedback methods like focus groups, open meetings, and surveys not only increase tenants' feeling of responsibility and engagement in the decision-making process, but also offer insights for ongoing development (Scurr et al., 2022). Tenants who feel their opinions are appreciated and heard are more likely to be satisfied with the project and to support it. Therefore, incorporating strong feedback loops is crucial to developing a communication strategy that is more inclusive and participative. An overview of these different components can be seen in Figure 14.

This model provides a comprehensive review of the various elements that can explain reasoning of the stakeholders. Building on this model, the research will determine and evaluate the communication strategies used by stakeholders by using the three components of information delivery, information adequacy, and information feedback as a framework. By using these components, it is ensured that the quality and thoroughness of the information provided by stakeholders, enable two-way contact with tenants, and evaluate stakeholder communication methods in an organized way. This approach enables to analyze the implemented strategies, evaluating the perceived effectiveness of several techniques and channels used to include tenants in the heat grid project. By concentrating on these elements, the study may identify the advantages and disadvantages of the communication strategies in use now, as well as areas that require development in order to raise tenants' level of technology awareness.

Additionally, this model makes it possible to compare the methods used by various stakeholders, offering insights into how tailored strategies might be developed that meet the particular requirements of diverse tenant groups. In the end, applying this approach will assist in developing strategies for communication that are efficient in distributing information while also encouraging tenant engagement and confidence, which will help heat grid projects be implemented successfully.

3.4 Barriers in technology adoption

3.4.1 Barriers

Acknowledging the importance of motivators and barriers is essential because it offers an in-depth understanding of the variables affecting behaviors and outcomes in projects (Biesbroek et al., 2013; (Seetharaman et al., 2019). By identifying these barriers, tailored methods to overcome barriers that hinder the project can be established. It is crucial to identify these barriers and drivers for this research since it ensures that the research goes beyond the expected findings and explores the fundamental causes affecting the current issue. The reliability and validity of the study findings are improved by doing this. The research will provide deeper understandings and useful suggestions by identifying the factors that encourage and hinder particular behaviors or outcomes. An example of this, which has been mentioned earlier, is the information gap between experts and the general public, or in this case the tenants (Krog et al., 2020). Acknowledging this, a strategy can be used or optimized to bridge this gap, ensuring that the tenants are well-informed.

As known, several barriers and motivators exist for the energy transition. As seen and discussed many, various barriers and drivers can be linked to the energy transition in general and poses several barriers related to implementing heat grids in neighborhoods (Rubio Agulló, 2024; Khatibi et al., 2021; Nunn et al., 2013; Seetharaman et al., 2019). In order to overcome these barriers, technological awareness is essential since ignorance could cause resistance. Tenants' views regarding new technology are significantly shaped by how they communicate and level of trust in their stakeholders. Effective stakeholder communication can deal with concerns about comfort, independence, and financial stability in order to address information gaps and increase acceptance. Addressing these issues is crucial for increased acceptance and participation. A topic highly relevant to this section is looking into technology adoption and highlights why adoption of new technology is difficult (Granić, 2023; Mkhonto & Zuva, 2024). This reveals certain specific motivators and barriers in the adoption of technology and therefore also gives insights in its role of technological awareness of tenants. Relevant

papers regarding this technology adoption are used to identify the barriers. This is then combined with the earlier stated barriers regarding the energy transition.

In this research the focus is on the barriers related to adoption of new technology. In the research conducted by Chersoni et al. (2021) the focus is on the role of economic, behavioral and social factors in technology adoption, this can be seen in Figure 15. This paper highlights the importance of seeing these three components as equal as important for the identification of technological adoption. It has been claimed that technology adoption is affected by these three elements, but their intertwining
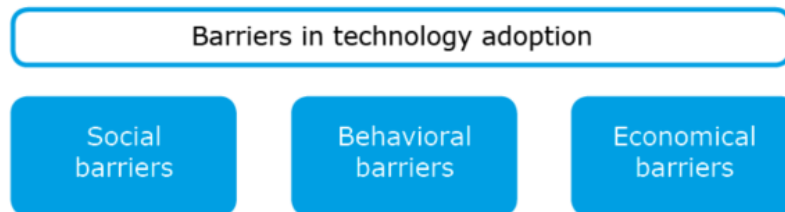
Figure 15: The three types of barriers encountered in adoption of new technology

roles should be looked more into (Chersoni et al., 2021).

The impact of social networks, trust, and cultural norms on the adoption of technology is referred to as the social barriers (Chersoni et al., 2021). Social factors such as peer influence, evidence of legitimacy, and community acceptance are crucial in determining how people perceive technology. Adoption can be discouraged by a lack of support from neighbors, or it can be encouraged by supportive social interactions (Chersoni et al., 2021). This is especially important in settings where individual actions can be influenced by collective acceptance or disagreement. Behavioral barriers are being referred as personal views, cognitive biases, and psychological elements that influence decision-making (Yue et al., 2023). These barriers include perceived complexity, fear of changing in what is perceived as safe, and not understanding the benefits. Often, people are less likely to adopt new technology even when it has clear benefits because of cognitive biases like being used to the traditional systems (Chersoni et al., 2021). Furthermore, individual experiences, information accessibility, and perceived knowledge with the new technology can all have an impact on behavioral aspects. Financial constraints and economic factors that prevent the adoption of new technology are referred here to as economical barriers. They include large upfront expenses, lengthy payback periods and are often perceived as financial risks (Osman, 2017). These barriers are especially important for large-scale projects like heat grids, where the costs can be seen as overshadowing the advantages by tenants. High upfront investment costs and unclear projected benefits could discourage adoption and therefore hinder awareness.

These three types of barriers are seen as most likely to occur when adopting new technologies according to the literature, and also most critical when looking at how to improve communication by overcoming these barriers. Other barriers that might impact adoption of new technology are not studied upon to keep focus on these three elements during the interviews. Once it becomes clear that other barriers are impactful as well, this will be addressed in the discussion.

3.4.2 Social barriers

There are several social barriers that affect the availability, reliability, and transfer of relevant knowledge. Research reveal that end users frequently encounter challenges when attempting to find complete and useful information on the several aspects and functioning of heat grids (Jia et al., 2021). The lack of specialized training programs and educational activities to bridge the information gap contributes to this issue (Otara, 2020).

Furthermore, resistance and skepticism exist due to a lack of confidence in stakeholders which further impedes communication and collaboration. A significant barrier is a lack of trust in technology, since

tenants frequently have worries about the safety, reliability, and possible dangers of unfamiliar heating systems. Inadequate communication about the advantages and workings of the technology contributes to this distrust, which makes people hesitant to use it. Furthermore, the community's impact is quite important (Chersoni et al., 2021). Individual adoption of technology is influenced by community support or resistance, since peer influence and validation from others play an important part in how technology is perceived. It generally prevents further acceptance when significant community members or neighbors express concerns or worries. The last barrier is privacy concerns. Users may worry that new technologies may compromise their privacy or violate their personal space, as in the case of automatic heating systems or smart meters. To ease concerns and build trust, these concerns need to be addressed via open and honest communication (Jia et al., 2021). An overview of these various barriers can be seen in Figure 16. An overview for who the barrier is impactful can also be seen. It should be noted that often the barrier is related and focused on the tenant, but due to it being a barrier for them, it becomes a barrier for the other stakeholders since they have to deal with overcoming this barrier.

		Barrier for tenant	Barrier for stakeholder
Social barriers (Trust and perception)	Lack of trust in stakeholders	X	X
	Influence of community	X	X
	Privacy	X	

Figure 16: Social barriers encountered in adoption of new technology (author)

3.4.3 Behavioral barriers

According to Jia et al. (2021), tenants encounter a variety of behavioral barriers related to their knowledge, perception, and understanding of the technology. These barriers hinder the correct communication and operation of the systems. The complex nature of the technology itself is an important barrier. Heat grids require complex systems that are difficult for the typical tenant to understand and frequently need for a high level of expertise. Users may become overwhelmed by this complexity and be hesitant to accept or utilize the technology to its full potential (Krog et al., 2020). The lack of technical expertise could result in the incorrect use and management of heat grid systems (Krog et al., 2020). In addition, the specialized jargon used by people involved in establishing heat-grids sometimes fails to communicate its meaning effectively to consumers, resulting in an interruption of communication that adds to the difficulty of transferring information (Al-Kurdi et al., 2018; Hirst, 2003).

		Barrier for tenant	Barrier for stakeholder
Behavioral barriers (Knowledge and expertise)	Lack of trust in technology	X	
	Complex systems	X	
	Failure of technology	X	X
	Disruption due to renovation of infrastructure	X	X
	Functioning of technology	X	
	Not knowing effects of alternatives	X	
	Unknown possible benefits	X	
	Disruption due to renovation of homes	X	X

Figure 17: Behavioral barriers encountered in adoption of new technology (author)

The immaturity of technology also is a barrier. Heat grids are still a relatively new technology for many people, therefore their effectiveness and reliability may not be entirely understood. Users who consider these technologies to be insufficiently tested may choose more traditional options that they consider to be reliable. Another problem is infrastructure organization, incorporating heat grids into pre-existing residential homes sometimes requires significant changes that might disrupt everyday activities and require complex retrofitting (Osman, 2017). Furthermore, there might be difficulties

with how the technology works itself. Tenants may be unwilling to use the system if they have concerns about maintenance needs, operational reliability, and possible technological problems (Krog et al., 2020). Lack of clear information about how the technology operates and what users should know during its installation and use often makes these worries worse. The existence of potential alternatives also creates behavioral barriers. Tenants can decide against implementing heat grids to use more conventional options, even if they are less efficient, if they are concerned about the unknowns or risks of the new system. This is particularly the case if the advantages of using heat grids are not clearly communicated. If the tenants do not see any benefits, they might opt-out. Lastly the need for renovations. It is sometimes necessary to make significant changes to already existing homes in order to implement heat grids, which may be challenging for both property owners and tenants. The requirement for renovations may serve as a discouragement, especially if there are no cleat long-term advantages that compensate for the initial costs and inconveniences (Roos & Manussen, 2011).

3.4.4 Economical barriers

As mentioned in the previous sections, economic barriers have a significant impact on how tenants make a well informed decision. One of the primary barriers is the initial cost of building heat grid systems. These consist of the initial costs associated with installing new pipes, heating systems, and the need for renovation in order to implement the technology into the current infrastructure (Roos & Manussen, 2011). Even though these costs might be covered by the housing associations, their monthly budget might be impacted, indicating that the future costs are unknown and supposed to be a barrier. These initial costs might seem disproportionate to tenants and property owners, particularly if the long-term benefits aren't visible or certain right away. The future costs of maintenance, efficiency of the installation, and other unexpected costs create another economic barrier. Tenants can be discouraged from agreeing if they are uninformed about the ongoing financial commitment, which includes things like maintenance costs, replacement parts, and future energy rates (Osman, 2017).

The costs of alternatives also have an impact. The high cost of heat grids in comparison to other heating systems may cause tenants to be a supporter of less efficient long-term options in favor of more familiar and believed cheaper alternatives. This comparison is especially important if tenants are obligated by long-term agreements for these systems or if alternatives, such gas boilers or electric heating systems, require smaller upfront investments (Roos & Manussen, 2011). All these barriers do exist and it needs to be researched how communication might have an impact on how these barriers are being perceived.

		Barrier for tenant	Barrier for stakeholder
Economical barriers (Cost and affordability)	Initial costs		X
	Future costs	X	X
	Costs of alternatives	X	X

Figure 18: Economical barriers encountered in adoption of new technology (author)

3.4.5 Overview of technological barriers

In the overview in Figure 19, all various barriers of the different components can be seen. This will be the foundation of the identifying how communication might positively influence these barriers. By analyzing the stakeholders roles and communication strategies, it might become clear how to orchestrate communication in such way that the technological awareness of tenants can be improved, and therefore contribute to a higher success rate of the project.

Barriers in technology adoption		Barrier for tenant	Barrier for stakeholder
Social barriers (Trust and perception)	Lack of trust in stakeholders	X	X
	Influence of community	X	X
	Privacy	X	
Behavioral barriers (Knowledge and expertise)	Lack of trust in technology	X	
	Complex systems	X	
	Failure of technology	X	X
	Disruption due to renovation of infrastructure	X	X
	Functioning of technology	X	
	Not knowing effects of alternatives	X	
	Unknown possible benefits	X	
	Disruption due to renovation of homes	X	X
Economical barriers (Cost and affordability)	Initial costs		X
	Future costs	X	X
	Costs of alternatives	X	X

Figure 19: Framework for encountered barriers in adoption of new technology (author)

Chapter 4 - Analysis

4.1 Data collection

4.1.1 Cases

To provide a focused and insightful study, two cases were chosen for this study based on earlier established criteria. In order to allow a thorough analysis of each case's unique characteristics, the selection criteria were created to choose cases that best represent the essential characteristics relevant to the study. An examination of contextual elements and their impact is chosen by selecting two cases, which allows for an in-depth comparison. This method also makes it easier to understand the variables in a more detailed way, which supports the thesis's goal of creating comprehensive and useful insights.

In order to research more upon the adoption of heat-grids by tenants, two cases have been selected and chosen based on their progress in implementing heat-grids, meaning both cases already succeeded in reaching the necessary 70% approval rate by their tenants. It is specifically chosen to search for two projects who both succeeded to compare the different success factors, and not being depended on one successful case, and one case that was not successful. It is ensured that both cases have different approaches in order to get a sophisticated comparison and see what strategies are useful and necessary at which phase. These cases are the starting point of the research and are done to determine the interviewees. The cases are anonymized due to the sensitivity of the scope and the potential of identification without consent.

Case 1

The first case is selected based on the following criteria: it is a heat grid project in the Netherlands in which the social housing association is actively involved and has multiple engaging stakeholders. These stakeholders were involved in different stages of the development. Even though the project is not finished and in the execution phase, conclusions can be drawn based on the current communication and what methods were used in order to reach the 70% approval rate. In an explorative interview with the housing association it became clear that multiple strategies regarding the communication were used in order to gain attention of the tenant. Besides this, a residents committee was intensely involved in several stages, ensuring that conclusions can be drawn based on involvement of this stakeholder. The residents committee was the voice of the tenants and ensured deliberate decisions were made during the project. Other interviewed stakeholders are the municipality, energy company and a supporting instance, with the last one arising from the need for more in-depth knowledge on how to successfully implement heat grids in neighborhoods.

The project has a scope of around 600 units, located in a dense area in the North-Western part of the Netherlands with multiple other high rise buildings, and is located in the outskirts of the center of the city. The city is considered large and has over 500.000 residents. The project stretches over different towers of twenty stories and all have a central entrance to enter the building, which also facilitates easier encounters between the residents of the buildings. Each entrance facilitated around 150 apartments and are all owned by the housing association. It is built between 1965-1975. This means 600 apartments will be renovated and retrofitted for the implementation of heat grids, by replacing the central heating system, adding new insulation and replacing the old cooking station for a new, induction, cooking station. The types of residents are varying a lot, with different backgrounds, multiple nationalities who have all different needs living in the apartments.

This is also something that can be seen when looking at the migration background of the neighborhood. During the interviews it was stated by the housing association that a lot of the residents have a non-Western background, indicating that communication is more difficult and different cultures are represented in this neighborhood with each culture possibly needing a different approach.

Case	Project phase	Initiators	Building typologies	Stakeholders interviewed	Units
1	Execution	Residents comittee, Municipality and Housing association	Residential, all social housing	Housing association, Municipality, Energy company, Supporting instance	600

Table 5: Characteristics of case 1 (author)

Case 2

The second case is selected based on the same pre-defined criteria: a heat grid project in the Netherlands, actively involved housing association and multiple engaging stakeholders. The main difference compared to Case 1 is the lack of a residents committee and thus the process is being quite different. It will be interesting to identify the successes and challenges this case experienced in comparison to the first case, hence an overview of the different approaches can be created and elaborated upon. The stakeholders that have been interviewed for this case are the housing association, the municipality, the energy company and a supporting instance. In this case the goal for the supporting instance was to aid people in understanding the communication distributed from the various stakeholders.

This project has a scope of around 1850 units and is located in a more open area with no central entrances, which is quite different compared to the first case. It is a significant bigger compared to case 1 and therefore is divided into multiple smaller projects, causing the project team to learn from itself during the heat grid implementation. The buildings are placed in a city also in the North-West of the Netherlands and is considered medium-large with a total of around 70.000 residents. Each of the units has its own front door, causing the residents to meet each other less often compared to case 1. The units are all low-rise and built between 1980-1990. All units will be individually renovated and retrofitted by replacing the current central heating boiler with a unit for the heat grids, new insulation will be added, new windows will be placed and the kitchen will be equipped with a new induction cooking station. As compared to the first case, there is a wide variety of residents living in the apartments with different backgrounds, nationalities and all having different needs.

Comparable to the first case, many migration backgrounds can be seen in this neighborhood. During the interview with the responsible housing association and during background research, many non-Western migration backgrounds were found, making this case also quite complicated in the light of communication from stakeholders to tenants. In the next paragraph a more in-depth analysis on the influence of many migration backgrounds is being discussed.

Case	Project phase	Initiators	Building typologies	Stakeholders interviewed	Units
2	Execution	Municipality and Housing association	Residential, all social housing	Housing association, Municipality, Energy company, Supporting instance	1850

Table 6: Characteristics of case 2 (author)

Background of the residents

The literature section of this research showed the impact of the community on willingness to adopt new technologies. Several components can be related to the influence of the community and selecting these cases already showed some major differences between the two cases. When conducting the interviews with the housing association, some extra background information was given that does influence the ways of communication from the stakeholders to the tenants. In both cases the histories of the residents have a big impact on the heat grid projects, especially when it comes to social cohesiveness and vulnerability (Onencan et al., 2024). The residents of Case 1, who come mainly from

non-Western immigrant backgrounds, have a variety of language and cultural difficulties. Because of this variety, certain communication techniques are needed to guarantee that all parties are aware of the objectives and advantages of the project, addressing possible weak points such language obstacles, financial difficulties, and problems with institution trust. By offering an opportunity for group representation, encouraging tenant agency, and strengthening social cohesiveness, the existence of a residents' committee helps to lessen these vulnerabilities. With their common entrances, the buildings' design promotes regular contacts, strengthening the community feeling and creating a positive atmosphere that may encourage group action and project approval. The residents of Case 2 also come from a variety of backgrounds, but there are less possibilities for social connection and cohesion since there is no residents' committee and the low-rise dwellings have single entry designs. Residents may become more vulnerable to miscommunications or opposition to the project as a result of this physical separation, which could create feelings of loneliness and reduce the effectiveness of community-wide communication initiatives (Roy et al., 2023). Although the supporting instance is essential for overcoming some of the communication barriers, the project will have a harder time getting general acceptance and confidence without the residents' committee's unifying structure. Therefore, the residents' backgrounds in both cases, together with the social and organizational structures, could have a direct influence on how the project handles communication, community involvement, and success in general.

The development and success of the heat grid initiatives are significantly shaped by the community's history of cohesiveness. In Case 1, a foundation of trust and collaboration is established by the already existing community cohesion, which is further strengthened by the architectural design of having this central entrance, and the active participation of a residents' committee. This long history of social interaction makes it easier for residents and stakeholders to communicate, allowing the community to work together to overcome barriers. Because structured social networks offer spaces for collaboration and group decision-making, research indicates that communities with a history of such networks are more likely to adopt innovations (Kolleck, 2014). Case 2 lacks this historical cohesiveness, as shown by the physical separation, thus having less social interaction with the neighborhood, and lack of a residents committee, which lead to a decreased feeling of collective identity and communication. The difference shows how a community's capacity to adjust to new initiatives is strongly impacted by its past contacts and social structures. As seen in Case 2, the project's communication strategies require more effort to overcome mistrust and detachment in lack of a common goal or established trust. Therefore, the historical social cohesiveness of a community determines the level of stakeholder involvement required to establish trust and encourage collaboration over the duration of the project.

4.1.2 Intercept interviews

Since the goal of this research is to identify how communication towards tenants can be enhanced, it is important to include viewpoints of the tenants. Whilst literature shows that tenants experience difficulties in adopting new technologies, it is not known how people experience the communication from stakeholders regarding information on heat grids. This is why intercept interviews are being conducted where tenants were asked three questions in order to capture their views. This approach is chosen due to the privacy and cooperativeness of the tenants. By approaching people in a generic scene and the relatively low barrier to participate, it was expected that the cooperativeness would be higher. It is important to note that the locations are not responding with the location of the cases, as this was asked by the project managers of one of the cases. The goal here is also not to identify how tenants experienced regarding the cases, but to identify how well-informed, and what communication is preferred in general.

In a four timeframes of two hours on 05-11-2024 and 07-11-2024, people were approached and asked if they were willing to answer three questions (once living in social housing was validated), which will be elaborated on in section 4.2.1. This was repeated three more times, as seen in Table 7. These three generic questions were regarding their knowledge on heat grids, how stakeholders communicate regarding the heat grid, and what they would like to see improved. This ensured that

tenants' views on heat grids and the communication is validated and could give suggestions in how this can be enhanced. It also gives new insights on what communication is being preferred.

	Setting	Date	Time	(x) of people
Location 1	Market	5-11-2024	10:00-12:00	7
Location 1	Supermarket	7-11-2024	16:00-18:00	5
Location 2	Mall	7-11-2024	10:00-12:00	9
Location 2	Supermarket	5-11-2024	16:00-18:00	6

Table 7: Structure of the intercept interviews (author)

4.1.3 Interview contents

Since the research has an exploratory nature to identify the various elements stated in the literature review, it was decided to interview stakeholders who take part in the project of establishing the heat grids. Based on the stakeholder analysis in section 3.3.2 in this research, the five possible engaging stakeholders in relation to tenants have been identified; the housing association (HA), the municipality (M), the energy company (EC), the supporting/consulting company (CC) and the residents committee (RC). For each of the cases mentioned above, all stakeholders were approached in order to get in touch with the person responsible for communication during the project, ranging from project managers to communication advisors. The goal for this was to see the perspectives of the key stakeholders in order to establish a strategy or advices regarding enhancing the communication to the tenants. Once the cases were selected, it was clear which stakeholders should be approached and thanks to the project manager of each of the project, the contacting was successful and can be categorized in the pre-determined stakeholder groups; the housing association, the municipality, the energy company and a supporting instance. The dates of the interview are visible in Table 8.

