

P5 Report - A thesis submitted to Delft University of Technology for the degree of Master of Science in Architecture, Urbanism and Building Sciences

Factors that influence the adoption of sustainable renovations in listed heritage buildings

The prior conditions, characteristics, decision-making process, drivers, barriers and personas of listed cultural heritage building owner-occupiers.

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Abstract

The research questions reads: “How to increase the adoption of sustainable renovations in listed cultural heritage buildings by providing insight into the decision-making process of owner-occupiers?” The research method first includes a theoretical study about the factors that influence the rate of adoption. Second, semi-structured interviews were held chronologically with 7 professionals, 9 LCHB owners and 7 professionals. And lastly, a workshop about the barriers of sustainable renovation in LCHBs attended by 25 Dutch professionals. The first round of interviews with 7 professionals and the interviews with 9 LCHB owners led to the creation of a sustainable renovation decision-making process for owners. And the interviews with 9 LCHB owners, the second round of interviews with 6 professionals and the workshop results led to the drivers, barriers, opportunities and recommendations

Furthermore, LCHB owners were asked questions about their sustainable renovation personality, the answers hereof resulted into two very different persona types. These persona types are also based on the characteristics of owners and the barriers they encountered. A recommendation is to take these personas into account when forming a strategies to increase sustainable renovations.

The other recommendations are to: add a building technology professional to the cultural heritage committee, make municipalities communicate more with LCHB owners, make municipalities use infra-red cameras to take some thermal images of before and after a sustainable renovation as inspiration for other LCHB owners, make LCHB owners use infra-red cameras to check if everything is installed properly, subsidize local community-organized information gatherings for LCHB owners, subsidize owners that can realize the sustainable renovation themselves (DIY) but face a lack of money as their main barrier and, lastly, emphasize making LCHBs beautiful and future proof.

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Table of contents

Abstract	2
Table of contents.....	4
List of tables.....	7
List of figures.....	8
List of photos	8
Terminology and abbreviations.....	9
1. Introduction	11
1.1 Subject	11
1.2 problem statement	14
1.3 Societal and scientific relevance	17
1.4 Research questions	18
2. Research method	20
2.1 Research design	20
2.2 Data collection	21
2.2.1 Theoretical research	21
2.2.2 Semi-structured interviews	21
2.2.3 Sample size interviews	21
2.2.4 Interviews with LCHB owners	22
2.2.5 Interviews with professionals about the decision-making process	25
2.2.6 Interviews with professionals about the results	25
2.2.7 Workshop.....	26
2.2.8 Sustainable renovations of the LCHB owners	26
2.3 Data analysis.....	28
2.4 Data plan	28
2.5 Ethical considerations	28
2.6 Research output.....	29
3. Theoretical background.....	31
3.1 Prior conditions and characteristics	31
3.1.1 What are prior conditions of the decision-making process?.....	32
3.1.2 What are the characteristics of the decision-making unit?	41
3.1.3 Conceptual model of prior conditions and characteristics	47
3.2 Decision-making process	49
3.2.1 What is a decision-making process?.....	49
3.2.2 What stages are there in a decision-making process?.....	50
3.3 Drivers, barriers and opportunities	54
3.3.1 Relative advantage.....	55
3.3.2 Compatibility	60
3.3.3 Complexity	62

3.3.4	Trialability.....	64
3.3.5	Observability	64
3.3.6	Type of adoption decision	66
3.3.7	Communication channels	66
3.3.8	Nature of the social system	68
3.3.9	Extent of change agent promotion efforts	71
3.3.10	Factors and variables that influence the rate of adoption.....	77
3.4	Theoretical framework.....	78
4.	Results.....	80
4.1	Prior conditions and characteristics	80
4.1.1	Prior conditions of the decision-making process	80
4.1.2	Characteristics of the decision-making unit.....	85
4.2	Decision-making process	89
4.2.1	Decision-making process explanation	90
4.2.2	Decision-making process stages	93
4.2.3	The decision-making process and influences on it	102
4.3	Drivers, barriers and opportunities	103
4.3.1	Relative advantage.....	104
4.3.2	Compatibility	113
4.3.3	Complexity	119
4.3.4	Trialability.....	124
4.3.5	Observability	124
4.3.6	Type of adoption decision	126
4.3.7	Communication channels	128
4.3.8	Nature of the social system	128
4.3.9	Extent of change agent promotion efforts	129
4.3.10	Identified opportunities	133
4.4	Personas.....	134
4.4.1	Characteristics of the personas.....	134
4.4.2	Drivers and barriers of the personas.....	136
4.4.3	Opportunities regarding the personas	137
5.	Discussion.....	141
5.1	Theoretical reflection	141
5.1.1	Rogers (2003)	141
5.1.2	Adopter categories	142
5.1.3	Personas.....	143
5.2	Policy recommendations	144
5.2.1	Drivers, barriers and opportunities	144
6.	Conclusion	148
6.1	Answering the research questions	148

6.1.1	Sub question 1	148
6.1.2	Sub question 2	148
6.1.3	Sub question 3	148
6.1.4	Sub question 4	149
6.1.5	Sub question 5	149
6.1.6	Main question.....	149
6.2	Limitations (further research)	150
7.	Reflection	152
	Reference list	155
	Appendix.....	160

List of tables

Table 1. Numbers of LCHBs (multiple sources)	12
Table 2. Measures carried out in LCHBs, N=526 (translated from Hamstra & Kommer, 2022, p. 17)	13
Table 3. First round of professional interviewees (author)	25
Table 4. Second round of professional interviewees (author).....	26
Table 5. Descriptions of owners their LCHBs and sustainable renovations (author)	27
Table 6. LCHBs year of construction, N=526 (translated from Hamstra & Kommer, 2022, p. 40)	32
Table 7. Typology of LCHBs (translated from Hamstra & Kommer, 2022, p. 40, Hamstra, 2023, p. 5)	33
Table 8. Square floor area LCHBs, N=526 (translated from Hamstra & Kommer, 2022, p. 41)	33
Table 9. Type of LCHB regarding government regulations (Hamstra & Kommer, 2022, p. 40, Hamstra, 2023, p. 1)	34
Table 10. Architectural condition LCHBs by type, N=1.043 (translated from Hamstra, 2023, p. 6)	35
Table 11. Number of people living in a LCHB, N=471 (translated from Hamstra & Kommer, 2022, p. 40)	35
Table 12. Occasions and sustainable renovation measures, N=497 (translated from Hamstra & Kommer, 2022, p. 18)	36
Table 13. Reducing energy consumption in the past 3 years, N=1.043 (translated from Hamstra, 2023, p. 23)	37
Table 14. Measures already undertaken in LCHBs, N=526 (translated from Hamstra & Kommer, 2022, p. 16)	37
Table 15. Things to consume less energy, N=526 (translated from Hamstra & Kommer, 2022, p. 14).....	38
Table 16. Previous measures that led to new renovations, N=424 (translated from Hamstra & Kommer, 2022, p. 29)	38
Table 17. Inconveniences of LCHBs, N=526 (translated from Hamstra & Kommer, 2022, p. 11)	38
Table 18. Age of LCHB owners (translated from Hamstra & Kommer, 2022, p. 40, Hamstra, 2023, p. 4)	42
Table 19. Years of LCHB ownership (translated from Hamstra & Kommer, 2022, p. 42, Hamstra, 2023, p. 4)	42
Table 20. Appreciation of organizations by LCHB owners, N=1.043 (translated from Hamstra, 2023, p. 14)	44
Table 21. The ranking of the reliable sources of information by renovators, N=1.946 (Ebrahimigharehbaghi, 2022, p. 81)	44
Table 22. Interest in the sustainable renovation, N=526 (translated from Hamstra & Kommer, 2022, p. 13)	44
Table 23. Member of LCHB organizations, N=526 (translated from Hamstra & Kommer, 2022, p. 42).....	46
Table 24. Most important reasons for measures, N=497 (translated from Hamstra & Kommer, 2022, p. 19)	55
Table 25. Experienced barriers of LCHB owners' sustainable renovations, N=1.043 (translated from Hamstra, 2023, p. 22)	55
Table 26. Reason why the condition of a LCHB is in a bad shape (translated from Hamstra, 2023, p. 7)	56
Table 27. Costs incurred to realize a sustainable renovation, N=497 (translated from Hamstra & Kommer, 2022, p. 25)	56
Table 28. Expected costs of a sustainable renovation by LCHB owners, N=1.043 (translated from Hamstra, 2023, p. 24).....	56
Table 29. Barriers of renovator towards energy efficient renovations by Ebrahimigharehbaghi (2022, p. 81)	59
Table 30. Knowledge about what is possible (translated from Hamstra & Kommer, 2022, p. 13, Hamstra, 2023, p. 21)	62
Table 31. LCHB owners need for information, N=1.043 (translated from Hamstra, 2023, p. 12).....	62
Table 32. Possible/received support from the municipality, N=1.043 (translated from Hamstra, 2023, p. 13)	63
Table 33. Type of support needed from the municipality, N=1.043 (translated from Hamstra, 2023, p. 13)	63
Table 34. Information sources of LCHB owners, N=1.043 (translated from Hamstra, 2023, p. 12)	68
Table 35. Variables influencing the decision-making process (author, based on Rogers, 2003, p. 222).....	77
Table 36. Characteristics of the LCHBs (author)	80
Table 37. Characteristics of the household (author) (- means no information)	81
Table 38. Occasions (author).....	82
Table 39. Previous practice (author).....	83
Table 40. Felt needs and/or problems (author)	83
Table 41. Innovativeness (author).....	84
Table 42. Socioeconomic characteristics of the decision-making unit (author)	85
Table 43. Personality variables LCHB owners (author, inspired by Haines & Mitchell, 2014).....	87
Table 44. Communication behavior of LCHB owners (author) (- means no information)	88
Table 45. Sustainable renovation decision-making processes of participants (author).....	90
Table 46. Ways in which LCHB owners gathered their information (author).....	94
Table 47. Designing stage of LCHB owners (author) (- means no information)	97
Table 48. Process of the permit application stage of LCHB owners (author) (- means no information).....	98
Table 49. Implementation of the sustainable renovation largely or partially DIY (author)	98

Table 50. Attitude of LCHB owners towards the implementation stage (author) (N = negative, P = positive, M = mixed).....	98
Table 51. Confirmation or attitude towards the realized sustainable renovation (author) (- means no information).....	99
Table 52. Sharing information (author)	100
Table 53. Main drivers of LCHB owners to realize their sustainable renovation (author)	103
Table 54. Main barriers of LCHB owners (author)	103
Table 55. Monetary costs as a barrier (author).....	104
Table 56. Owners' attitudes towards financial incentives (author) (- means not applicable or no information)	104
Table 57. Transaction cost barrier (author)	111
Table 58. Attitude towards limitations because of the listed cultural heritage building status (author).....	115
Table 59. Reason for LCHB owners their attitude towards limitations because of the LCHB status	116
Table 60. Current attitude of LCHB owners towards the policy in their municipality (author) (- means no information).....	117
Table 61. Complexity of the sustainable renovation decision-making process (author) (- means no information)	119
Table 62. Attitude towards the Monumentguard among LCHB owners (author)	121
Table 63. Visibility of sustainable renovations (author) (- means no information).....	124
Table 64. Attitude towards a sustainable renovation obligation in 3 years and wealth and income (author).....	128
Table 65. Attitude towards effort in contacting of the municipality (author) (- means no information)	129
Table 66. Variables and variables with opportunities (author, based on Rogers, 2003, p. 222)	133
Table 67. Personality variables and persona identification (author, inspired by Haines & Mitchell, 2014)	135
Table 68. Socioeconomic characteristics and persona identification (author, inspired by Haines & Mitchell, 2014)	135
Table 69. Main drivers of the two personas (author, inspired by Haines & Mitchell, 2014).....	136
Table 70. Main barriers of the two personas (author, inspired by Haines & Mitchell, 2014)	136

List of figures

Figure 1. Research design (author)	20
Figure 2. The decision-making process (innovation-decision process) by Rogers (2003, p. 171)	31
Figure 3. The relation between prior conditions and characteristics and the decision-making process (author)	47
Figure 4. Stages of the decision-making process in the literature (author).....	49
Figure 5. Factors determining the rate of adoption of innovations (author, adapted from Rogers, 2003, p. 222)	54
Figure 6. Technology adoption life cycle (Moore, 2014, p. 15)	73
Figure 7. Stages of the decision-making process in the literature and influences on it (author, based on Rogers, 2003)	78
Figure 8. One cycle (all at once) decision-making process for a sustainable renovation (author)	89
Figure 9. Multi-cycle (step-by-step) decision-making process for a sustainable renovation (author).....	89
Figure 10. Decision-making process and influences on it (author)	102

List of photos

Photo 1. Peuscher, J. (2018). <i>Solar panel installation</i> [Photograph].....	1 & 150
Photo 2. Peuscher, J. (2018). <i>New top façade</i> [Photograph].....	10
Photo 3. Peuscher, J. (1986). <i>Installing a cavity wall</i> [Photograph].....	19
Photo 4. Peuscher, J. (2018). <i>Installed heat pump</i> [Photograph].....	30
Photo 5. Peuscher, J. (2018). <i>Insulating the hayloft</i> [Photograph].....	79
Photo 6. Kastelic, M. (2016). <i>Thirty years old manual worker</i> [Photograph]. Shutterstock. https://www.shutterstock.com/nl/image-photo/thirty-years-old-manual-worker-wall-519528235	133
Photo 7. Rijksdienst voor het Cultureel Erfgoed. (2023). <i>Ontzorgingsprogramma helpt monumenteigenaren bij verduurzaming</i> [Photograph]. Cultureelerfgoed. https://www.cultureelerfgoed.nl/onderwerpen/duurzaamheid/handreiking-voor-eigenaren/ontzorgingsprogramma-voor-monumenteigenaren	133
Photo 8. Van Oorschot, H. (2020). <i>Interior wall</i> [Photograph].....	137

Terminology and abbreviations

LCHB = Listed cultural heritage building = A municipally or nationally listed cultural heritage building (Dutch= gemeentelijk- of rijksmonumentaal pand).

Sustainable renovation = A renovation improving the energy performance of a building while taking a balanced and holistic approach between social, environmental and economic sustainability, which includes cultural heritage values (Nielsen et al., 2016), thus meaning more than an energy-saving renovation. In this thesis a sustainable renovation also requires two or more sustainable renovation measures similar to Ebrahimigharehbaghi (2022, p. 76).

The term is also convenient because Dutch cultural heritage professionals often use the term: 'make sustainable', (in Dutch: verduurzamen). Sustainable renovation and sustainable renovation measures are used interchangeably.

Additionally, the term 'sustainable renovation' contains any of the following terms as long as they meet the definition: energy-saving renovation, energy-saving retrofit, energy-saving refurbishment, energy-efficient renovation, energy-efficient retrofit, energy-efficient refurbishment, sustainable retrofit, sustainable refurbishment, repair, maintenance, improvement and restoration.

Owner = A private owner-occupier of a listed cultural heritage building, who is or can be the investor in a sustainable renovation for his or her building, and typically the head, or decision-maker regarding sustainable renovations, of the household.

Cultural Heritage Agency of the Netherlands (in Dutch: Rijksdienst voor het Cultureel Erfgoed)= An executive body of the Dutch Ministry of Education, Culture and Science and the Netherlands' center of expertise for heritage, in particular built heritage, historical landscapes, archaeology and museum collections (Ministerie van Onderwijs, Cultuur en Wetenschap, 2024).

Cultural heritage committee (in Dutch: monumentencommissie) = The committee that gives advice to the municipality about what is permitted with the listed cultural heritage buildings in the municipality. The advice of the committee should neither always be indiscriminately adopted or often ignored by the municipality (Magdelijns et al., 2009, p. 8). A cultural heritage committee is assigned by the municipality. The cultural heritage committee can be integrated with the aesthetics committee (welstandscommissie), 30% of municipalities had this in 2009 (Magdelijns et al., 2009, p. 6). Within this thesis a cultural heritage committee that is integrated in an aesthetics committee it is still referred to as the cultural heritage committee.

The researcher/author = Refers to the master student who wrote this thesis.

A large city = A city with 100.000 inhabitants or more.

A small city = A city with less than 100.000 inhabitants.

A change agent = A change agent is an individual with the goal to direct potential adopters to make the decision to adopt an innovation that seems desirable, or not adopt an undesirable innovation. The change agent is part of the change agency, which is most likely an organization (Rogers, 2003, p. 27).



1. Introduction

1.1 Subject

Listed cultural heritage buildings

In this thesis a LCHB refers to a municipally listed cultural heritage building or a nationally listed cultural heritage building. Provincially listed cultural heritage buildings also exist, but there are relatively few of them (Hobma & Jong, 2022, p. 136), therefore this thesis will not cover them.

Nationally LCHBs are designated by the minister of culture in consultation with the Mayor and Alderman of the municipality the building is located in. Municipally LCHBs are designated by the municipal council (Hobma & Jong, 2022, pp. 136-138). A cultural heritage committee is often installed to give expert advice. And it is possible to appeal against a designation decision. Buildings are designated as LCHBs because of their beauty, meaning for science and cultural heritage value (Erfgoedwet art. 3.1 para 1). The difference between national and municipal LCHBs is that municipally LCHBs have local significance (Hobma & Jong, 2022, pp. 136-138).

LCHBs are designated in the local physical environment plan (in Dutch: omgevingsplan). The physical environment plan holds when a permit application is necessary and what the assessment criteria are. The physical environment plan will most likely stipulate that the permit will only be granted if the alteration is in agreement with the interests of historic preservation (Hobma & Jong, 2022, p. 138).

Listing is not a preservation order, preventing change. It does not freeze a building in time, it simply means that the owner of the listed building needs to apply for any changes which might affect the building's special interest and get consent to do so (Historic England, n.d.). In the case of the Netherlands the permit application, and consequent procedure, needs to be undergone at the municipality where the LCHB is located in.

A LCHB can be a building of any typology; it can be a detached single-family home, a terraced canal house, a farmhouse, a whole apartment building, a library, a castle, a palace and many more. This research spans all municipally and nationally listed cultural heritage buildings that are used as homes by their owners.

Numbers of LCHBs in the Netherlands

The Dutch listed cultural heritage building stock consists of more than 63.000 nationally listed cultural heritage buildings (Central Bureau for Statistics, 2022, Ministerie van Onderwijs, Cultuur en Wetenschap, 2022), 55.000 municipally listed cultural heritage buildings, 800 provincially listed cultural heritage buildings, and 450 listed urban conservation areas (in Dutch: beschermde stads- en dorpsgezichten) (Hobma & Jong, 2022, p. 135). Making the cumulative of Dutch LCHBs at least 118.800 LCHBs excluding urban conservation areas. Housing in urban conservation areas can have similar restrictions as neighboring LCHBs, adding these to the LCHB category would drastically increase the number of LCHBs. Similar to the National Heritage List for England a single entry of a LCHB can sometimes cover a number of individual units, e.g. housing units like a row of terraced houses (Historic England, n.d.). Therefore this cumulative number of Dutch LCHBs could hold many more addresses and households than the number implies, however some LCHBs could also not have residents.

The majority of LCHBs are residential buildings (Elbers & Geurts, 2006, p. 6, Nationaal

Restauratiefonds, n.d.) and a large part of these residential buildings are privately owned and inhabited by the owner (Elbers & Geurts, 2006, p. 6). The majority of privately owned LCHBs also function as residential buildings (Briene et al., 2020, p. 19). Due to the lack of information about how many LCHBs have the owner living in it, i.e. being owner-occupied, it is assumed in this thesis that around 50% of listed cultural heritage buildings are both a residential building and owner-occupied.

Numbers of LCHBs in Europe

European countries have different names and classifications for their stock of listed cultural heritage buildings. LCHBs are often classified based on significance, with the more significant LCHBs being protected to a higher degree. **Table 1** shows the numbers of LCHBs in different European countries, with the categories as a simplification, from a Dutch point of view, of the real classification in each country.

Country	Total number of LCHBs	Number of national LCHBs (highest protection)	Number of municipal LCHBs (protected)
Belgium	110.000	10.000	100.000
Italy	60.000	60.000	
France	46.000	46.000	
The UK	500.000	41.500	458.500
Germany	630.000*		630.000*
Switzerland	75.000	2.750	72.250
Denmark	309.000**	9.000	300.000**
Netherlands	118.000	63.000	55.000

Table 1. Numbers of LCHBs (multiple sources)

*Includes listed gardens **Includes phone booths and pavilions (Sources: De Bouw et al. (2017, p. 1), Kurmayer (2023), Ministère de la Culture (2022), Historic England (n.d.), Federal Statistical Office (2018), Federal Statistical Office (2019, p. 1), Agency for Culture and Palaces (2023), CBS (2022), Hobma & Jong (2022, p. 135))

Sustainable renovations

The term renovation refers to any improvement in the performance of a building, distinguishing between medium and large-scale changes. And energy retrofits are often associated with energy saving, which usually takes the energy rating of a dwelling to a higher level (Ebrahimigharehbaghi, 2022, p. 34).