The interview protocol has been established in such way it was applicable to all the stakeholders and their background in the project. Due to it being semi-structured, it allowed the conversation to go more in-depth and really understand the reasoning in why certain choices were made regarding the communication and the encountered barriers. The interview was structured in three themes, identifying the role, identifying the encountered barriers and identifying the communication strategies used in the project. This is based on the three models which are researched upon. The entire protocol can be found in Appendix B. By starting off with exploring and identifying their role, they were given the chance to introduce themselves, their roles and their responsibilities, but also the responsibilities of the organization as a whole. This part introduced the mutual relations between the stakeholders and where certain conflicts or misalignments in the project organization were visible. This also is the start of creating a social graph for the project.

Before exploring the communication used in the project, the barriers were analyzed first to validate if the literature was correct. By questioning which barriers the stakeholders encounter, it is expected that a certain strategy is used to minimize those barriers. After the stakeholders argued their encountered barriers, an explanation was given on the division of the barriers encountered when implementing new technologies, in order to shift the focus to that certain subject and have a more in-depth conversation in why these barriers are significant in heat grid projects and how this impacts the way stakeholders communicate with each other and the tenants.

The communication part served to identify how the tenants needed to be approached and how the stakeholders themselves ensure a good flow of information in the project. The goal is to identify what strategies were used in order to get the 70 percent acceptance rate of tenants that is necessary to start the project. It identified which communication channels are being used, how the timing of information is essential, how the adequacy of information influences the tenants and how feedback on the information is important in order to be successful.

4.1.3 Coding of the interviews

Based on the two cases and the stakeholders related to the cases, 9 participants were interviewed, which can be seen in Table 8. The codes are based on the role of the stakeholder (HA = housing association), the number of the interviewee per stakeholder (1 is a one-to-one conversation, 2 were two people attending the interview) and its case (CS1 is Case 1). There were no specific stakeholders interviewed who had a direct role in addressing vulnerable households, but the communication advisors and the project manager were well aware of the social situation and mentioned having in-depth knowledge and understanding of vulnerable situations some of the residents are experiencing.

Code	Organisation	Role within organisation	Case	Date of interview
HA.1.CS1	Housing association	Projectmanager	1	9-10-2024
HA.1.CS2	Housing association	Projectmanager	2	15-10-2024
HA.2.CS2	Housing association	Communication advisor	2	15-10-2024
M.1.CS1	Municipality	Area manager	1	10-10-2024
M.1.CS2	Municipality	Communication advisor	2	18-10-2024
EC.1.CS1	Energy company	Participation manager	1	9-10-2024
EC.1.CS2	Energy company	Area manager	2	16-10-2024
CC.1.CS1	Supporting company	Program manager	1	10-10-2024
CC.1.CS2	Supporting company	Social worker	2	8-10-2024

Table 8: Overview of the interviewees, with each personalized code (author)

Based on the literature by Hamdan et al. (2021), several stakeholders regarding heat grids were identified, in which a selection was made to reduce the number stakeholders to only include those (partly) responsible for communication to tenants. For both cases it was succeeded to include them in the research, apart from the residents committee. As mentioned, tenants are highly important in this research, but none of the residents has been interviewed. This approach is chosen due to the difficulty in contacting them, and the question from the housing association to exclude them from the research to not disrupt the process. Therefore it is chosen to do a field research to include the views of the residents, as mentioned in the previous section. After conducting the interviews, transcripts have been created and coded using Atlas.TI, a software program that helps analyzing the various transcripts. It is a qualitative data analysis software that assists in methodically examining textual data. It facilitates the coding, classification, and visualization of data, which helps the identification of themes, patterns, and insights in qualitative research projects. This helps to effectively manage large, complicated data sets and improves the depth and accuracy of qualitative research approaches by structuring and organizing data (Atlas.TI, 2024). Based on the structure of the interviews, codes directly related to the different models as explained in the literature study were created to categorize the quotes. This helped to identify which topics were more discussed upon and therefore say something about the experience of the different stakeholders in the different cases. It also helps in noticing trends regarding the opinions of the stakeholders which might reveal how these stakeholders approached the project. Based on the interviews it became clear that not only the focus was on overcoming the barriers, but also how the story is being told to the tenants. This new information is therefore also being coded and visualized in order to see what elements are crucial in the storytelling to tenants.

4.2 Generic analysis

During the analysis, the different research methods are being examined and analyzed. Prior to each of the subsections in this chapter, an overview will be given on what sub-question is being researched to enhance overall clarity in the analysis part.

4.2.1 Identifying tenants' viewpoints

To identify the current openness of adapting heat grids and how the communication from stakeholders is being experienced by tenants, intercept interviews have been conducted. This will help answering the first sub-question: 'What is the current level of adoption and openness to new technology of tenants in heat grid projects?' As explained in section 5.1.2, tenants have been asked three questions in a low barrier setting in order to receive direct feedback from tenants of social housing. The three questions aimed to assist in discovering how tenants bluntly experience these topics.

The following questions were asked:

Q1: **What do you know about heat grids**? The purpose of this question is to identify the level of knowledge that tenants already have. Tenants responses could reveal any misunderstandings or knowledge gaps, which helps identifying what they want to know.

Q2: **What is your opinion on how your housing association talks about this?** The goal is to find out how tenants feel about the current information sharing method . This question will provide insight into whether the housing association's strategy is effective by identifying if tenants feel well-informed confused, or excluded by current communication.

Q3: **How could this communication be improved?** Tenants might provide feedback in response to the last question. By doing this, the housing association could receive direct feedback from tenants on what they need to feel more at ease and educated about the project.

The questions are intentionally short and easy to understand, since literature already showed that tenants are less comfortable with difficult questions, so straightforward questions were expected to be more comfortable in sharing their thoughts without feeling overwhelmed.

What do you know about heat grids?

The intercept interviews started off by asking what is known about heat grids. Within the short answers given by the respondents, a total of 8 categories were examined in which the respondents answered, with some respondents covering multiple categories within the answer. An overview of this can be seen in Table 9.

Question 1	Counts
Not that much	12
Do not really care	6
Something with sustainability	6
Costs	4
Different kind of heating	3
Disturbance	3
Gas-free	3
Difficult to understand	2

Table 9: Current awareness of tenants (author)

As can be seen, the awareness of tenants is low and in general they do not know that much regarding heat grids, other that it is related to sustainability, it is a different kind of heating and it can cause disturbance during the implementation. 'Not that much' was the most frequently given response (12 counts), suggesting a lack of understanding of this topic. This implies that tenants are either not well-informed about heat grids or simply do not care that much. It does show some similarities to the identified barriers as discussed in section 3.4, especially related to the behavioral barriers, since tenants mentioned it is difficult to understand and that there will be disturbance, indicating it are complex systems and disruptions will occur. The answer 'not that much' also indicates that tenants are often unaware of the benefits and functioning of the technology.

Some of the interviewees associated the heat grids directly with sustainability and different kind of heating, indicating that there is some level of awareness regarding the topic. There is often no in-depth knowledge for these people, allegedly because the tenants, as mentioned in the literature review, often have other priorities regarding their homes. There were mentions regarding disturbance and costs, indicating that affordability and disruptions of their daily routines can be affected by this, and this might be the biggest hassle for the majority of the tenants. Seeing the amount of tenants mentioning 'do not care' also highlights the unawareness.

What is your opinion on how your housing association communicate regarding this?

For this question a total of 7 common answers have been identified. The goal here is to discover how people experience their communication with the housing association. An overview of the given answers can be seen in Table 10.

Question 2	Counts
It is okay	11
I do not really know	6
It is nice	5
Not much communication	5
Visiting is helpful	5
It is too difficult	4
It is too much	2

Table 10: Current experiences of communication from stakeholders (author)

As can be seen, the responses indicate mixed feelings among the tenants. The most common response to the question was 'it is okay', indicating that tenants are in general moderately satisfied, but not having a strong opinion on this topic. The communication methods might be not impactful enough or not memorable. Some of the responses indicated that it is not really known what to think of the communication, suggesting that the people are not that influenced either by this. It does confirm the first question, where it shows that the general tenant is not that much impacted by the communication regarding heat grids. It is unknown what impact and what communication method the responsible stakeholders have used to transfer information to the tenants, making it hard to directly relate this to the communication model as discussed in section 3.3.

Several tenants mentioned that the communication was nice and sufficient, and indicated that visiting them positively impacted their experience, showing that in-person interactions does help engaging people. It also does show some challenges regarding the information delivery, since some responses mentioned it was in general too difficult, or too much, while in some instances the tenants responded with 'not much communication'. These insights indicate there is room for some improvement in clarity and accessibility. The differences in answers can be explained due to the different approaches of the engaged stakeholders and of course also the different preferences of the tenants regarding how to be approached.

How could this communication be improved?

The last question aimed to identify what should be improved for better communication between tenant and stakeholder. A total of 7 types of answer have been identified, as seen in Table 11.

Question 3	Counts
I think it is okay	8
I do not know what to improve	7
Make it more easy	6
Not that much	6
Communicate more often	5
Less information	2
Use pictures	2

Table 11: Overview of how communication could be improved (author)

The responses in how it could be improved are varying a lot, indicating that a tailored and varied communication approached is necessary to reach all the tenants. It does also shows that most of the tenants do not essentially know what to improve. This is in line with the previous two questions and show the lack of awareness and interest in general regarding heat grids. Most tenants do not exactly know what it means or have in general not enough knowledge regarding this topic. It was also mentioned six times that communication could not really be improved, emphasizing this wide range of thoughts between the tenants.

Not every tenant did agree that the current method is good and suggested there is a need in balance between the amount of information given, and how easy it is to understand the information. On location 1 more changes are necessary within the homes of the tenants, and therefore more information was spread to inform the tenants. Regarding location 2 less changes in the homes will be executed, therefore impacting the tenants way less. In general it can be concluded that while many tenants are somehow satisfied, there is room for improvement to enhance clarity, frequency and possible visual support to help understand the changes.

4.2.2 Analyzing barriers in new technology adoption

The second topic being discussed in the interviews are the barriers. Section 3.4 analyzed more in-depth various literature regarding barriers encountered in new technology adoption. This analysis is done to answer the second sub-question: What are the barriers encountered by tenants in the adoption of heat grids? It is explained which barriers exist and why these barriers play a significant role in heat grid projects. Based on the interviews, a table is created to analyze the similarities and differences compared to the literature. To get to this comparison, a column will be added in which the frequency of how often the barrier is mentioned by the interviewees. A distinction will be made between a general table, and a bar-graph in which the two cases are being compared. After analyzing all the interviews, it became clear that the barriers exist and extra barriers should be added, but that this is not the hassle in communicating heat grids to tenants.

4.2.2.1 Overall findings

As seen in Figure 20 below, a total of just 106 counts are present, which is lower than previous anticipated. The reason, according to the interviewees, is clear; in general the tenants just are not interested enough to understand it (HA.2.CS2). The tenants are a diverse group of people in which the barriers are not regarding adopting new technology, but understanding what is being told, something what will be further elaborated on in the next few paragraphs. When looking at the graph, the three types of barrier can be seen: social barriers, behavioral barriers and economical barriers. To see the differences between the barriers, a bar-graph is shown in Figure 20.
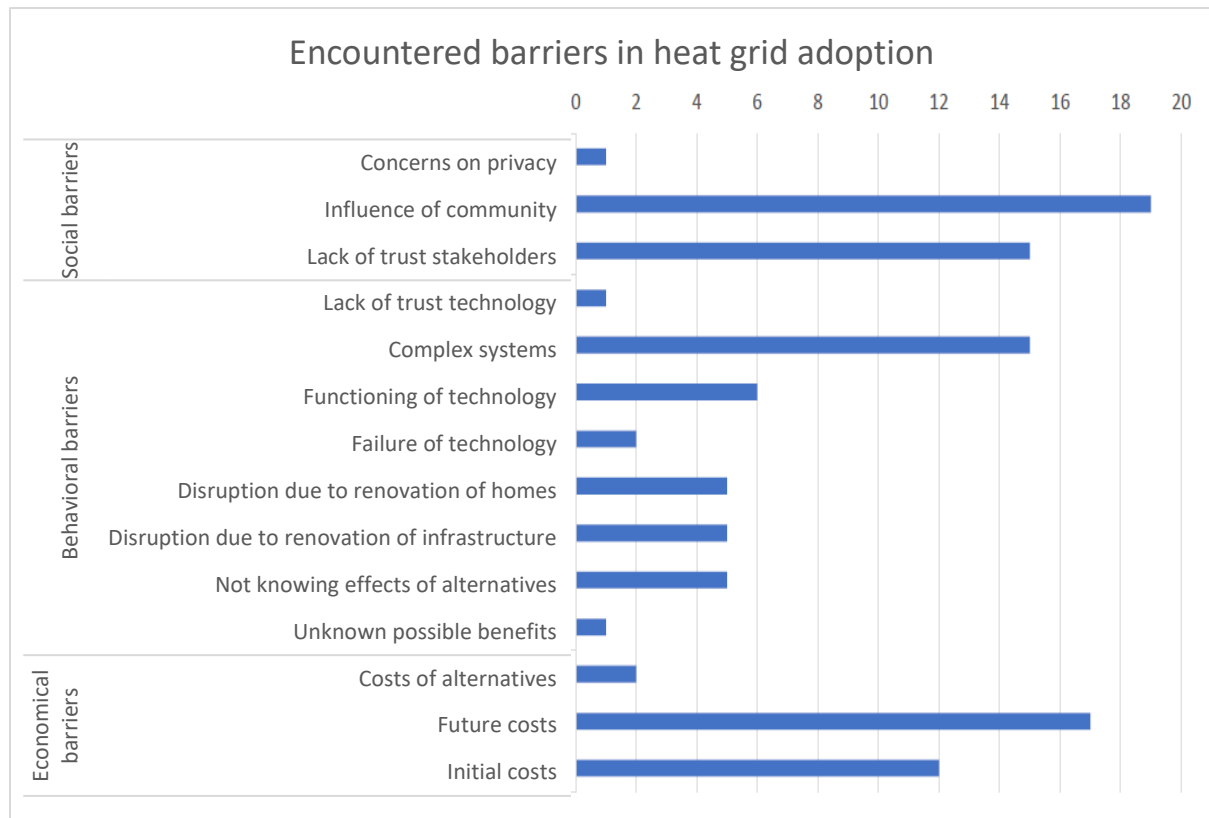
Figure 20: Barriers encountered in heat grid adoption, counts from both cases (author)

Social barriers

All barriers were mentioned, but it is clear that privacy is not the main concern. People might be hesitant to open the door, but in most cases it is clear that the installment will happen (CC.1.CS2). The focus is more on influence of the community, since in neighborhoods with a stronger social cohesion are more likely to accept or neglect heat grids as a whole (EC.1.CS1). Negative feedback from neighbors and prior experiences with noise and disruptions can foster this resistance, since people will express the potential disturbances (CC.1.CS1).

'There was very little attendance by residents at the information evening and so they went very much on the trust of their fellow residents and that is something very nice, but also what is very fragile. You saw that this year the tariffs went up very much, the residents went to address their fellow residents with: ''you had said this was good for me, but now that price is going up?'' and that makes it vulnerable.' (EC.1.CS1)

It is more important to maintain trust in the stakeholders. It is important for all parties who communicate to the tenants to remain transparent about what will happen within the house and how it will impact their financial situation (HA.1.CS1; HA.1.CS2). When there is a misunderstanding on costs or renovation measurements, the trust can quickly be damaged, which can and will lead to delays (EC.1.CS1). It should be noted that most of the comments mentioned above are not directly related to the adoption of new technology, but more on social barriers regarding acceptability.

Behavioral barriers

Tenants may not fundamentally be against these technologies, but it's usual for them to lack the knowledge and motivation to truly engage with the technical details. Heat grids and other energy-related renovations may seem abstract and overly complicated to many social housing tenants, which discourages them from learning how the system works (EC.1.CS2). Tenants may also be hesitant to embrace new technologies due to unfamiliarity. 'What I see, people often do not have that much interest in this' (EC.1.CS2). They are used to the current heating systems that are and often do not see

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the need to shift to another heating system, particularly if there are no immediate personal benefits (CC.1.CS1).

'They were especially curious about the modifications in their homes, but not related to the heat grid. They asked more about things like: "What kind of tiles will be in the bathroom?" and other home modifications, but the heat grid itself did not interest them.' (EC.1.CS2)

The effort needed for change is a further barrier. According to EC.1.CS2, tenants often explain feeling overwhelmed with technical knowledge, which reduces their level of participation. To overcome these behavioral barriers and encourage a smooth adoption process, it is essential to provide simple details regarding disruption, long-term comfort, and possible cost savings (M.1.CS1). As seen in the figure, this is what has been mentioned the most, and therefore should get more attention.

Economical barriers

The last type of barrier discussed are the economic effects of implementing new technology. Whilst this a barrier that is in general quite important, in social housing extra attention is necessary on this matter since affordability and financial stability is critical. Many of the tenants already have tight budgets, but this may be greatly impacted by increases in monthly expenses. Since they sometimes lack the financial flexibility to absorb unanticipated costs, tenants find the initial investment and ongoing expenses connected with heat grids stressful and many questions are regarding this topic (EC.1.CS1; HA.2.CS2).

''Well, look, ultimately that bill lands with the tenant, and our tenants really don't just have an extra €10, €20 or €30 a month. Every euro is turned over. So any increase, in any form, just poses a risk.' (HA.1.CS1)

Even little costs can cause a lot of stress and hinder tenant acceptance when implementing new technologies in an already difficult financial condition. As a result, even small monthly cost increases can be overwhelming. The implementation of new technology in social housing has the potential of burdening tenants too much when there is no targeted financial support or fixed price structures, which could hinder their successful adoption and engagement.

Other barriers

When looking into the barriers regarding adopting new technologies, there was mentioned another barrier not existing in the framework, the legal barriers. Even though this might seem less relevant regarding this research, it does propose difficulties for the stakeholders. With new technologies and new developments, new and unclear legal requirements come up. Delivering heat through heat grids is quite different compared to gas. There is only one supplier, which is sometimes seen as a barrier since the tenants cannot choose their supplier. The expenses are also different, since there is a fixed price per month, and on top of that a monthly fee based on usage is asked for. That fixed monthly fee can be quite a barrier for the tenants, which is why the HA decided to buy off this part. The problem with this is that it is uncertain 'if housing associations are allowed to buy off a part of the fixed price. The energy bill is not our responsibility' (HA.1.CS1). Due to its legal uncertainty, communication regarding this is not always clear and thus quite a barrier. It is not always clear for the stakeholders what is allowed to do, and what is not allowed to do.

Also political barriers are shortly mentioned. Since the beginning of 2024, often heat grids and its related stakeholders got attention in the media, which was more often negative than positive. This attention means the project should be handled with extra care, otherwise extra resistance from the tenants might occur. 'Deals that are made in The Hague really influenced this project, which is normally not the case' (HA.1.CS1). This barrier can be related to the social barriers, since due to this political pressure, more resistance and thus less trust from the tenants in governmental bodies or stakeholders occurs. This is also highlighted by EC.1.CS1, as this interviewee mentioned that 'the media handled it (information regarding heat grids) pretty badly past few years, a lot of things are said in the news, and that makes it complicated'. There is an overarching goal given by the politics, but its

contradicting and unclear goals makes it sometimes difficult in how to translate the message to the tenants.

The narrative

An interesting finding that came to light in the interviews, is that the barriers of the adoption of new technologies is not mainly based on the literal implementation of new technologies, but more in how the story is being told. As EC.1.CS1 mentioned: '...translate the jargon we know well into a clear story. That is really the key question: how do you say this in a way that is understandable'. This aspect is mentioned by many other stakeholders during the interview. This illustrates that good communication focusses more on communicating the implications of technology for tenants' comfort, affordability, and daily routines than it does on describing the technology itself.

For instance, a number of participants pointed out that rather than the heating system's functioning, tenants frequently express worries about problems to their daily routines. They are often familiar with the current technology in place, and do not see the need for shifting this and paying extra expenses, especially since "These people just survive for the most part, and are happy to make ends meet every day or every week or every month," HA.2.CS2 highlighted in one instance. Explaining what will happen and change in a tailored approach has much more effect on the willingness to adopt. Stakeholders can help tenants feel listened to and included by focusing the communication on their lived experiences, such as less maintenance and cost related issues, rather than overwhelming them with technical jargon. What this influence is and how this should be provided will be talked about in section 4.2.4.

4.2.2.2 Similarities and differences

In order to research why these two case both have reached the 70%, it is important to compare both approaches. In section 4.2.1 both cases have been analyzed in several ways to see the structure of the project. As mentioned several times before, the main difference between both cases is the difference in the existence of a residents committee, which partly explains why certain barriers are mentioned more often by one case compared to the other. This will be elaborated on in this paragraph. Figure 21 shows the differences in total counts per case, in which can be seen that regarding case 2, more barriers where encountered compared to case 1. One explanation for this is that less resistance to the plans occurred due to the residents committee. As expressed by HA.1.CS1, the tenants trusted the residents committee a lot. Less efforts had to be done in overcoming the barriers regarding adopting new technology due to the trust the tenants had in their peers. This does suggest that one of the social barriers should have a higher count on case 1, but this is not perse true. Both case 1 and 2 show a significance in influence of the community and both elaborated on how neighbors and other prominent figures familiar by the tenant, who seem educated to make a decision, can be a barrier that has to be minimized. Also, the trust in stakeholders was mentioned several times by both cases, indicating that this is an overarching barrier in general, but does also show that the stakeholders know this and try to minimize this by using certain communication channels and strategies, which will be discussed in section 4.2.5.
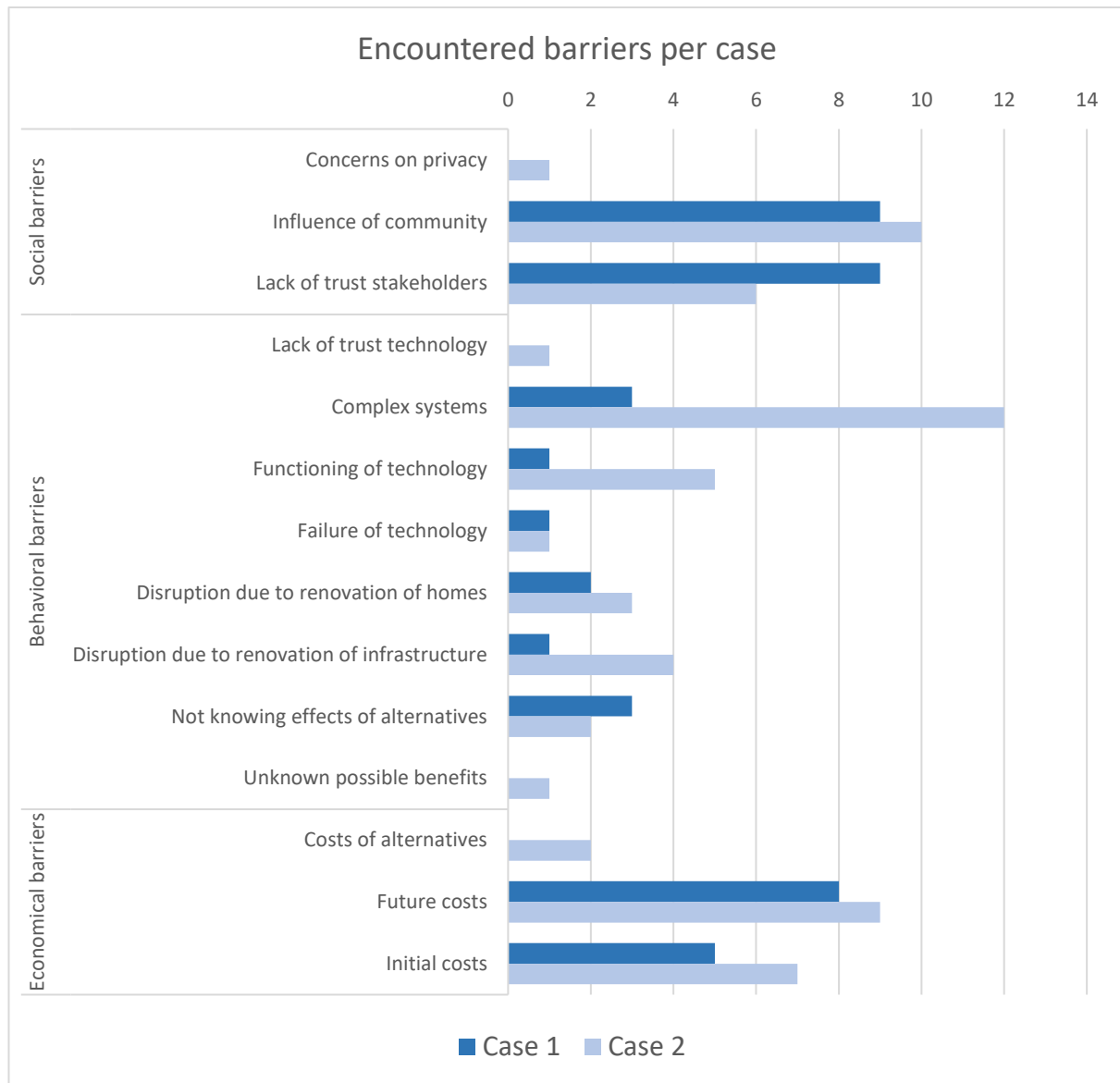
Figure 21: Comparison of encountered barriers per case (author)

The real differences in barriers is regarding behavioral barriers. In case 2, where there was no residents committee, behavioral barriers related to knowledge, such as complex systems, the functioning of the technology, and the need of renovations, were more common. By making complex information easier to understand and providing tailored communication, the residents committee in case 1 acted as a trustworthy middleman, reducing the knowledge gap between tenants and stakeholders. The committee's involvement helped the tenants in case 1, which encouraged confidence and reduced the project's perceived complexity. Tenants in case 2, on the other hand, received information directly from stakeholders, which was more impersonal and technical, and communicated by unknown and unfamiliar people. Tenants in case 2 had less opportunities for expressing issues or asking questions since there was no direct committee to mediate or give opportunities for peer-to-peer learning. Besides this, not having a central area in which the new system can be places proposed new challenges. On more locations in the neighborhood changes had to be done by adding new structures, comparable to transformer stations. Also, all individual apartments have to be connected in a different way compared to case 1 due to not having a central heating system, making it even more complex, which does explain the big difference when looking at complex systems. The importance of residents committees in filling in knowledge gaps and lowering behavioral resistance is highlighted by the way that this lack of customized communication increased

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behavioral barriers. A lot more effort has to be done by the housing association to overcome this specific barrier and a tailored approach is seen as necessary for this.

The third group of barriers, the economic barriers, is quite comparable in both cases. It is known and highlighted by both stakeholder groups that the tenants often have financial struggles, and that this is the most often mentioned when communicating to the tenants, causing dominance when talks regarding the heat grid are happening. By offering clear insights and explaining how the finances are expected for the coming years, it is hoped to lower this barrier and get tenants earlier on board with the proposed heat grid. This includes clearing up misunderstandings regarding financial risks, describing potential long-term costs, and explaining how the initial costs are for the housing associations.

4.2.3 Identifying the stakeholders' roles

In order to get a grip on the third sub-question: 'What role do the actively involved stakeholders have in facilitating and communicating technological knowledge to tenants?', the stakeholders were interviewed and presented with a set of questions regarding their role within the organization, how this changes and how this is related to other stakeholders in the project. This helps to create an overview of which stakeholders are responsible for communicating to the tenants or how these stakeholders share the information to other stakeholders. Via the RASCI-scheme it is visualized what the role of the stakeholder is regarding facilitating and communicating information and knowledge to the tenants. The social graph a more in-depth analysis is done in who communicates to who, and what barriers might come up. It is important to note that the RASCI-scheme is focusing on communication in the project, who communicates to the tenants and what role the other stakeholders have in this.

Case 1

The first topic that was talked about during the interviews was about the roles of the stakeholders. During the interviews it was discussed what the role of their organization was throughout the project and how this changes over the projects lifespan. Also the relationship between the stakeholders was examined to see who communicates to whom and how this was perceived. The literature showed that a RASCI-scheme can be established to identify the changing roles of the stakeholders. For case 1 all parties were involved in some way from the start (HA.1.CS1). The housing association (HA) is in the first phases of the project the responsible and the accountable stakeholder and thus has a double role, it is their stock and they are responsible and accountable in ensuring the communication of information is according to the expectations. The interviewee did not directly discussed the various roles within the department and mainly discussed its role in managing the project, but it can be expected that several departments within the housing organization have several roles in the responsibility and accountability, but looking at the organization itself, it has a double role. The housing association did this by collaboration and transparency, as good 'communication ensures a project succeeds or not' (HA.1.CS1). Maintaining trust is crucial, which came to light when the talks about rising energy costs started between the HA energy company (EC). Balancing the demands and expectations created pressure, but were handled quite positively in general.

The municipality (M) was mostly involved in the start of the project to oversee the process, having more of a consulting role and feeling the pressure as the stakeholder responsible for ensuring all stakeholders are at the same level. The municipality mentioned that 'the start was searching for the right path and a little uneasy, but later on this was getting better'. Throughout the phases the municipality tried to find clarity for all stakeholders to stay on track (M.1.CS1). This was especially necessary when the supporting company joined this project. In order to standardize future projects, this company joined the project. In the beginning it was unclear what their role was and how this could benefit the project (CC.1.CS1). This stakeholder mentioned that 'as soon as I started, it was exploring what my role was and what we were going to do' (CC.1.CS1). This eventually became cleared, but never has been completely clear. The energy company (EC) joined at the start of the project, and saw its role more as a consulting party that could help with guiding the project since they had some experience on how to tackle this. They did not feel the responsibility of taking the lead, as they 'believed that every stakeholder has a certain role' and 'we really focused on what heat grids are and the costs related to this' (EC.1.CS1). The This can be seen in Figure 22, where the role of the EC can be seen as a consulting and supporting role for the first phases, regarding facilitating information.
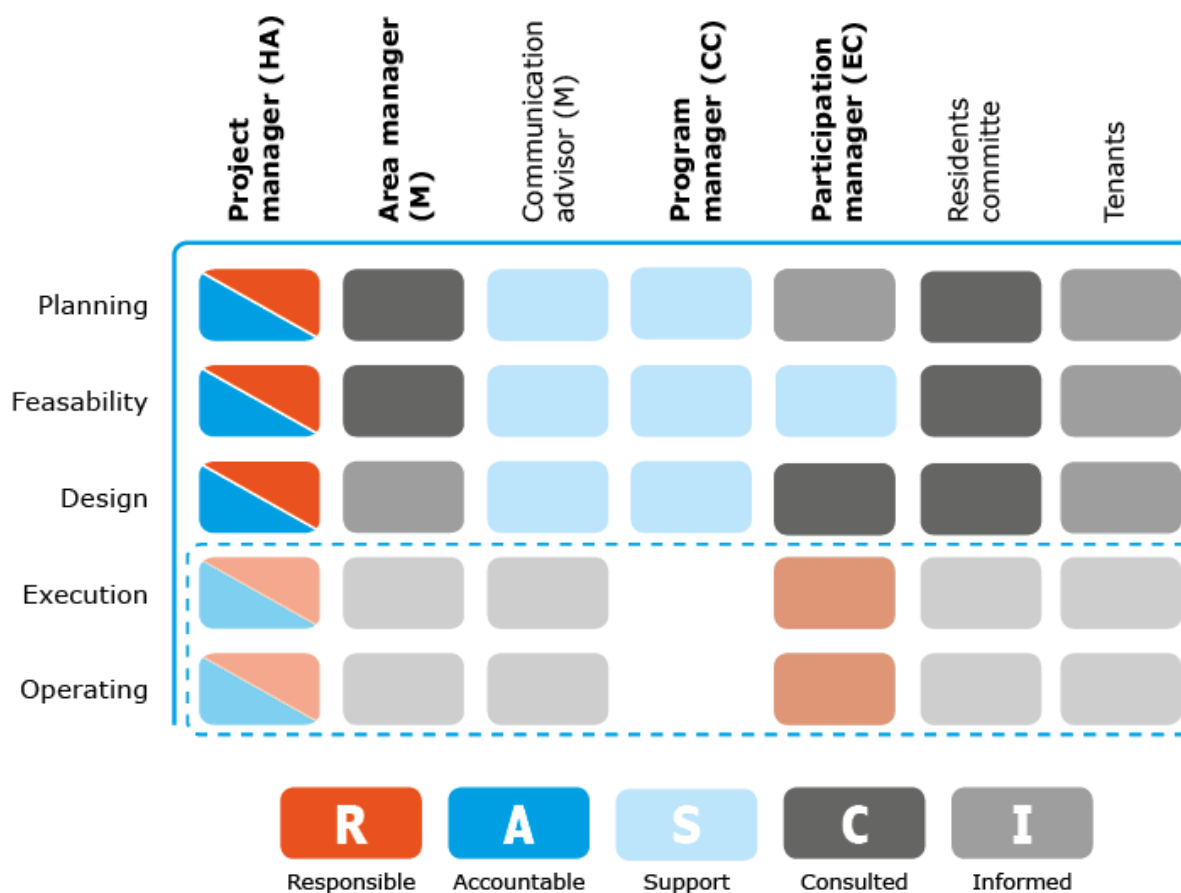
Figure 22: RASCI scheme regarding communication for case 1 (author)

By informing the HA with their knowledge, the EC knew better how to approach the residents with the right information. The HA discussed the technical information with the residents committee (RC) to gain more trust. The RC was consulted in what their expectations are and how this can be reflected in the project (HA.1.CS1). As said, Figure 22 has been established based on the conversations during the interviews to get a grip on how the roles of the various stakeholders shifted in this project, and what is expected to be their role in the following phases. When communicating this scheme back to the projectmanager, no specific commentary and changes appeared to be necessary, validating the different roles of the stakeholders.

The figure highlights in bold the interviewed stakeholders. The execution and operating phase are yet to be finished and therefore are speculated based on the interviews and the expected roles in these phases. Interesting to note is the shifting role of the participation manager (EC), since this role shifted quite a bit and was dependent on when the residents and housing associations required information regarding the technical and financial part of the heat grid. This RASCI scheme does provide a nice overview of the specific roles related to communication, but it does not become clear which stakeholder communicates to who. Therefore, social graphs are established to see how the communication does change over the phases. The social graphs are established in such way that each stakeholder group is represented in its color and role given in the RASCI scheme. Then, based on the interviews the relation and information exchange between the stakeholders is visualized. The thicker the arrow, the more information exchange between these stakeholders in this phase, which is based on the interviews when asked on how the role of the stakeholder shifted over time and how this impacted the communication between the stakeholders. This eventually shows where more communication might be beneficial, or why certain barriers in the project exist.
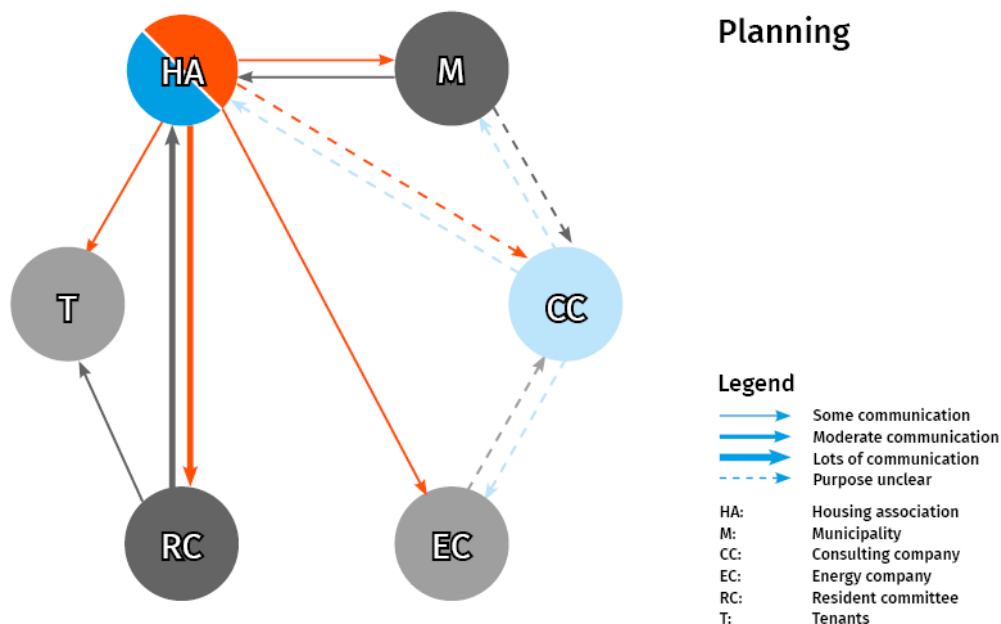
Figure 23: Social graph, planning phase case 1 (author)

When looking at the first phase, Figure 23, within heat grid project, the planning phase, not much communication is going on between the stakeholders. As seen, quite some lines are dotted, indicating the exact purpose of the communication was not clear and therefore creates uncertainty in the first phase of the project, a potential barrier. The role of the CC has been unclear, also due to its newly established role, but this hindered some parts of the project. Its goal was to eventually improve other cases by learning, and one of the lessons learned here is that clarity and well-defined goals is important for better communication. They mentioned that 'there were so many difficulties. But if you can stick together as a core group and believe in this, and if there are a few people who are pushing, that helps.' (CC.1.CS1). The relation between the HA and RC is already well established from the start, and transparent communication from the HA led to more trust from the RC. It can be seen that, apart from the residents within the RC, the tenants are not actively involved, it was especially more focussed towards gathering information, which is explainable in the planning phase. Also visible are one way communication channels or no communication between certain stakeholders at all, influencing the transperency between the stakeholders.

By restricting the flow of essential communication lines and insights and creating information restrictions, a lack of communication between some stakeholders, such the EC and RC or EC and T, can have an impact on the planning process. The difference may cause expectations and goals to not align, which might cause delays and ineffective planning. For example, the tenants and thus the RC are essential in comprehending the requirements and realities on the property, which should ideally guide the EC's tactics. But without a direct channel of contact, important resident input might be missed, which could result in less successful planning. Fostering a unified and inclusive planning process where each stakeholder's role is clearly defined and all perspectives are heard and taken into consideration requires addressing these communication gaps. The lack of inclusion of the EC poses problems. Plans are being established without the knowledge of the EC, lacking critical information for feasibility aspects such as financials and duration of the project. It would be beneficial for the project if communication between the RC or the tenants is established by all stakeholders. This would foster transparency and therefore would be more engaging for these parties to ensure cooperation in the planning phase.
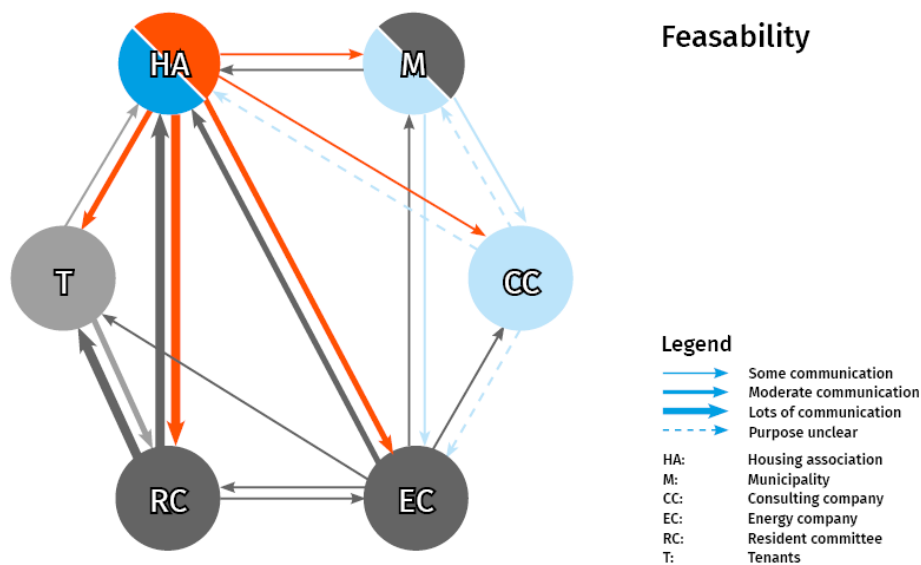
Figure 24: Social graph, feasibility phase case 1 (author)

When moving on to the next phase, the feasability phase as seen in figure 24, a lot more connections can be seen between the different stakeholders. It shows that this is the most important phase within the project, since in this phase the tenants decide whether the project will succeed to the next phase, or if there is not enough support. It is emphasized that transparency and a clear structure in who is responsible for what is necessary to maintain a structured project. It becomes even more clear how important the HA is in these projects, and a lot of management and responsibility is for this stakeholder. With communication between all stakeholders, and receiving feedback as well, a clear and well-defined communication plan is critical. In this phase the relation between the HA and the RC is even more visable. Lots of communication between these parties happened and it became clear for the HA that trust was really the key to connect with the RC. The tenants got more involved as well, but as mentioned already, this group trusted the RC, something that will be referred to more often in this project. The EC also become more influential and their consulting role helped the HA in providing insight regarding technology and finances. Comparable to the first phase, the role of the CC is not that clear and served mainly as an instance gathering information. When looking at the tenants, it can be seen that multiple communication lines are towards them, causing a risk in receiving too much information and thus clear alignment of information providence is necessary.

Compared to the planning phase, a lot more communication is happening between the different stakeholders. The main difference is the inclusion of the EC, The feasibility phase shows an increase in communication intensity in comparison to the planning phase, with the EC's involvement being crucial in determining choices. The EC's technical and financial knowledge gives the HA a strong basis on which to evaluate the feasibility of the project. Tenant involvement is becoming more important, which adds complexity. Although their involvement is essential for project approval, the possibility of information overload makes a structured communication strategy necessary. In order to ensure that tenants' issues and feedback are properly addressed, the RC still is an essential link between the HA and tenants. At the same time, the CC's unclear position causes doubt in their long-term usefulness, indicating that clarification is necessary to maximise their contribution. Recurring themes include trust and transparency, which are crucial for tenant satisfaction and function as the unifying factor for all stakeholders involved. To effectively go into the next stage of the project, it will be essential to maintain trust, make sure that messaging aligned and clearly define the roles of all stakeholders. The M still has barely any contact with the other stakeholders, and does not communicate to the tenants or their representatives at all. It maintains it overseeing and organizing role to facilitate help where necessary.
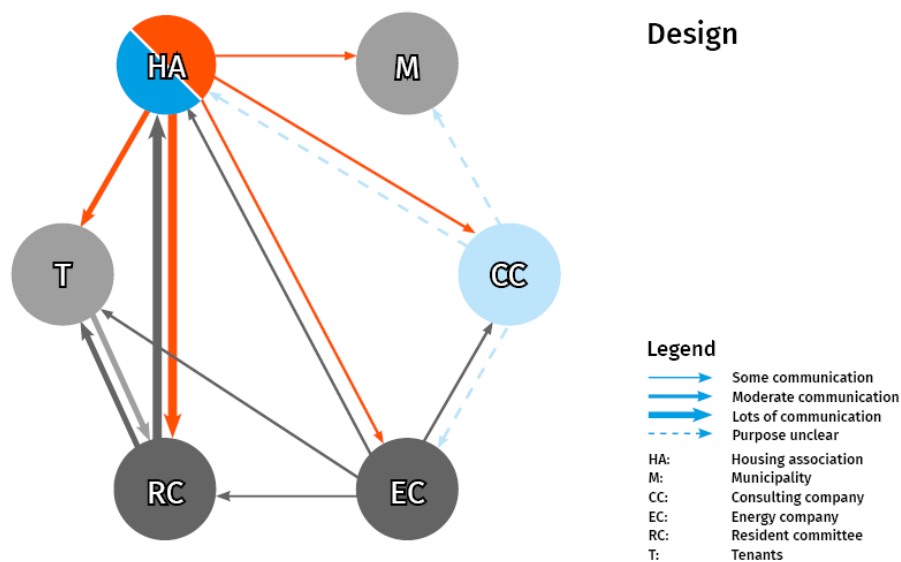
Figure 25: Social graph, design phase case 1 (author)

The third phase, in which the design is being further developed, there still is this strong connection between the HA and the RC. It can be concluded that this strong communication between these parties caused the project to succeed in terms of reaching the 70%. In general, less communication between these parties is happening, indicating less direct impact is created in this phase, or at least less communication is necessary to continue the project. Alignment of the implementation of the heat grids is being discussed and is primarily between the EC and the HA, and the HA and the RC. Interesting to note is that the M is not really active anymore. This stakeholder needs to be kept updated, but does not feel the responsibility in communicating boundaries and is mostly approached for required permits. The role of the CC is still not that clear, throughout the project this stakeholder tried to learn and give input, but in general this is not entirely reflected in the project, which can be explained due to this project being one of the first analyzed projects. Tenants, but also the RC are less updated on the regular due to the shifting to technical planning, causing a possible risk of disengagement.