This thesis uses the term ‘sustainable renovation’, this definition encompasses both a renovation and an energy retrofit. However it means more, the term ‘sustainable renovation’ also represents a balanced and holistic approach between social, environmental and economic sustainability (Thuvander et al., 2012, United nations, 1992, as cited in Nielsen et al., 2016). Social sustainability is already more important when it comes to existing housing, since it concerns the residents and their connection to the site (Thuvander et al., 2012). But the real reason, and first point, why sustainability was added is because the preservation of cultural heritage value is contained in the aspects of social sustainability, which are: indoor environmental quality, architectural quality, functionality, quality of life, employment and cultural aspects (Nielsen et al., 2016). Thus, using the term ‘sustainable renovation’ can account for a balanced approach between the renovation and preserving cultural heritage value. Secondly, the term ‘energy-saving renovation’ does not take potential and disproportionately high emissions that the work and materials may emit into account. Luckily, the aspects of environmental sustainability are: energy and environmental impact, and use of resources (Nielsen et al., 2016). And lastly, economic sustainability includes the aspects: construction and operation costs (Nielsen et al., 2016), which are now also holistically taken into the definition of ‘sustainable renovation’.

In short, the term sustainable renovation is defined in this thesis as: a renovation improving the energy performance of a building while taking a balanced and holistic approach between social, environmental and economic sustainability, which includes cultural heritage values. In this thesis a sustainable renovation also requires more than just one measure, because just like Ebrahimigharehbaghi (2022, p. 76) mentions; a sustainable renovation (energy-efficient renovation) entails a more complex decision-making process than a single improvement or reparation (energy-saving measure). Thus, a single sustainable renovation measure or a combination of basic energy-saving measures is not a sustainable renovation. What would suffice as a sustainable renovation are multiple measures, for example the proper insulation of a house (Ebrahimigharehbaghi, 2022, p. 76). Because insulating a house can consist of insulating measures regarding the roof, wall, floor or glass, combining two or more of these measures makes for a sustainable renovation, just like two or more other combinations would.

One LCHB owner calls replacing the roof a restoration, while another calls it maintenance (Hamstra, 2018, p. 9). The replacement of a roof for a more insulated roof without disproportionately high energy use, environmental impact and use of resources, and preserving the cultural heritage value is a sustainable renovation measure in the context of this thesis. Two or more sustainable renovation measures together make for a sustainable renovation.

Hamstra and Kommer (2022) surveyed LCHB owners about their implemented sustainable renovation measures, and identified the following sustainable renovation measures (**table 2**): HE boilers, PV panels, a heat pump, other installation that may fit the definition, all the insulating measures and added interior or exterior windows (in Dutch: voorzestraam). Next to the sustainable renovation measures, there are also basic energy-saving measures (**table 2**): smart use of the heating system, energy-saving lighting fixtures, draft sealing, etc.

Basic measures	2022	Energy supplies	2022	Insulating measures	2022
Energy efficient lighting	80%	HE boilers	69%	Insulated roof	57%
Draft sealing	66%	Solar/PV panels	31%	increase the insulation value of windows	37%
Smart radiator valves	55%	Wood-burning installation	21%	Floor insulation	41%
Pipe insulation	49%	Heat pump	9%	Facade insulation	36%
Smart thermostat	46%	Solar boiler	5%	Added interior or exterior windows	32%
Energy efficient appliances	50%	Hybrid heat pump	3%		
Thick insulating curtains or window shutters	37%	Fuel cell	0%		
Radiator foil	32%				
Chimney damper	13%				

Table 2. Measures carried out in LCHBs, N=526 (translated from Hamstra & Kommer, 2022, p. 17)

Owner-occupiers

In this thesis an owner is defined as: a private owner-occupier of a listed cultural heritage building, who is or can be the investor in a sustainable renovation for his or her building. These homeowners are the main actor of the decision-making process to sustainably renovate their LCHBs, and fully responsible for the realization (Ebrahimigharehbaghi, 2022, p. 247). Thus, each LCHB owner-occupier is, or is part of, the decision-making unit for the sustainable renovation of their LCHB. In 8% of cases a LCHB is inhabited by one owner-occupier who likely comprises the entire decision-making unit. But in 82% of cases 2, 3, 4 or 5 people live in the LCHB (Hamstra & Kommer, 2022, p. 40). This means that the decision-making unit is

likely to be larger and could more often consist of two partners than just a single individual.

The study of Hamstra (2018, p. 19) showed some insights about owners of LCHBs: “Owners are, without exception, proud to own their LCHB. The unique character, history and location ensure that people enjoy living in the LCHB and often want to continue living there for the time being. Despite the pleasure people get from living in a LCHB, people indicate that living in a LCHB also entails burdens. The costs are many times higher, and the rules that must be met also mean that it is not always possible to provide the LCHB with modern living comfort. People often take these burdens for granted for the pleasure of living in a unique home.”

More recent reports of Hamstra (2023) and Hamstra and Kommer (2022) mapped who the owners of listed cultural heritage buildings are and the factors that influence the decision-making process, this research will serve as a foundation to this thesis.

The innovation

An innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption (Rogers, 2003, p. 12). Terms like technology and behavior change are also used interchangeably with innovation. An innovation may have been invented a long time ago, but if individuals perceive it as new, then it is still an innovation (Rogers, 2003, p. 12). The innovation of this thesis is the adoption of a sustainable renovation by the owners of LCHBs.

A technology cluster consists of one or more distinguishable elements of technology that are perceived as being closely interrelated. Some change agencies promote such a package of innovations, because they find that the innovations are adapted more rapidly in that way (Rogers, 2003, p. 14). The Cultural Heritage Agency of the Netherlands also promotes a package/clustered approach for sustainable renovations rather than individual measures. According to Rogers (2003, p. 15) more researchers should pay attention to technology clusters, since in reality the innovations that diffuse at about the same time in a system are interdependent. A sustainable renovation is a cluster of multiple sustainable renovation measures. Therefore, this research also contributes to filling the research gap of innovation clusters.

The decision-making unit

In this thesis the decision-making unit equates to the owner-occupiers of LCHBs. These owner-occupiers make the decision to, or not to, adopt the innovation, i.e. the sustainable renovation of their LCHB.

1.2 problem statement

The built environment determines whether you feel fine and secure, it is a place packed with emotions (Van Hal, 2014, p.7). The built environment is about feeling at home and connected to the environment, and thereby creating cohesion, connection and meaning. LCHBs are a unique and beautiful part of the built environment, they are anchored in history and give meaning to so many peoples’ lives. Thus, it is extremely important LCHBs are well preserved. Van Hal (2014, p. 6) describes how for her sustainable building is less about technology and money, it is about people. Sustainability is about meeting the interests of people. The people of here and now, and of there and later.

Broader context

To tackle the negative effects of large human populations, the European Commission made directives to stimulate sustainable renovations of the existing building stock, such as the Energy Performance of

Buildings Directive (EPBD), the Energy Efficiency Directive (EED), and the renovation wave. Together, the directives promote policies that will help achieve a highly energy efficient and decarbonized building stock by 2050, create a stable environment for investment decisions, and enable consumers and businesses to make more informed choices to save energy and money (European Commission, 2024a).

The EPBD signed by the Netherlands holds many articles with requirements regarding renovations. Article 5 (1) states: “Member states shall take the necessary measures to ensure that minimum energy performance requirements for buildings or building units are set with a view to at least achieving cost-optimal levels and, where relevant, more stringent reference values such as nearly zero-energy building requirements and zero-emission building requirements (European Commission, 2024b).” And article 5 (2) mentions that member states can demand the energy performance requirements of paragraph 1 for listed cultural heritage buildings as well, in so far as compliance with certain requirements would unacceptably alter their character or appearance (European Commission, 2024b).

The EED states in article 4 (1): “Member States shall collectively ensure a reduction of energy consumption of at least 11,7% in 2030 compared to Member States shall make efforts to collectively contribute to the indicative Union primary energy consumption target amounting to no more than 992,5 Mtoe in 2030 (European Commission, 2023)”. And article 4 (2) mentions that the indicative national energy efficiency contribution that each member state has to set also takes residential contribution into account (European Commission, 2023).

The Renovation wave aims to double annual energy renovation rates in the next 10 years, as well as reduce emissions, renovations will enhance quality of life for people living in and using the buildings, and should create many additional green jobs in the construction sector. This all while safeguarding cultural heritage (European Commission, 2020). The renovation wave is also focused on renovating the worst-performing buildings (European Commission, 2020). LCHBs are part of the worst performing residential buildings with regards to energy consumption.

By 2050, the Dutch central government made it known, as a voluntary agreement, that it wants to reduce the Netherlands' emissions of greenhouse gases, like carbon dioxide, to zero. This is outlined in the Energy Agreement for Sustainable Growth that the government made with 40 groups, including employers, trade unions and environmental organizations (Ministerie van Algemene Zaken, 2017). Two years later in 2019, the climate agreement of the Dutch government was concluded with 100 parties. This has the goal of reducing 49 percent carbon dioxide emissions by 2030 and 95 percent by 2050. Affiliated parties are companies, social organizations and parts of the Dutch government itself (Ministerie van Economische Zaken en Klimaat, 2020). The vision set out in the Dutch climate agreement for the built environment reads as follows: “We are on the eve of a sustainable transformation in the built environment, an adjustment of our more than 7 million houses and 1 million other buildings, often moderately insulated and almost all heated by natural gas, to well-insulated homes and buildings, which we heat with sustainable heating and in which we use clean electricity or even generate it ourselves. We will do this step by step until 2050, together with the residents and owners of these buildings” (Ministerie van Economische Zaken en Klimaat, 2019).

In the 1990s policies for sustainable building in the Netherlands were mainly focused on new-built residential areas, today the retrofitting of existing housing stock is of major concern. Apart from applying insulation measures, houses needed to be applied with mechanical ventilation and renewed heating

systems. In occasional cases new energy generation technologies like PV, solar heaters, combined heat power units, or geothermal heat systems need to be implemented (Van Vliet & De Feijter, 2017).

Energy and LCHBs

Homeowners are the ones who make the decision to sustainably renovate, since it is their property, therefore getting them on board is essential for any efforts regarding the energy transition in the existing building stock that is individually owned.

One often overlooked homeowner is the owner of a listed cultural heritage building (LCHB). In the Netherlands, energy labels are mandatory for the sale, rental and new delivery of homes and apartments, however LCHBs are excluded from this rule (Ministerie van Algemene Zaken, 2022). And if LCHBs do have an energy label, which they do not have in 65% of cases, it is most often label G (8%) (Hamstra & Kommer, 2022, p. 41). This indicates that the average LCHB is less sustainable, i.e. energy efficient, than the average residential building. Since 49% of Dutch residential buildings have energy label B or higher, and 74% label C or higher (CLO, 2023). To note however is that energy labels are not mandatory for LCHBs, because the advice that comes with an energy label is generic and not focused on LCHBs. For example, this advice does not take into account the historical construction technique, cultural-historical value and necessary permits (Dubbeld, 2022). The preconditions are different for LCHBs so there is no point in comparing, however this does contextualize the current state of the LCHB stock.

Professionals at the Cultural Heritage Agency of the Netherlands are convinced that the time to reduce the energy consumption of LCHBs is upon us, and sustainable renovations are highly encouraged. Climate goals are an enormous challenge for the Netherlands. LCHBs shall have to become sustainable as well. Not only because of the climate, the preservation of LCHBs also depends on the future use. And future use is depended on a realistic upkeep, e.g. energy costs need to be manageable. Only by sustainably renovating Dutch LCHBs can the buildings be preserved and passed on to future generations (Buchner et al., 2023).

This research is also very relevant for the Cultural Heritage Agency of the Netherlands, since they are the governmental organization that, among other things, shares information to help owners with sustainable renovations.

Customized work/tailor-made solutions

A cliché is that LCHBs cannot be changed in any way, this might have been more pronounced a decade or two ago, however many municipalities allow for sustainable renovations. Whenever sustainable renovations are allowed, the LCHB that is proposed to be altered needs to be individually assessed (Hobma & Jong, 2022, p. 136). This requires customized work (maatwerk), i.e. a tailor made solution, for each sustainable renovation of each LCHB. The restrictions are based on the listed building status, which is derived from the cultural heritage value of the LCHB. And the cultural heritage value of different LCHBs is rarely identical. Customized work still allows multiple sustainable renovation measures. Thus, a sustainable renovation can only be undertaken as long as the preconditions of the cultural heritage values of the LCHB are taken into account.

Instead of dealing with customized work and the balance between cultural heritage values and sustainable renovations, this thesis tackles the processes that are general in each sustainable renovation

decision-making process. For instance, each owner needs to: gather information, make a design and plan, often go through a permit application process, realize the sustainable renovation and end up in a confirmation stage. Together these general steps are called a decision-making process or customer journey. This thesis addresses the relevant literature about decision-making processes and builds upon it with new information that may help owner-occupiers of LCHBs with their sustainable renovation journey.

1.3 Societal and scientific relevance

The research group of LCHB owners is chosen because an impact can be made here for several reasons.

1. Individuals make decisions to adopt an innovation generally more rapidly than organizations. The more persons involved in making a decision to adopt an innovation, the slower the rate of adoption (Rogers, 2003, p. 221).
2. LCHBs offer untapped potential when it comes to sustainable renovations in the existing building stock, because making LCHBs more sustainable can be a challenge, however much can be learned; if a LCHB can be made sustainable, many other buildings can too.
3. Sustainable renovations in LCHBs still have much potential. A small study of 41 LCHBs in the Dutch Municipality of Rheden found that 80% of the studied LCHBs can obtain an energy label A or B with the preservation of cultural heritage values (Haitink, n.d.). And a professional explained to the researcher that LCHBs have not been subjected to many rules that non-LCHB buildings are, thus interventions in the LCHB stock could be much more effective.
4. The average floor area of houses that are part of a LCHBs or are a LCHB outright, is close to 250 square meters (Hamstra & Kommer, 2022, p. 41). Meanwhile the average Dutch residence is 120 square meters (Central Bureau for Statistics, 2013), this means the impact of sustainably renovating LCHBs could be more significant.
5. The Dutch government has the aim to reduce 40% of CO₂ emissions in 2030 and 60% in 2040 for national, provincial and municipal LCHBs (Duurzaam Erfgoed, 2019).
6. 82% of LCHB owners are considering to realize sustainable renovation measures in the future (Hamstra & Kommer, 2022, p. 27).
7. Dutch provincial Monumentguards say the need for information about sustainability is high among owners (Monumentenwacht, n.d.).
8. Questions about how to deal with obstacles when trying to sustainably renovate LCHBs have been asked multiple times in the Dutch parliament, one recent time in 2021 (Rijksdienst voor het Cultureel Erfgoed, 2022).
9. The Cultural Heritage Agency of the Netherlands views making LCHBs more sustainable as being inextricably linked to the preservation of heritage in the future (Ministerie van Onderwijs, Cultuur en Wetenschap, 2022).
10. Costs LCHB owners incurred to realize a sustainable renovation are significant: in 25% of cases between 25.000 and 50.000 euros, 15% between 50.000 and 100.000 euros and 14% more than 100.000 euros (Hamstra & Kommer, 2022, p. 25).
11. It is important to help LCHB owners since many are enthusiasts who maintain and sustainably renovate their LCHBs out of love, while paying extra for energy costs, advice and labor.

1.4 Research questions

Main question

How to increase the adoption of sustainable renovations in listed cultural heritage buildings by providing insight into the decision-making process of private owner-occupiers?

Sub questions

Sub 1: What are the prior conditions of the decision-making process and the characteristics of the decision-making unit?

- Answered with a theoretical research and interviews of LCHB owners.

Sub 2: What is the decision-making process for owner-occupiers of listed cultural heritage buildings to sustainably renovate?

- Answered with a theoretical research and interviews with both professionals and LCHB owners

Sub 3: What are the drivers, barriers and opportunities for LCHB owners during the decision-making process to sustainably renovate their listed cultural heritage building?

- Answered with a theoretical research, interviews with LCHB owners and professionals and a workshop with professionals.

Sub 4: What are the personas of LCHB owners and how can they be used to increase adoption of sustainable renovations?

- Answered with theoretical research and interviews with LCHB owners.

Sub 5: How is the adoption of sustainable renovations different in LCHBs than in non-LCHB?

- Answered in the theoretical background, the interviews with LCHB owners and professionals and the workshop with professionals. But not with specific chapters, and rather dispersed between the chapters of the other sub questions.

The reason behind the sub questions

The structure of the sub questions accounts for all of the aspects of the innovation-decision process of Rogers (2003), **figure 2**, regarding sub questions 1, 2 and 3. Sub question 4 about the personas was first partly answered in the theoretical research of sub question 3, since it is an opportunity, but this opportunity is explored much further than others, thus it deserved its own sub question and results and discussion subchapters. Lastly, sub question 5 is added to easily have an overview of the difference between LCHBs and non-LCHBs, which helps to relate the results of this thesis with the broader context of how to increase sustainable renovations in the existing owner-occupied housing stock.



2. Research method

The research method chapter consists of:

- 2.1 Research design
- 2.2 Data collection
- 2.3 Data analysis
- 2.4 Data plan
- 2.5 Ethical considerations
- 2.6 Research output

2.1 Research design

A literature review combined with a qualitative empirical research is the most suitable approach to answering the research questions. Detailed open-ended interviews can garner a deeper understanding about the sustainable renovation decision-making process of homeowners (Arning et al., 2020, Skelton et al., 2009, as cited in Wilson et al., 2015, Emmert et al., 2010, as cited in Wilson et al., 2015).

The research design consists of three types of research: (1) the theoretical background, (2) the empirical research and (3) finalizing. The research design is shown below, in **figure 1**, and includes: a schedule, the research type, the data collection, how the research questions are answered and the research output.

The schedule is based on time frames that are derived from the P terms, these P terms were extended.

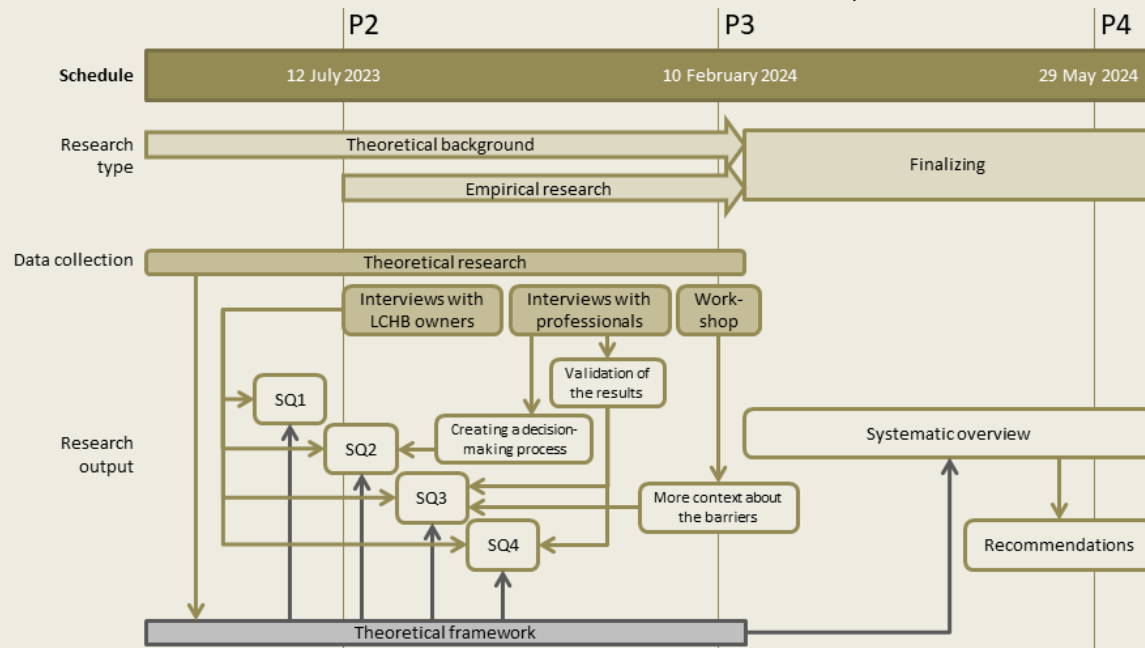


Figure 1. Research design (author)

Theoretical background

The first type of research is a theoretical research which sought to answer all of the four research sub questions. This resulted in the theoretical background (chapter 2). The theoretical background serves as

a fundament for the upcoming empirical research, since it represents the guidelines for the collection and analysis of empirical data.

Empirical research

The second stage is about collecting the data of the empirical research. This stage focuses on collecting answers on all of the four research sub questions with semi-structured interviews and a workshop. The interview results validate or contradict the decision-making process of the literature. And the interviews and workshop give clarity about the underlying factors and behaviors that influence LCHB owners' decision for a sustainable renovation.

Finalizing

The third stage is about analyzing, and concluding on, the data of the empirical research; addressing all of the research sub questions plus the main questions. This is done by reflecting on the differences between the literature and the results of the interviews and workshop. For example, the differences between the decision-making process of the literature and the interviews. And a systematic overview of the results, e.g. the drivers and barriers of the interviews, leads to the identification of the interesting areas where improvement can occur; leading to recommendations.

2.2 Data collection

The data collection of this research consists of theoretical research, semi-structured interviews with owners and professionals and a workshop with professionals. The theoretical research was necessary to provide the theoretical support. The semi-structured interviews were necessary to gather information about LCHB owners': prior conditions, characteristics, sustainable renovation decision-making process, drivers and barriers. This subchapter describes how the data collection occurred.