While communication between the RC and the HA is still crucial during the design phase, there are a number of gaps that might cause barriers in the project's progress. First off, aside from issuing permissions, the M seems to be mainly disengaged from this phase. The M may not be completely aware of the project's changing technical needs and timeframes as a result of this lack of cooperation, which might cause delays or unanticipated regulatory issues. To guarantee cooperation and prevent administrative setbacks, it is essential to keep the lines of communication open with the M. Additionally, there is no direct connection between the tenants and the EC. Tenants could feel excluded from choices that directly affect them because the EC has a big say in the technical planning of heat networks, and have to fully rely on the RC and HA. Tenants could become resistant, particularly if their preferences or concerns are not taken into consideration during the design stage. Similarly, the CC's potential contribution is reduced due to its limited direct connection with other stakeholders. The CC might assist close gaps between the project's technical and social components if they were more active in promoting communication or offering professional perspectives. It can be said that improvements can be done to improve overall structure for the future phases in the project.

Case 2

The second case is slightly different compared to the first case. Whereas the first case is starting the execution phase in 2024, the second case has already started since 2023. The buildup towards the execution of the heat grid is comparable. From the start, all stakeholders are involved in some way. The plan originally started as a plan to increase the livability of the neighborhood, and part of this was the branding of a shared platform by all stakeholders (HA.2.CS2). The goal of all stakeholders is the same, but the road towards this goal and their responsibilities differed, especially when the heat grid was introduced. In this heat grid project, as initiated by the housing association, they were the stakeholder responsible for ensuring the project could start. This stakeholder was in charge of getting in touch with residents to make sure they were on board with the project's objectives and getting their consent to make the planned changes to their housing stock (HA.1.CS2). Since trust was essential for tenant collaboration, the housing association maintained an emphasis on being transparent in its operations.

In contrast , the municipality was consulted mainly in the early phases of the project and engaged in an informed role throughout most of the project phases. Even though their focus is not directly on this case, it is ensured the communication is on the same line and milestones are celebrated among all stakeholders (M.1.CS2). 'I am at the front of the process of thinking along about what the core message should be, how far along people are, how we can bring them along' (M.1.CS2). The supporting stakeholder is slightly an odd name for this stakeholder, since this organization is mainly involved to check information and help tenant to understand the information in explaining what to do and how this impacts the tenant (CC.1.CS2). Whilst in the start their role was not prominent, the influence in the design and execution phase was becoming increasingly more supporting. The energy company was involved from the start but more in an informing way. The company was being informed
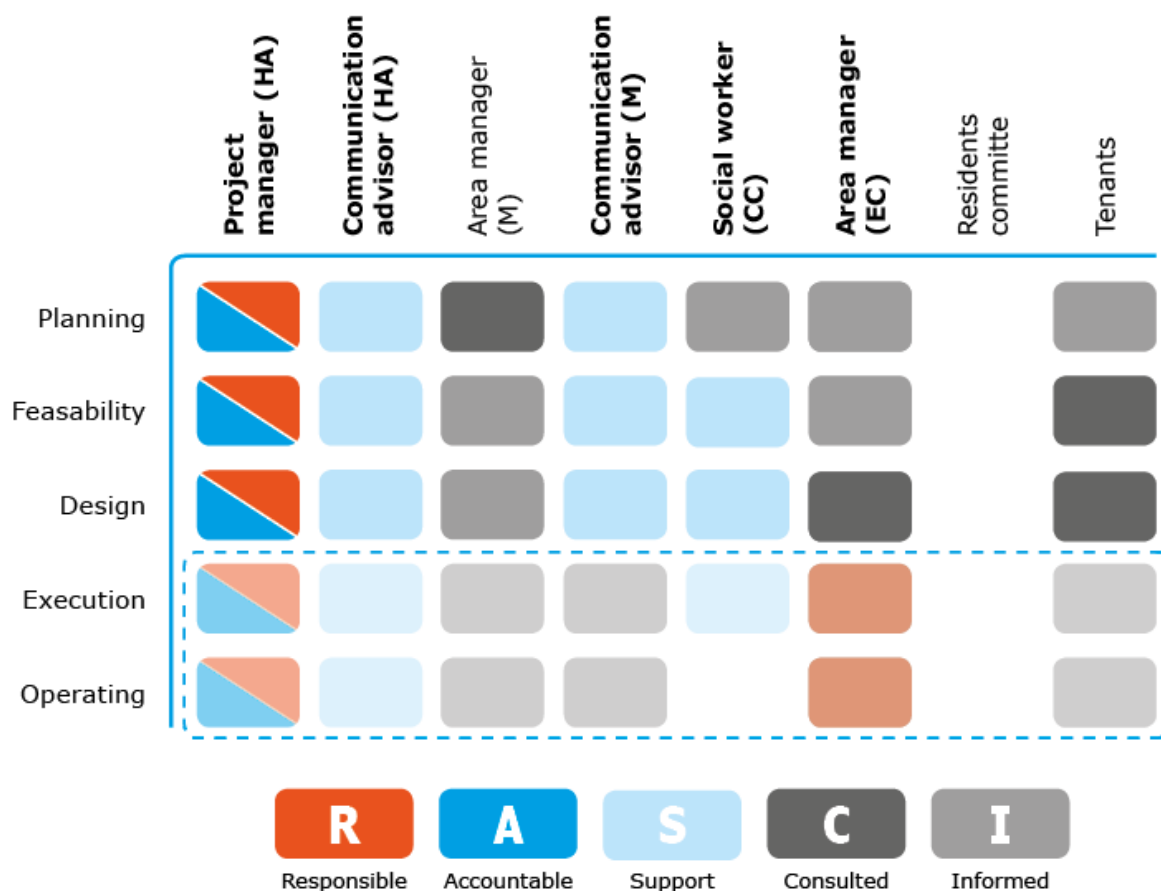
Figure 26: RASCI scheme regarding communication for case 2 (author)

in what the plans were, and how this would lead to eventually an execution for them (EC.1.CS2). In the design phase this came to light, since the original plans were not aligned with the feasibility of the project and caused some delays, showing this organization was consulted too late. The interesting part of this case is the lack of a residents committee. Despite efforts from the housing associations to create such committees, this was not succeeded: 'we are always in for a residents committee, but it is quite hard to get one started here' (HA.1.CS2). There is an overarching renters committee, but this party was barely involved in the project. This meant a different approach in communication was necessary in order to overcome the feasibility phase and reach the 70% of votes. The various roles are being visualized in Figure 26. As seen, two area managers were active and involved in this project, but both have varying roles of involvement, since their consulting role and expertise is used at different moments in the project. The projectmanager of the HA and both area managers had and still have bi-weekly meetings to align expectations and being honest and transparent on their wishes (HA.1.CS1).

The RASCI scheme is in general comparable to the first case, with one major exception, the lack of a residents committee organized by the residents. In the social graphs of the first case the communication relation between the HA and the RC was highlighted, something not possible for this case. It is interesting to see how this missing stakeholder influences the communication between the stakeholders, and how this affects the communication strategy. As comparable to the first case, for each of the three completed phases a social graph has been established to identify the intensity of the communication, with thicker lines indicating more communication between the parties. Figure 27 shows the social graph for the first phase.
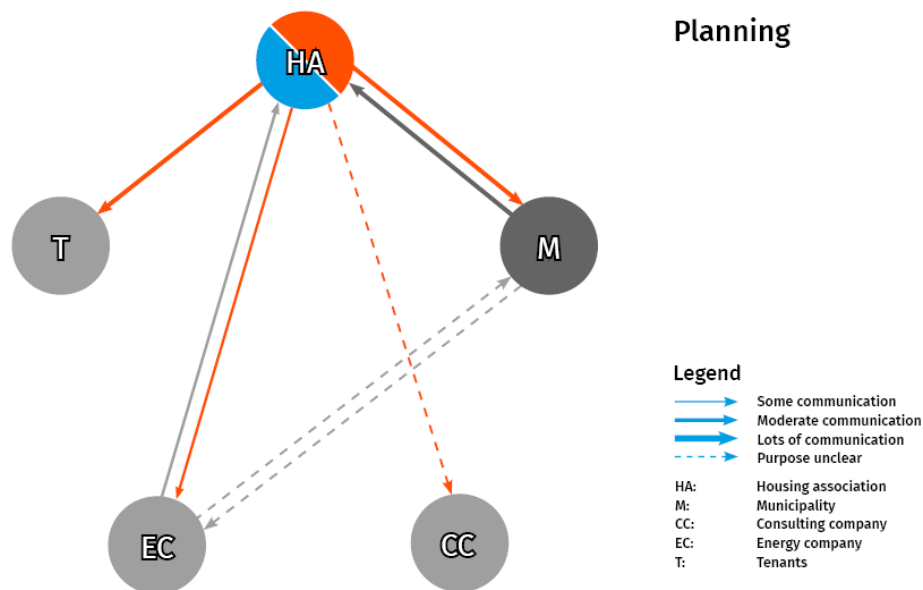
Figure 27: Social graph, planning phase case 2 (author)

In the planning phase the triangle between the HA, M and EC can be seen. This triangle of stakeholders was the start of the project and alignment of goals, dissemination of information and boundaries have been defined. In general, the communication between the stakeholders appears to be minimal, as can be explained since this phase is used to define the project. The HA is again the main communicator with the other stakeholders, due to its role as being the responsible and the accountable stakeholder. From the start, tenants are being communicated to in what the plans are and how this could impact them. The role of the CC is notably not clear and is mainly updated on what the plans are going to be, without any consideration of modification. The communication between the M and EC is unclear, since it is given that communication exist, but what communication and its purpose is not well-defined.

Missing links in the planning phase are often due to the exploring nature of the planning phase, where the HA, EC and M came together to discuss the possibilities of implementing heat grids. This does explain why the tenants are barely involved at all, and just updated on what the HA is planning to implement. The lack of effective communication between the tenants and the EC is a more important missing link. Tenant feedback at this point could assist shape the project to better suit end-user demands, as the EC is quite more involved in the design and implementation of the heat grids. Tenants may eventually become resistant or unhappy as a result of this lack of involvement as they may believe that their concerns were not taken into account at first. Additionally, the M and Tenants, are not in contact with the CC. Its absence of participation limits its efficacy as a stakeholder who may offer insights that tenants could benefit from, leaving its position unclear. This further restricts its ability to support the strategic planning of the project.
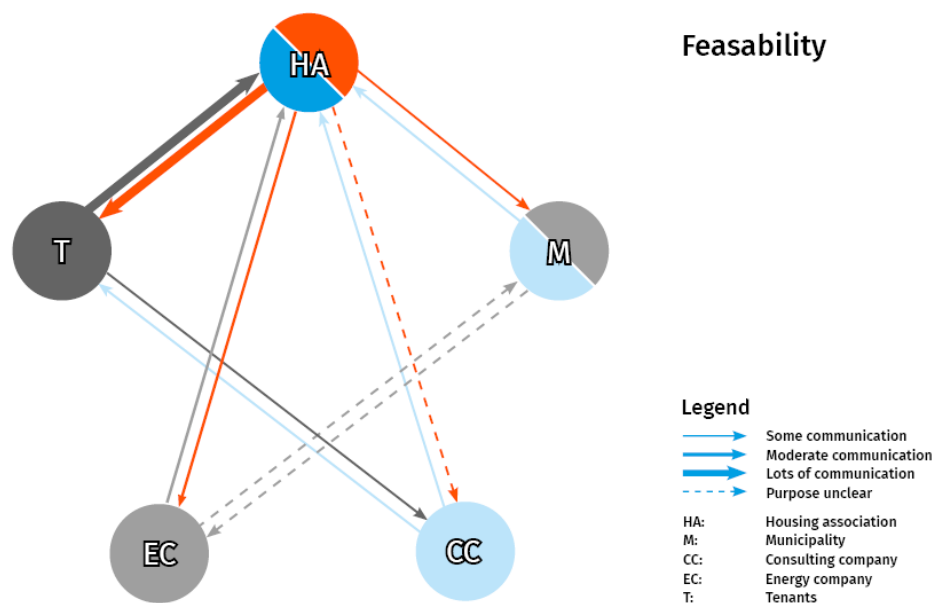
Figure 28: Social graph, feasibility phase case 2 (author)

Moving on the feasibility phase, visible in Figure 28, the communication is expanded significantly. The first thing noticeable is the strong communication between the HA and the tenants. Since there is no RC, this connection needs more attention and since it is not a group, but all individuals, this needs to be handled with a lot of care and is extremely time consuming. Based on the interviews it was really emphasized how important this relation and communication is and how carefully one should handle these individual tenants. The CC also becomes more active, since this is the place, apart from the HA, can come to for advice and help. The communication triangle between the HA, M and EC is still existent, but less emphasized on. It was mentioned that being kept updated on the situation is important to create unity between these three parties and same answers can be given when questions are asked (M.1.CS2). The communication between the EC and the M is still not clear, since most of the alignment will happen on the advice and experiences of the HA. One of the most significant barriers is trust. Once tenants do not trust the HA, communication is hindered and this can greatly impact the overall communication within the project. Being aware of this ensures more careful communication. Once trust is established, it can also be expected a bit more engagement from tenants is happening.

In this phase, still some perceived critical communication between stakeholders is not happening. From the triangle between the HA, M and EC, just the HA is communicating to the tenants. Even though this might indicate communication is not existent, an agreement has been made to deliver the information all via one channel; the HA, which explains the thicknesses of the communication arrow between these two stakeholders. The missing link between the CC and the M and EC can be explained due to its more clarifying role for both the HA and the tenants. It tries to facilitate help in making the information more understandable for the tenants, and often checks the information sent by the HA to oversee why certain complications do exist (CC.1.CS1).
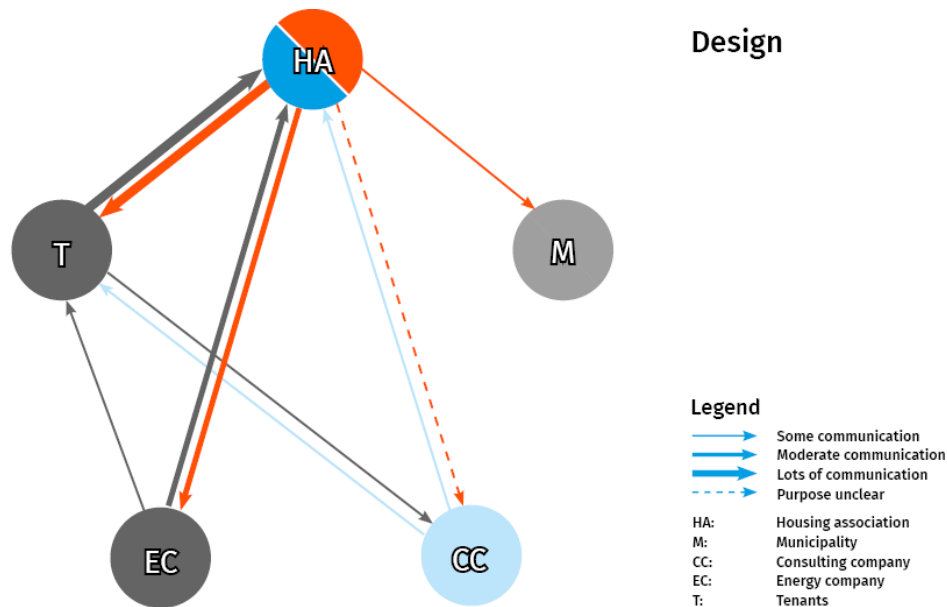
Figure 29: Social graph, design phase case 2 (author)

The third phase, the design phase as visible in figure 29, shows the increasing influence of the EC. Whilst the communication intensity with the HA and tenants is at the same level, this does increase with the HA and EC. Agreements on the design are established. When this is not happening or different design choices are preferable, which happened in this case, delays and trust issues can occur. Due to the misalignment in design, the project faced delays and transparent communication in earlier phases could have prevented this. In order to maintain trust to the tenants, transparent communication was necessary. As comparable in the first case, the role of the municipality is slowly decreasing, and its main focus is being kept updated and giving support on communication when necessary. The role of the CC has not changed and is focusing on giving support when necessary. A new communication line can be seen between the EC and the tenants, showing that its influence is increasing and giving information regarding the execution is being done by the EC, in accordance with the HA.

What is quite interesting to note is the similarity of the role of the M compared to the first case. Its role is becoming less and less important and notable, and eventually only facilitates as an overseeing organization which is kept updated on progress to oversee the process. In this phase, the EC is communicating to the tenants, but no feedback is received from the tenants. The EC facilitates information for the tenant on which design choices are made, but feedback on this goes via the HA. Other changes are not really happening compared to the feasibility phase, indicating that the strategy worked to maintain significant trust between the HA and the tenants, as the HA is the familiar face in this project for the tenant where they can rely on.

4.2.4 Analyzing the role of storytelling

The role of storytelling came to light during the interviews and therefore was not structured as a topic throughout the interview, but many aspects of communication are directly related to storytelling. In order to research the influence of storytelling, a thematic analysis approach has been used to identify which themes came to light the most and therefore identify which components are most crucial in storytelling. According to Braun and Clarke (2006), thematic analysis is a flexible technique for finding, examining, and summarizing patterns in data. It involves familiarizing the data, creating initial codes, looking for themes, evaluating themes, defining and naming themes, and creating a final report with an in-depth explanation (Braun & Clarke, 2006).

4.2.4.1 Overall findings

The reason why a thematic analyses has been conducted is due to the fact that during the interviews it became clear that generic barriers and communication strategies are not solely what is necessary to ensure a good project. How this information is being delivered is crucial for tenants willingness to adapt new technologies. Based on the interviews, 7 general themes were mentioned regarding how to tell the story to the tenants. Transparency, honesty, trust, impact, familiarity, clarity and empathy are the overarching themes used by the interviewees to express how communication is used. This component of communication strategy has not been discussed in the literature study and is something that appeared to be important during the interviews. It somehow does relate to the proposed model in section 3.3 where trust was mentioned for example, but the direct influence of the narrative has not been elaborated on. Once these themes were validated, coding is used to analyze how often the interviews mention something in regard to the specific theme. This eventually leads to an overview in which it becomes clear what part of storytelling is used by the specific case in order to get people familiar with heat grids and its impacts. An overview of the themes and how often these themes are mentioned is visible below in Figure 30.

Each of the seven themes will be analyzed and elaborated on to discover why this specific theme is important for the stakeholders and how this could impact the willingness of tenants to cooperate in the project. It is good to note that these themes are of course not structured in the interview protocol, and therefore an interpretation of each theme has been identified. When the stakeholder is talking regarding one of the themes, this is noted as one count, regardless of how often it is mentioned in the same sentence or paragraph. When talking about a different topic and it is mentioned again, it gets another count added to the graph.

Components in the narrative

|	Clarity	Empathy	Familiarity	Honesty	Impact	Transparency	Trust
■ Count	21	18	30	16	26	34	29
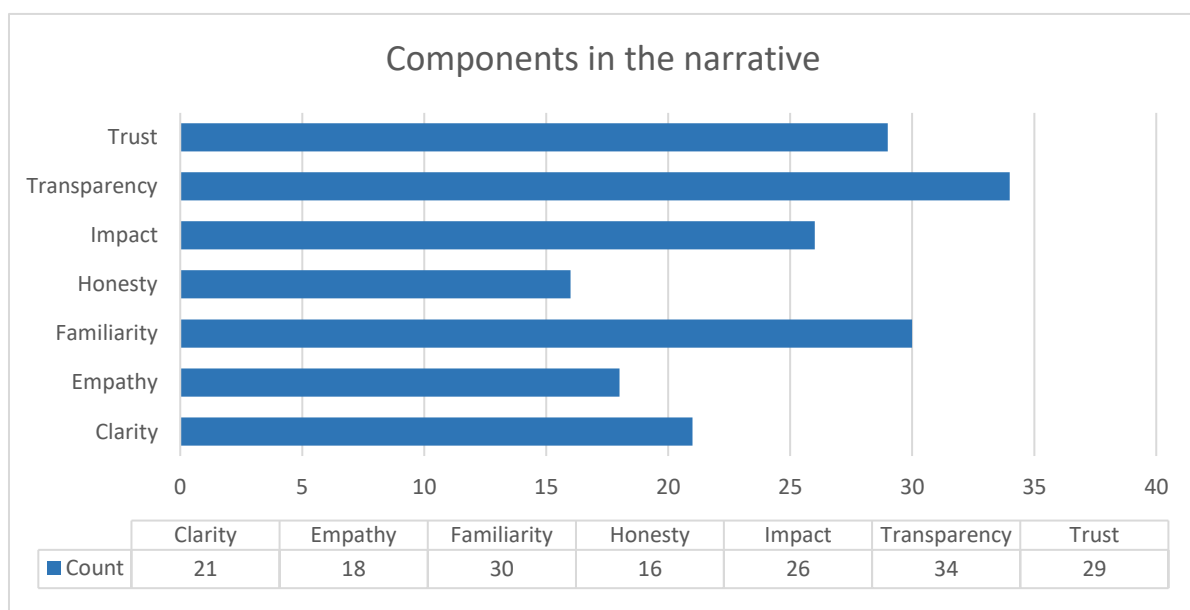
Figure 30: Counts for mentioned themes regarding the narrative (author)

Clarity

The first component in storytelling is clarity. Both cases expressed the need for clear, straight forward communication towards the tenant. In order to make the information understandable to tenants who are not familiar with such technology, stakeholders emphasized the importance of simplifying technical jargon, since people have no technical knowledge, and the information might be hard to comprehend (HA.1.CS1). They try to avoid using technical jargon that might cause misunderstandings by communicating in simple, direct words. As HA.1.CS mentioned, writing should be 'very simple, B1 level, in as much accessible Dutch as possible, but also in English' It is important that tenants will understand every stage of the procedure and what the installation of a heat grid will entail for their day-to-day life. Tenant knowledge will be improved this way and more positive attitudes regarding the project result from clearer communications, which helps the implementation process. HA.2.CS2 also mentioned that the individual approach can be from importance to explain the difficulties upfront.

Empathy

The interviewees acknowledged that many tenants deal with daily challenges, especially financial ones, and that empathy is an essential component of communication. Stakeholders make an effort to fully understand the worries of tenants, in particular with regard to the costs and disturbances caused by the project. Tenants may engage with stakeholders on a personal level and feel appreciated and understood because of this empathetic approach. It also shows that the project team is concerned about the impact on the community and not just the technical ones, and the project is looked from a 'different communication strategy that is tailored to the area' (HA.2.CS2). Tenants are more likely to feel included and appreciated in an inviting setting when communication is done with empathy. Listening to the tenant is crucial, since this might reveal new issues that are only visible for the tenants (HA.1.CS1).

Familiarity

Tenants are more at ease and engaged when heat grid technology is introduced in a familiar setting or through trusted local figures and familiar faces (HA.1.CS1). Tenants are more likely to respond positively to information from people they know or in environments they trust (HA.1.CS1). One approach that was suggested was the use of respected people of the residents committee, who are well-known and respected in the community, to inform the tenant about the project. It is also important to highlight what will be affected by the project, and what remains the same.

'There is no benefit in it for people. Why would they sign for nuisance? They now have something they know how it works, so why should they sign for something they can't estimate how it will work?'
(HA.1.CS1)

In order to overcome cultural and social barriers and make the project a positive contribution to the community, stakeholders should use trusted messengers and familiar information channels. It is also recommended 'using an overarching trademark, …, to emphasize it is not just us, but all stakeholders' (HA.1.CS2).

Honesty

The next theme that came to light was honesty. Since the interviewees feel that honesty establishes trust and creates reasonable expectations, the subject of honesty is highly emphasized. There has been talks talked about how crucial it is to explain not only the advantages, but also the difficulties of installing a heat grid, including any possible disturbances like noise or temporary delays (HA.1.CS2). The stakeholder should always explain and express 'the true story' (HA.1.CS2) Stakeholders try to be as honest as possible, rather than overly hopeful and blind-sided so that tenants can make informed choices without feeling misled (HA.1.CS1). The stakeholders establish a foundation of trust by openly discussing the advantages and disadvantages, which lowers criticism and gives tenants more confidence in their relationship with the project stakeholders, as mentioned by HA.1.CS1.

Impact

This theme is related to familiarity. Not only will the project change their familiar setting, it does impact how certain routines should be used. Tenants must know how the heat grid project immediately impacts their lives in order for them to support it. As mentioned by HA.2.CS2, most people 'want to know what happens when we switch to heat grids, what are the costs going to be.' While the respondents mentioned the significance of emphasizing advantages including increased home comfort and environmental benefits, this is not what the tenants care most about. Tenants are more likely to perceive the benefits of implementing the new technology when they are aware that it can save heating costs, or are explained what their role is. It is important that the tenants have a sense of involvement and can express their opinions on what they like to see as well. Stakeholders can improve the project's relevance to tenants' lives and create a sense of personal gain that increases engagement (HA.1.CS1). If the project doesn't benefit the tenants, resistance can be expected. It is not only just about the heat grid, but the entire package the stakeholder can offer the tenant (HA.1.CS1; HA.1.CS2).

> *'You make the house more sustainable and you indicate that you will also do something about the public area, and in addition you offer them individual help. So you actually hope, with that total package, they will also embrace the heat grid.'* (HA.1.CS2)

An important factor to note, is that impact on living situations is different for each individual. A small change might have a big impact for individual 1, but barely an impact for individual 2. It is therefore even more important to understand the tenants and where they belong when looking at what impact means. An interesting relation can be seen when looking at Rogers innovation adoption curve (E. M. Rogers, 1962) where it is being shown that different individuals are willing to adopt at different times, whereas some residents are willing to take risks with new technologies, and other want to wait and see what the results are.

Transparency

The topic that has been discussed the most is transparency. Given the project is a multi-stakeholder project, transparency is emphasized as being essential. The importance of open communication regarding the schedule, roles, and any unforeseen changes was emphasized by HA.1.CS1. This means keeping tenants informed of developments on a regular basis and being clear about who is in charge and who can be approached for any upcoming questions and remarks. Transparency minimizes misconceptions and false information while ensuring that tenants are kept informed, and timing is a crucial aspect within this since stakeholders 'do not want to start to early, not too late, but still being transparent' (HA.2.CS2). A lot of the stakeholders struggle in deciding when the timing is right. Tenants are less likely to become upset or not willing to cooperate when they believe they are involved and well-informed on the project's progress because they are aware of the delays, construction and process that leads to the choice of heat grids. This is especially seen in the first case, where transparency regarding the possibility for alternatives has been discussed openly, and the residents are 'included within the meetings' (HA.1.CS1). Once a stakeholder can discuss the alternatives since it has been researched upon, it is easier to explain why certain alternatives are not feasible.

Trust

A lot of the themes are related to trust. Once all the themes are being executed correctly, trust is being established. It is explained that trust is the foundation of any communication strategy, and trust is the key to success (HA.1.CS2). Tenants' trust in the organization and its representatives is an important indicator in their willingness to cooperate and talk with the stakeholders, according to the interviewees. Over time, this trust is developed via regular, truthful communication and keeping your word. Tenants are often more likely to trust the stakeholders commitment to fulfilling the promises if they see, for example, that smaller promises are fulfilled. As explained by HA.1.CS2, 'not executing regular maintenance, …, and you do not take the resident seriously regarding this

maintenance, that is something that will come after you'. The organization's reputation also contributes to trust; tenants who perceive their housing association as trustworthy are more willing to cooperate during the project. The stakeholders constantly need to show their trustworthiness (HA.2.CS2)

4.2.4.2 Comparing both cases

The thematic analysis highlights some differences in how storytelling components are mentioned more often in the two cases, as seen in figure 31. In both cases all the themes are mentioned quite often, but the prioritization and application does change. For case 1, the focus is more towards impact, suggesting it should address how the heat grid will change their daily routines. Case 2 stands out due to its emphasis on empathy and familiarity, indicating that for successful adoption, the tenants need to feel understood and listened to. The reason why this differs to case 1 is that there is no trusted and familiar party like the residents committee. The stakeholders have to establish this trust and empathy with the tenants which can be challenging due to the wide variance of preferences by the tenants. As mentioned before, for both cases four interviews have been conducted with a similar interview protocol, ensuring similar possibilities in mentioning these themes.

Thematic analyses regarding the narrative per case

	Clarity	Empathy	Familiarity	Honesty	Impact	Transparency	Trust
Case 1	11	7	14	7	19	13	11
Case 2	10	11	16	9	15	16	10
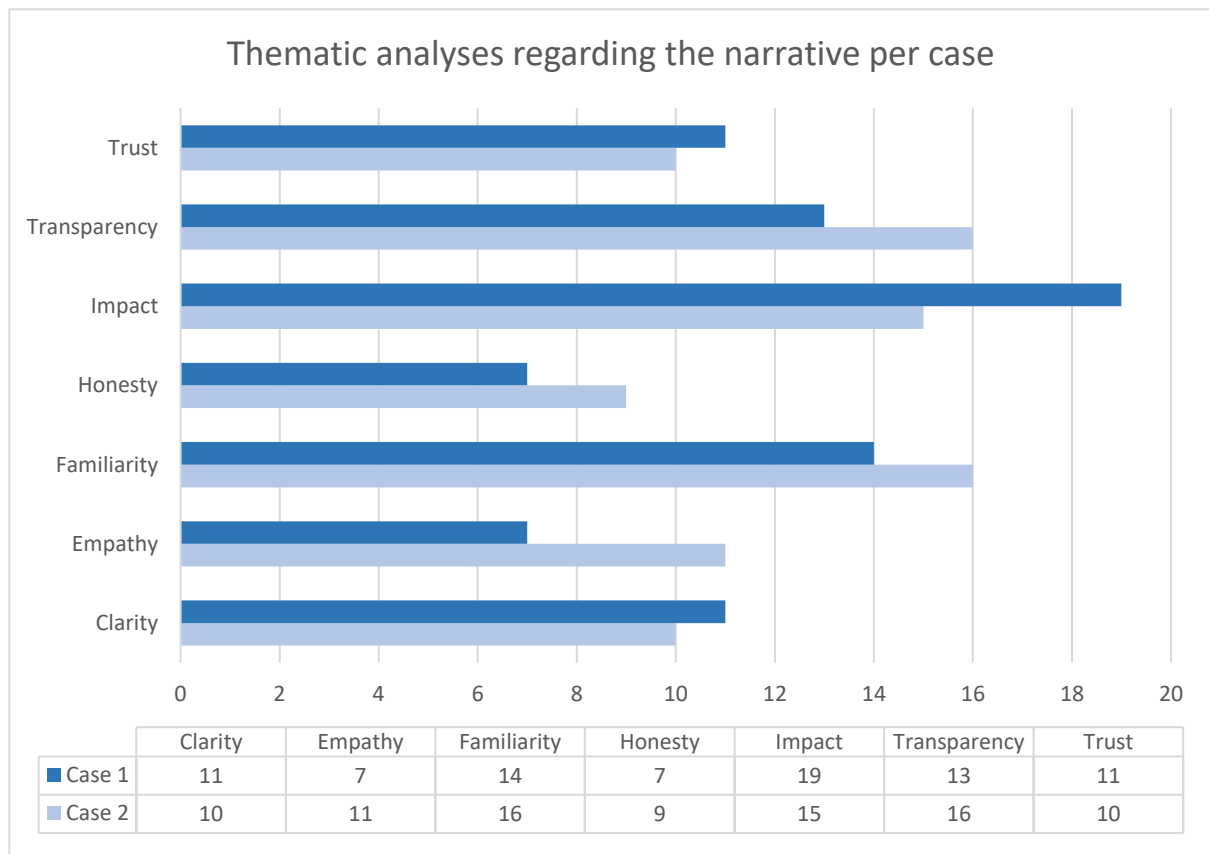
Figure 31: Comparison of narrative elements between case 1 and case 2 (author)

These differences show that the storytelling strategy for each case is dependent on the specific context and challenges of the tenant population. Case 1 has established quite some trust, partly caused by the residents committee, and therefore the focus lies more on clear and useful information in which it is described what the direct impact is, how familiar it is for the tenants and how transparent the stakeholders are regarding the information. In case 2 the focus tends to be on overcoming social barriers by bridging the gap between tenants and the stakeholders by the use of empathetic communication and trusted messengers. This implies that communication strategies that use storytelling must be customized to meet the needs of each tenant group, giving priority to particular topics according to the social, cultural, and technological setting of the project. It should be

noted that some of the themes are quite similar to each other, since trust is established when being transparent and honest, but it does have different characteristics when looking more close at these themes. When taking the similarities in consideration, higher scores for a combined theme can be seen, giving more priorities on the overarching theme of trust, transparency and honesty.

Overall, the thematic analyses does show that a successful narrative is depending on balancing the different themes to build trust and engagement. It can be said that these themes are depending on one another, since with no transparency and honesty, trust cannot be increased. This layered approach tries to explain that tenants need to feel informed, respected and involved in order to increase their willingness to adopt the new technology. It shows that flexibility and adaptability are crucial elements in addressing the barriers that tenants face in heat grid projects.

4.2.5 Analyzing communication strategies

The last topic that has been discussed in the interviews are the communication strategies. This is the key element that eventually has something to say regarding how communication can be enhanced. It is related to sub-question 4: What communication methods do stakeholders believe would best improve adoption among tenants in heat grid projects? And sub-question 5: What communication approaches can be used to overcome the barriers regarding the adoption of heat grids? In order to research this, the interview talked about what communication methods have been used. First, a division can be made in engaging and informing method, then there has been looked into the type of

Categorie		Case 1	Case 2	Totals
Information delivery	Engaging	13	12	42
	Informing	8	9	

Categorie		Case 1	Case 2	Totals
Information delivery	Apps	0	3	109
	Brochures	2	10	
	Door to door	5	15	
	Information market	1	1	
	Letters	4	29	
	Meetings	11	8	
	Phone calls	0	2	
	QR-codes	1	1	
	Social media	2	3	
	Video's	3	3	
	Websites	0	5	

Categorie		Case 1	Case 2	Totals
Information delivery (timing)	Phases	3	2	25
	Response	4	1	
	Timeframe	8	7	

Categorie		Case 1	Case 2	Totals
Information adequacy	Comprehensive	3	6	58
	Readable	3	9	
	Relevance	2	4	
	Understandable	15	16	

Categorie		Case 1	Case 2	Totals
Feedback on information	Improvement	5	1	56
	Sense of involvement	19	9	
	Gaining trust	13	9	

Table 12: Times mentioned per case regarding used communication strategies (author)

information delivery and the timing. The next part was regarding the adequacy of information and the last part was regarding the feedback on the information. The goal is to identify how the two cases approached the project and decided how and when to contact the tenants in order to achieve their cooperation. For the next part there will be looked to the two cases and both are being analyzed. Table 12 shows the results for both cases combined, in which it is visible what areas are mostly focused upon. Based on this figure not much can be said on what approached is being used, therefore the cases themselves will be more elaborated on, and afterwards a comparison between the cases is being done.

Case 1

According to the first case, communication strategies at first tended more towards providing tenants with essential information than towards engaging them in a balanced way, but it soon became clear that simply spreading knowledge was not enough to encourage acceptance and trust. Rather, it was crucial to combine direct communication with active tenant engagement. Through the residents' committee, whose members became well-known to tenants, stakeholders relied on personal connections that significantly facilitated the development of trust and increased project involvement (CC.1.CS1). As seen in Table 13, 11 counts regarding information delivery (channels) that were given in this case throughout the interviews were meetings. These were all group meetings with often the RC heavily involved. Group meetings are used frequently which emphasizes their importance in bridging the knowledge gap between project information and tenant understanding. Tenants were able to ask questions, express concerns, and get a better understanding of how the project will affect their lives through in-person sessions that allowed for real-time participation. It might need to be cleared that meetings in this case are also residents' evenings in which the committee was invited, and not only 'official' meetings. One stakeholder (HA.1.CS1) emphasized the inclusivity that meetings had by stating, 'They actually attended all the important consultations, with all the different parties, on investigations and previewing reports, and they were able to make additions to those reports.' This is once more reflected by CC.1.CS1.

> *'So initially the HA comes up with that plan, and the residents' committee says: 'Wait a minute, we don't know if that's the best solution.' Then the HA repeatedly said, 'Okay, fine, then we're going to do our homework again, and then you guys get to help decide who's going to advise us.' That was a crucial success factor in the whole process: that the RC was allowed to co-decide on the agency that was going to perform the analysis, and thus also got a say in the outcome'* (CC.1.CS1)

Additionally, meetings allowed for more responsive and flexible communication than written updates, which helped in altering the project's strategy in response to tenant input. Residents felt heard and appreciated as a result of this participation, which increased acceptance. Residents' openness to the initiative was further increased by the presence of community representatives, who encouraged stakeholders to disseminate information through reliable and recognizable channels. Having a single entry made it easier to interact and communicate with residents across the building. This well accessible, often used space evolved into a natural meeting spot where tenants could easily obtain project information and stakeholders could share updates. This entrance area had a lot of informal contacts, which allowed tenants to express concerns or ask enquiries in a relaxed environment with familiar persons. "Since you have a central entrance in those buildings, ..., we stood in each building for an afternoon. We also stood there with the residents' committees, so with people who are already a familiar face." (HA.1.CS1). Tenants felt more informed and involved as a result of this setup, which also reduced barriers to communication and increased support for the project.

When looking at the timing of information delivery, the results are as expected. It is known that timing of communication has a vital role in how tenants experience the project, but the balance is sometimes

difficult: 'What I can remember is that you have to include the residents early, but not too early' (CC.1.CS1). When delays occur, it is important to remain honest and open about the delays by regularly informing the residents on the current status of the project. 'Even if there is no new information, we communicate it so they know: 'It's still the same.' (HA.1.CS1). According to the interviews, the most important is the timeframe. When do you communicate information to the tenants, to ensure there is enough time to understand the information and provide an opinion, but not that the tenant should wait weeks before something is executed regarding the project.

As mentioned before, information adequacy means making sure that the information given to tenants is on time, comprehensive, and understandable. Delivering project updates is only one aspect of this, each message's relevancy and clarity must be carefully assessed. Stakeholders struggled with making procedural and technical information understandable to everyone because of the socioeconomic and demographic variety among tenants. In order for tenants to make well-informed decisions on the adoption of the heat grid technology, understandability is essential to effective information adequacy, seen in Table 12. As seen in section 5.2.3, storytelling proves to be a useful technique, creating a narrative that places the project's goals, expected benefits and tenant's involvement in the process in perspective. Stakeholders have pointed out that it's important to adjust the delivery to tenants' varying comprehension levels in addition to focusing on the story. 'I know there are also some people who cannot read. For those people, how are you going to communicate something that is understandable?' (HA.1.CS1).

The stakeholders avoided using a one-size-fits-all strategy to deal with this. Information was spread in a number of languages and through a variety of channels, including letters, face-to-face meetings, and video's. Tenants were able to obtain information in a manner that was appropriate for their abilities and preferences thanks to this multi-channel, multi-language approach. Even though this method takes a lot of effort, it shows a commitment to diversity and acknowledgement that relevant, clear information is essential for encouraging support and engagement. Stakeholders essentially wanted to break down communication barriers and create a more inclusive project environment by emphasizing adequacy and understandability in information delivery. This way the stakeholders tried to ensure that all tenants, regardless of background or literacy level, felt informed and taken into consideration during the process. Good alignment between the stakeholders is necessary for this.

'The best way is always to watch and listen carefully, and act with that. I don't have one specific recipe ready, except that I think you have to have good people on those projects. They have to understand each other well and make sure they work well together.' (M.1.CS1)

Tenant engagement requires feedback on information since it serves as a link between trust and communication. The interviews indicate that this feedback loop enables stakeholders to actively listen to tenant problems, requests, and recommendations in addition to delivering updates. In the adoption of new technology, when disagreement can develop due to mistrust or misunderstanding, this two-way communication is especially crucial. Since trust strengthens the tenants' sense of involvement and confidence in the project, it is essential to this process. Tenants have to see that their opinions are respected. According to CC.1.CS1, it is important that 'tenants need to have the idea that they can decide something.' Tenants who feel involved are more likely to comprehend and value the project's potential positive influence, which is crucial in encouraging adoption of new technologies, but it is important to keep in mind that you should not 'pretend that people can have a say in it when in fact they cannot' (CC.1.CS1).

Tenant input also influenced the project's communication strategy, according to the interviews. Stakeholders improved their engagement strategy and fostered a feeling of shared responsibility and collaboration within the community by letting input shape project ideas and methods of

communication. Tenants felt like active participants rather than passive recipients because to this adaptive communication strategy. There was the possibility to discuss their wishes, since 'everybody put their wish lists on the table. Once there is some overlap, there was an agreement'. Due to the sense of involvement, especially with the clear communication and discussing alternatives to heat grids, ensured that trust was being build and more acceptance within the community came to life. This is clearly explained by HA.1.CS1:

> *'We found in our approach that it worked out very well to include all alternatives. ... If you then start zooming in on certain ideas, it turns out that it is not feasible, but then it is also explainable...'*
> (HA.1.CS1)

People really felt listened to, and that approach led to lots of trust that indeed heat grids are the best solution for the project, and this way the story can be told better to the tenants. It is interesting and important to note what EC.1.CS1 mentioned: 'I also do think that this was really a very exceptional group. I don't think it's realistic to think we can keep doing it this way'. This shows and expresses that how the trust was established in this case is unique and something special. Due to the enormous involvement of the residents committee, trust between this party and the tenants was even greater and helped to reach the necessary support.

Case 2

The communication strategy for the second case is quite different compared to the first case, partly due to not having a residents committee. This is seen extremely well when looking into Table 12. Based on the interviews it can be seen that the communication channels are mentioned way more, which indicates more thought has gone in this process in order to establish a well-suited approach. What is interesting to note is the high count of letters. Whereas in case 1 the focus mainly was on meetings, and meeting the residents in the central entrance, this could not be done in case 2 due to not having a central place where the tenants had to pass through or visited on the regular. The focus tends to be way more individual and approaching each of tenants personally. This is also what happened, according to HA.1.CS2 it was 'important to be a reliable partner, to unburden people, and to have those one-to-one conversations'. This neighborhood had less social interactions and the feeling of a 'community' was quite different compared to case 1, and therefore a different approach was necessary.