2.2.1 Theoretical research

The theoretical research combined sources from books, reports and scientific papers, resulting in the theoretical background. To collect this data, the search engine google scholar was used, making use of the keywords: decision-making, residential, homeowners, energy-efficient retrofit, renovation, personas. Later on, the mentor team proposed fundamental literature, i.e. Rogers (2003) and Ebrahimigharehbaghi (2022) from the TU Delft repository.

2.2.2 Semi-structured interviews

Besides the workshop, the empirical research uses a qualitative inductive research method, consisting of semi-structured interviews. This was chosen by the researcher as the most suitable data collection technique to create sufficient understanding regarding the research questions.

The semi-structured nature of the interviews coupled with a relatively low number of participants offers the flexibility and time to cover almost all of the concepts, factors and variables in each interview, allowing for a wide range of results which is useful for qualitative inductive research.

2.2.3 Sample size interviews

Sim et al. (2018) concluded that when the goal of the research is to create sufficient understanding of what is still unknown through inductive, exploratory research, then defining a sample size of participants

prior to the research is inherently problematic, because the key themes of the explored phenomena cannot be identified in advance. A rough estimate of the sample size may be given at the start of such a research. However, an adequate sample size that meets a study's aims is subjected to the ongoing process of interpretation by the researcher. "The sample size is an iterative, context-dependent decision made during the analytical process as the research begins to develop an increasingly comprehensive picture of the developed themes, the relationship between these themes, and where the conceptual boundaries of these themes lie (Sim et al., 2018)." Sim et al. (2018) adds that the issue of sample size should not constitute a disproportionate importance that overshadows other essential elements of the qualitative data collection and analysis.

The number of research participants of this master thesis, as shown in the following data collection subchapters, was determined by the researcher based on trying to answer the research question as good as possible, and on saturation of the research data. Regarding whether or not this sample size indicates that saturation has been achieved depends on the type of research, which needs to be clearly articulated by the researcher (Saunders et al., 2017). The type of research is covered in the previous section (2.2.2). Moreover, the saturation, or completeness of the research data, can be gauged by the saturation, or repeating, of data. This saturation of data occurs when the same things are emphasized by multiple participants in different interviewees, or workshops where the information is also starts to repeat. Thus, the decision to stop collecting data on this topic because it is no longer necessary can be made by the researcher, and the saturation is based on the researcher's sense of what they are hearing within interviews (Saunders et al., 2017). Meaning, the researcher can pivot to new questions, stop with the interview and/or interview new participants, thereby making the work more efficient, less time spend on coding interviews and more time for finding inductive results. This is also the data collection approach of this master thesis, and the reason why the number of participants, time spend with interviewees and amount of topics covered is what it is, besides because of reaching the goal to cover all the factors and variables of the theoretical background and determining their importance.

2.2.4 Interviews with LCHB owners

The interviews with LCHB owners make up the vast majority of the empirical research. The interview results build on the theoretical background about the decision-making process and the factors and variables that influence it.

To find the LCHB owner-occupiers that would be interested in participating in a semi-structured interview. A blog post was made on a Dutch LCHB forum community named the 'Monumenten Community', with a call to action to fill in their contact details and the following selection criteria on a form of the Cultural Heritage Agency of the Netherlands. This form included:

- Name
- Email
- Age
- Address
- Type of LCHB (Municipal/national LCHB)
- Function of the LCHB (residence)
- Years of LCHB ownership

- Condition of the building

The goal of the selection criteria was to select the participants in such a way that their characteristics matched, percentage wise, the characteristics of the group of LCHB owners at large. Only owners who had realized a sustainable renovation were interviewed. This makes it possible to research all of the stages, because they went through the whole decision-making process, plus these research subjects are the most knowledgeable about sustainable renovations. Another selection criteria was that the main interview participant was the owner with most of the building technical knowledge of their household, while taking into account that partners were also part of the decision-making unit.

All of the interviewees were volunteers. All of the interviews were audio recorded and transcribed. The transcripts and interviewees were anonymized and given a number. Only a limited amount of interviews were conducted, since the format of the interviews is more about exploring the whole decision-making process, and less about proving certain results, e.g. barriers, statistically, which has been done by Hamstra and Kommer (2022) and Hamstra (2023). Too many interviews could also lead to overlapping information, making the time spend on later interviews less useful than on earlier ones.

Lastly, sustainable building research has been the scene of socially desirable answers. To conduct interviews with genuinely wonderful results, the existing emotions need to be touched (Van Hal, 2014, p. 16). The results of this thesis are surely results that came together with strong emotions.

2.2.4.1 Interview structure owners

The semi-structured interviews with LCHB owners started with an unrecorded welcome section where the researcher explained the decision-making process as described by the professionals and the literature. And the welcome section contained an explanation of the interview structure, that was: (1) telling a little bit about the LCHB and mainly about the sustainable renovations the owner realized in their LCHB, (2) going through owners their decision-making process stages and (3) questions about owners' sustainable renovation personality. Then, the recorded part started and the interview structure (1-3) commenced. Inspiration was taken from Arning et al. (2020).

1. The LCHB and the sustainable renovation

The researcher sought to understand the sustainable renovation that was realized to validate if it really was a sustainable renovation, and to understand the influence it had on the decision-making process. Thus, this part had many questions about the prior conditions of the decision-making process, for example regulations that applied to the LCHB. More prior conditions also came to light in later parts of the interview.

2. the decision-making process

The LCHB owners were guided through all of the stages of the decision-making process, and asked to reflect on each stage in depth. From the initial idea to the realization and confirmation of the sustainable renovation. During each of the stages the following questions were asked:

- What were the barriers
- Which stakeholders influenced the process?
- What information influenced the process?
- Did owners trust this information, think it was credible and useful?

- How was the complexity solved?
- What created uncertainty in the process?
- How did you share your acquired information on?

And other questions that were asked here were:

- What was the motivation to go on?
- What was the difference if it was not a LCHB?
- What are the specific solutions you found or designed?
- What policy would you propose?
- Would an obligation to send a masterplan of a sustainable renovation to the municipality help to make the process easier?
- Would information gatherings with a local group of LCHB owners help make the process easier?
- How and why they procured architects, contractors, etc?
- Attitude towards the financial incentives (subsidies/loans)?

Owners were also allowed to propose a different decision-making process that was more aligned with how they experienced the process.

3. Sustainable renovation personalities

This part was added to explore the characteristics of the decision-making unit, and to look for patterns among LCHB owners which allow the categorization of owners into personas. Personas allow for a more targeted and tangible representation of owner-occupiers which can be useful for policy makers (Haines & Mitchell, 2014). The questions were based on the personality variables of Haines & Mitchell (2014), who also created personas out of a small sample of owner-occupiers (N=33 (20 households)):

- Does your profession involve working with buildings/LCHBs, sustainability or construction?
- How do you balance the cultural heritage values with the sustainable renovation? Do you regard yourself more as a modernizer or restorer?
- Do you have a low or high motivation for DIY (doing it yourself)?
- Do you have a low or high trust in professionals (architects, advisors, contractors) to realize the sustainable renovation?
- Do you have a low or high trust in civil servants/ government bodies to help with the sustainable renovation?
- Do you have a low or high tolerance for disruption of the sustainable renovation process?
- Do you have a low or high hunger for information (the urge to research everything regarding the sustainable renovation)?
- Do you have a low or high interest in saving energy?
- Do you have a low or high price sensitivity?
- Do you have a low or high concern about climate change?
- Do you like or dislike a challenge regarding the sustainable renovation?
- Do you have a low or high expectation of comfort in the LCHB (heating, ventilation, cooling)?

And some even more personal questions:

- Did you make use of low interest loans, subsidies and/or tax deductions?
- How did you pay for the sustainable renovation? (income/wealth/savings/inheritance)
- What is the household comprised of?
- What is the household income?
- Level of education?
- Would you still buy the LCHB knowing a certain energy label needs to be achieved in 5-10 years with sufficient support from the municipality?

The duration of each interview was at the minimum one hour, but 2 hours on average, since a few interviews with LCHB owners exceeded 2 hours, especially when the researcher visited their LCHB.

2.2.5 Interviews with professionals about the decision-making process

Before the interviews with the LCHB owners started, descriptions of the decision-making process from the perspective of professionals were gathered and combined with the decision-making process of the literature to create a decision-making process that is most applicable to LCHB owners. Because the decision-making process of the other literature is much more compact compared with the one from the theoretical background (**figure 4**). Subsequently, this decision-making process was used as a tool for the interviews with the LCHB owners.

The professionals that were interviewed (N=7) to create the decision-making process were: two construction engineers, two municipal cultural heritage advisors, one marketing specialist and two heritage building coaches. They were asked to: (1) explain the decision-making process Dutch LCHB owners go through to realize a sustainable renovation, (2) identify the other stakeholders in the decision-making process and (3) indicate barriers to the sustainable renovation decision-making process.

The decision-making process was drawn up on an A4 paper and voice recorded, with the recording subsequently transcribed. The firms and government bodies of the professionals were contacted by email, which led to the semi-structured interviews about the decision-making process.

These prior interviews with professionals also made the research more practice-orientated and prepared the author of this thesis for the reality of the work field.

The duration of each interview was approximately one hour.

#	Professional	Title and expertise
1	Sjoerd Slagter	Marketing specialist regarding sustainability, heritage, real estate and finance (loans/subsidies)
2	Nadja keuter	Heritage building coach, advice and guidance about finance, the process of restoration and maintenance of LCHBs
3	Barbara Geus	Heritage building coach, advice and guidance about finance, the process of restoration and maintenance of LCHBs
4	Hans de Witte	Advisor heritage & sustainability
5	Rients-Anne Slotema	Advisor heritage & sustainability
6	Jeroen Goudeau	Architectural historian, heritage advisor
7	André van Veen	Project manager of an architecture firm, specialized in final designs, building permits and specifications.

Table 3. First round of professional interviewees (author)

2.2.6 Interviews with professionals about the results

A second round of interviews with different professionals (N=7) was held after the interviews with LCHB owners to verify the information given by LCHB owners, rate whether the information was important

enough for this thesis and to come up with creative solutions to barriers owners faced, leading to recommendations. This was also undertaken due to the shortcomings of qualitative research, thus strengthening the credibility of the results.

The professionals were contacted by email or through the networks of officials. And all of the interviews were voice recorded and transcribed.

The duration of these interviews was on average one and a half hours, with some exceeding two hours.

#	Professional	Title and expertise
1	Jeroen Westerman	Architectural historian, advisor heritage & sustainability
2	Harriën van Dijk	Architect, specialized in: architectural history, restoration, repurposing and renovation
3	Heidi Buijs	Advisor heritage
4	Vincent de Kieviet	Advisor heritage
5	Christine Huisman	Advisor culture and heritage
6	Frank Buchner	Program manager for the Heritage and Sustainability Program
7	Michael de Langen	Operations coordinator of the Monumentguard Zuid-Holland

Table 4. Second round of professional interviewees (author)

2.2.7 Workshop

The workshop is a more quantitative method to understand and validate the drivers and barriers of the sustainable renovation decision-making process. A workshop was held for cultural heritage and sustainable renovation professionals (N=25) by the municipality of Haarlem on the 9th of February 2024. Present were 28 participants, of which: 16 were professionals, 9 were civil servants of the city of Haarlem, 2 were from supporting organizations and the author of this thesis. Most of the professionals were from the region of Haarlem and there were some from the Cultural Heritage Agency of the Netherlands. Participants were asked to participate by the municipal officials who held the workshop or recommended to go by officials from the Cultural Heritage Agency of the Netherlands in the case of the author.

The professionals identified the top 10 barriers that are obscuring sustainable renovations (**appendix I**) by going around the room, having between twelve and fifteen professionals mention a barrier that came to mind that had not yet been mentioned. Subsequently, a few barriers were deemed irrelevant by the municipal officials who held the workshop and were thus eliminated, leaving 10 barriers remaining. These 10 barriers were categorized according to prevalence by allowing every participant to place 3 stickers, with one, two and three points, on the board next to their 3 perceived to be the most relevant barriers. This resulted in a categorization of points, with the first few barriers being quite important and the last few less so.

2.2.8 Sustainable renovations of the LCHB owners

The interview data of the LCHB owners was collected from the owner-occupiers of nine households (N=9), due to the input of partners the actual owner-occupier participant count was twelve (N=12). All owners realized a different sustainable renovation, therefore this section clarifies what the participants understood as a sustainable renovation. Plus a description of their LCHB for context, which already includes prior conditions (e.g. the characteristics of the building).

Owner	Description LCHB	Description sustainable renovation(s)
1	National LCHB. Terraced house, dating back to at least the 17 th century, but probably older. Located in the center of a small city. Condition: good.	Staged in 3 different steps with multiple years in between each sustainable renovation. <ol style="list-style-type: none"> 1. An integral insulation of the outer shell including the roof and the walls, this includes layered glass (painted with metal) in the façade (not recommended), monument glass in the rear façade and vacuum glass in the back door. Also shutters for behind the window frames were made and installed. 2. PV panels on the roof, which were replaced by newer ones with more capacity 10 years later. 3. An air heat pump, not a regular one but a heat pump that is still in a development stage.
2	Municipal LCHB. Parsonage, dating back to around 1900. Located in a village. Condition: reasonable.	The sustainable renovation is undertaken in one continuous step. <ol style="list-style-type: none"> 1. Interior added windows were installed on the first floor, PIR insulation boards were installed on the walls of three rooms, insulating the rooms towards both the exterior and interior. 2. The interior walls of the three rooms were plastered with lime for moisture balance. 3. PV panels were installed on the roof of an outbuilding (carport), this outbuilding is not part of the LCHB and thus no permit was needed. 4. Solar collectors for a solar boiler are also on the roof of an outbuilding. 5. Roof leakages were fixed and the drained insulation of the roof replaced.
3	National LCHB. A large terraced house from the late 19 th century. Located in the center of a large city. Condition: good.	In a time span of 10 years the sustainable renovation measures were continuously implemented, including: <ol style="list-style-type: none"> 1. Exterior added windows in front of (from the outside) the original stained glass windows. 2. The roof and the floor were insulated. 3. Window frames that lost most of the heat were reduced in size. 4. A new concrete basement floor to stop the groundwater from entering.
4	Municipal LCHB. A large detached house from the interwar period. Located close to the center of a large city. Condition: good.	The sustainable renovation occurred in two steps. The first one was 20-15 years earlier and only included interior added windows behind (from the outside) the stained glass windows. The second one was in 2019 and included: <ol style="list-style-type: none"> 1. Insulating the roof while keeping the original roof tiles. 2. Installing an air heat pump on the original central heating system, except for replacing two original radiators for a low temperature radiator more suited for the heat pump. 5. Solar collectors. 6. Replacing an unoriginal steel window frame with a wooden one with HR++ glass. 7. Sealing gaps, such as windows that can be opened were sealed shut. 8. Balanced ventilation with heat recovery.
5	National LCHB. A large detached country house from the 17 th century. Located on the outskirts of a village in the countryside. Condition: good.	There were two main distinct sustainable renovations; first the exterior and secondly the interior. And two smaller sustainable renovations took place. <ol style="list-style-type: none"> 1. Restoring the whole outer shell; roof, window frames and the plaster on the entire wall. And adding insulation to the roof with a multi-layered foil. 2. The interior included: 3. Completely redoing the central heating system. Low temperature wall heating heated by a buffer tank powered by solar collectors or by biomass boilers, and high temperature radiators heated by biomass boilers. 4. Completely redoing the electrical system. 5. Redoing the water and sewage system. 6. Sustainable renovations in outbuildings, which includes also both exterior and interior. Exterior being the outer shell, and interior a boiler was installed that is heated by the buffer tank from the main building.
6	National LCHB. Detached house from the early 19 th century. Located in a very small city. Condition: good.	Ongoing sustainable renovation of 10 years, with measure 5 and 6 occurring even later, that included: <ol style="list-style-type: none"> 1. Fixing leaks 2. Interior added windows 3. Insulating the interior of the roof and the brick wall. 4. Humidifier to remove moisture from the air. 5. Replacing single glass by double glass. 6. A draft door in the hall.
7	National LCHB. Terraced house from the early 18 th century. Located in the center of a large city. Condition: good.	Staged in 4 steps with multiple years in between the sustainable renovations. <ol style="list-style-type: none"> 1. Central heating system including floor heating in a new basement floor, mechanical air extraction ventilation, wall insulation and interior added windows. 2. Roof insulation with a complicated package of foil and an insulated interior rear wall. 3. Monument glass 4. Vacuum glass
8	National LCHB. Farmhouse, dating back to around 1700. Located in a village. Condition: reasonable.	One ongoing sustainable renovation of multiple years, that included: <ol style="list-style-type: none"> 1. Interior added windows 2. 8 mm of floor insulation underneath the parquet. 3. A thermostat, Honeywell Home, which is programmed to heat only the rooms that are used. 4. PV-panels 5. Electrical kitchen appliances, electrical hob etc. 6. Replacing the radiators with new convactor radiators.
9	National LCHB. Train station, dating back to the end of the 19 th century. Located in a village. Condition: good.	<ol style="list-style-type: none"> 1. Double glass 2. Insulation with sheep's wool in the roof and the upper floors, ground floor insulation with Rockwool and exterior wall insulation with 10 cm layer of techno plaster with a vapor permeable lime plaster. 3. Rerouting a heating pipe through a damp wall.

Table 5. Descriptions of owners their LCHBs and sustainable renovations (author)

2.3 Data analysis

The interviews were audio recorded and transcribed, and the transcripts were analyzed with a qualitative content analysis, using Atlas.ti software as a data analysis tool. A qualitative content analysis entails a group of codes that are applied, i.e. coded or marked, onto the text of the transcription. The group of codes was based on the factors and variables of the theoretical background. Thus, the analysis entailed going over all of the transcripts and marking, i.e. coding, each part of the text that conveyed something about the factors and variables or showed a new variable. This provided a clear oversight of the factors and variables that influence the decision-making process, since a variable can be selected and the coded text of all of the interviews that relate to that variable are shown.

This method of analysis is similar to Broers et al. (2019) and Arning et al. (2020), since they both used semi-structured interviews that led to factors that influence the decision-making process as well, although Broers et al. also made extensive use of a survey and Arning et al. had more participants.

Another way the data of the interviews was analyzed was by making the most appropriate types and number of personas. The interview data had been gathered by asking questions to LCHB owners, these were based on the theoretical background, in particular about prior conditions (3.1.1), characteristics (3.1.2) and barriers (3.3). For example, questions about their sustainable renovation personality which is part of the characteristics (personality variables 3.1.2.2). These personas can be used in the future by change agents for strategizing.

2.4 Data plan

This thesis will be accessible for everyone in the TU Delft repository, and finding it can be done with the keywords. The consulted literature in this report is all referenced using APA 7th, and can thus be found easily. Only the processed data will be made public on the TU Delft repository. The raw data, e.g. the interview transcripts, will remain private to comply with the ethical issues pertaining to the protection of the participants identities. For a more detailed description of the data plan, the data management plan is added in **appendix IV**.

2.5 Ethical considerations

Anonymizing transcriptions is about only leaving in the details that are essential to the point that is being made, and creating a smoke screen where necessary. This process of anonymizing is extremely time-consuming. And even with all the effort, anonymity cannot be completely guaranteed if interviews are shared (Saunders et al., 2014).

The transcriptions of the interviews are anonymized, which includes their statements, quotations and details that could lead to their person. The anonymization code of each interviewee is just a number that only leads back to the transcription, and in this document to details about their LCHB and their sustainable renovations. By keeping the personal data of the research participants private they are protected from potential risks, which in turn makes them able to provide truthful responses. The anonymized collected data, i.e. transcriptions, are stored securely and only accessible by the research team, and not shared, thus guaranteeing the largest amount of privacy for the interviewees.

Fully informed consent was required for every LCHB owner who participated, by means of signing the consent form (appendix V). This consent form aligns with Saunders et al. (2014) who concluded on

how to maximize informed consent, which includes asking permission for the research team to access and archive the data, and to alert participants to the possibility of future, currently unanticipated risks to their anonymity. Saunders & Townsend (2018) also emphasize the need to act ethically and ensure that the rights of participants are respected. This can include open and honest communication with participants, and following through on the agreed-upon precautions to put the safety and wellbeing of participants first.