It should be noted that for this case the heat grid was part of a broader project which is focused on improving the social cohesion of the neighborhood. Whereas in case 1 the alternatives were discussed with the residents committee, case 2 is more strict. The heat grid is fixed, this is being informed to the tenants:

> *'When talking about making homes more sustainable and connecting them to the heat grid, that is something where there is no choice. We are going to do that.'* (HA.2.CS2)

The interesting part here is how the housing association managed to reach the people. Every tenant is being informed and asked if they are willing to cooperate, if this is not the case then 'we engage with them in person. If we do not hear anything, that is also an immediate alarm for us' (HA.2.CS2). This way it is mapped which addresses might need extra attention and extra effort in order to comply with the project. Letters are used quite often to inform the tenants. When letters are not understandable, these tenants might visit CC.1.CS2 and together with this stakeholder it might become clear what the letter is about. This stakeholder has 'time to sit down calmly for chat with the resident' (CC.1.CS2), which underlines the very personal approach in this case.

It is important to ensure the timing of information is well matched with the actual situation with the project. It is known that delays can cause disturbance, which is what happened in this case. Due to a mismatch in the technical delays, a redesign had to be made, even though the 'door-to-door meetings already were completed for 80%' (HA.1.CS2). This caused substantial delays and caused the project to 'slip away from the tenants' (HA.1.CS2). It is mentioned that in order to reassure the tenants, you should be honest and transparent in why the delays occur. The fact this is a multistakeholder project makes this even harder, since within the organization all stakeholders should be on the same line when it comes to information dissemination. By governing this structure within the project, every stakeholder knows what information is send at what time. EC.1.CS2 confirms this: 'We really talk to each other every week. That way, you also know about each other when you send a letter.'

The next topic is quite interesting. Whereas in the first case it was noted that information adequacy was important, here it is even more emphasized, also seen in Table 12. Case 2 lacked a residents committee, in contrast to the previous case, where one helped regulate conversation and ensured trust. Efforts were made to create such residents committee: 'In ... they tried very hard to get individuals to join as well, but it just didn't work out' (M.1.CS2). Tenants tend to be hesitant to accept the changes, partly as a result of not having a familiar face like a residents committee, but also due to the lack of initial trust and understanding why changes have to be done. They are often 'afraid to not have a warm home anymore' (EC.1.CS2). This emphasizes the need of easily understandable information. Stakeholders had to put in more effort in creating a story that tenants could relate to and understand.

'Regarding the heat grid; since it is given that it is coming, you do want to create support. Here you show that you care about the opinion of residents, but the message will always remain that we are moving to the heat grid.' (HA.2.CS2)

'Now the story is that since they are the poorest people, it is being forced. Yes, indeed, you don't have that much choice. But you do get rid of the problem, while all the people who own homes have to figure it out themselves.' (M.1.CS2)

It is highlighted that an engaging strategy is the most important, ensuring people understand the given information and know how to deal with this information. Information that might be understandable for the majority of people, 'is not always understandable for the tenants' (CC.1.CS2). This entails to the fact that, as mentioned in case 1, there is no one-fits-all approach and one should offer information on multi-channels to create a more inclusive project where every tenant can perceive the information as understandable and relevant. It is once more highlighted that 'you have to involve people even more into why you are doing it and what added value it gives.' (EC.1.CS2). Similar to case 1 it is emphasized that the language should be easy and stakeholder should 'not use difficult words and ensure that this does not put people off, even in one-to-one communication' (HA.1.CS2). It can be seen that this information adequacy can be directly related to the storytelling and that the various components of adequacy are part of how effective the storytelling will be. When this communication is not organized well, resistance can be expected. It is key to understand how tenants think, and how to handle this resistance. M.1.CS2 mentioned the process, and how to deal with this.

'You know how it goes: when people are against something, they go through a series of steps. First they start protesting, then they get a councilor involved. If that doesn't work, they approach the press, and if that doesn't work, they go talk to the alderman. Well, you can really draw that out. You do have to talk to those people and take them seriously, but the trick is to not let them determine the debate.'

(M.1.CS2)

In contrast to case 1, feedback on the information is less highlighted, which can be explained by, again, the lack of a residents committee. The essence from the interviews was that trust and a sense of involvement is important, but less relevant compared to the way the story has been formulated and communicated to the tenant. It has to be noted that in order to create adequate information that is readable and understandable, trust is an important factor. HA.2.CS mentioned this by explaining that recognizing people related to the project helps with trust within the project.

'It is very important that you work with similar faces and that there is always someone to contact. Residents should always know how and when they can reach someone.' (HA.2.CS2)

When information is not received as perceived, change is necessary. Tenants want to be heard and want to be provided with information what is relevant to them. HA.2.CS2 explains this by mentioning that personal attention is very important, and 'from the moment you gain trust, it is important to visit them and explain them what is going to happen'. This straightforward, observant approach made it possible for stakeholders to adjust their messaging in response to tenant input, creating a supportive environment. Even in the absence of a formal feedback system such as a residents' committee, this approach of individualized follow-up not only improved understanding but also strengthened trust, making tenants feel taken into consideration and involved.

| Information delivery										
	Websites	Video's	Social media	QR-codes	Phone calls	Meetings	Letters	Information market	Door to door	Brochures	Apps
Case 1	0	3	2	1	0	11	4	1	5	2	0
Case 2	5	3	3	1	2	8	29	1	15	10	3
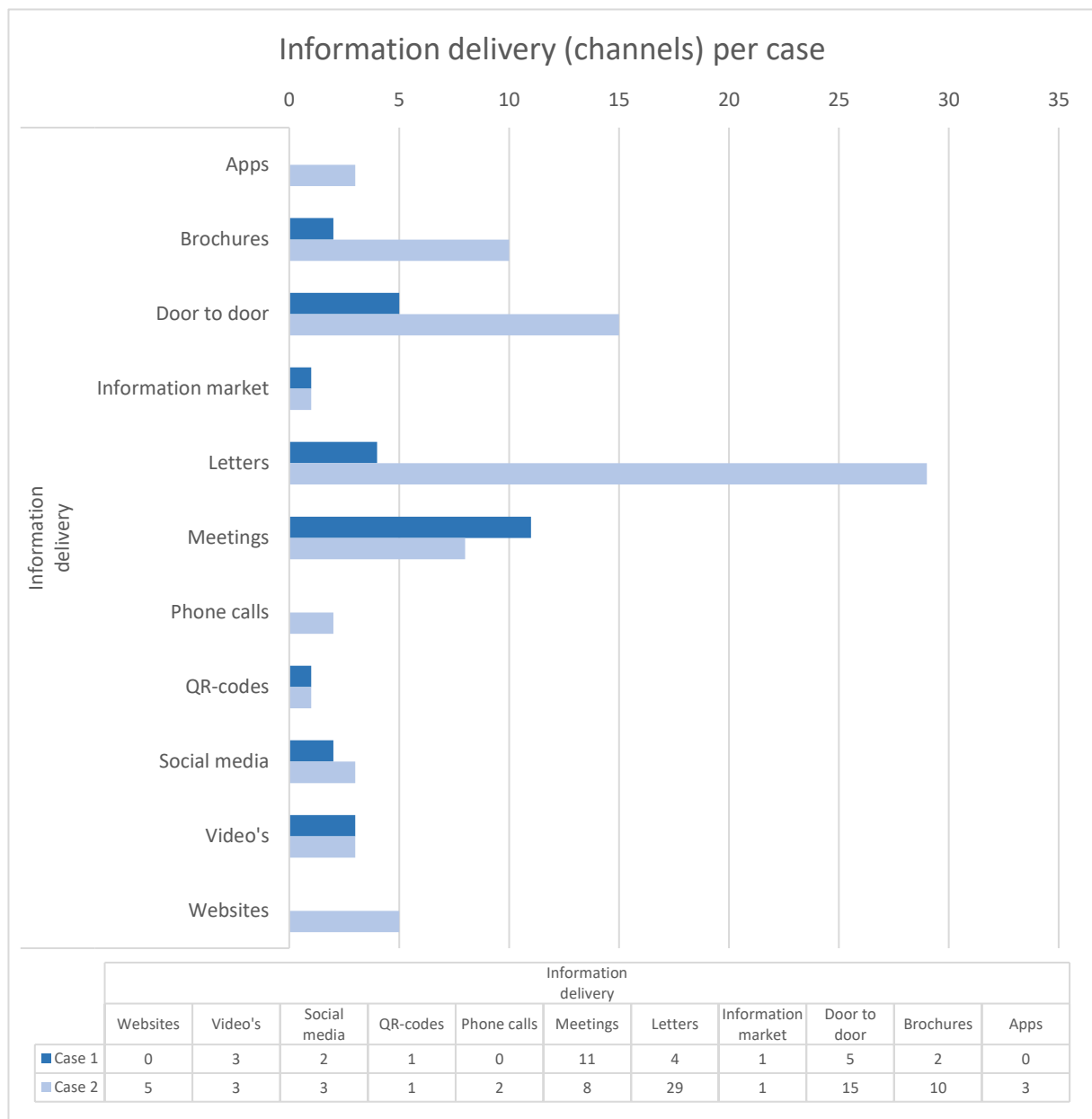
Figure 32: Overview of the information delivery channels per case (author)

Comparing both cases

As per every chapter, an analysis of the comparison for both cases is essential to understand and get a grip on why the stakeholders chose for certain strategies, or at least mention certain strategies more than others. The four components in which a deeper analysis will be done are the information delivery (channels), information delivery (timing), information adequacy and feedback on information. Based on the projects' organization and engaged stakeholder there will be sought after an explanation in the choice for certain communication strategies. It has to become clear why the emphasis is on certain aspects of communication and what effect this had on the project. A comparison of the information delivery (channels) can be seen in Figure 32.

Immediately it can be seen that in case 2, the channels for information are mentioned way more often. A more extensive and diverse strategy to contact tenants is shown in case 2. This can be explained by the lack of a residents committee, which probably made it necessary to use a variety of strategies to close the communication gap and establish trust. The most often indicated channel in case 2 was the use letters, which were mentioned almost seven times as frequently as in case 1. This suggests that written communication is used more often to directly contact the tenants. Also, door-to-door interaction was given priority, showing an enormous effort to interact with all the tenants one-on-one and handle their specific issues. Case 2 also showed a need to diversify communication channels, as seen by the increased use of digital tools including websites, social media, and videos. Due to the existence of a residents committee, which acted as the main party for communication and fine-tuning the project lessened the need for more comprehensive initiatives. These variations highlight how flexible stakeholder communication tactics may be and how important trustworthy and familiar faces are in determining the strategy and impact on information dissemination. For the first case, meetings were more often mentioned, which makes sense due to the inclusion of a residents committee. This is often the most practical use to include this party in the discussions and hear the opinions from this group.


Information delivery (timing)		
Timeframe	Response	Phases
■ Case 1	8	4	3
■ Case 2	7	1	2
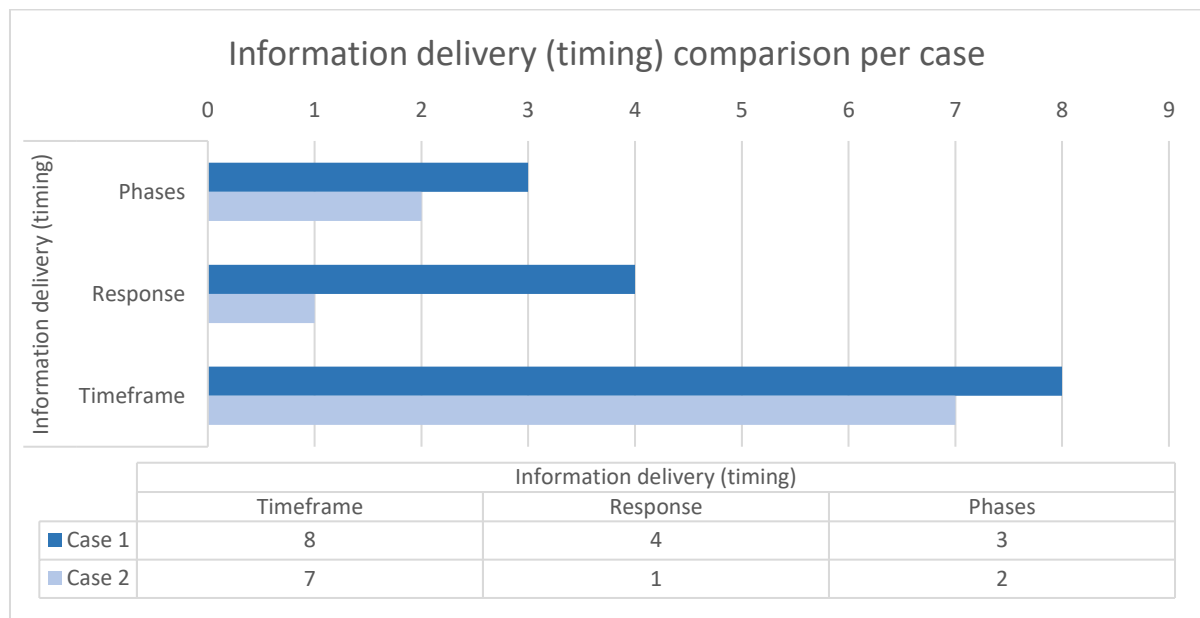
Figure 33: Overview of the information delivery (timing) per case (author)

On the other hand there is timing of information delivery, in which not that much variance can be seen between the cases, except for response. The reason for this could be that tenants in case 1 might need more time to really comprehend the information and are in general a bit more distant from the project, while the tenants in case 2 are due to the very personal strategy more directly informed. Given the relatively low number, with a total of 25 counts, this aspect is less relied upon and more accepted that it needs attention in general, without any specific strategies or opinions.
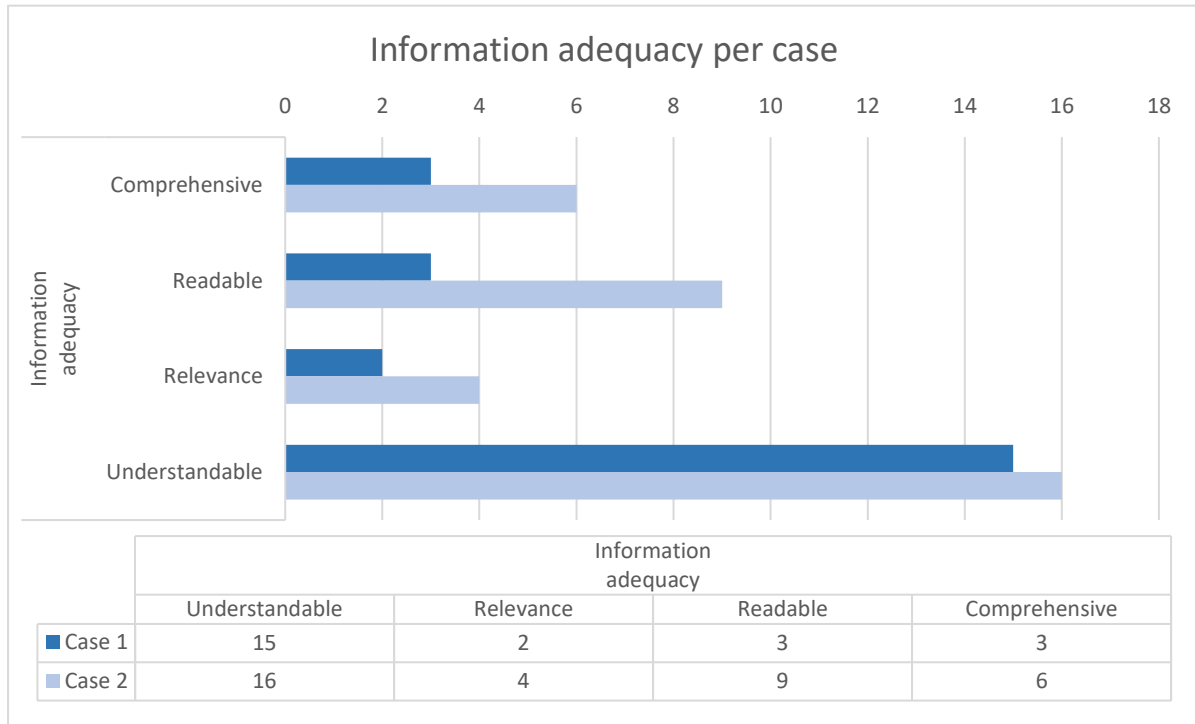
Figure 34: Overview of the information adequacy per case (author)

Information adequacy does show some significant differences between the cases. It is understood by all stakeholders that adequacy of information cannot be forgotten, but especially in the second case this was mentioned more often. The simple explanation is this is due to the variance of communication channels and the direct communication to the tenants. Creating understandable information for each tenant, ensuring every letter is readable for most tenants and ensuring its relevance and comprehensiveness is a difficult task and quite hard to achieve. In case 1 the adequacy appeared to be less important. Information transferred often via the residents committee to the tenants and as shown previously, these tenants often relied on the information and familiarity of this committee. Therefore, less efforts had to be done to create clear adequate information to make the project move on to the next phase.

A significant difference can be seen in making the information readable, which in case 2 was heavily emphasized. Due to less cohesion and less community among the tenants in the neighborhood, possibly less help from tenants to each other occurred. Being more individual caused the need for more readable information for every individual in order to make it understandable as well. Important to note is how both cases mention that it should be understandable. The topics all are dependent on understandable, because if the information is not understandable, the relevance, comprehensiveness, and readability are also not sufficient. It is clear that the stakeholders recognize the need that tenants need to clearly understand the project details in order to foster cooperation and reduce resistance.

Feedback on information per case

	Feedback on information		
	Gaining trust	Sense of involvement	Improvement
■ Case 1	13	19	5
■ Case 2	9	9	1
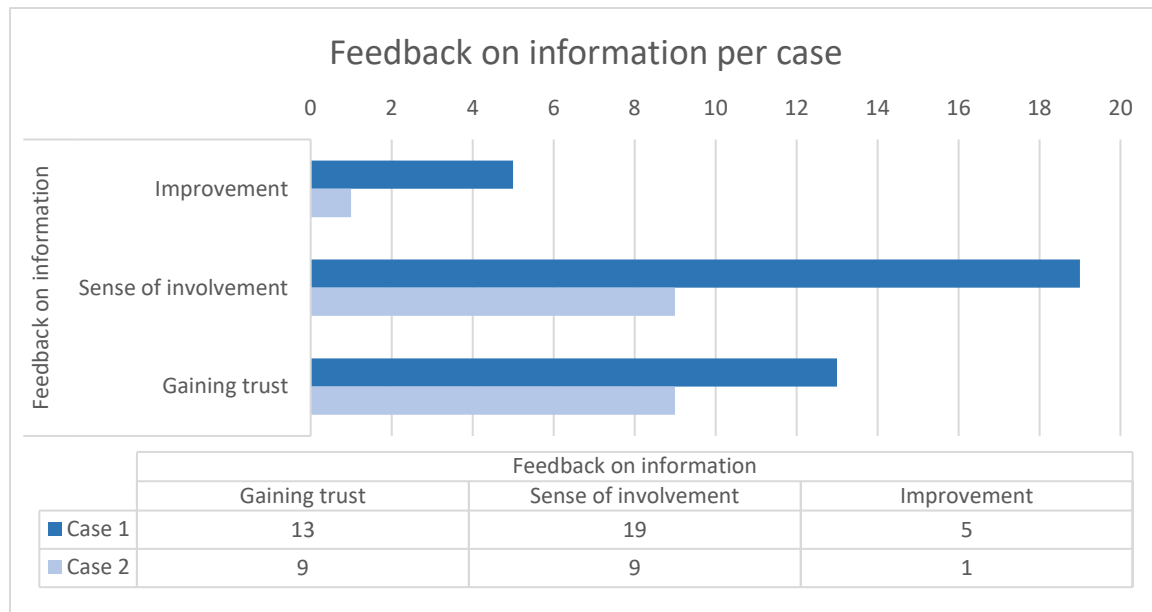
Figure 35: Overview of the feedback on information per case (author)

It is interesting to see how this is the opposite for feedback on information, in which case 1 was more persuasive. This can be explained by the role the residents committee. This committee acted as a critical intermediary between the stakeholders and ensured that feedback from the tenants was properly addressed. Once this committee would not have felt involved, taken seriously or neglected, this would have been passed on to the tenants. Thus, careful treatment and consideration has to be done on this specific aspect. It was for this committee really important that they are involved in the decision making and that they are treated respectfully. Since this was done well by the stakeholders, trust was established and increased significantly. By respecting the committee's input and involvement, the stakeholders created the necessary feedback loop that helped establishing trust and collaboration.

The tenants in case 2, on the other hand, were more individual, and there was no organizational structure to bring their views together. Therefore, there was less emphasis on the sense of involvement and the chance for feedback on possible improvements. Stakeholders in case 2 adapted by emphasizing customized communication based on the requirements of each tenant. Although tenants were more cooperative and their problems were effectively handled one-on-one, this strategy also reduced the relevance of organized feedback methods. Personalized narratives can improve tenant comprehension and engagement, but they also come with a more investment in time and money. Stakeholders risk missing out on seeing patterns or reoccurring problems that might enhance overall communication strategies in the absence of a more organized feedback mechanism.

Chapter 5 - Discussion

5.1 Key findings

Successful implementation of heat grids plays a role in achieving climate goals, since it is an alternative to natural gas. However, their adoption in the social housing sector presents some significant challenges. Tenants often have a lower level of acceptance and understanding of heat grids due to several barriers, caused by mistrust, financial concerns, life-style changes and a lack of clear communication of the impact and implications of the new technology. Addressing how stakeholders can improve communication strategies to improve adoption of heat grids is the goal of the research. The results present several ways on how communication strategies can be organized. Key findings reveal that communication strategies for heat grid adoption rely on stakeholder alignment of goals and transparency in how to reach these goals, tailored narratives addressing the barriers experienced by tenants, and fostering trust throughout the project through transparency and honesty. Often, the tenants prioritize immediate benefits, and rely less on long-term goals, suggesting that personalized, relatable messaging is crucial. Using two-way engagement and familiar messengers enhances trust and encourages engagement.