2.6 Research output

Goals and objectives

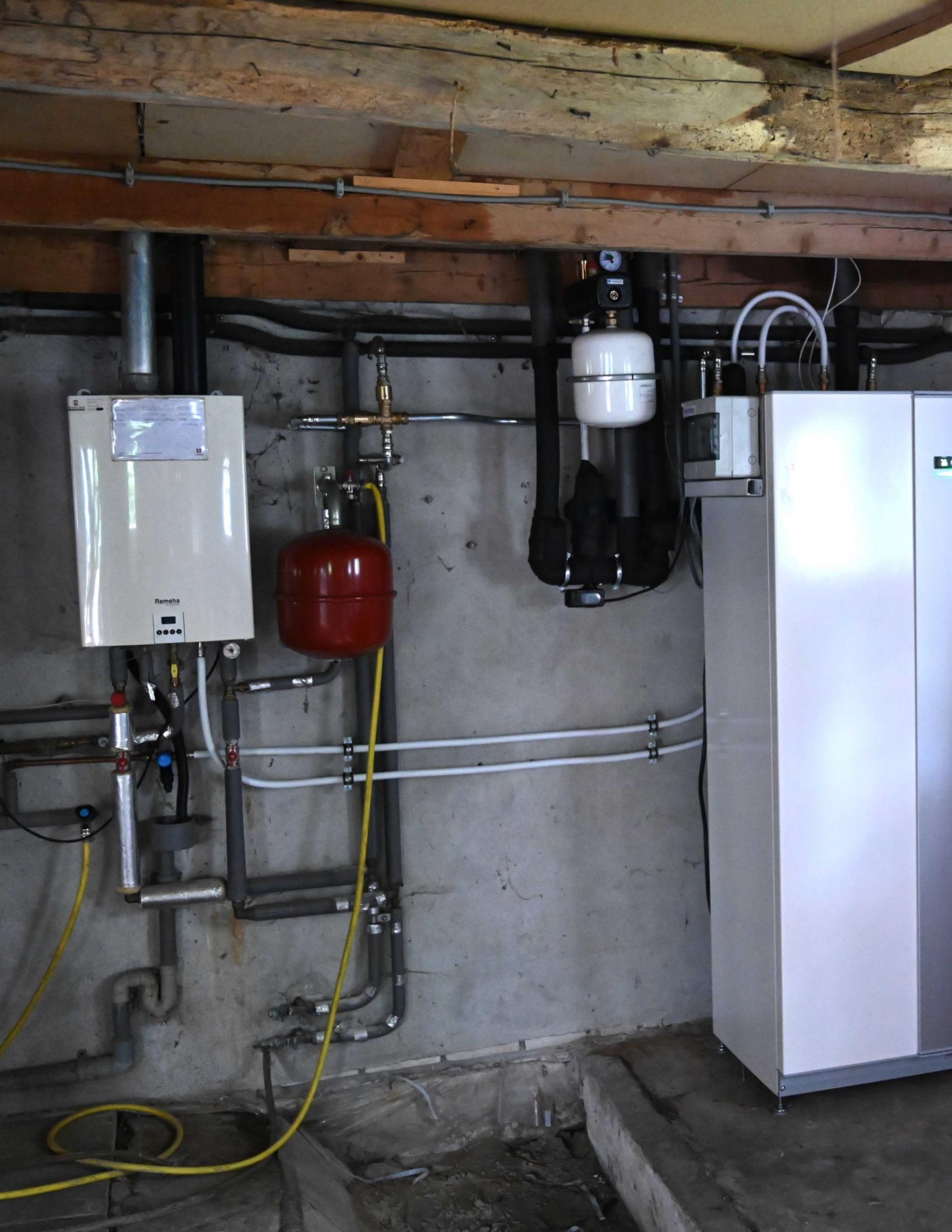
- Creating the sustainable renovation decision-making process of LCHB owners.
- Finding the factors and their variables influencing the decision-making process of LCHB owners.
- Using the knowledge and insights gained from LCHB owners and professionals to develop useful recommendations that can lead to promising policy steps to assist LCHB owners in their sustainable renovation goals.

Deliverables

- The sustainable renovation decision-making processes of LCHB owners.
- Factors and variables that influence the decision-making process.
- Recommendation to help LCHB owners in the sustainable renovation decision-making process.

Audience

This research is useful for the Cultural Heritage Agency of the Netherlands, sustainable renovation and heritage professionals in municipalities, foundations and associations in the heritage sector and LCHB owners. The findings of this thesis can highlight areas of interest to policymakers, or other influential stakeholders, that they may not have considered yet. This is because this report delves into much detail about the decision-making process, which may lead to new understanding or even new policy interventions.



3. Theoretical background

The theoretical background chapter consists of:

- 3.1 Prior conditions and characteristics
- 3.2 Decision-making process
- 3.3 Drivers, barriers and opportunities
- 3.4 Theoretical framework

3.1 Prior conditions and characteristics

A decision-making process is not a vacuum. There are preconditions that shape the decision-making process. And the decision-making process depends on the characteristics of the individual or group that is making the decision. Therefore the (1) prior conditions of the decision-making process and the (2) characteristics of the decision-making unit are mapped in this literature chapter.

Sub question 1: What are the prior conditions of the decision-making process and the characteristics of the decision-making unit?

To answer this sub question, this thesis uses the prior conditions of the decision-making process and the characteristics of the decision-making unit of Rogers (2003, p. 171) (**figure 2**). This subchapter only concerns the prior conditions and characteristics of the decision-making unit and their relationship with the decision-making process. The remainder of the decision-making process of Rogers (2003, p. 171) will be used in the next subchapter, where several relevant decision-making processes are bundled together into one literature decision-making process.

Rogers' theory does represent a fundament of diffusion theory, and is a true and tested method to analyze the adoption of innovations. Rogers (2003)' prior conditions and characteristics also covers similar ground as the contextual and personal behavioral factors of Ebrahimigharehbaghi (2022, p. 106).

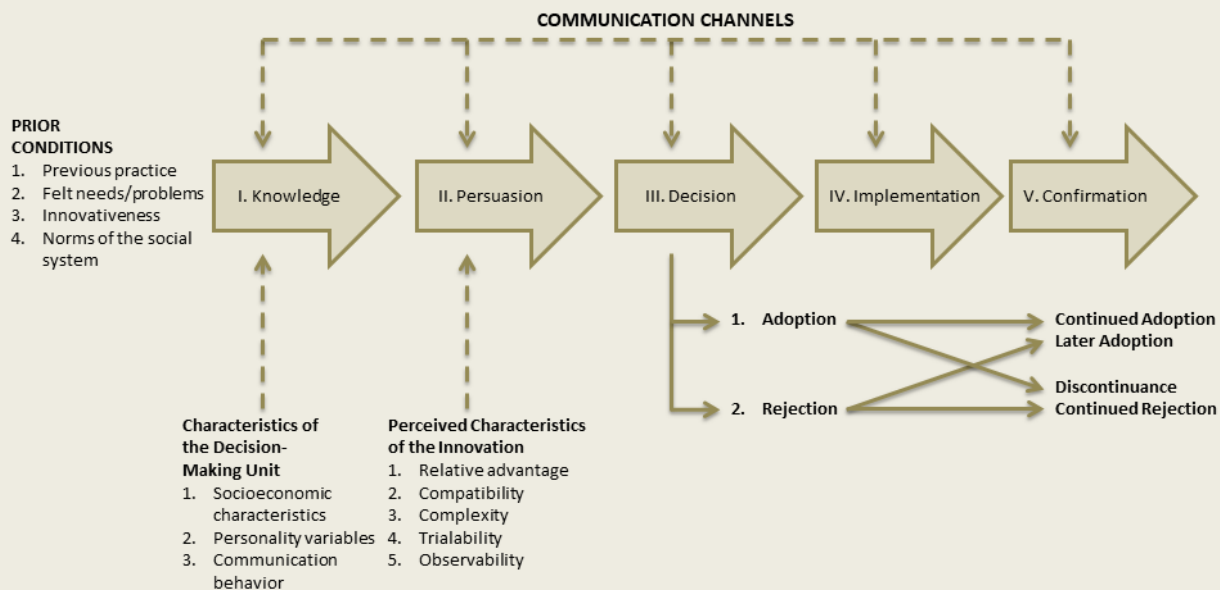


Figure 2. The decision-making process (innovation-decision process) by Rogers (2003, p. 171)

3.1.1 What are prior conditions of the decision-making process?

Decisions and events occurring previous to the adoption of an innovation often have a strong influence on the diffusion process (Rogers, 2003, p. 136). The prior conditions are explanatory variables for sustainable renovation propensity (Wilson et al., 2018). For example, the exact sustainable renovation measures depend on the preconditions that each LCHB is subjected to. This thesis identified the prior conditions of the decision-making process by taking inspiration from both Rogers (2003, p. 170) and Wilson et al. (2018) to get a full picture. First, the prior conditions, i.e. conditions of domestic life, of Wilson et al. (2018) were used, which can be summarized into the categories: characteristics of the building, characteristics of the household and occasions. And secondly, the prior conditions of Rogers (2003, p. 170): previous practice, felt needs/problems, innovativeness and norms of the social system.

This subchapter is structured as follows: (1) the header is explained, (2) the variables and their influence on the decision-making process are explained and the (3) reports of Hamstra and Kommer (2022) and Hamstra (2023) are referenced to address what the prior conditions for LCHBs are, if they are available.

3.1.1.1 Characteristics of the building

The LCHBs of owners differ greatly (Briene et al., 2020, p. 19), to make sense of these differences the characteristics and their correlations are mapped in this subchapter. The variables of the characteristics of the building are: age, location (Wilson et al., 2018, Nair et al., 2010), typology, size (Wilson et al., 2018), technical restrictions, government regulations (Stieß & Dunkelberg, 2013) and condition.

Age

The age of the building may have an impact on an owner's decision to implement a sustainable renovation. Because old buildings may be in poor physical or aesthetic condition, thus requiring sustainable renovation measures (Nair et al., 2010). Older buildings predict a propensity to change things around at home including through a sustainable renovation (Wilson et al., 2018).

Year of construction of LCHBs	%
Until 1799	40%
1800-1899	32%
1900-1999	28%

Table 6. LCHBs year of construction, N=526 (translated from Hamstra & Kommer, 2022, p. 40)

Location

Nair et al. (2010) found that the geographical location of the buildings of owners may influence the adoption of a sustainable renovation; with regions far away from big cities having higher adoption rates.

When it comes to LCHBs, they are not evenly spread through the Netherlands, because some municipalities have disproportionally high amounts of LCHBs. For example, the municipalities with the most municipal LCHBs are: Utrecht (3.491), Maastricht (2.000), Amsterdam (1.639), Leiden (1.574), Zeist (1.538), Apeldoorn (1.303), The Hague (1.300), Haarlem (1.238) and Eindhoven (1.080) (Redres, n.d.).

Typology

An easy way to categorize building typologies is by the original function the building was built for. For example, churches are similar to other churches and have different preconditions than farmhouses. Many tools have been developed to show the different sustainable renovation options between

buildings with different original functions, such as ‘De Groene Menukaart’ of De Groene Grachten (n.d.). The building typology is thus a prior condition that influences the sustainable renovation measures that are likely to be undertaken. An example is that owners of apartments and semi-detached houses have the highest probability of installing a boiler rather than other building typologies (Ebrahimigharehbaghi, 2022, p. 119).

The typologies of Dutch LCHBs are measured by the Ministry of Education, Culture and Science: 51% are residential houses and housing complexes, 21% farms, mills and companies, 11% religious, 4% castles, country houses and parks and 13% other (Ministerie van Onderwijs, Cultuur en Wetenschap, 2022). The LCHBs of owners who partook in Hamstra and Kommer (2022) and Hamstra (2023) are in table 7.

Typology of LCHBs	Hamstra and Kommer (2022), N=526	Hamstra (2023), N=1.043
Residential	58%	56%
Farm	21%	20%
Church or monastery	3%	4%
Castle or country house	4%	5%
Mill or pumping station	1%	1%
Industrial		3%
Other	13%	11%

Table 7. Typology of LCHBs (translated from Hamstra & Kommer, 2022, p. 40, Hamstra, 2023, p. 5)

Size

Smaller buildings predict a propensity to change things around at home including through a sustainable renovation (Wilson et al., 2018). And larger buildings are more likely to require more work than smaller ones.

How many square meters of living space does the LCHB have?	2022
0-99 m ²	6%
100-199 m ²	20%
200-299 m ²	27%
300-399 m ²	16%
400-499 m ²	6%
500-599 m ²	4%
600-899 m ²	3%
900 m ² or more	2%
No information	16%

Table 8. Square floor area LCHBs, N=526 (translated from Hamstra & Kommer, 2022, p. 41)

Technical restrictions

Technical restrictions vary widely among LCHBs.

Government regulations

Not only are LCHBs subjected to the same government regulations that all buildings in the Netherlands are subjected to, for instance the physical environment plan (omgevingsplan) and the design code (beeldkwaliteitsplan) (Hobma & Jong, 2022, p. 39). Additionally, LCHBs have their own extra regulations stipulated in the local physical environment plan, this includes a permit requirement (Hobma & Jong, 2022, p. 137) and a maintenance duty (Hobma & Jong, 2022, p. 136). The permit for a LCHB will in

general only be granted if the proposed alteration is in agreement with the interests of historic preservation. Examining this often requires expert advice from a municipal cultural heritage committee. Maintenance and indoor alterations are in some cases permit free (Hobma & Jong, 2022, p. 137).

The government regulations regarding LCHBs are a barrier to sustainable renovations. Because the idea that realizing a sustainable renovation in a LCHB requires a tailor-made approach already keeps owners from gathering information. And the regulations also make LCHBs more complex to sustainably renovate than regular buildings, partly because permits are more often required (Briene et al., 2020, p. 33).

The government regulations for LCHBs also differ in each Dutch municipality, this makes it more difficult to look for sustainable renovation solutions that can be applied on a larger scale (Briene et al., 2020, p. 34). And there is a difference between municipal and national LCHBs, for example in terms of available subsidies and possible involvement of the Cultural Heritage Agency of the Netherlands.

Owners of a national LCHB can make use of the ‘woonhuissubsidie’ which states: “The work must serve the maintenance of the nationally LCHB and its monumental values, the work must be sober and efficient and technically necessary, and the work must be aimed at maximum preservation of existing monumental values, in particular historical materials and constructions. Work aimed at preventing decay or preventing consequential damage is also eligible. This includes: painting, repairing joints, repairing or replacing gutters and drains, replacing broken roof tiles, or repairing cracks in the exterior plaster. The costs of labor hours of the owner or a volunteer are not eligible. The subsidy amounts to 38% of the eligible costs (Wettenbank, 2024).”

Type of LCHB regarding government regulations	2022, N=526	2023, N=1.027
National	78%	80%
Municipal	19%	17%
Urban conservation area or provincial LCHB	2%	3%
Other	1%	-

Table 9. Type of LCHB regarding government regulations (Hamstra & Kommer, 2022, p. 40, Hamstra, 2023, p. 1)

The cultural heritage committee is established according to Article 15 of the cultural heritage act of 1988 (Magdelijns et al., 2009, p. 1): “The municipal council shall adopt a regulation in which at least the involvement of a committee in the field of the cultural heritage department that advises the mayor and aldermen about applications for a permit as referred to in Article 11. The committee does not include members who are the mayor or aldermen of the municipality in question. Some members within the committee are experts in the field of historic preservation.”

Condition

It is inefficient to perform sustainable renovations on LCHBs that are already in a good condition, it is better to wait for the right moment (Briene et al., 2020, p. 33). With the logic about old buildings from Nair et al. (2010); the owner of a building with a physically or aesthetically poor condition may be more inclined to adopt sustainable renovation measures.

Architectural condition of LCHBs by type	National LCHB	Municipal LCHB
Good	67%	57%
Reasonable	26%	30%
Moderate	5%	9%
Bad	2%	5%

Table 10. Architectural condition LCHBs by type, N=1.043 (translated from Hamstra, 2023, p. 6)

3.1.1.2 Characteristics of the household

The characteristics of the household are: household composition, household lifecycle, length of expected stay in the home, use of the house, attitude towards housing/lifestyle and perceived energy usage.

Household composition

Larger households and households with young children or elderly people predict a propensity to change things around at home including through a sustainable renovation (Wilson et al., 2018). Households with children are more likely to install sustainable renovation measures, such as double glazing and PV panels, compared to households without children and one-person households (Ebrahimigharehbaghi, 2022, pp. 115-117).

How many people live in LCHBs	2022
1	8%
2	54%
3	12%
4	11%
5	7%
More than 5	8%

Table 11. Number of people living in a LCHB, N=471 (translated from Hamstra & Kommer, 2022, p. 40)

Household lifecycle

Less able to walk stairs is a positive factor to the implementation of a sustainable renovation (Broers et al., 2019). Households with elderly members are also more likely to physically experience thermal discomfort which predicts a propensity to change things around at home including through a sustainable renovation (Wilson et al., 2018).

Length of expected stay in the home

Households that have just moved in are more likely to sustainably renovate (Wilson et al., 2018). A short expected length of tenure suggests moving home rather than sustainably renovating (Coulter et al., 2011, as cited in Wilson et al., 2018). Uncertainty about the remaining time living in the house is a negative factor to the adoption of a sustainable renovation (Broers et al., 2019).

Use of the house

Working at home is a factor that positively influences the adoption of a sustainable renovation (Broers et al., 2019).

Attitude towards housing/lifestyle

The influence of housing practices and related attitudes towards the home, its maintenance, upkeep and improvement may influence the adoption of sustainable renovations (Gram-Hanssen et al., 2007, as cited in Stieß & Dunkelberg, 2013)

Perceived energy consumption

Household's perception of their energy consumption compared to other household is a factor determining the propensity of the adoption of sustainable renovation measures. Households that perceive their energy consumption as higher compared with other households have a 2 times higher propensity to replace their boiler (Ebrahimigharehbaghi, 2022, p. 119).

3.1.1.3 Occasions

Whether an occasion suddenly arises, or has been on the horizon for a longer time, it may be convenient to combine it with a sustainable renovation, therefore occasions seem to be positively correlated with the adoption of sustainable renovations. Occasions are external motivational factors that can act as a trigger leading to a perceived need to realize a sustainable renovation (Arning et al., 2020). Variables of occasions are: extensions/alterations (Stieß & Dunkelberg, 2013), maintenance (Stieß & Dunkelberg, 2013, Ebrahimigharehbaghi, 2022, p. 38), purchase of a building (Arning et al., 2020, Stieß & Dunkelberg, 2013), restorations (which are common in LCHBs), extraordinary advice, attractive financial incentives (Wilson et al., 2018), something breaks down, having changes in the household composition (Wilson et al., 2018, Broers et al., 2019), moving (Wilson et al., 2018, Broers et al., 2019, Ebrahimigharehbaghi, 2022, p. 38), taking out a mortgage (Ebrahimigharehbaghi, 2022, p. 38), uncertainty about the remaining time living in the house, wanting to combine the sustainable renovation with other construction work, making use of the organization of implementation measures of the municipality (Broers et al., 2019) and the decision by homeowner association (VVE) to sustainably renovate (Ebrahimigharehbaghi, 2022, p. 80). The last occasion has been identified as one of the least important drivers for a homeowner to sustainably renovate but could still arise.

Occasions that went together with sustainable renovation measures	%
During the restoration of the LCHB	26%
When purchasing the LCHB	23%
During major maintenance of the LCHB	22%
Without the reasons restoration, purchase or major maintenance	24%
Owner does not know	5%

Table 12. Occasions and sustainable renovation measures, N=497 (translated from Hamstra & Kommer, 2022, p. 18)

One of the primary drivers for sustainable renovation measures, such as double glazing, sustainable heating and PV panels, is maintenance (Ebrahimigharehbaghi, 2022, pp. 115-118). Increasing the efficiency of the boiler, or the boiler needed to be replaced, is one of the main drivers for why homeowners realized a sustainable renovation (Ebrahimigharehbaghi, 2022, p. 80). Maintenance is inevitable and once this occasion arises a sustainable renovation is more likely to occur together with it.

3.1.1.4 Previous practice

Change agents and others who introduce an innovation often assume that potential adopters are blank slates who lack any relevant experience with which to associate the new idea. Instead, a change agent needs to understand the prior experiences of potential adopters which includes the practices that the innovation will replace (Rogers, 2003, pp. 254-257). This also applies to the owners of LCHBs who evaluate the sustainable renovation based on their previous practice and experience. Ignoring previous practice will lead to not fully understanding the adoption and could lead to opposition (Rogers, 2003, p. 257).

Thus, ‘previous practice’ refers to the existing methods, behaviors, or technologies that are already being used before the introduction of the new innovation. Understanding the ‘previous practice’ also helps in assessing the relative advantage of the new innovation compared to what is currently in use. It influences how potential adopters perceive the new innovation’s benefits and drawbacks in relation to the current practices. Therefore, evaluating ‘previous practice’ is crucial since it affects the rate and extent to which an innovation is adopted.

Variables of previous practice are: a past investment in a sustainable renovation (Nair et al., 2010), knowledge, technical skills, do-it-yourself (Stieß & Dunkelberg, 2013), skills (Nair et al., 2010) and dealing with sustainability at work or a technical job (Broers et al., 2019).

The previous adoption of a sustainable renovation is also previous practice which may garner experience for the owner that can be used for a possible next sustainable renovation, or may improve owners confidence (Costanzo et al., 1986, as cited in Nair et al., 2020). Past sustainable renovations could also deter future sustainable renovations because of budgetary limitations or because homeowners might think they have made enough investments in sustainable renovations (Nair et al., 2010). However, it was found that owners are more likely to adopt a sustainable renovation if they had made past investments in the building envelope (Nair et al., 2010), which may constitute a sustainable renovation.

Most of the owners in Arning et al. (2020), N=20, worked in a nontechnical profession; only one interviewee was an expert in the field of sustainable renovations. Nontechnical owners are less able to do a renovation themselves (Arning et al., 2020). Having a technical job or dealing with sustainability at work has a positive influence on the adoption of a sustainable renovation (Risholt & Berker, 2013, as cited in Ebrahimigharehbaghi, 2022, p. 104, Broers et al., 2019).

Table 13 & 14 cover aspects of ‘previous practice’, together with **table 2** that covers the sustainable renovation measures that have already been carried out in LCHBs.

Investments over the past 3 years to reduce energy consumption	%
Yes	65%
No	35%

Table 13. Reducing energy consumption in the past 3 years, N=1.043 (translated from Hamstra, 2023, p. 23)

Sustainable renovation measures already undertaken in LCHBs	%
Basic measures	91%
Energy supplies	82%
Insulating measures	78%
Other	6%
None of these measures	6%

Table 14. Measures already undertaken in LCHBs, N=526 (translated from Hamstra & Kommer, 2022, p. 16)

These sustainable renovation measures are classified into three categories: 'basic measures' (e.g. energy-efficient lighting/appliances, smart thermostat, radiator foil), 'energy supplies' (e.g. HR(e)-boiler, solar panel, heat pump) and 'insulating measures' (e.g. insulation roof, floor, facades). The breakdown of these categories according to individual measures is shown in **table 2**.

Things LCHB owners are already doing to consume less energy	%
Turn off lights in rooms that are not in use	83%
Heating low in rooms that are not in use	83%
Energy efficient lighting (LED)	74%
Turn the thermostat down one degree	66%
Thermostat lower at night to approximately 15 degrees	61%
Double glazing, additional added windows	51%
Turn the thermostat lower one hour before going to bed	48%
Reducing standby consumption	43%
Walls, floors and/or roof insulation	38%
Using a woodstove (more often)	30%
Solar panels installed	30%
Other	7%
None of these measures	2%

Table 15. Things to consume less energy, N=526 (translated from Hamstra & Kommer, 2022, p. 14)

Some of these measures are just basic measures, like the more sustainable, i.e. energy efficient, use of the LCHB, others are sustainable renovation measures, if multiple sustainable renovation measures are introduced together it makes for a sustainable renovation.

Whether previous practice actually influences the decision to sustainably renovate has been researched by Hamstra and Kommer (2022), **table 16**: 29% of respondents answered that previous sustainable renovation measures have led to newly planned sustainable renovations in the coming 3 years.

Whether introducing previous sustainable renovation measures led to newly planned sustainable renovations in the coming 3 years	%
Yes	29%
No, we were already planning this	71%

Table 16. Previous measures that led to new renovations, N=424 (translated from Hamstra & Kommer, 2022, p. 29)

3.1.1.5 Felt needs and/or problems

The innovation process often begins with the recognition of a problem or need (Rogers, 2003, Wilson et al., 2018). This in turn stimulates research and development activities to create an innovation to solve the problem or need. The problem and/or need can exist now or arise in the future (Rogers, 2003, p. 137). Examples of a need and/or problem could be the thermal comfort or the perceived energy costs (Nair et al., 2010, Broers et al., 2019). Therefore the owner may be more open to a new innovation that offers a solutions for the problems at hand.

Some felt needs and/or problems of LCHB owners have been researched by Hamstra and Kommer (2022), **table 17** and **table 24**, since perceived energy costs also constitute a felt need and/or problem.

Inconveniences experienced by LCHB owners in their LCHBs	2022
Cold draft through the house	33%
Indoor climate too cold	30%
Cold feet	23%
Moisture in the house	17%
Mold	9%
Bad indoor climate	8%
Indoor climate too warm	7%
Other	1%
None of these	38%

Table 17. Inconveniences of LCHBs, N=526 (translated from Hamstra & Kommer, 2022, p. 11)

3.1.1.6 Innovativeness

Rogers (2003, pp. 267-268) tackles the concept of innovativeness; which is the degree to which an individual is relatively earlier in adopting new ideas than other members of the same system. Unlike just a cognitive or attitudinal shift, innovativeness implies the actual implementation of the new idea. Thus, innovativeness tells something about the potential adopter in relation to all the other adopters and potential adopters of the innovation.

The innovation in this thesis is the realization of a full sustainable renovation in a LCHB, this cannot be measured easily, because that requires a lot of context about the LCHB and what is potentially possible. Hamstra (2023) surveyed the condition of the building, from a scale of 1 to 4: Good, reasonable, moderate and bad (**table 10**). This does not address whether the building has had a sustainable renovation. Surveying to what extent the LCHB has been sustainably renovated by LCHB owners may yield insight about the innovativeness of LCHB owners. With the question: to what extent did you sustainably renovate (verduurzaam) your LCHB on a scale from 1 to 10? However this question may be interpreted in many ways, and may still not give a good overview of their innovativeness.

What can be measured is the innovativeness regarding each sustainable renovation measure, which has been researched by Hamstra and Kommer (2022, p. 17), **table 2**. And with those percentages you could categorize an owner who sustainably renovated in 2022 on their innovativeness in comparison with the sustainable renovation measures that have been realized by the whole group of LCHB owners.

A change agent may find it useful to know the innovativeness of LCHB owners who have to realize a sustainable renovation, because there are differences between earlier and later adopters of an innovation, which is explained in ‘**adopter categories**’ (chapter 3.3.9.3). For example, different adopter categories may have their own drivers and barriers, responding to this may greatly support a strategy.

3.1.1.7 Norms of the social system

Norms are the established behavior patterns for the members of a social system. Norms define a range of tolerable behavior and serve as a guide or standard for the behavior of members of a social system. The norms of a system tell individuals what behavior they are expected to perform (Rogers, 2003, p. 26). Thus, the norms of a social system can be a barrier or a driver to the adoption of sustainable renovations among LCHB owners. Because an individual is more likely to adopt an innovation if more of the other individuals in his or her personal network adopted previously (Rogers, 2003, p. 359). Norms can operate at the level of a nation, a religious community, an organization, or a local system such as a village (Rogers, 2003, p. 26). Likewise, all of the LCHB owners of the Netherlands are a social system with certain norms. Simultaneously, the LCHB owners of a particular municipality can also be a social system with different norms.

Within this thesis the ‘norms of the social system’ can also be the norms of the broader society about the innovation. These norms can be inferred by looking at the attitudes towards sustainable renovations among colleagues, friends, relatives and neighbors. These people are seen as trustworthy sources of information, because there is no financial self-interest like with professional experts or companies (Stieß & Dunkelberg, 2013).

Nevertheless, the behaviors and attitudes of other people always influence peoples behaviors, examples of social norms are herd behavior and the bandwagon effect (Ebrahimigharehbaghi, 2022, p. 143). Social norms can initiate decisions, particularly in the majority segments of potential adopters who

are more receptive or susceptible to social influence (Wilson et al., 2018). The positive or negative experiences of a social network that make their way to the owner is a factor influencing the decision to sustainably renovate (Broers et al., 2019). These experiences of social systems where owners find themselves in can be analyzed to determine the effects. 'Following other people in the neighborhood' has been identified as one of the least important drivers. And 'experiences of those around renovators' has been identified as an insignificant barrier (Ebrahimigharehbaghi, 2022, p. 80). Social and personal norms, such as belonging to an environmentally friendly group in the neighborhood, may increase the likelihood of being more willing to realize a sustainable renovations (Gardner & Stern, 1996, Steg & Vlek, 2009, as cited in Ebrahimigharehbaghi, 2022, p. 36).

Social norms can be considered as both an internal, being the household perception of social norms, and an external, being the acceptability by society, influence on household motivations (Ebrahimigharehbaghi, 2022, p. 106). This subchapter is about both, however it could be argued that the perception of the social norms by the owner would be more suitable in the characteristics of the decision-making unit chapter.

3.1.2 What are the characteristics of the decision-making unit?

Characteristics of the decision-making unit such as the socioeconomic characteristics (e.g. education and income) are important when thinking and acquiring knowledge about sustainable renovations. Therefore, making socioeconomic characteristics of the individual or group who makes the decision another essential factor in the decision to adopt an innovation (Ebrahimigharehbaghi, 2022, p. 66). Besides socioeconomic characteristics, the personality variables and communication behavior of the decision-making unit affects the decision-making process and has an influence on the adoption or rejection of the innovation (Rogers, 2003, p. 171).

The characteristics of a decision-making unit are categorized into three headings, taking inspiration from Rogers (2003, p. 287). This subchapter is structured as follows: (1) the header is explained, (2) the variables and their influence on the decision-making process are explained, (3) the reports of Hamstra and Kommer (2022) and Hamstra (2023) are referenced to address what the characteristics of LCHB owners are, if they are available.

3.1.2.1 Socioeconomic characteristics

The factor socioeconomic characteristics has a lot of overlap with social status. Social status is determined by income, level of living, possession of wealth, occupational prestige, self-perceived identification of social class and more. And these variables are all usually positively correlate with the early adoption of an innovation (Rogers, 2003, p. 288). Thus, these variables are included and combined with others. The variables that determine the socioeconomic characteristics of the decision-making unit are: age, years of LCHB ownership, building size, household income, household wealth, education and occupation.

Age

Age as a characteristic of the decision-making unit is acknowledged by Rogers (2003), Stieß & Dunkelberg (2013), Nair et al. (2010), Wilson et al. (2018) and many more. In general adoption theory there is no correlation between adoption speed and age (Rogers, 2003, p. 288). However the age of the decision-making unit can be influential regarding homeowner's decision to adopt a sustainable renovations. For example, older homeowners in Sweden are less likely to adopt sustainable renovation measures (Mahapatra and Gustavsson, 2008, as cited in Nair et al., 2010). This could be linked with the perceived uncertainty older homeowners feel about the sustainable renovation's payback time during their occupancy of the house, or a reason could be: less concern about the energy situation, lower income, and/or less awareness about sustainable renovation measures (Nair et al., 2010). Meanwhile in the UK, respondents with a mean age of 55 years were more likely to undertake sustainable renovation measures, both as an investment and a non-investment, than were younger age groups (Barr et al., 2005, as cited in Nair et al., 2010). And Nair et al. (2010) found that Swedish homeowners who were younger were more likely to adopt a sustainable renovation measure than homeowners who were older (>55 years). On the contrary, households that include elderly people are more likely to experience thermal discomfort, which in turn predicts an inclination to change things around at home, including through a sustainable renovation (Wilson et al., 2018). And to make a distinction in the type of sustainable renovation measures by age; homeowners in the age group of 36-45 were more likely to adopt a sustainable renovation measure regarding the building envelope while older homeowners (>65 years)

were more likely to adopt other sustainable renovation measures, like installations (Nair et al., 2010). Older homeowners are more likely to install PV panels (Ebrahimigharehbaghi, 2022, p. 117).

Age of LCHB owners	2022, N=526	Age of LCHB owners	2023, N=1.043
18-29	0%	20-35	2%
30-39	4%	36-50	13%
40-49	12%	51-65	43%
50-59	27%	65 years and older	43%
60-69	25%		
70-79	29%		
80 and older	3%		

Table 18. Age of LCHB owners (translated from Hamstra & Kommer, 2022, p. 40, Hamstra, 2023, p. 4)

Years of LCHB ownership

The years an owner lived in a LCHB can be a socioeconomic characteristic, since living in a LCHB is special and may be of influence on one's social status. Years of LCHB ownership can also be of influence on the decision-making process, because an owner has more time to get to know the technical aspects of the building and its history, i.e. more time for information gathering.

Years of LCHB ownership	2022, N=526	2023, N=1.043
Less than one	6%	4%
1-5	28%	24%
6-10	12%	14%
11-15	12%	10%
Longer than 15	43%	48%

Table 19. Years of LCHB ownership (translated from Hamstra & Kommer, 2022, p. 42, Hamstra, 2023, p. 4)

Building size

The size of the building, as shown in **table 8**, is not only a prior condition of the decision-making process, it is also a socioeconomic characteristic of the decision-making unit. The unit size, i.e. building size, of the decision-making unit has an impact on the adoption of an innovation; earlier adopters have larger-sized units (farms, schools, companies, and so on) than do later adopters (Rogers, 2003, p. 288).

Household income

Income is a factor in the adoption of a sustainable renovation (Nair et al., 2010, Stieß & Dunkelberg, 2013). Households with higher incomes may be more willing to invest in sustainable renovations than other groups (Mortensen et al., 2016, as cited in Ebrahimigharehbaghi, 2022, p. 36, Nair et al., 2010). Counter to the assumption that a higher income equals a higher propensity to sustainably renovate, some sustainable renovation measures are more likely to be installed by lower income households, like double glazing (Ebrahimigharehbaghi, 2022, p. 115).

Household wealth

Possession of wealth is a factor in the adoption of a sustainable renovation (Stieß & Dunkelberg, 2013, Broers et al., 2019).

Education

Years of formal education have a positive correlation with the adoption of an innovation (Rogers, 2003, p. 288). This also applies to the decision to adopt a sustainable renovations which is also influenced by

education (Nair et al., 2010, Stieß & Dunkelberg, 2013), or technical education (Broers et al., 2019). Homeowners who are educated on a higher level were more likely to adopt a sustainable renovation than homeowners who only had a primary education (Nair et al., 2010). And having a technical education is a positive influence on the adoption of a sustainable renovation (Broers et al., 2019).

Occupation

Occupational prestige determines social status and social status is usually positively correlated with the early adoption of an innovation (Rogers, 2003, p. 288).

3.1.2.2 Personality variables

To better understand the personality and beliefs of the decision-making unit, the variables that make up the personality of owners regarding sustainable renovations are: how the job gets done, trust in professionals, tolerance of disruption, hunger for information, interest in energy saving, environmental values, attitudes towards a sustainable renovation, interest in technology and involvement. Inspiration for these variables is mainly taken from Haines & Mitchell (2014) who did a study to identify different types of homeowner personalities according to personality variables. Rogers (2003) also mentions multiple personality variables that determine adopter categories, and could therefore also explain the proneness of the decision-making unit to adopt the innovation. A few personality variables have been researched for owners of LCHBs as well by Hamstra and Kommer (2022) and Hamstra (2023).

How the job gets done

The sustainable renovation can be realized ranging from doing-it-yourself to paying others (Haines & Mitchell, 2014). Sustainable renovations are mainly carried out by companies and experts on behalf of the owner. Only 35% of owners have implemented sustainable renovations themselves/with help of acquaintances (Ebrahimigharehbaghi, 2022, p. 82). For example, 70% of households asked an expert to install PV panels instead of installing the panels themselves (Ebrahimigharehbaghi, 2022, p. 117).

Trust in professionals, the municipality or trust in general

Trust plays an important role in the opinions and choices of residents. A lack of trust is an important barrier for residents to participate with a sustainable renovation neighborhood scheme. This can be a concrete lack of trust in the supplier of a sustainable renovation measure, the approach chosen by the municipality, or more in general a feeling of being fooled (De Koning et al., 2020). Trust in professionals for executing the work ranges between low and high (Haines & Mitchell, 2014). The appreciation, related to trust in professionals, intermediaries and the municipality among the owners of LCHBs has been researched by Hamstra (2023), **table 20**, making use of a five-point scale. The appreciation of, or trust in, civil servants seems to be the lowest and the architect or contractor the highest.

Appreciation of organizations by LCHB owners	2023
Architect / contractor	4.1
Monumentguard	3.9
National Restoration fund	3.9
Installer	3.8
Financial intermediary	3.6
Cultural Heritage Agency of the Netherlands	3.5
Sustainability advisor	3.3
Real estate agent	3.3
Bank	3.3
Municipality	2.8

Table 20. Appreciation of organizations by LCHB owners, N=1.043 (translated from Hamstra, 2023, p. 14)

Ranking of the reliability of sources of information by owners who have renovated	2022
VVE	56,8%
Government	53,5%
Environmental agencies, etc.	49,4%
Family, friends and acquaintances	46,9%
Contractors	32,6%
Energy companies	27,4%
DIY companies	20,6%
Media	11,8%
Real estate	6,1%

Table 21. The ranking of the reliable sources of information by renovators, N=1.946 (Ebrahimigharehbaghi, 2022, p. 81)

Tolerance of disruption

Tolerance for disruption in the sustainable renovation decision-making process ranges between low and high (Haines & Mitchell, 2014). Early adopters are better able to cope with uncertainty and risk than are later adopters (Rogers, 2003, p. 290).

Hunger for information

Hunger for information about sustainably renovating ranges between low and high (Haines & Mitchell, 2014).

Interest in energy saving

The attitude or interest in reducing energy use is a factor in homeowners' decision to sustainably renovate (Nair et al., 2010). Interest in energy saving ranges between low and high (Haines & Mitchell, 2014). Households that are more energy-conscious have a higher probability of introducing a sustainable renovation (Risholt & Berker, 2013, as cited in Ebrahimigharehbaghi, 2022, p. 104, Broers et al., 2019). The actual causal reasons for interest in energy saving will be discussed in the drivers and barriers literature chapter. Hamstra and Kommer (2022) found that 87% of LCHB owners are interested or very interested in sustainably renovating, **table 22**.

Interest of owners in the sustainable renovation of their LCHBs	2022
Not interested	2%
Little interested	11%
Interested	39%
Very interested	48%

Table 22. Interest in the sustainable renovation, N=526 (translated from Hamstra & Kommer, 2022, p. 13)

Environmental values

A study among 249 households in England showed that there is a positive relationship between environmental values and knowledge on energy-saving behaviors, attitudes, and habits (Pothitou et al., 2016, as cited in Ebrahimigharehbaghi, 2022, p. 104, Broers et al., 2019).

Attitudes towards a sustainable renovation

The attitude towards a sustainable renovation also influence the decision to sustainably renovate (Arning et al., 2020, Stieß & Dunkelberg, 2013). The attitude is split into two attitudes: (1) towards the results and (2) towards the process (Stieß & Dunkelberg, 2013). There are many attitudes about sustainable renovations, it can for example be perceived as a good investment (Broers et al., 2019), these attitudes will be discussed in depth in the drivers and barriers chapter. Logically, the attitudes and norms to sustainably renovate are significantly stronger in households planning a sustainable renovation (Wilson et al., 2018).

Interest in technology

Interest in technology is positively related to the decision to adopt a sustainable renovation (Stieß & Dunkelberg, 2013, Broers et al., 2019).

Involvement

According to Briene (2020, p. 19) owners of LCHBs can be categorized into two groups: owners who are very involved with the LCHBs and are well informed about the technological possibilities, laws and regulations, and owners who 'happen' to live in a LCHB and have less knowledge about it.

Relevant personality variables from Rogers (2003):

Dealing with abstractions

Similar to tolerance of disruption, dealing with abstractions is also a personality variable. Early adopters are better in dealing with abstractions, while later adopters can observe the innovation in the here-and-now of a peer's operation (Rogers, 2003, p. 289).

Dogmatism

Dogmatic is the degree to which an individual has a relatively closed belief system. Early adopters may be less dogmatic than later adopters (Rogers, 2003, p. 289).

Attitude towards change

Early adopters have a more favorable attitude towards change than later ones (Rogers, 2003, p. 290).

Attitude towards science

Early adopters have a more favorable attitude towards science than later ones, since innovations are often the product of scientific research (Rogers, 2003, p. 290)

Fatalism

Fatalism is the degree to which an individual perceives a lack of ability to control his or her future. Early adopters are less fatalistic than are later adopters (Rogers, 2003, p. 290).

3.1.2.3 Communication behavior

Rogers (2003, p. 290) gathered variables with which communication behavior can be measured, they are: social participation, connectedness, cosmopoliteness, contact with change agents, exposure to mass media, exposure to interpersonal communication, seeking information, knowledge of innovations, and the degree of opinion leadership. In this thesis communication behavior is not only about absorbing information but also about sharing information on.

Social participation

Early adopters engage more in social participation than later ones (Rogers, 2003, p. 290). An example of social participation is the level to which a LCHB owners is a member of an organization.

Membership of LCHB owners at LCHB organizations	2022, N=526
National Restoration fund	35%
Monumentguard	43%
Federation for the conservation of monuments	1%
Not a member of these organizations	41%

Table 23. Member of LCHB organizations, N=526 (translated from Hamstra & Kommer, 2022, p. 42)

Connectedness

Connectedness is the degree to which an individual is linked to others. Earlier adopters are more highly interconnected through interpersonal networks in their social system than are later adopters (Rogers, 2003, p. 290).

Cosmopoliteness

Cosmopoliteness is the degree to which an individual is oriented outside a social system. Earlier adopters are more cosmopolite than are later ones (Rogers, 2003, p. 290).

Contact with change agents

Early adopters have more contact with change agents than later ones (Rogers, 2003, p. 290).

Exposure to mass media

Early adopters have greater exposure to mass media communication channels than later ones (Rogers, 2003, p. 290).

Exposure to interpersonal communication

Early adopters have greater exposure to interpersonal communication channels than later ones (Rogers, 2003, p. 290).

Seeking information

Earlier adopters seek more actively information about innovations than later ones (Rogers, 2003, p. 290).

Knowledge of innovations

Knowledge of innovations can be the awareness about sustainable renovation measures, which is a factor influencing the adoption of a sustainable renovation (Nair et al., 2010). Awareness of the benefits of a sustainable renovation during the planning process can persuade homeowners to adopt it (Ebrahimigharehbaghi, 2022, p. 66). It can also be about gathering more detailed or technical knowledge

about innovations. Early adopters have greater knowledge of innovations than later ones (Rogers, 2003, p. 290).