5.2 Interpretations and implications

Current openness of tenants

The analysis does reveal that the tenants openness related to the adoption of heat grids is not hindered by the resistance of the technology itself, but more often related to the lack of understanding and engagement. In general, tenants have other interests in which they worry about, and since they do not own the home, they are less worried about changes on the technology. This does not mean that the tenants do not want to understand it. This aligns with the research performed by Jia et al. (2021), where it was emphasized that it is more from importance that the information is accessible and tailored to the needs of the tenants, since this can foster tenant participation in the energy transition. The lower interest in technical details, which came to light in the intercept interviews, is reflected by Van den Nouwelant and Pawson (2017) in which it is highlighted that tenants have in general less interest in renovation since they are not the owner of the home. This shows that the results from the intercept interviews, are indeed aligned with the claims from the literature.

From the analysis it became clear what the tenants are mostly interested in when it comes to adoption of new technology. The tenants openness is often influenced by how the narrative is provided. They want to know what immediate effects it gives such as the affordability and the nuisance caused by the necessary renovations, rather than any long-term effects. This was not only mentioned by Nouwelant and Pawson (2017), but also mentioned in the research performed by Arthurson (2013) and Khor et al. (2023). These researches explained the contrasting priorities between tenants and homeowners. The implication suggest that the stakeholders should emphasize practical and personal effects and alterations caused by the implementation of heat grids. The intercept interviews further showed that communication is not always clear or easy to understand, what implies that this influences their openness to cooperation and engagement in the project.

It was expected that in the intercept interviews not much interest was shown regarding the heat grids due to not having the communication methods necessary to educate and contact these tenants, but once information was asked with regard to their experiences regarding the communication from the stakeholders not much claims were given. While there were some variances is response, in general they mentioned they do not have preferred communication method or that this could be improved to understand the project better. Literature showed that communication has influence on the openness and engagement, but since the tenants only experience the communication from this project they do not have experienced other strategies to compare. This explains why the tenants do not mention direct improvements in communication.

Barriers

This research used for the expected barriers regarding the adoption of new technologies a framework created by Chersoni et al. (2021). These categories have been refined and divided into barriers related to heat grid adoption for tenants. To validate if these were indeed the barriers, interviews with stakeholders have been done and revealed that these barriers are encountered but on a lower level, which is in contrast to wat was expected, and extra barriers were given. While the literature expresses the social, behavioral and economic barriers regarding heat grid adoption, stakeholders bring additional insights into the impact of legal and political barriers. The analysis showed that the fixed prices introduced by heat grids propose a monopolistic structure, which is a barrier that has been validated by Rubio Agullo (2024). It shows the complexity of getting tenants engaged by lowering all the barriers to ensure a smoother project.

Political influences further complicate the necessary narrative, as has been discussed multiple times in the interviews where it was mentioned how negative media has a bad impact on the trust tenants have in such projects. Explaining how these discussions pictured by the media are mitigated in these projects are difficult and often time consuming, since trust need to be regained. It is clear that stakeholders have to deal with these external pressures and should reflect this in being extra transparent in communication and within the project agreements should be made in policies regarding ensuring trust and project viability.

Storytelling

One of the themes discussed in the analysis part is the importance of crafting a good story or narrative for the tenants, in which the seven themes are taken into consideration; transparency, honesty, trust, impact, familiarity, clarity and empathy. Its importance is due to the way it acts as a way to bridge the gap between technical complexities and tenant understanding, and poses a possibility to make abstract knowledge concepts relatable and memorable, important to lower certain barriers. This subject came to light during the interviews, thus interpretations and implications regarding existing literature is difficult and will be highlighted here.

Literature mentions the significant social and psychological effects of storytelling. Rutledge (2024) describes how stories facilitate emotional connections, common understanding, and the learning of difficult material. It emphasizes storytelling as a communication technique that builds empathy and improves recall of information while bridging cultural and cognitive differences. Storytelling can be a powerful tool for changing behavior and delivering values when it engages the audience with narrative frameworks (Rutledge, 2024). This in line with the results of the analysis, in which the stakeholders often mentioned the importance of empathy and listening, since this eventually engages the tenants more in the project. Through the use of relevant storytelling, stakeholders can make abstract topics easier to understand and interesting. By creating emotional bonds and demonstrating the impacts of adopting new technology, this interpretive method emphasizes how storytelling could overcome behavioral and social barriers like skepticism or mistrust. However, the implications go further than simple understanding; by offering relevant scenarios that speak to tenants' actual experiences, storytelling can also increase their sense of responsibility and inclusion. This not only improves acceptance but also strengthens trust in the stakeholders. This all is validated in the research by Wuttke et al. (2015). There are some essential components necessary for information transfer through storytelling to be effective. Logical flow and ongoing interest are ensured by a story that is well-structured, with a distinct beginning, middle, and finish. Stories need to be relevant, contextual, and tailored to the needs and experiences of the audience (Wuttke et al., 2015). Particularly for those with less formal education, the story is accessible due to its clarity and simplicity in language. Engagement is increased through emotional connections, which are made by addressing related issues or common experiences (Wuttke et al., 2015). Including interactive components enables listeners to ask questions and establish a personal connection. It can be seen that a lot of components

that came to light in the thematic analysis regarding are indeed validated by the literature, showing its significance in the adoption of heat grids.

A different way to look at it in how to craft the story, is explained by Erlach and Müller (2020), in which there is looked into a systematic four-step approach for efficient information dissemination. To identify key knowledge and design the narrative process, stakeholders should collaborate and align their goals at start of the process (Erlach & Müller, 2020). After that, several discussions are used to gather explicit and implicit information. Narrative storytelling and structured interviews can be used to obtain experience insights. To ensure effectiveness and relevance, the gathered information should then be assessed and documented in accordance with the tenants' particular needs (Erlach & Müller, 2020). This is also a validation of the analysis and the results from this, since the stakeholders indeed mentioned the need for knowing what information you want to distribute based on the type of tenants, and how this should be presented.
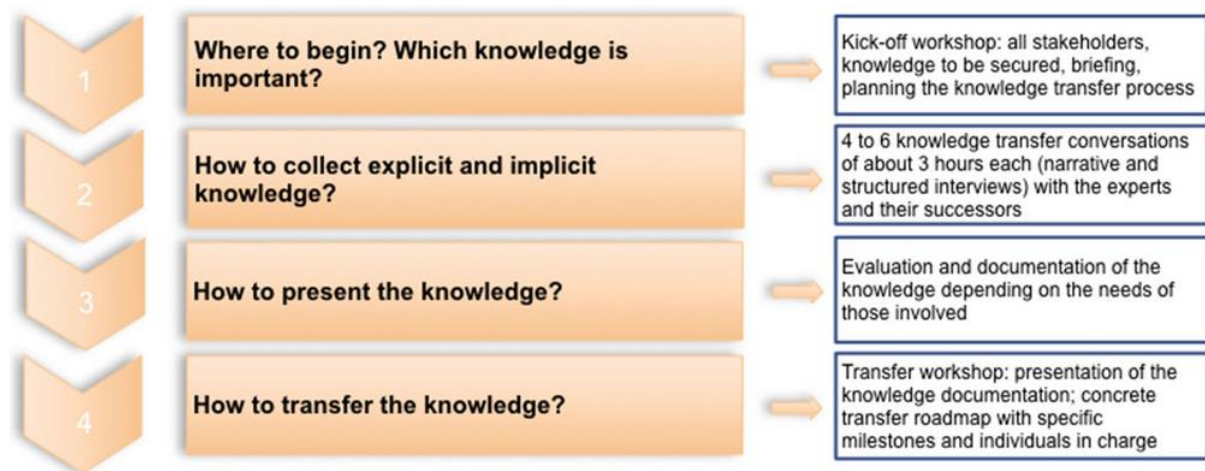

Figure 36: Steps for knowledge transfer process (Erlach & Muller, 2020)

Communication strategies

Based on the analysis, it came to light that in general not all roles in the project regarding the responsibilities on communication are clear. Improving communication management will help make the project more successful. A centralized structure that prevents overlapping responsibilities and guarantees that stakeholders are aware of their obligations is the RASCI model (smith & Erwin, 2005). Key involved stakeholders need to coordinate messaging and close any communication gaps by keeping each other updated on the regular. Furthermore, including tenant feedback loops guarantees that their questions are actively considered throughout project design. By establishing a relevant connection between tenants and stakeholders, trust-building strategies like appointing representatives or familiar faces may improve communication management even further. This method increases the general effectiveness and clarity of information distribution while also building trust. Simplifying communication tools, may improve alignment even further and reduce delays brought on by misunderstandings.

These case comparison reveals important variations in communication strategies. The multi-channel strategy that is being used is consistent with research suggesting a variety of communication channels to increase engagement (Jia et al., 2021). Furthermore, using engaging narratives to emphasize the economic and environmental advantages is more successfully than the rather abstract technical explanations used in the cases. A hybrid approach that combines digital and traditional channels is crucial for improving communication in heat grid projects. This ensures that no tenant is left behind. Tenant priorities and project objectives may be connected through the use of narratives that explain economic and environmental advantages, which will make the adoption process more accessible and motivating. Enhancing stakeholder coordination is similarly important. Inefficiencies and overlapping

roles may be avoided by using a flexible RASCI framework with regular role evaluations as explained in the literature review (Smith & Erwin, 2005). It can be seen that in the analyzed cases not all roles were clear throughout the project, thus influencing the information load and distribution towards the tenants. Missing communication lines and not having certain fixed strategies did impact the information overload and is something that can be more improved. If strategies are more aligned between the involved stakeholders, greater impact can be seen on the willingness to cooperate by the tenants. Surveys and interactive Q&A sessions are examples of ongoing feedback methods that offer real-time insights into tenant concerns and help in strategy refinement, guaranteeing response to shifting needs. Stakeholders may contribute to the larger goals of sustainable energy transitions and community resilience by adopting these broad strategies, which will also help to develop trust, encourage collaboration, and facilitate the effective adoption of the heat grids.

Tenants' overall interest in participating in the renovations seems to be affected by a number of variables, such as their perception of disruptions, trust in stakeholders, and understanding of the advantages. The findings indicate that although tenants tend to be initially hesitant because of worries about costs, nuisance, and uncertainty, their interest in becoming involved increases when the advantages of heat grids for the economy and its direct additional impact on their living situation are made clearly visible, which is something that is being validated by Jia et al. (2021). Trust is essential, when stakeholders show reliability, show empathy in addressing issues, tenants are more willing to participate. Tenants also like having an opportunity to express their views and participate in decision-making, particularly when these opportunities are accessible and structured. Differences in socioeconomic status and knowledge of technology, also affects the level of interest, certain tenants need more proactive and tailored interaction to be inspired to participate. Tenants were more likely to actively participate in the renovation process if they were informed and trusted the stakeholders participating, according to the intercept interviews. Clear timelines, upfront financial implications, and concrete examples of advantages like energy savings or improved comfort were all highly preferred by tenants.

Interesting to see was the involvement of the media. From the interviews it became clear that the media has quite an impact on how tenants perceive heat grids. Tenants' perceptions of heat grids are significantly affected by media interaction, especially when it comes to public awareness, attitudes, and trust. Although media outlets are important sources of information regarding renewable energy projects, how these stories are presented can have a significant impact on how tenants see them (Rochyadi-Reetz et al., 2019). Distrust or disagreement may result from media coverage that emphasizes challenges such possible cost increases, technical failures, or project delays. This is particularly important in neighborhoods with a variety of socioeconomic and cultural backgrounds because, in the absence of direct communication from stakeholders or if it is not properly clear, tenants may rely on media narratives to shape their views (Rochyadi-Reetz et al., 2019). One-sided news has the potential to spread disinformation about the project and its goals, which increases tensions, and weaken confidence. It therefore is important to explain to tenants why negative media coverage exists and how this is different compared to the project that is being executed. It has a big impact and addressing this will help mitigating doubts.

Real estate management

This research provides insightful results and conclusions which are helpful in the real estate management sector. This study has significant implications for the real estate management industry, especially when it comes to tackling challenges with tenant participation and renovations driven by sustainability. In order to ensure inclusion across a range of demographics, real estate managers may use this information to implement tenant-centric communication strategies that use both traditional and digital techniques. Fostering tenant collaboration involves building trust via open and honest communication regarding timelines, expenses, and visible benefits such as comfort and energy savings. Furthermore, the roles and responsibilities could be clarified through efficient stakeholder collaboration using frameworks like RASCI, avoiding inefficiencies throughout renovation projects. In

order to adjust strategies to changing tenant demands, real estate managers should also give attention to ongoing feedback methods. Managers can enhance project performance, tenant happiness, and make a significant contribution to larger climate goals by coordinating communication efforts with tenant demands and highlighting the long-term advantages of sustainable renovations. In addition to addressing immediate operational challenges, these strategies lay the foundation for improved tenant relations and continued cooperation.

Keeping in mind the discussed barriers regarding implementation of new technologies and its measurements to mitigate some of these barriers will positively impact the other renovation projects in the built environment. Knowing your tenants and what barriers are most often occurring based on their social backgrounds will help shape the narrative for project managers. One way to bridge gaps and improve understanding is through the use of bilingual resources, suitable messaging, and community relationships. Tenant confidence may be increased by showing these changes and providing workshops or demonstrations regarding the advantages of new technology, such as energy savings or increased living comfort. Gaining the support of tenants requires incorporating their input frequently and early in the planning and implementation stages, since this creates a sense of trust and ownership. Standing at the early days of implementing heat grids in already existing infrastructure is challenging and this research will provide a starting point for those parties involved in this project and in need for structure for the project.

5.3 Limitations and recommendations

As with every research, several limitations have to be acknowledged. One of the main limitations regarding this research is the lack of involvement of tenants. The intercept interviews gave a general idea of the current viewpoint of random tenants, but including tenants who experienced the project have not been included. Unfortunately, due to the difficulty of getting in touch with these people, and the wish from the other stakeholder to not include them due to the change of interrupting the project, an alternative approach was chosen. The second limitation is also in regard to the tenants view. For case 1, it would have been very insightful to have an interview with the residents committee, but despite efforts to get in touch, this was not possible. This does impact the results, since in general just the experiences of the stakeholders, who are eventually responsible for the communication, have been researched upon. It is therefore advised for future research to include more the tenants experience from cases, to compare if their experience can be aligned with how the stakeholders describe the project, or if there is a misalignment.

Regarding the interviews it has to be noted that often stakeholders were not directly involved in communicating with the tenants. Due to its complex nature, only several topics were being discussed to get in-depth information regarding these topics. When a stakeholder does not have direct influences or experiences regarding that topic, other topics were more focused upon. This might have led to bias in some of the discussed topic, since one stakeholder had more experience to share compared to other stakeholders. Besides this, the complexity also asked for simplicity, and since quite some topics needed to be discussed, time would lack to dive deeper into follow-up questions. From the beginning it became clear that the narrative has significant impact, but altering the protocol would have meant that not all stakeholders were posed with the same level of questions. It would be interesting to do extra research with this in mind, and identify the structure of the narrative and the reasoning behind this. A comprehensive step-by-step analysis for the use of the narrative based on the proposed themes in this research can provide better insights.

The inclusion of the supporting instance was sometimes challenging and differed for both cases slightly due to its variance of involvement of the project. It is necessary to better align this and ensure these stakeholders have the same kind of influence of the project. A different stakeholder who is not included in this research, but based on the interviews were partly responsible for the communication to the tenants, is the construction executor. It is mentioned that the provided information is mostly

during the execution phase, and in accordance with the other stakeholders, but its effect on comprehensiveness and the overall narrative has not been research upon.

In this research only cases were selected in which the 70% was reached, thus looking into how the projects did this, what their successes are but also what hurdles they experienced to even further improve it. Further research should include more cases to validate the research. It is also advisable to include cases in which the 70% was not reached, and what strategy was used that did not work out. Both cases are still in the execution phase, meaning there cannot be said if the project was really a success. Despite the fact that the 70% was reached, this is not always a guarantee that the project will be a success. Therefore, cases in which the heat grid is already in the operational phase should be researched. This all can lead to a more in-depth comparison study to validate the results in this research, but also propose new strategies, or mention what can be learned from failed cases.

Chapter 6 - Conclusions

The goal of this research is to enhance communication regarding heat grid adoption among tenants by looking into two cases where the construction of implementing heat grids has started. These two cases both provided insights in how the project reached the 70% votes necessary for implementing the heat grid, both with different approaches due to existence of a residents committee. Based on the cases, conclusions can be drawn on why these were successful and what communication strategies appeared to by most fitting for their tenants. In order to come to the conclusion, the following main research question was formulated: '*How can actively involved stakeholders enhance communication to improve the adoption of heat grids among housing association tenants?'*. Five sub-questions have been formulated in order to help answer the main question. First, the current level of openness and its barriers in adopting new technology of tenants is identified. Second, the roles of stakeholders in facilitating and communicating technological knowledge has been mapped. Third, communication methods that could improve this adoption have been examined and lastly it has been researched what communication approaches can be used for better adoption of heat grids. This is researched by the use of three models in order to get an understanding of current communication and its most important factors. The three models can be found in section 3 and are related to the RASCI-scheme, the communication strategies and the barriers in technology adoption.

6.1 SQ1: What is the current level of adoption and openness to new technology of tenants in heat grid projects?

Based on the literature and the intercept interviews it became clear that this openness and familiarity of heat grids varies a lot in social housing, and is influenced by factors like trust, knowledge gaps and socio-economic concerns. It is seen that tenants are most often hesitant due to limited understanding of the technology and have major concerns regarding costs and possible disruption. In the intercept interviews it also became clear that most tenants do not care that much regarding adopting new technology, which can be explained due to the many other problems these people do experience and prioritize.

Tenants often are more attracted to their immediate living conditions and affordability, not on long-term environmental goals. This disconnect does show a gap in technological awareness, which could influence their openness to new technologies. Additionally, socio-economic factors such as education levels, demographic backgrounds and past experiences with housing association project could influence tenants' openness to new technology, as they might expect to be excluded from the decision-making process.

6.2 SQ2: What are the barriers encountered by tenants in the adoption of heat grids?

Social barriers, behavioral barriers and financial barriers are all encountered and this has been validated by the interviewees. The cases show significant differences due to its approach and how the tenants are contacted. When there is a residents committee, social barriers are more prominent due to the need for trust and influence of peers. Not having a residents committee means approaching the tenants in a more personal and individual way, where the barriers regarding behavior are more occurring. Here the most encountered barriers are more regarding the need for more explanation on technology since this is difficult to understand and comprehend for the tenants. Financial barriers are encountered in all instances and is one of the prominent barriers to mitigate.

During the interviews, new barriers were mentioned, the legal barrier, and political barriers. The legal barrier explained the uncertainty about the current law and how this can be adopted by the stakeholders. It is sometimes unknown what is allowed, and what is not allowed, causing confusion for both stakeholders and tenants. The most dominant barriers appeared to be regarding the economical category, related to future costs, and the social category, related to influence of fellow peers and trust.

6.3 SQ3: What role do the actively involved stakeholders have in facilitating and communicating technological knowledge to tenants?

Based on the literature, stakeholders who have a direct relation towards information providence have been identified; the housing association, the municipality, the energy company, sometimes supporting companies and sometimes resident committees. Whereas housing associations are the primary contact for tenants, ensuring information is shared and impact of the changes is explained, municipalities are more focused on setting regulations and providing guidance throughout the project. The municipality is often looked upon as the organization responsible for organizing structure within the project. The energy company and supporting companies often act, in the first phases, more as consulting and supporting instances, explaining past experiences and defining technical requirements for the heat grid. Lastly, the residents committee is representing the tenants and often, not always, represent a uniform position towards the project plans. This committee explains the wishes, desires and problems of the tenants and tries to shape the project in a, for them, beneficial way.

Based on the cases and the interviewees from successful projects, good relationships and trust between the parties is necessary to ensure that all stakeholders are on the same line. The RASCI model shows that most parties know what to communicate at which moment to each other. Open communication and transparency between the stakeholders, with fixed 'rules', helped to create a uniform take on the project and therefore the project organization as a whole expressed confidence, which helped the trustworthiness of the project. A coordinated approach, with each party ensuring the delivery of clear and consistent messages, is key to foster a positive perception of the project, encouraging tenants to engage more.

By ensuring this transparency, trust and confidence is more fostered in the project. Once stakeholders share information openly, with each-other but also the tenants, a culture of accountability and cooperation is created. Stakeholders keep in line with the projects objectives and this reduces the possible miscommunication and conflicting messages. Knowing who communicates what information at what stage of the projects, helps aligning this information internally. Based on the RASCI models and communication graphs, the responsibility is mainly by the housing association. Their communication is most influencing the tenants, but without knowledge from other stakeholders, this information can be perceived as not reliable.

6.4 SQ4: What communication methods do stakeholders believe would best improve adoption among tenants in heat grid projects?

In general, stakeholders agreed that there is no one-fits-all approach and a tailored, clear, multi-channel communication approach is critical for improving the adoption of heat grids by tenants. Stakeholders emphasized multiple times the importance of delivering information in a way that is in accordance with tenants everyday concerns and priorities. It is not advisable to focus on hard and direct information, but a personal and tailored approach, where trust is essential, is much better to engage tenants. The stakeholders also recognized the need for consistent, two-way communication that allows the tenant for providing their thoughts and concerns.

From the interviews it became clear that barriers regarding the adoption of heat grids is not necessarily the problem to improve adoption of heat grids, but having a tailored narrative on how this technology and renovation is implemented has much more impact on the willingness to adopt the heat grid. When crafting this narrative, it is from importance that there has been thought into transparency, honesty, trust, impact, familiarity, clarity and empathy. This significantly impact tenants willingness to adopt heat grids. The tenants are not directly interested in the technology, but more how this benefits them. From the interviews it is therefore also suggested to offer a total package, where not just heat grids are being implemented, but also other, more direct beneficial adjustments for the tenant are being implemented. Explaining this in a tailored narrative helps to address the

tenants' specific needs, fears and preferences. When the communication emphasizes how the changes within the project influences their lives, people feel more attached and engaged.