Degree of opinion leadership

Degree of opinion leadership is the extent to which the individual influences others. Early adopters have a higher degree of opinion leadership than later ones (Rogers, 2003, p. 290).

3.1.3 Conceptual model of prior conditions and characteristics

The prior conditions are already present before the decision-making process starts and shape the decision-making process. And the characteristics of the decision-making unit have an influence during the decision-making process. **Figure 3** shows a conceptual model of the prior conditions and characteristics of the decision-making unit and their influence on the decision-making process.

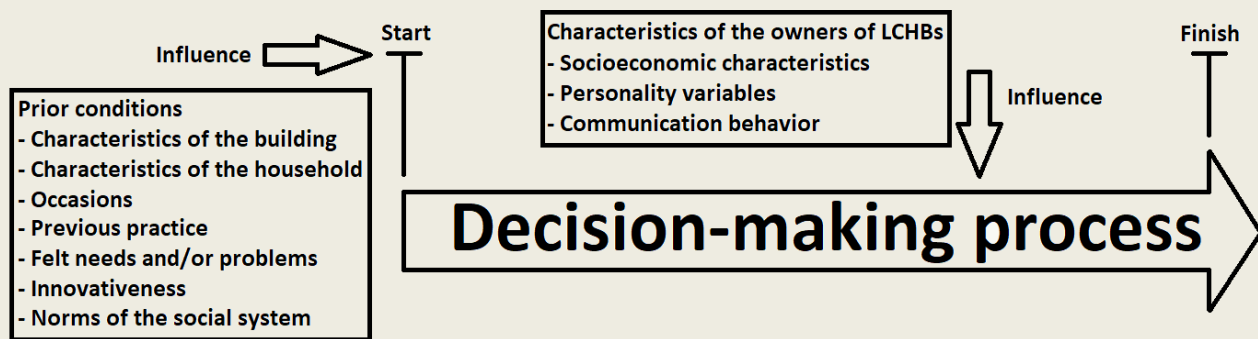


Figure 3. The relation between prior conditions and characteristics and the decision-making process (author)

The variables of the prior conditions of the decision-making process are:

1. Characteristics of the building: age, location, typology, size, technical restrictions, government regulations and condition.
2. Characteristics of the household: household composition, household lifecycle, length of expected stay in the home, use of the house, attitude towards housing/lifestyle and perceived energy usage.
3. Occasions: extensions/alterations, maintenance, purchase of a building, restorations, extraordinary advice, attractive financial incentives, something breaks down, having changes in the household composition, moving, taking out a mortgage, uncertainty about the remaining time living in the house, wanting to combine the sustainable renovation with other construction work, making use of the organization of implementation measures of the municipality and the decision by homeowner association (VVE) to sustainably renovate.
4. Previous practice: a past investment in a sustainable renovation, knowledge, technical skills, do-it-yourself, skills and dealing with sustainability at work or a technical job.
5. Felt needs and/or problems: thermal comfort or the perceived energy costs, but many more needs and problems exist.

6. Innovativeness
7. Norms of the social system: the attitude towards sustainable renovations in LCHBs among colleagues, friends, relatives and neighbors.

The variables of the characteristics of the decision-making unit are:

1. Socioeconomic characteristics: age, education, social status, building size, years of LCHB ownership.
2. Personality variables: how the job gets done, trust in professionals, tolerance of disruption, hunger for information, interest in energy saving, attitudes towards a sustainable renovation and interest in technology.
3. Communication behavior: social participation, connectedness, cosmopolitanism, contact with change agents, exposure to mass media, exposure to interpersonal communication, seeking information, knowledge of innovations and the degree of opinion leadership.

3.2 Decision-making process

Sub question 2: What is the decision-making process for owner-occupiers of listed cultural heritage buildings to sustainably renovate?

This question is answered in this theoretical background chapter by combining literature about decision-making processes in general, sustainable renovation decision-making processes of non-LCHB homeowners and the sustainable renovation decision-making processes of LCHB owners. Since a chapter about only the decision-making process of LCHB owners would be too brief and not cover all essential components. The results chapter holds the specific sustainable renovation decision-making process for LCHB owners proposed in this thesis.

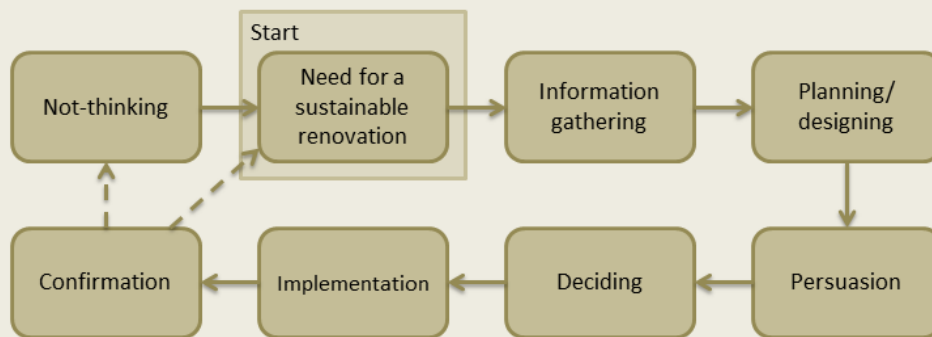


Figure 4. Stages of the decision-making process in the literature (author)

Figure 4 shows the decision-making process derived from combining all of the stages in the literature. This subchapter first explains what a decision-making process is (3.2.1), and then addresses all of the stages of decision-making processes in the literature related to sustainable renovation decision-making by owners (3.2.2).

3.2.1 What is a decision-making process?

Decision-making processes come in many different compositions and have many different names, for example a customer journey can also be a decision-making process. The decision-making process of Rogers (2003, p. 171) is called: the 'innovation-decision process' and has the following definition (Rogers, 2003, p. 168): "the process through which an individual passes from gaining initial knowledge of an innovation, to forming an attitude toward the innovation, to making a decision to adopt or reject, to implement the new idea and to confirm this decision. This process consists of a series of choices and actions over time through which an individual or a system evaluates a new idea and decides whether or not to incorporate the innovation into ongoing practice".

Other decision-making processes of Pettifor et al. (2015) and Wilson et al. (2018) are based on the decision-making process of Rogers (2003). The decision-making process of Arning et al. (2020) is based on that of Wilson et al. (2018), thus also leading back to Rogers (2003). This chapter will take Rogers (2003) into account, and also go over multiple recent decision-making processes for sustainable renovations in both general housing renovation decisions, and the decision in LCHBs.

Decision-making processes are important for a change agent who seeks to change the adoption

rate of a new idea, because achieving this requires a different strategy in each of the stages. Each stage has different communication channels that are effective, for example, mass media communication channels are generally more effective if most individuals do not yet have much knowledge about an innovation (Rogers, 2003, p. 198). And a decision-making process can also be seen as a framework, that organizes the barriers and recommendations to the enhancement of sustainable renovations in LCHBs (Briene et al., 2020).

3.2.2 What stages are there in a decision-making process?

A decision-making process consists of stages. In general, the stages consist of understanding the needs, information searching, pre-evaluating, finalizing the decision, implementing, and post-evaluating (Baginski & Weber, 2017, as cited in Ebrahimigharehbaghi, 2022, p. 66).

This subchapter will map all these stages chronologically with Rogers (2003) and the literature about the decision to adopt a sustainable renovation: Pettifor et al. (2015), Wilson et al. (2018), Rijksdienst voor het Cultureel Erfgoed (2019), Arning et al. (2020), De Koning et al. (2020), Briene et al. (2020), Mlecnik (2021) and Ebrahimigharehbaghi (2022).

Not-thinking

In the ‘not-thinking’ stage there is no intention to adopt a sustainable renovation (Pettifor et al., 2015). It is included as a control condition that allows the identification of differences between adopters and non-adopters of a sustainable renovation (Wilson et al., 2018).

Need for a sustainable renovation

In the ‘need for a sustainable renovation’ stage the initial perception of a need to pursue a sustainable renovation arises (Arning et al., 2020, Mlecnik, 2021). This need can be a sense of urgency and a concrete reason for a sustainable renovation (De Koning et al., 2020), for example draft, energy costs (Rijksdienst voor het Cultureel Erfgoed, 2019) or any other driver. Or it can be many other things like a prior condition or a characteristics of the decision-making unit, for example an occasion or a positive attitude towards a sustainable renovation (Arning et al., 2020). Before such a need can arise, the owner needs to know about the building and its problems. Briene et al. (2020, p. 20) also includes a first stage where the owner examines the current state of the LCHB and looks at, among other things, the state of maintenance, the current energy performance and the cultural heritage value. Once the building has been inventoried, inspiration of what is possible or has already happened elsewhere (preferably similar LCHBs) can strengthen the need for the adoption of a sustainable renovation in a LCHB (Rijksdienst voor het Cultureel Erfgoed, 2019, Briene et al., 2020, p. 20).

Other ways a need for a sustainable renovation among homeowners can arise is by: having homeowners talk with their peers who have already implemented a sustainable renovation, having homeowners visiting an open house where a sustainable renovation has been implemented and communicating the energy use of the LCHB to homeowners (Mlecnik, 2021).

Information gathering

The ‘information gathering’ stage takes place after the homeowner has realized there is a need for a sustainable renovation, and prior to the actual planning and decision to implement the sustainable renovation (Arning et al., 2020). During this stage an individual is exposed to an innovation’s existence

and gains an understanding on how it functions (Rogers, 2003, p. 171). This stage is also where thinking about a sustainable renovation at some point in the future starts (Pettifor et al., 2015, Wilson et al., 2018). The homeowner will try to find information and advice of professionals to realize a sustainable renovation (Arning et al., 2020, Mlecnik, 2021). And the owner has to find out whether sustainable renovation measures are possible and allowed by the municipality to be implemented in the LCHB (Rijksdienst voor het Cultureel Erfgoed, 2019, Briene et al., 2020).

During this stage, households are likely to be receptive to ideas and information that aid the gathering of knowledge (Pettifor et al., 2015). There is a need for information about: regulations, suitable sustainable renovation measures, costs, savings, subsidies, financing, benefits like comfort (Rijksdienst voor het Cultureel Erfgoed, 2019, Briene et al., 2020) and parties the owner has to deal and collaborate with (Rijksdienst voor het Cultureel Erfgoed, 2019).

Regarding change agents in this stage, they need to provide: exemplary projects, reliable information, clarity about the roles and tasks of the municipality, heritage organizations and advisors (Rijksdienst voor het Cultureel Erfgoed, 2019) and everything to make it practically possible for owners to implement sustainable renovations (De Koning et al., 2020).

Ebrahimigharehbaghi (2022, p. 67) has a similar stage where the following questions are asked: what type of sustainable renovations are there, which one is appropriate and how much are the costs/benefits? In this awareness stage, homeowners can learn about sustainable renovations and their benefits, such as energy cost savings or improved comfort, through government, local agency letters, community energy events or social media. And an aware person or group can take action to increase awareness or even organize the implementation of sustainable renovations (Ebrahimigharehbaghi, 2022, p. 36).

Planning/designing

In the planning stage the initial sustainable renovation idea is refined into a plan or design with the needed sustainable renovation measures. To achieve this; homeowners are more actively seeking out information and advice (Pettifor et al., 2015, Arning et al., 2020, Mlecnik, 2021) from intermediaries like consultants (Arning et al., 2020, Mlecnik, 2021) or the municipality (Mlecnik, 2021).

Appropriate questions to ask in the planning stage are: which procedures, who can help, examples, and what permission is required (Ebrahimigharehbaghi, 2022, p. 67)?

Persuasion

During the persuasion stage the owner forms a favorable or unfavorable attitude towards the design of a sustainable renovation. Attitude is a relatively enduring organization of an individual's beliefs about an object that predisposes his or her actions. The main type of thinking at the knowledge stage was mainly cognitive (or knowing), the main type of thinking at the persuasion stage is affective (or feeling). Until an individual knows about a new idea, of course, he or she cannot begin to form an attitude toward it (Rogers, 2003, pp. 174-175). The meaning of 'persuasion' is equivalent to 'attitude formation' and 'change on the part of an individual', this is not necessarily in the direction intended by some particular source of information.

De Koning et al. (2020) describe a similar stage wherein the change agent seeks to create a positive opinion about a sustainable renovation among homeowners, hereby making the decision to adopt the

sustainable renovation more likely. This has partly to do with costs and benefits, but status, social comparison and non-financial benefits (like comfort) can also play a role (De Koning et al., 2020).

Rogers (2003, p. 176) also mentions the KAP-gap, the gap between action and practice, this is when a positive attitude towards an innovation does not translate into implementing this innovation. Here the barrier is not the attitude towards the innovation, but something else. It can be because of cognitive dissonance for example. This action practice gap can be resolved by a cue-to-action, which may be: an occasion that occurs naturally, the positive experience of a peer or a created cue-to-action by a change agency, e.g. an incentive (Rogers, 2003, pp. 176-177). In the context of this thesis the KAP-gap means that an owner has a positive attitude towards the sustainable renovation of their LCHB, everything seems ready to go, however nothing is done.

Deciding

In the 'deciding' stage homeowners select their specific sustainable renovation measures (Arning et al., 2020, Briene et al., 2020). The 'deciding' stage takes place when an individual engages in activities that lead to a choice to adopt or reject the innovation (Rogers, 2003, p. 177). So in this 'deciding' stage the last actions necessary to realize the sustainable renovation take place.

Typically, the fundamental decision to carry out the sustainable renovation has already been made at an earlier stage (Arning et al., 2020). Or, the fundamental decision to sustainably renovate can be an accumulation of determination built up in all of the previous stages. For example, Ebrahimigharehbaghi (2022, p. 66) mentions how awareness of the benefits of a sustainable renovation during the planning stage can persuade homeowners to adopt it. Similar places where the decision to stop or go on with a sustainable renovation could occur are in the 'need for a sustainable renovation' stage until the 'implementation' stage. For example, there could be a decision that is necessary to start with the design stage (Thuvander et al., 2012).

In the deciding stage there is a need for: expert advice, what suits the LCHB regarding the balance between cultural heritage values and sustainable renovation measures, how to filter different options, a view on feasibility and finance options and the local initiatives, for example a district-oriented approach to making buildings gas-free (Rijksdienst voor het Cultureel Erfgoed, 2019). The decisions that are taken in this stage mainly depend on the financial feasibility of the sustainable renovation options and the effects on the cultural heritage value (Briene et al., 2020). Appropriate questions to ask here are: which reliable contractors to procure and what subsidies/loans to make use of (Ebrahimigharehbaghi, 2022, p. 67)?

Since this final decision stage is right before implementation, homeowners can be helped here with what they need on a basic level to be able to implement the sustainable renovation (De Koning et al., 2020). For example, municipalities can help homeowners who are still looking for some independent guidance, need help with executing or want to assure the quality of some initial works (Mlecnik, 2021).

Implementation

The 'implementation' stage, also called the 'finalizing', 'realization' or 'action' stage, is when households are committed to going ahead or the sustainable renovation is already taking place (Pettifor et al., 2015). Until the implementation stage, the process wherein a decision to adopt was formed has been a strictly mental exercise of thinking and deciding. The implementation involves overt behavior change to realize

the sustainable renovation (Rogers, 2003, p. 179).

In the 'implementation' stage there is a particular need for: good implementing parties (contractors, installers, sustainability advisors (as supervisors for large assignments)), guidance during implementation (Rijksdienst voor het Cultureel Erfgoed, 2019, Briene et al., 2020), control over costs and adjustments to unforeseen matters during implementation also for the purpose of taking care of the balance between the cultural heritage values of the LCHB and the sustainable renovation (Rijksdienst voor het Cultureel Erfgoed, 2019), applying for permits for the plan from the municipality/province and applying for the subsidy/financing (if applicable) (Briene et al., 2020). Appropriate questions to ask are: what can be done by homeowners and how much hassle /mess (Ebrahimigharehbaghi, 2022, p. 67)?

Confirmation

The confirmation stage takes place when an individual seeks reinforcement of an adoption decision already made, but he or she may reverse this previous decision if exposed to conflicting messages about the innovation. At the confirmation stage, the individual seeks to avoid a state of dissonance or to reduce it if it occurs (Rogers, 2003, p. 189). In the confirmation stage households are experiencing and evaluating the outcomes of the sustainable renovation (Pettifor et al., 2015, Mlecnik, 2021). This is similar to the aftercare stage by reports about the sustainable renovation of LCHBs. In the confirmation, or aftercare, stage the owner needs: a manual, insight into proper use, the timely maintenance of new installations with a good management plan and the evaluation and monitoring of what the effects of the sustainable renovation are (e.g. in terms of the environment and comfort) (Rijksdienst voor het Cultureel Erfgoed, 2019, Briene, 2020). Appropriate questions to ask here are: how much expectations are achieved and what other sustainable renovations are appropriate in the future (Ebrahimigharehbaghi, 2022, p. 67)? The confirmation stage forms a diving board to new sustainable renovations in the future.

The homeowner could be a great source of knowledge for other homeowners who want a sustainable renovation. This can be done by looking at how homeowners can: be ambassadors in target areas to convince other homeowners, help directly and create awareness (Mlecnik, 2021).

Adoption/rejection

Something that is not a stage but is an essential part of the decision-making process of Rogers (2003, p. 171) involves the decision to adopt or reject, and a subsequent later adoption or discontinuance or a continued adoption or rejection. Regarding sustainable renovations in LCHBs, these later adoptions after rejection and discontinuance after adoption are theoretically possible.

3.3 Drivers, barriers and opportunities

Sub question 3: What are the drivers, barriers and opportunities for LCHB owners during the decision-making process to sustainably renovate their listed cultural heritage building?

The rate of adoption of an innovation is determined by five things: perceived attributes of innovations, type of adoption decision, communication channels, nature of the social system and extent of change agents' promotion efforts (Rogers, 2003, pp. 15-16). The perceived attributes of innovations are the characteristics of an innovation, as perceived by individuals (Rogers, 2003, p. 15), consisting of: relative advantage, compatibility, complexity, trialability and observability. Innovations that are perceived by individuals as having greater relative advantage, compatibility, simplicity, trialability and observability will be adopted more rapidly, and have a shorter adoption decision period, than other innovations (Rogers, 2003, p. 214). These five qualities are the most important characteristics of innovations in explaining the rate of adoption. The first two attributes, relative advantage and compatibility, are particularly important in explaining an innovation's rate of adoption (Rogers, 2003, pp. 16-17).

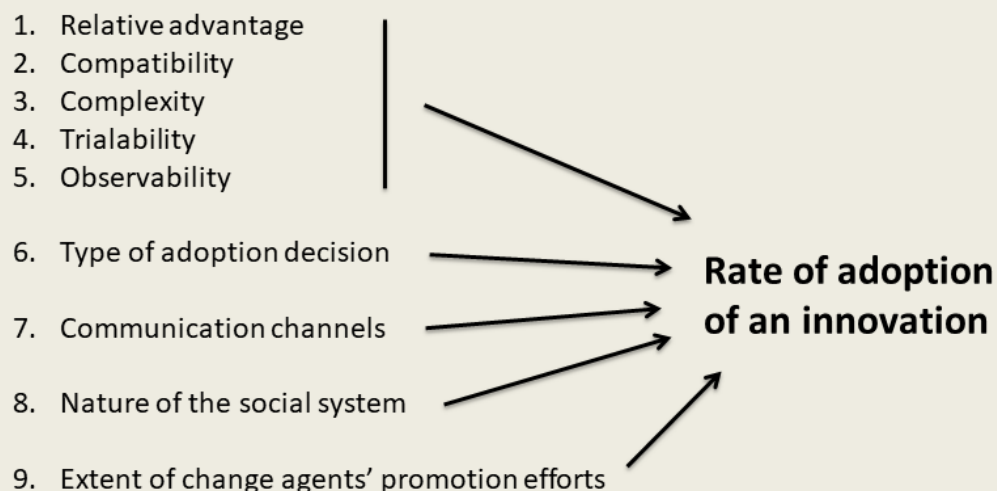


Figure 5. Factors determining the rate of adoption of innovations (author, adapted from Rogers, 2003, p. 222)

The factors determining the rate of adoption of innovations (**figure 5**) is based on the model of Rogers (2003, p. 222) and was slightly amended to accommodate a more even distribution of the factors and variables. This is valid because Rogers (2003, p. 222) claims that the five perceived attributes of innovations explain about half of the variance in adoption rates for innovations. Thus, the five perceived attributes of the innovation were given equal footing to the other four factors that determine the rate of adoption.

The factors (**figure 5**) will now be used as a framework to list all of the factors and their variables that influence the rate of adoption of sustainable renovations in homes in general and LCHBs. The drivers and barriers are fused into one chapter, since many variables are on a spectrum that ranges from positive to negative for the adoption of the innovation.

The structure of this literature subchapter is as follows: (1) explanation of the factor, (2) listing all the factor's variables and their possible influence, (3) the reports of Hamstra and Kommer (2022) and

Hamstra (2023) and (4) opportunities in the literature regarding many of the variables that may speed up adoption. And the last subchapter sums up all the identified factors and variables in a table (**table 35**).