It has also been recognized that having a residents committee positively influences the communication towards the tenants due to the trust they establish within the community. Since committee members are typically familiar with the local context and share familiar living experiences with the other tenants, this group is more able to transfer information to the tenants in a relatable and trusted manner. This trust within the community significantly improves the success of the project, due to the trusted and familiar faces throughout the project. The residents committee is able to provide the stakeholders with direct insights into tenant concerns, allowing for better adjustments and coherence of the narrative. It is key that the stakeholders communicate transparent and honest to this residents committee to ensure cooperation and trust.

6.5 SQ5: What communication approaches can be used to overcome the barriers regarding the adoption of heat grids?

The last sub-question has been established to identify what communication approaches should be used that help familiarize tenants with the heat grids and overcoming the barriers related to the adoption of heat grids. To overcome these barriers, communication strategies have to be carefully designed to address tenants' concerns and establish a structure of trust, understanding and engagement. The identified barriers do highlight the projects' complexity and underline its need for a multi-channel and tenant-focused approach. Looking at the most recurring barriers, an overview of how to approach the communication in order to mitigate or minimize the barriers can be seen in table 13.

Categorisation	Barrier	Communication approaches	In short
Social barriers	Influence of the community	Make advantage of community-focused activities like meetings to establish a common understanding of the project. To emphasize goals and create a feeling of shared purpose, highlight the benefits to the community to create trust and minimize negative influences of the community.	Organisational: - Create trust Communication: - Organize meetings - Highlight benefits
	Lack of trust in stakeholders	To mediate and foster trust, use regular, transparent face-to-face communication and seek the help of trusted familiar faces, such as tenant representatives or leaders in the neighbourhood. Provide possibilities for the tenants to be involved in the project. Also, ensure hierarchy between the stakeholders, ensure the story is clear between al involved stakeholders and minimize information overload.	Organisational: - Clear objectives - Avoid information overload Communication: - Face-to-face communication - Use familiar faces
Behavioral barriers	Complex systems	Use visuals, such infographics or animations, to simplify technical information so that the systems are easier to comprehend. To improve understanding, provide guided tours of show pilot projects or demonstrations in order for tenants to get grip on the new technology. A personal approach will help the tenant to understand information more quickly. Know that there are vulnereble people who have difficulties in comprehending the information. Align communication standards between the stakeholders to ensure uniformity and creates trust.	Organisational: - Align communication standards for uniformity Communication: - Use visuals, guided tours or pilot projects - Use personal approach
	Disruption due to renovation	Establish clear expectations for the renovation process and a comprehensive timeframe. Be transparent regarding delays of changes in construction to maintain trust. In the narrative, explain the impact of the renovation and provide additional, directly beneficial renovations to get more understanding.	Organisational: - Use a clear narrative on impact Communication: - Transparency on delays and changes
Economical barriers	Future costs	Provide honest and comprehensive financial models that address long-term energy bill expectations. Provide case studies or stories from related initiatives to illustrate the system's feasibility and create familiarity. Be transparent on who is responsible for what costs.	Organisational: - Know who is responsible Communication: - Provide expectations - Similar stories create feasibility
	Initial costs	Be upfront via informing channels on who will cover the costs and is responsible for extra costs. Be honest and clear on how the freedom of choice for supplier is limited and how this could be affected in the future.	Communication: - Informing channels of responsibilities - Clarity on energy supplier

Table 13: Overview of communication approaches regarding barriers (Author)

Based on this table, several conclusions can be drawn. The most critical element regarding the communication strategy appears to be knowing your tenants and using tailored messages regarding their concerns and priorities. In general, most tenants are too overwhelmed or have other priorities besides getting to know what a heat grid is. Therefore stakeholders should create a narrative that clearly communicates how the project will impact the tenants' life and what immediate changes and benefits it brings. This should include transparency and honesty regarding costs, and showing what benefits the retrofit will have, thus offering a 'total package' including the renovations. It is not about offering just a heat grid since this is not a direct improvement for the tenants, it should be visible what other improvements will be done. This all has to be in simple and accessible language, which is already often done nicely.

The second factor which influences the barriers, is the establishment of trust. Tenants are more often likely to engage and cooperate when stakeholders are upfront about challenges, disruptions and benefits, but also when they feel listened to and included. Two ways in how this can be reached are the use of social structures and the use of trusted messengers. Having familiar faces lowers the barrier to communicate and leads to more trust. Committees organized by residents often have a good reputation within the community, and it is easier to communicate with them. Having or being a trusted messenger also ensures that in general people are more open to conversation and more willing to engage in the project. Personal attention in which the tenant feels listened to attributes positively to the success of a project. Once the narrative is shaped according to the needs of the residents, barriers are easier to overcome and tenants are more willing to adopt heat grids. This also can be used as a foundation for future cooperation in similar projects.

Engaged stakeholders should focus on a multifaceted communication approach that is inclusive, transparent, and tenant-focused in regard to the table and findings that have been offered. First, it is essential that stakeholders get to know their tenants by learning about their socioeconomic history, priorities, and difficulties. Customized messaging should highlight the project's benefits, including improvements outside of the heat grid, and highlight its immediate advantages, such increased living comfort. Second, technical topics should be explained simply and easily through the use of animations, infographics, and visuals. It is important to actively include trusted communicators, such tenant committees or community leaders, to promote transparency and trust. In order to guarantee that tenants feel heard and appreciated, stakeholders must also have a strong emphasis on relationships by holding one-on-one discussions. Consistent updates along with open and honest communication regarding expenses, delays, and schedules can improve project confidence and reduce distrust. Stakeholders could also make use of well-known social organizations in the community to reduce barriers to participation and communication. Lastly, stakeholders should establish a common vision of success by focusing on the story on the project's advantages.

6.6 How can engaged stakeholders enhance communication to improve the adoption of heat grids among housing association tenants?

Communication is key. A well-structured communication strategy will enhance the adoption of new technologies like heat grids. At the moment, stakeholders often struggle to identify the right strategy of communicating information and knowledge regarding the project to the tenant. If the results show one thing, it is the necessity of knowing what you communicate to which audience, and how this is aligned with views of other stakeholders within the project. The results show several components; having an organized structure with the engaged stakeholders, knowing what the barriers for the specific context are, knowing who the tenants are and how one crafts the narrative for the tenants regarding implementing heat grids.

First, the findings highlight the significance of stakeholder organization and alignment in project goals and communication strategies. Often, three main stakeholders are within the organizational part from the start, the housing association, the energy company and the municipality, each with their own expertise and priorities. The social graphs have shown that communication between these parties are

not always aligned, something that can be improved. This is important since when all perspectives are aligned and this is continuously communicated, it can be translated into coherent and consistent communication towards the tenants, essential in building trust. Disjointed and not aligned messages and communication methods can confuse tenants and create resistance. Knowing who is responsible for which communication at what part of the project, helps unify the overall communication strategy, resulting in more confidence and trust for the tenant. Having an overall establishment of being a trusted party, will help in getting project more easily done. Levering the use of trusted and familiar faces for communication also proved to be effective for engaging the tenants.

Second, the results emphasize the need for contextualized communication strategies. Every project has different barriers regarding the adoption for heat grids and are depending on the contextual situation, internal organization of the stakeholders and the type of tenants. The adoption is depending on their unique social, behavioral and economic barriers, as well as some legal barriers. Understanding this requires knowing the tenant group, their technological awareness and any concerns they have. When this is understood, there can be looked into how the narrative is crafted. The results showed that barriers can best be dealt with by using a narrative which is clear and understandable for the tenant. It should address the most upcoming barrier in such way it is known and explainable to the tenant. The barrier of lack of trust is one of the barriers that can be lowered by ensuring the organization is well-structured and clear, and a unified view on the project is visible. Being honest and open to communication helps building a better relation with the tenants, which leads to more trust.

Ultimately, creating a robust and well-defined communication strategy depends on ensuring a two-way communication with tenants, allowing for feedback and altering the strategy based on this input. Ensuring that the tenants, or the residents committee, feels heard and valued, strengthens the trust. Listening to the needs and offering more than just the head grid, helps in crafting the narrative in which transparency, honesty, trust, impact, familiarity, clarity and empathy are incorporated. Offering alternative benefits related to renovations and community building further helps in getting the necessary support. As mentioned, it is a combination of factors, listening to the tenants and addressing their needs helps lowering the barriers encountered in the adoption of heat grids. By addressing the challenges regarding communication, stakeholders can improve not only the adoption of heat grids, but also the broader acceptance of sustainable energy, or any other future projects.

Concluding, the communication regarding the adoption of heat grids can be enhanced by ensuring the organization is familiar with the context, and goals are clear and aligned with all stakeholders, thus sharing and transparency is necessary. This leads to more confidence, which leads to more trust among tenants. Knowing who your tenants are and how to approach them creates more trust, often leading to more engagement and openness to conversation. Knowing how to communicate to them by crafting a understandable narrative in which the communication channels are aligned with the expectations contributes to improving the adoption of heat grid among housing association tenants.

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Appendix

Appendix A

Plan Overview

A Data Management Plan created using DMPonline

Title: Enhancing urban heat grid development through tenant involvement

Creator: Stef Gitzels

Affiliation: Delft University of Technology

Template: TU Delft Data Management Plan template (2021)

Project abstract:

For this thesis there will be looked into how communication from stakeholders has influence on the technological awareness of tenants. Via casestudies various strategies will be researched, discussed and explained, to learn from both positive and negative aspects. This will give new insights, and both cases will be compared to eachother to identify differences in strategies and communication methods. To identify this process, in-depth interviews will be conducted with relevant stakeholders who have direct influence eg. Municipalities, housing corporations and energy cooperatives. These stakeholders will be contacted by asking if they are willing to participate in this research by conducting an in-depth interview of 1/1.5 hours and they are expected to give insights in their experiences.

ID: 158653

Start date: 02-09-2024

End date: 16-01-2025

Last modified: 12-09-2024

Enhancing urban heat grid development through tenant involvement

0. Administrative questions

1. Name of data management support staff consulted during the preparation of this plan.

Question not answered.

2. Date of consultation with support staff.

Question not answered.

I. Data description and collection or re-use of existing data

3. Provide a general description of the type of data you will be working with, including any re-used data:

Type of data	File format(s)	How will data be collected (for re-used data: source and terms of use)?	Purpose of processing	Storage location	Who will have access to the data
Audio recordings	.mp4	Interviews	Documenting the interviews in order to create a transcript	Onedrive protected by TUDelft and encrypted local storage	Primary researcher and thesis supervisor
Video recordings	.mp4	Interviews	Documenting the interviews in order to create a transcript	Onedrive protected by TUDelft and encrypted local storage	Primary researcher and thesis supervisor
Informed consent form	.pdf	Prior the interviews, the participants are asked to fill the consent form	Prove that the participant was willing to contribute voluntarily	Onedrive protected by TUDelft and encrypted local storage	Primary researcher and thesis supervisor

Contact information (Name, Institution, email)	.cvs	Contacting participants/interviewees	Contacting participants/interviewees	Onedrive protected by TUDelft and encrypted local storage	Primary researcher and thesis supervisor
Transcripted interviews	.pdf	Interviews from the participants	Saving results and being able to quote	Onedrive protected by TUDelft and encrypted local storage	Primary researcher and thesis supervisor

4. How much data storage will you require during the project lifetime?

< 250 GB

II. Documentation and data quality

5. What documentation will accompany data?

Data will be deposited in a data repository at the end of the project (see section V) and data discoverability and re-usability will be ensured by adhering to the repository's metadata standards

Methodology of data collection

III. Storage and backup during research process

6. Where will the data (and code, if applicable) be stored and backed-up during the project lifetime?

Another storage system - please explain below, including provided security measures

OneDrive

Local storage, which is not accessible for anyone but the primary researcher

IV. Legal and ethical requirements, codes of conduct

7. Does your research involve human subjects or 3rd party datasets collected from human participants?

Yes

8A. Will you work with personal data? (information about an identified or identifiable natural person)

If you are not sure which option to select, first ask your [Faculty Data Steward](#) *for advice. You can also check with the* [privacy website](#) *. If you would like to contact the privacy team: privacy-tud@tudelft.nl, please bring your DMP.*

- Yes

8B. Will you work with any other types of confidential or classified data or code as listed below? (tick all that apply

If you are not sure which option to select, ask your [Faculty Data Steward](#) *for advice.*

- Yes, confidential data received from commercial, or other external partners

9. How will ownership of the data and intellectual property rights to the data be managed?

For projects involving commercially-sensitive research or research involving third parties, seek advice of your [Faculty Contract Manager](#) *when answering this question. If this is not the case, you can use the example below.*

The research is conducted by a masters student from TU Delft. Hence, the university will remain the owner of the underlying datasets from the published paper. During the active phase of research, the primary researcher from TU Delft will manage the access rights to data and other outputs.

10. Which personal data will you process? Tick all that apply

- Names and addresses

- Email addresses and/or other addresses for digital communication

- Photographs, video materials, performance appraisals or student results

- Signed consent forms

- Data collected in Informed Consent form (names and email addresses)

11. Please list the categories of data subjects

Housing associations, municipalities, consultancy companies, energy cooperatives, tenants

12. Will you be sharing personal data with individuals/organisations outside of the EEA (European Economic Area)?

- No

15. What is the legal ground for personal data processing?

- Informed consent

16. Please describe the informed consent procedure you will follow:

The participant in this research will receive an informed consent form in which the participant will read what will happen with the data, what the rights are and that the participant is not obliged to answer questions. There will be an introduction in what the research covers and what their role is.

17. Where will you store the signed consent forms?

- Same storage solutions as explained in question 6

18. Does the processing of the personal data result in a high risk to the data subjects?

If the processing of the personal data results in a high risk to the data subjects, it is required to perform a Data Protection Impact Assessment (DPIA). In order to determine if there is a high risk for the data subjects, please check if any of the options below that are applicable to the processing of the personal data during your research (check all that apply).

If two or more of the options listed below apply, you will have to complete the DPIA. Please get in touch with the privacy team: privacy-tud@tudelft.nl to receive support with DPIA.

If you have any additional comments, please add them in the box below.

- None of the above applies

22. What will happen with personal research data after the end of the research project?

- Personal research data will be destroyed after the end of the research project

V. Data sharing and long-term preservation

27. Apart from personal data mentioned in question 22, will any other data be publicly shared

- All other non-personal data (and code) produced in the project

29. How will you share research data (and code), including the one mentioned in question 22?

30. How much of your data will be shared in a research data repository?

- < 100 GB

31. When will the data (or code) be shared?

- At the end of the research project

32. Under what licence will be the data/code released?

Question not answered.

VI. Data management responsibilities and resources

33. Is TU Delft the lead institution for this project?

- Yes, leading the collaboration - please provide details of the type of collaboration and the involved parties below

Internship with Platform 31, helping with finding cases and therefore finding relevant stakeholders.

34. If you leave TU Delft (or are unavailable), who is going to be responsible for the data resulting from this project?

TUDelft or leading mentor Erwin Mlecnik

Erwin Mlecnik - Assistent Professor - E.Mlecnik@tudelft.nl

35. What resources (for example financial and time) will be dedicated to data management and ensuring that data will be FAIR (Findable, Accessible, Interoperable, Re-usable)?

Question not answered.

Check the necessities for this interview, teams, protocol, informed consent

Interview protocol - Case study, importance of communication on tenants' technological awareness

1. Introduction (5-10 minutes)

- **Intro:** Goodmorning …,

  First of all I would like to express our appreciation for your willingness to participate in this interview. It is a valuable contribution to my research on the importance of communication on tenants' technological awareness. Before we begin, I would like to ask you to agree to the recording of this interview for scientific purposes. I would like to emphasize that the information I am collecting today is for research purposes only. Your identity and any personal details you share will be kept confidential. The goal is to create a safe space for open and honest conversation.

  I have sent you the informed consent prior to this interview and hope everything stated in this document is clear. Your verbal confirmation and signature on the informed consent document allow us to start the recording. Let's proceed when all is clear.

  Start recording

  We have just begun recording, having handed over, read and signed the informed consent letter. Could you confirm again if you agree to the recording of this interview? Before I go deeper into the interview, I want to assure you that your privacy and confidentiality are of utmost importance to me. The information you share will be treated with the utmost care, and all personal data will be anonymized. If there are any questions you do not feel comfortable answering, please feel free to let me know, and we can proceed.

- **Background information**

  My name is Stef Gitzels, and currently I am studying Management in the Built Environment (MBE) at the TU Delft. For this research I started an internship with Platform 31 who helped me gain extra insights, information and useful contacts for this research. For my master's thesis I conduct a research in which I focus on the context of implementing heat grids in the Netherlands, where successful adoption relies heavily on effective stakeholder communication and engagement. Heat grid projects are complex and involve multiple stakeholders, including housing associations, municipalities, technical experts, and tenants, each with varying levels of involvement and responsibility. The communication strategies used in these projects significantly impact tenant awareness, acceptance, and participation, particularly when dealing with innovative or unfamiliar technologies. Understanding each stakeholder's role and their approach to communication is critical for identifying areas of improvement and ensuring project success.

2. Perceived Role in the Project (15-20 minutes)

- ➢ **Objective**: Understanding how the interviewee perceives their role within the project, what their responsibilities are and to whom they communicate.

First I would like to get to know you and your role a little bit better, I know this is sensitive information and I highly appreciate your openness. This information will help in better understanding your vision on the project.

- Could you share a bit on your background, how did you start at this organization?
    - Can you describe a typical day in your role??
    - How much experience do you have at this job?

Now let's shift the focus more towards the case, creating a heat grid for X (some more explanation)

- Could you describe your role and responsibilities in this project?
- Can you describe your relationship with other stakeholders in the project?
- How do you interact and collaborate with other stakeholders?
    - What is your role in facilitating these interactions?
- Are there any areas where your role overlaps with others?
    - How do you handle such overlaps?
- Who do you typically report to, and who do you consult when making decisions?
- Does your role changes over the projects lifespan?
    - Is your role different in the planning phase compared to the feasibility/design phase?
    - How do you deal with these shifting roles?
- How is your relationship with the tenants, the end-user in this project?
    - Are you aware of how tenants experience this relationship?

3. Perceptions of Tenant Technological Awareness and Barriers (20-30 minutes)

- ➢ **Objective**: Identify stakeholders' views on tenants' technological awareness and explore perceived barriers (psychological, cognitive, and economic) that hinder awareness and acceptance.

Regarding technological awareness, various barriers are being encountered. This can be a complex task to overcome and mitigate this, and communication might affect this

- In your view, how familiar are tenants with the heat grid technology?
    - Is it something that should be simplified?
    - What do you think the tenants role is in the process of establishing heat grids
- What challenges or barriers have you observed tenants are facing regarding this technology?
    - How do you think the current level of awareness impacts their acceptance or resistance?
    - Which barriers have the greatest impact on tenant awareness?

In this research the barriers regarding technological awareness are split into three categories, psychological barriers, cognitive barriers and economical barriers. (*Some more elaboration on this*)

- Do you recognize these barriers?
    - How would you categorize these barriers?
    - What elements do you believe are most important to overcome?
- What strategies do you believe are most effective in overcoming these barriers?
    - Is there something you like to change on the current communication strategy?

- Can you share an example where communication helped change a tenant's perception of the technology?

4. Communication Strategies and Methods (30-40 minutes)

> **Objective**: Identify how stakeholders communicate to tenants and (if relevant) other stakeholders, focusing on information delivery, adequacy and feedback. Identify how stakeholders believe this communication would improve technological awareness

Now that we identified your role in the project and how this might shift over time, I would like to discuss the communication methods and strategies.

Information Delivery (*should focus on the sharing of technological subjects*)

- Is there a specific strategy you use in communicating to tenants regarding information delivery?
  - What makes this strategy useful or successful?
- How do you typically communicate information to tenants (e.g., meetings, brochures, online platforms)?
  - Are you familiar with the ladder of citizen participation? Where do you see yourself?
  - Is there a certain thought behind why you chose this method?
  - Are you trying to get the tenants on board?
  - How do you ensure that all tenants receive the information?
  - How do you reach the people that cannot be reached?
- Is the level of the information in line with the tenants knowledge?
  - How do you know that?
  - How do you ensure this is on the same level?
  - How is that being tested?
- What communication methods (e.g., digital channels, face-to-face meetings, workshops) have you found to be the most engaging?
  - What gives you validation in this?
- Do you communicate to other stakeholders?
  - Is the communication in line with the other stakeholders?
  - Is there an agreement in which information is being communicated to the tenants?
  - Is the communication on the same level with other stakeholders?
- How do you decide the timing when communicating to the tenants?
  - Are the tenants aware of the status of the project?
  - Would you say the timing between information and action is sufficient?
  - Do you strategically keep in mind when you deliver certain information?
- Could you describe any specific techniques or tools you use to ensure your message is understood by tenants?
- Do you think your strategy can be improved to deliver a clearer message?
  - How?

Information Adequacy:
- How do you decide whether the information you provide is comprehensive and understandable?
  - How do you handle complex information?
  - Is this being tested or tailored to the tenants?
- What criteria do you use to decide the depth and complexity of the information shared?

- How do you ensure that tenants receive enough information to make informed decisions without feeling overwhelmed?

Information feedback:
- What mechanisms (e.g., surveys, follow-up meetings, Q&A sessions) do you use to collect feedback from tenants?
    - o Is this being communicated to the other stakeholders?
    - o Is this something you do regularly?
- How do you assess whether tenants have truly understood the information provided?
- Could you share an example of a situation where tenant feedback led to changes in your communication strategy?
- How do you keep tenants informed about changes made based on their feedback, and what impact has this had on their engagement?
- How do you gain trust from tenants?
- What do you think could improve tenant communication?

5. Closing (5 minutes)

Again, I would like to thank you for your valuable contribution to our research. Should you have any questions in the future, feel free to get in touch. Feedback or extra information is always appreciated. When the interview has been processed, I will seek contact with you to ensure any statements are in line with the interview and your experiences and thoughts on the project.

Thank you …, and have a great day!