Main drivers and barriers

Before the variables of drivers, barriers and opportunities are discussed, here is a small overview of the main drivers, **table 24**, and the main barriers, **table 25**.

Most important reasons to undertake sustainable renovation measures	2022
To reduce the energy costs	92%
To improve living comfort	80%
To make the LCHB future proof	79%
Because of the environment	72%
The possible return on investment	34%
To increase the value of the LCHB	33%
The possibility to receive a subsidy for it	33%

Table 24. Most important reasons for measures, N=497 (translated from Hamstra & Kommer, 2022, p. 19)

Experienced barriers by LCHB owners for their sustainable renovations	2023
Solar panels	18%
Glass	15%
Financial	12%
Cooperation of the municipality	10%
Limitation due to the listed cultural heritage status	8%
Building technical limitations of the building	7%
Knowledge (need for information)	6%
Insulation	6%
Expertise advisors / contractors	4%
Permit	4%
Heat pump	3%
No subsidy / subsidy difficulties	2%
Other	5%
None	24%

Table 25. Experienced barriers of LCHB owners' sustainable renovations, N=1.043 (translated from Hamstra, 2023, p. 22)

3.3.1 Relative advantage

The relative advantage is the degree to which an innovation is perceived as better than the idea it supersedes. The degree of relative advantage can be measured in: economic profitability, conveying social prestige, convenience, satisfaction or in other ways (Rogers, 2003, p. 15).

The nature of the innovation determines what specific type of relative advantage is important to adopters. However, whether an innovation has a great deal of objective advantage matters less than the perceived advantage. Therefore, the characteristics of the decision-making unit may also affect which specific variables of relative advantage are most important (Rogers, 2003, p. 229).

Variables of relative advantage for a sustainable renovation are: monetary costs, financial incentives, energy cost savings, comfort, environmental, real estate value, social status, waiting for improved technology and transaction costs.

3.3.1.1 Monetary costs

One of the main barriers to sustainable renovations are the monetary costs for it (Arning et al., 2020, Ebrahimigharehbaghi, 2022, p. 80). However, costs of a sustainable renovation can also be a significant

driver for a sustainable renovation (Gamtessa, 2013, as cited in Ebrahimigharehbaghi, 2022, p. 106). High perceived costs of a sustainable renovation is a barrier, while lower perceived costs or it being a good monetary investment may be a driver.

Sustainable renovation measures are generally more expensive for LCHBs than for non-LCHBs, making financial feasibility more difficult to achieve (Briene et al., 2020, p. 33).

According to Hamstra (2023) the lack of financial resources is a barrier in 30% of cases when a LCHB is not in a good architectural condition and is not being sustainably renovated, **table 26**.

Reason why the condition of LCHBs is in a bad shape	2023
Insufficient financial resources	30%
Maintenance or restoration is not a priority at the moment	12%
It is a long-term restoration	12%
The planning process is difficult	12%
The construction problems have recently come to light	9%
the monument was recently purchased. I haven't had time for any maintenance or restoration work yet	8%
Other	18%

Table 26. Reason why the condition of a LCHB is in a bad shape (translated from Hamstra, 2023, p. 7)

Costs LCHB owners incurred to realize a sustainable renovation	2022
Less than €25.000	38%
Between €25.000 and €50.000	25%
Between €50.000 and €100.000	15%
More than €100.000	14%
I do not want to say that	8%

Table 27. Costs incurred to realize a sustainable renovation, N=497 (translated from Hamstra & Kommer, 2022, p. 25)

Expected costs of implementing a sustainable renovation by LCHB owners	2023
Less than €25.000	30%
Between €25.000 and €50.000	32%
Between €50.000 and €100.000	17%
More than €100.000	8%
I do not know yet	13%

Table 28. Expected costs of a sustainable renovation by LCHB owners, N=1.043 (translated from Hamstra, 2023, p. 24)

3.3.1.2 Financial incentives

To speed up the rate of adoption of an innovation, change agencies can award incentives or subsidies to adopters. Hereby increasing the relative advantage of the innovation. Incentives are direct or indirect payments of cash or in kind that are given to an individual encourage behavior change, which is often the adoption of a new idea (Rogers, 2003, p. 236). Incentives (1) increase the rate of adoption of an innovation, (2) make different individuals adopt an innovation than those who would otherwise and (3) increase the quantity but lower the quality of the adoption decision, limiting the intended consequences of adoption (Rogers, 1973, as cited in Rogers, 2003, p. 238).

Examples of incentives regarding sustainable renovations in LCHBs are subsidies and attractive loans. An incentives can be a significant driver for a sustainable renovation (Gamtessa, 2013, as cited in Ebrahimigharehbaghi, 2022, p. 106). And, 'limited to no subsidies' is a main barrier keeping homeowners from adopting sustainable renovations (Ebrahimigharehbaghi, 2022, p. 80).

The subsidies, i.e. financial incentives, for LCHB owners are:

Woonhuissubsidie

Since the 1st of January 2019, the maintenance costs of LCHBs are covered by the home subsidy (woonhuissubsidie), before 2019 the costs for maintenance were deductible from income tax (Ministerie van Algemene Zaken, 2023). This subsidy/tax deduction is only applicable for conservation and did not and does not offer any assistance to sustainable renovations of LCHBs.

Municipal subsidies

And different municipalities offer widely varying financial incentives to LCHB owners, depended on what is determined by the mayor and aldermen, and the municipal council.

ISDE

Since 2016, there is the ISDE subsidy of the Dutch Agency for Entrepreneurship (RVO). The ISDE is short for investment subsidy renewable energy (Investeringsubsidie Duurzame Energie), and this can be used for a heat pump, a heat pump boiler, solar panels, subsidizing between 20% and 50%.

Ontzorgingsprogramma

In the 'ontzorgingsprogramma' owners of nationally LCHBs receive advice and guidance from an advisor who is specialized in sustainable renovations and LCHBs. The 'ontzorgingsprogramma' offers advice and guidance in different forms. Sometimes it is sufficient to read quotations and in other cases an advisor can, for example, attend a construction meeting, provide insight into financing options, provide support during the permit process or remove questions or possible barriers. All guidance costs of the DuMo advisor will be reimbursed 100% up to a maximum of €2500 excluding VAT (on the condition that the permit application for the sustainability measures has been submitted) (Monumenten.nl, 2024).

Opportunities regarding financial incentives

The Dutch government stated in 2019 that it must be possible to carry out a sustainable renovation that makes the home gas-free in a 'costs of living-neutral' manner, implying the government may help out financially, however this has not been made concrete in any agreements (De Koning et al., 2020, p. 69). Doing that would be likely to increase sustainable renovations. And Briene et al. (2020, p. 38) recommends to make it more attractive for LCHB owners to finance a sustainable renovation.

3.3.1.3 Energy cost savings

Energy cost savings, because of reduced energy consumption, are a significant driver, if not the most prevalent driver, for owners to adopt a sustainable renovation (Wilson et al., 2015, as cited in Arning et al., 2020, Stieß & Dunkelberg, 2013, Ebrahimigharehbaghi, 2022, p. 75), and a primary motivation for PV panels (Ebrahimigharehbaghi, 2022, p. 118). Limited expected energy cost savings that come with a sustainable renovation could act as a barrier to the adoption.

3.3.1.4 Comfort

Comfort has many dimensions when it comes to homes, for example: temperature, acoustics, air quality, user friendliness and so on. This comfort subchapter involves comfort in general and the dimensions noise and ventilation/moisture.

Improving comfort is a driver for homeowners to realize a sustainable renovation (Jafari and Valentin, 2017, as cited in Arning et al., 2020, Ebrahimigharehbaghi, 2022, pp. 115-118). Improving

comfort is one of the main drivers for a sustainable renovations (Ebrahimigharehbaghi, 2022, p. 75). Improving comfort is a primary motivation especially for the sustainable renovation measures double glazing and insulation, and also significant for PV panels (Ebrahimigharehbaghi, 2022, pp. 115-118).

Noise

Another type of comfort is about reducing noise, which is a statistically significant driver (Ebrahimigharehbaghi, 2022, p. 82). Reducing noise is in particular a primary driver for the sustainable renovation measure of double glazing (Ebrahimigharehbaghi, 2022, p. 115).

Ventilation/moisture

And another type of comfort is about improving ventilation and tackling moisture problems. Improving ventilation is a significant driver for homeowners to sustainably renovate (Ebrahimigharehbaghi, 2022, p. 82). Ventilation and moisture problems are a primary driver for the sustainable renovation measure of insulation (Ebrahimigharehbaghi, 2022, p. 116).

3.3.1.5 Environmental

Reducing CO2 emissions is a driver for homeowners to realize a sustainable renovations (Jafari and Valentin, 2017, as cited in Arning et al., 2020). Protecting the environment is a driver that is not statistically significant for homeowners who have renovated their building, but it is a main driver for potential renovators (Ebrahimigharehbaghi, 2022, pp. 82-84). The environment has been a primary motivation for households to install the sustainable renovation measure of PV panels (Ebrahimigharehbaghi, 2022, p. 118).

3.3.1.6 Real estate value

Another financial aspect identified as a driver influencing the adoption of sustainable renovations is the increase in the value of real estate (Wilson et al., 2015, as cited in Arning et al. 2020). A higher energy label has a positive influence on the selling price (Ebrahimigharehbaghi, 2022, p. 266). 'Increasing the house value' has been identified as a significant drivers for homeowners to sustainably renovate (Ebrahimigharehbaghi, 2022, p. 82). Selling the house at a higher price is in particular a primary motivation for the sustainable renovation measure of double glazing (Ebrahimigharehbaghi, 2022, p. 115). The change in real estate value could also act as a barrier if the real estate value would not increase, increase little or decrease because of a sustainable renovation.

3.3.1.7 Social status

Another driver for individuals to adopt an innovation is the desire to gain social status, i.e. conveying social prestige (Rogers, 2003, p. 230). Status as a driver seems to be more important for innovators, early adopters and early majority, and less for the late majority and laggards. Adopters may be reluctant to admit that they adopted a new idea for the status conferral. Thus questioning about it is likely to underestimate its real importance in the decision to adopt, but other methods may be used (Rogers, 2003, p. 230). The implementation of a sustainable renovation could be a way to enhance ones social status as well. How a sustainable renovation scores on social status and social comparison can influence the rate of adoption (De Koning et al., 2020, p. 21).

Introducing a sustainable renovation is already correlated to social status, i.e. income and possession of wealth (Stieß & Dunkelberg, 2013), since sustainable renovations costs can be costly.

3.3.1.8 Waiting for improved technology

Technological developments are moving so quickly that many owners are inclined to wait a while until other or better solutions are developed (Briene et al., 2020, p. 33). Thus, relative advantage in the future is keeping LCHB owners from implementing a sustainable renovation now.

Opportunities regarding waiting for improved technology

Briene et al. (2020, p. 38) recommends to stimulate product development at companies or technical universities. This would make the technology available earlier, or at least it can show that the available technology is at the edge of technological development. This recommendation also applies to other relative advantage variables depending on the type of products developed, e.g. more energy cost savings or comfort.

3.3.1.9 Transaction costs

Transaction costs are often regarded as a framework that covers many other previously mentioned topics, e.g. monetary costs and financial incentives. However, since the framework ‘factors that determine the rate of adoption of an innovation’ of Rogers (2003, p. 222) (**figure 5**) is used, the transaction costs of this thesis include the following definition and variables.

Coase (1960, as cited in Ebrahimigharehbaghi, 2022, p. 184) defines transaction costs as any indirect inevitable cost in a transaction that affects the consumer’s decision. Transaction costs are regarded as one of the main barriers in achieving more sustainable renovations (Ebrahimigharehbaghi, 2022, p. 181). Transaction costs include the search for information, negotiating, monitoring costs (Ebrahimigharehbaghi, 2022, p. 184), time, effort, complexities in doing renovations, hassle factors, mess, nuisance and uncertainties. Furthermore, transaction costs are inevitable, usually unpredictable (Ebrahimigharehbaghi, 2022, p. 181) and non-monetary (Ebrahimigharehbaghi, 2022, p. 179). The most relevant transaction costs variables, categorized based on prevalence, are (Ebrahimigharehbaghi, 2022, pp. 80-81):

Barriers towards energy efficient renovations experienced by homeowners who renovated	2022
Limited/no subsidies	53,7%
Costs of a sustainable renovation	50,3%
The time and effort it takes to apply for subsidies and loans	49,9%
Finding a reliable expert	33,7%
The time and effort that the work takes	32,2%
Knowledge and skills required for the work	31,8%
Examining the reliability of the information	30,9%
Mess and nuisance because of the work	26,8%
Time and effort of finding information	25,3%
Expectations of helping from friends	17,9%
Discouragement by media reports	15,1%
Past experiences	10,6%
Experiences of those around the renovators	6,9%

Table 29. Barriers of renovator towards energy efficient renovations by Ebrahimigharehbaghi (2022, p. 81)

1. Limited/no subsidies is a main identified barrier (placed under the header ‘financial incentives’ of this subchapter).
2. Costs of a sustainable renovation is a main identified barrier (placed under the header ‘monetary costs’ of this subchapter).

3. The time and effort it takes to apply for subsidies and loans is a main barrier for sustainable renovations by homeowners (Ebrahimigharehbaghi, 2022, p. 80). 87% of homeowners of the study of Ebrahimigharehbaghi (2022, p. 82) ended up paying for the sustainable renovation by themselves, this might be due to the complicated and time-consuming process of acquiring subsidies.
4. Finding a reliable expert to carry out the sustainable renovation is a barrier (Ebrahimigharehbaghi, 2022, p. 80). The right contractors are not available (Briene et al., 2020, p. 34).
5. The time and effort that the work takes.
6. Knowledge and skills required for the work.
7. Examining the reliability of the information (Ebrahimigharehbaghi, 2022, p. 81). It is difficult to estimate the reliability of information; there is little independent information (Briene et al., 2020, p. 33).
8. Mess and nuisance because of the work (Ebrahimigharehbaghi, 2022, p. 81). For example, the restrictions homeowners have on their living comfort during construction (Arning et al., 2020).
9. Time and effort of finding information (Ebrahimigharehbaghi, 2022, p. 81). The multitude of information sources about sustainable renovation measures makes the search for information confusing (Briene et al., 2020, p. 33).
10. Expectations of helping from friends.
11. Discouragement by media reports.
12. Past experiences (placed under subchapter 3.1.1.4 'previous practice').
13. Experiences of those around the renovators (Placed under subchapter 3.1.1.7 'norms of the social system').

An extra transaction cost owners of LCHBs perceive during the adoption of a sustainable renovations is that sustainable renovations in LCHBs require a tailor made solution. And transaction costs could also be seen as driver. For example, realizing a sustainable renovation could make selling the house easier. However, 'selling the house easier' is a driver that has not been identified as statistically significant (Ebrahimigharehbaghi, 2022, p. 82).

Opportunities regarding transaction costs

Briene et al. (2020, p. 37) recommends to investigate the possibilities to standardize sustainable renovation measures that currently require a tailor-made permit application. This will reduce transaction costs, because the permit application process may become less of a hassle for owners who want a sustainable renovation in their LCHB.

3.3.2 Compatibility

Compatibility is the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters. Compatibility helps the individual give meaning to the new idea so it is regarded as more familiar, less uncertain and is more suitable for the individual's situation. An innovation can be compatible with sociocultural values and beliefs, previously introduced ideas and potential adopters' needs for the innovation (Rogers, 2003, p. 240). Variables that

make sustainable renovations compatible or incompatible are: cultural heritage value, listed cultural heritage status, values and beliefs, previously introduced ideas and needs of potential adopters.

3.3.2.1 Cultural heritage value

Sustainable renovation measures in LCHBs undesirably or unexpectedly affect the cultural heritage value (Briene et al., 2020, p. 34). Therefore, the sustainable renovation needs to be found compatible enough with the LCHB by the owner and other decision-makers.

3.3.2.2 Listed cultural heritage status

The sustainable renovation needs to be compatible with the preconditions from the listed cultural heritage status of the LCHB, otherwise the sustainable renovation is not permitted. Limitations regarding sustainable renovation measures in LCHBs because of the listed cultural heritage status are (**table 25**): PV panels 18%, glass 15%, insulation 6%, heat pumps 3% and the listed cultural heritage status outright 8%.

3.3.2.3 Needs of potential adopters

The needs of potential adopters have already been covered in literature subchapter: felt needs and/or problems (3.1.1.5). The LCHB owners with these needs and/or problems are more susceptible to a sustainable renovation, which could offer a solution.

3.3.2.4 Previously introduced ideas/past experiences

If owners have introduced certain ideas, or gained certain experience, that are compatible with the adoption of a sustainable renovation it makes these owners more likely to adopt a sustainable renovation. Past experiences have previously been identified as an insignificant barrier (Ebrahimigharehbaghi, 2022, p. 80). Literature subchapter: previous practice (3.1.1.4), goes over the already introduced sustainable renovation measures and experiences of LCHB owners.

3.3.2.5 Values and beliefs

If the owner's values and beliefs are aligned with the preservation of the LCHB by means of sustainable renovation, then a sustainable renovation is compatible. If the owner's values and beliefs are aligned with the preservation of the LCHB by means of restoration and keeping the building as it was in earlier years, then a sustainable renovation is not compatible. These values and beliefs are also discussed in the literature subchapter: personality variables (3.1.2.2), for example 'interests in energy saving' is an outcome of certain values and beliefs (**figure 22**).

Opportunities regarding needs of potential adopters

Batshalom & Cohen (2002, as cited in Van Hal, 2014, p. 16) recommends to: "Find out what people are really thinking and worrying about, and connect that with your knowledge of sustainable building. Because if sustainable building measures could contribute to resolving existing problems or achieving existing ideals, the chance that people would become enthusiastic about it increases markedly."

And Van Hal (2014, p. 16) recommends to: "Always take the needs, wishes and interests of those parties directly involved as your starting point, and use that as your foundation. Work out which sustainable renovation measures could make a contribution to this. The chance of large-scale adoption of these measures increases considerably as a result, because good news travels fast."

3.3.3 Complexity

Complexity is the degree to which an innovation is perceived as difficult to understand and use (Rogers, 2003, p. 257). A sustainable renovation consists of a combination of sustainable renovation measures which range from simple to very complex in their meaning to the potential adopters. This complexity of sustainable renovations, as perceived by LCHB owners, is negatively related to its rate of adoption. For some innovations complexity is a very important barrier to adoption (Rogers, 2003, p. 257). Variables that explain the complexity of sustainable renovations in LCHBs are: easiness to apply, knowledge about sustainable renovation measures, need for information and need for support.

3.3.3.1 Easiness to apply

The easiness of applying a sustainable renovation in the building has been identified as a driver that is not statistically significant (Ebrahimigharehbaghi, 2022, p. 82).

3.3.3.2 Knowledge about sustainable renovation measures

The percentage of owners that know about what sustainable renovation measures are possible in their LCHB is not very high; 56% in 2022 and 46% in 2023. This could be a barrier for the decision-making process as well, since there is no vision on what is possible.

Whether owners know the sustainable renovation measures that are possible in their LCHB	2022, N=526	2023, N=1.043
Yes	58%	46%
No	42%	54%

Table 30. Knowledge about what is possible (translated from Hamstra & Kommer, 2022, p. 13, Hamstra, 2023, p. 21)

3.3.3.3 Need for information

Table 31 shows that 79% of LCHB owners indicate they are in need of information about sustainability, i.e. sustainable renovations of their LCHBs, 47% about laws and regulations regarding LCHBs, 44% about where to find specialists, 28% about financial advice, 26% about the impact of climate change on LCHBs, 26% historical information, 25% about experiences of other LCHB owners, 11% about foundation repair, 10% about the process, planning and lead times, 8% about repurposing, 6% other and 4% are not in need of information. **Table 25** shows how with 6% of owners this need for information turns into a barrier.

Information needs of LCHB owners	2023
Sustainability	79%
Laws and regulations surrounding LCHBs	47%
Where can I find specialists	44%
Financial advice	28%
Impact climate change on LCHBs	26%
Historical information	26%
Experiences of other LCHB owners	25%
Information about foundation repair	11%
Information about the process, planning and lead times	10%
Information about repurposing	8%
Other	6%
I do not know (yet)	3%
I do not need this kind of information	4%

Table 31. LCHB owners need for information, N=1.043 (translated from Hamstra, 2023, p. 12)

Possible / received support of the municipality	2023
Yes, the municipality offers me free advice and information	20%
Yes, the municipality provides a subsidy	9%
Other	0%
I do not know	24%
No, I do not get support	51%

Table 32. Possible/received support from the municipality, N=1.043 (translated from Hamstra, 2023, p. 13)

Type of support needed from the municipality	2023
Advice / think along / knowledge	17%
Advice on sustainability	15%
Advice about subsidies	13%
Advice about permits	12%
Cooperation / leniency / speed up	7%
Financial support	5%
Advice about restoration / maintenance	4%
Advice / clarity regarding regulations	4%
Conservation LCHBs	2%
Financial advice	1%
Process supervisor	0%
Other	3%
I do not know	24%
I do not expect support	4%

Table 33. Type of support needed from the municipality, N=1.043 (translated from Hamstra, 2023, p. 13)

Opportunities regarding need for information

To increase the rate of adoption of sustainable renovations such as gas-free homes, the costs (and benefits) of such a sustainable renovations needs to be clarified. Because the lack of certainty about costs leads to resistance (De Koning et al, 2020, p. 69).

3.3.3.4 Need for support

65% of LCHB owners indicate they need support in the shape of advice about sustainable renovation options. Somewhere between 46% and 36% are in need of financial support. 24% needs support during the design- and permit application process. 21% needs support during the realization. 18% needs support in the shape of financial advice. And 9% does not need any support (Hamstra, 2023, p. 8).

3.3.3.5 Credibility of experts and information

Reliable experts and information is a barrier to the adoption of sustainable renovations by homeowners. Significant variables to measure this reliability are: the lack of reliable experts, and the information provided by do-it-yourself companies. Other sources of information than DIY have more positive responses (Ebrahimigharehbaghi, 2022, p. 82).

Opportunities regarding complexity in general

A way to resolve complexity, give a trial experience and create observability is to bring consultancy into a target area by using a mobile pop up center. This was done by (Mlecnik, 2021), and it was noticed that these pop-ups in the target areas can be very successful in attracting visitors and the main outcome of doing that would be to really direct the homeowners to a specific consultant that can help them and give them advice for their specific situation.

A coherent, step-by-step plan on how homeowners can achieve long-term goals would reduce

complexity. This is really needed because it is very difficult to convince homeowners to do renovation measures beyond a few single measures (Mlecnik, 2021).

3.3.4 Trialability

Trialability is the degree to which an innovation may be experimented with on a limited basis. New ideas that can be tried on an installment plan are generally adopted more rapidly than innovations that are not divisible (Rogers, 2003, p. 258). A sustainable renovation is difficult to divide for trial, but not impossible. The personal trying out of an innovation is one way for an individual to give meaning to an innovation and to find out how it works under one's own conditions, and is therefore positively related to the rate of adoption. Trialability is less important to later adopters because their peers act as a kind of vicarious trial for them, and hence their own personal trial of the new idea is less crucial (Rogers, 2003, p. 258).

The Trialability of sustainable renovations in LCHBs really depend on the specific sustainable renovation measures. Many measures are not particularly trialable. Take PV panels for example, they are in some way trialable because they can always be removed again, or initially only a few can be installed, but these trials are definitely not without costs. Paying upfront for a sustainable renovation is definitely a barrier, because there is much uncertainty about the outcome. For example, PV panels combined with a heat pump works better in some buildings than in others. Having these measures installed, finding out how well it works and then making a decision would get rid of this barrier, but this would make the costs higher or the arising costs and risks will need to be covered by another party.

Mlecnik (2021) noticed that pop-ups in target areas can be very successful in attracting visitors, the main outcome of doing the pop-ups was to direct homeowners to a specific consultant that can help them give advice for their specific situation. However the pop-ups are a form of trialability, because they show how certain sustainable renovation measures would look like to local homeowners.

The Cultural Heritage Agency of the Netherlands developed a traveling exhibition about sustainable renovations in LCHBs, to help municipalities support LCHB owners who are looking for information. The exhibition travels mostly to different municipalities where it is set up in each municipality for one month at a time (Rijksdienst voor het Cultureel Erfgoed, 2024).

Opportunities regarding trialability

If an innovation can be designed so as to be tried more easily, it will have a more rapid rate of adoption (Rogers, 2003, p. 258).

And Mlecnik (2021) advises anyone who organizes pop-ups in target areas to attract visitors, to also direct the visitors, which would ideally be LCHB owners regarding this thesis, to a specific consultant that can help them and give advice for their specific situation. This is not yet a feature of the traveling exhibition of sustainable renovations in LCHBs by the Cultural Heritage Agency of the Netherlands.

3.3.5 Observability

Observability is the degree to which the results of an innovation are visible to others (Rogers, 2003, p. 258). This visibility of the innovation also stimulates peer discussion about it, as the friends and neighbors of an adopter often request innovation evaluation information about it. Sustainable renovations range from being easily able to be observed and communicated to difficult to observe or to describe to others. Since sustainable renovations vary widely in their composition.

Visibility

Rogers (2003, p. 16) mentions how Californian homes with solar water-heating adopters are clustered in some city blocks and not spread out. This is evidence for observability (and peer-to-peer networks), since when neighbors adopt, individuals can see it and are more tempted to adopt as well.

PV panels on LCHBs are often not visible on purpose due to the listed cultural heritage status not allowing for it, hereby maintaining the cultural heritage value. Thus, increasing visibility of PV-panels is not an option.

What is possible to increase visibility is to showcase sustainable renovations in LCHBs more, by for example organizing more open houses, or house tours.

Opportunities regarding visibility

A way to increase observability is to realize demonstration projects within a target area that then could also be effectively used to convince other homeowners to sustainably renovate by showing the results, e.g. during an open house (Mlecnik, 2021).

3.3.6 Type of adoption decision

Innovations that require an individual decision, or optional adoption decision, are generally adopted faster than innovations involving an organizational or collective decision. Because, the more persons involved in making a decision to adopt an innovation, the slower the rate of adoption. Therefore, one means of speeding the rate of adoption of an innovation is to attempt to alter the unit of decision so that fewer individuals are involved (Rogers 2003, p. 221).

Innovations can be adopted or rejected by (1) an individual or member of a system, or by (2) the entire social system. The decision to adopt by the entire social system is made by a collective or an authority (Rogers, 2003, p. 28). Thus, the types of innovations decisions are:

3.3.6.1 Optional

An optional decision is the choice to adopt or reject an innovation made by an individual independent of the decisions by other members of a system (Rogers, 2003, p. 403). The decision of a LCHB owner to adopt a sustainable renovation seems to mostly be an optional decision.

3.3.6.2 Collective

A collective decision is the choice to adopt or reject an innovation made by consensus among members of a system (Rogers, 2003, p. 403). The innovation decision to adopt a sustainable renovation can be a collective decision because the decision often needs be approved by the municipality through a permit.

Opportunities regarding an optional/collective adoption decision

Less interference of authorities, e.g. less permit application requirements, would make the sustainable renovation decision more optional and less collective, and thus increase the adoption rate.

3.3.6.3 Authority

An authority decision is the choice to adopt or reject an innovation made by a relatively few individuals in a system who possess power, high social status, or technical expertise (Rogers, 2003, p. 403).

Legislation can act as an authority decision, for example an obligation to install a heat pump instead of a boiler when a boiler needs to be replaced.

Opportunities regarding an authority adoption decision

An obligation on the owner to realize a sustainable renovation in the LCHB is an authority decision.

3.3.7 Communication channels

Communication is the process by which participants create and share information with each other to reach a mutual understanding (Rogers, 2003, p. 18). A communication source is an individual or institution that originates a message. And a communication channel is the means by which a message gets from the source to the receiver (Rogers, 2003, p. 204). Communication channels are categorized along the lines of: mass media, interpersonal and internet. And a distinction is made between localite and cosmopolite communication channels (Rogers, 2003, p. 205).

3.3.7.1 Mass media

Mass media communication channels are usually the most rapid and efficient means of informing an audience of potential adopters about the existence of an innovation. It enables few individuals to reach a large audience (Rogers, 2003, p. 18). It can also change weakly held attitudes (Rogers, 2003, p. 205). Examples are: radio, television, newspapers and the internet.

Mass media could in theory also have a contra productive influence. However, discouragement by media channels has been identified as an insignificant barrier to the adoption of sustainable renovations (Ebrahimigharehbaghi, 2022, p. 84).

Mass media communication channels are relatively more important at the knowledge stage, and interpersonal communication channels are relatively more important at the persuasion stage (Rogers, 2003, p. 205). Therefore, using the right communication channels at the right time is essential for maximizing adoption. The ideal time sequence being: progressing from mass media to interpersonal communication channels (Rogers, 2003, pp. 205-206).

Mass media is relatively more important than interpersonal for earlier adopters than for later ones (Rogers, 2003, p. 211).

Opportunities regarding mass media communication channels

Briene et al. (2020, p. 36) recommends organizing a national public campaign to change the view of many LCHB owners, who believe sustainable renovations are not possible due to the custom solutions it requires, to a more realistic view which is that many sustainable renovation options are possible with the conservation of cultural heritage values.

3.3.7.2 Interpersonal

Interpersonal communication channels involve a personal exchange between two or more individuals, this can be face-to-face or online (Rogers, 2003, p. 215-216). The two-way exchange of information makes interpersonal communication more effective in dealing with resistance or apathy on the part of the potential adopter. Because one individual can get clarification or additional information about an innovation from the other, which allows potential adopters to overcome for example the barriers of selective perception and selective retention (forgetting) (Rogers, 2003, p. 205). Interpersonal communication is also more proficient than mass media in persuading an individual to form or to change a strongly held attitude. Especially if the interpersonal channel links two or more individuals who are similar in socioeconomic status, education or other important ways (Rogers, 2003, p. 18). Because, most people depend mainly upon a subjective evaluation of an innovation that is conveyed to them by other individuals like themselves who have already adopted the innovation (Rogers, 2003, pp. 18-19).

The need for personal (face-to-face) contact about sustainable renovations, and some other things, among LCHB owners is 28% and growing (Hamstra, 2023, p. 12).

Opportunities regarding interpersonal communication channels

Briene et al. (2020, p. 36) recommends to share information proactively with the public by organizing information meetings on provincial or municipal scale. Information meetings are not fully interpersonal, but they are more interpersonal than mass media since participants can ask questions.

3.3.7.3 Internet

Interactive communication via the internet has become more important for diffusion of certain innovations in recent decades (Rogers, 2003, p. 18). This seems to be a primary source of information for at least 11% of LCHB owners, **table 34**. An interesting combination between all three communication channels are forum communities like the 'Monumenten Community', which was used for gathering the participants of this thesis research.

Information sources used by LCHB owners	2023
Cultural Heritage Agency of the Netherlands / Monumentenzorg / Government	19%
National Restoration fund	17%
Municipality	14%
Monumenten.nl / community	13%
Monumentguard	13%
Google / internet in general	11%
Contractor / architect	5%
Province	3%
Other LCHB owners	1%
De Groene Grachten	1%
Vereniging Eigen Huis	1%
Tax authorities	1%
Bewoond Bewaard	1%
Other	20%
None	37%

Table 34. Information sources of LCHB owners, N=1.043 (translated from Hamstra, 2023, p. 12)

Opportunities regarding internet communication channels

Briene et al. (2020, p. 35) recommends to make technical knowledge and experiences available through a central and independent platform.

3.3.7.4 Localite vs cosmopolite communication channels

Cosmopolite communication channels are those linking an individual with sources outside the social system under study, and localite are the communication channels within a system. Interpersonal channels may be either local or cosmopolite, while mass media channels are almost entirely cosmopolite (Rogers, 2003, p. 207).

Cosmopolite channels are relatively more important at the knowledge stage, and localite channels are relatively more important at the persuasion stage (Rogers, 2003, p. 207).

Cosmopolite channels are relatively more important than localite channels for earlier adopters than for later adopters (Rogers, 2003, p. 213).

3.3.8 Nature of the social system

The nature of the social system, or network of the potential adopter, determines the rate of adoption (Rogers, 2003, p. 359). A social system is defined as a set of individuals, or other units, that engage in joint problem solving to accomplish a common goal (Rogers, 2003, p. 23). The social system constitutes a boundary within which an innovation diffuses, meaning the social system affects the diffusion process

(Rogers, 2003, p. 24). The way in which the social system influences diffusion is shaped by the following aspects (Rogers, 2003, p. 24):

1. Social structure
2. Norms of the social system (literature subchapter 3.1.1.7)
3. Opinion leaders and change agents
4. Types of adoption decisions (literature subchapter 3.3.6)
5. The consequences of innovations.

3.3.8.1 Social structure

The structure of the social system can facilitate or impede the diffusion of innovations (Rogers, 2003, p. 25). A social structure consist of the patterned social relationships among the members of a social system. This structure gives regularity and stability to human behavior in a system, which allows for the prediction of behavior with some degree of accuracy (Rogers, 2003, p. 24). One example given by Rogers is the hierarchy of an organization, here individuals with a higher-ranked positions are given the right to issue orders to lower-ranked individuals. The social system of LCHB owners does not have a hierarchy like the example has, but there may be other forms of social structure.

Besides this formal social structure, there is an informal communication structure, which consists of the interpersonal networks that link members of a social system. These communication network patterns predict, in part, the behavior of individual members of the social system, including when they adopt an innovation (Rogers, 2003, pp. 24-25). Learning more about the social structures of LCHB owners regarding sustainable renovations may be interesting. Currently, the information sources, regarding organizations, other owners and the internet have already been surveyed by Hamstra (2023), **table 34**.

Another way the adoption rate is determined is by the potential of the information exchange, which is related to the communication proximity and the similarity of the individuals (Rogers, 2003, p. 340). Since individuals within networks tend to be linked more to others who are close to them in physical distance and who are relatively similar in social characteristics (Rogers, 2003, p. 341).

Opportunities regarding social structure

Sustainability as a theme may also help strengthen a sense of “we” in a neighborhood. This addresses significant societal issues like loneliness and it establishes warm and supportive social networks (Van Hal, 2014, p. 9).

“The building world needs to operate less on an ad-hoc basis, and should focus more on collaboration in the form of networks” (Van Hal, 2014, p. 37).

3.3.8.2 Norms of the social system

Opportunities regarding norms of the social system

The effectiveness of energy policy has been improved by a range of behavioral evidence from social and environmental psychologists. Descriptive social norms and commitment gave the most prominent results. Descriptive social norms are about informing how most other people behave and thereby changing behavior. If these behaviors are of individuals that are similar to the receiver of the message, then it is the most effective (Ebrahimigharehbaghi, 2022, p. 228).

An example, is a study about information provision to potential adopters where the norms of the

social system were used to enhance effectiveness. Taranu & Verbeeck (2016, as cited in Ebrahimigharehbaghi, 2022, p. 102) studied the impact of five types of information messages to households. The information provision that achieved the highest electricity savings in households was: “joining neighbors in conserving energy”. The less impactful information messages were: “save money by conserving energy”, “protecting the environment by conserving energy”, “conserving energy for future generations” and “saving energy by using fans instead of air conditioning”. Thus, making the social norms known can be a huge motivator.

Norms of the social system can be used by the change agent to his advantage, Ebrahimigharehbaghi (2022, p. 143) recommended to counter bias ‘conform to social norms’ by formulating energy-saving practices which are aligned with socially desirable behavior. Steg & Vlek (2009, as cited in Ebrahimigharehbaghi, 2022, p. 99) also used social norms for enticing sustainable renovations.

3.3.8.3 Opinion leaders and change agents

Certain members of a social system function as opinion leaders. They provide information and advice about innovations to many other individuals in the system (Rogers, 2003, p. 26).

Opinion leadership is the degree to which an individual is able to influence other individuals’ attitudes or overt behavior informally in a desired way with relative frequency. This informal leadership is not a function of the individual’s formal position or status in the system. Instead, opinion leadership is earned and maintained by the individual’s technical competence, social accessibility and conformity to the system’s norms (Rogers, 2003, p. 27).

Many social systems have both opinion leaders that encourage and that oppose innovations. These influential people can lead the spread of an innovation or they can create an active opposition, since they are at the center of interpersonal communication networks. Opinion leaders can also lose their respectable position by straying too far from the social system’s norms. Similarly, opinion leaders can be worn out by change agents who overuse them for diffusion activities (Rogers, 2003, p. 27).

A change agent is an individual with the goal to direct potential adopters to make the decision to adopt an innovation that seems desirable or not adopt an undesirable innovation. The change agent is part of the change agency, which is most likely an organization (Rogers, 2003, p. 27). The change agency regarding this thesis can be the Cultural Heritage Agency of the Netherlands, with the change agents being the professionals that make up the program Heritage and Sustainability. And other change agencies are the municipalities with the relevant municipal officials making up the change agents.

3.3.8.4 The consequences of innovations

Consequences are the changes that occur to an individual or to a social system as a result of the adoption or rejection of an innovation. Consequences can be classified according to desirability, timing and anticipation (Rogers, 2003, p. 30-31). The consequences of an innovation logically influence the social system when the innovation changes occur at the level of the social system.

3.3.9 Extent of change agent promotion efforts

The extent of change agent promotion efforts affects the rate of adoption of an innovation (Rogers, p. 222). A change agent is an individual who seeks to bring about the adoption of an innovation on the part of potential adopters, in a direction deemed desirable by a change agency (Rogers, 2003, p. 400). A concept similar to change agent is intermediary. Intermediaries can be a group of people or institutions, that promote the diffusion of technologies through knowledge exchange, skill development and as a mediator (Bush et al., 2017, as cited in Arning et al., 2020). The success of a change agent depends on the following eight variables from Rogers (2003, p. 400): Effort in contacting potential adopters, an orientation on potential adopters, compatibility with the needs of potential adopters, empathy with potential adopters, change agent similarity to potential adopters, credibility in the eyes of potential adopters, the use of opinion leaders and improving the evaluation ability of potential adopters.

As mentioned in nature of the social system (3.3.8.3): the change agency promoting sustainable renovation can be the Cultural Heritage Agency of the Netherlands, with the change agents being the professionals that make up the program Heritage and Sustainability. And other change agencies are the municipalities with the relevant municipal officials making up the change agents.

3.3.9.1 Effort in contacting potential adopters

The extent of the change agent's efforts in contacting potential adopters.

Some municipalities lack the knowledge and capacity to support owners in the orientation process (Briene et al., 2020, p. 33). And the support of municipalities is limited in that they can only grant a permit for the sustainable renovation measures that have been applied for (Briene et al., 2020, p. 34).

Opportunities regarding effort in contacting potential adopters

Briene et al. (2020, p. 35) recommends increasing the communication capacity of municipalities. And to steer more actively on the use of preliminary consultation (vooroverleg), make these more accessible and also facilitate consultations with experts (Briene et al., 2020, p. 36). These recommendations are also about shifting the focus more towards interpersonal communication channels (literature subchapter 3.3.7.2). And facilitating consultations with experts may provide credibility, empathy and/or trust in the eyes of potential adopters (literature subchapter 3.3.9).

3.3.9.2 An orientation on potential adopters

A potential adopter orientation, rather than a change agency orientation.

Opportunities regarding an orientation on potential adopters

Behavior change can make a significant contribution to reducing environmental problems. However, stimulating this behavior through information campaigns and education is not effective. Neither is financial benefit, which counterintuitively does not bring about apparent behavior change in practice (Van Hal, 2014, p. 18). McKinsey-Mohr (2011, as cited in Van Hal, 2014, p.18) believes these common approaches fail because too little attention is paid to the 'people' factor. Solving this requires community-based social marketing, which has shown to be extremely effective in practice, and involves the following steps:

1. Carefully establishing desired behavior.

2. Identifying the barriers and benefits associated with the behavior.
3. Developing a strategy with instruments aimed at behavioral change, that removes the identified barriers and enhances the benefits.
4. Testing this strategy on a small scale.
5. Evaluating the pilot scheme, and then embracing the broad roll-out of the strategy with proper evaluation of its results.

More focus should also be put on making stakeholders listen to each other. Collaboration is often subconsciously influenced by preconceptions, leading to people selectively listening to each other, which results in people talking past each other (Van Hal, 2014, p. 29). Listening more to the experiences of home occupants with a minimal energy bill could be a good start (Van Hal, 2014, p. 37).

3.3.9.3 Compatibility with the needs of potential adopters

The degree to which the diffusion program is compatible with the needs of potential adopters.

In 2020, the Cultural Heritage Agency of the Netherlands was not yet fully focused on the demand for sustainable renovations. This created uncertainty among municipalities and owners (Briene et al., 2020, p. 33). Furthermore, owners' feedback of information to government bodies is limited (Briene et al., 2020, p. 34).

Opportunities regarding compatibility with the needs of potential adopters

To improve the compatibility of support with the needs of potential adopters, change agents can: create neighborhood approaches, support market parties, pay attention to collaboration and behavior, use personas and use adopter categories.

Neighborhood approaches

To create compatibility with the needs of potential adopters De Koning et al. (2020, p. 68) recommends to develop a neighborhood approach that responds to the different stages of the customer journey towards sustainably renovated homes, gas-free in this case. This is necessary because homeowners find themselves at different stages of the customer journey that hold their own drivers and barriers.

A neighborhood approach is best suited to implement sustainable renovations, such as gas-free homes. However, to create a successful neighborhood program it is necessary that local homeowners: pay attention, have the opportunity to implement the sustainable renovation and want to live gas-free in this case (De Koning et al., 2020, p. 68).

Support market parties

Government support should not only include information and cost reduction, but also practical support. Supporting market parties that are developing one-stop-shops and other relief concepts, to e.g. reduce hassle, can lead to overcoming barriers regarding sustainable renovations (De Koning et al., 2020, p. 69).

Collaboration and behavior

When conflict occurs, it also needs to meet the needs of potential adopters. Reaching agreements in conflict should be done in a way that makes all parties feel good about it. This can be done by separating people and problems, placing the focus on the interests and not on ultimate positions. Collaboration should lead to mutually-borne solutions, and the work should be executed creatively but without dirty

tricks (Batshalom & Cohen, 2002, as cited in Van Hal, 2014, p. 17).

Compatibility with the needs of potential adopters is also about taking inventory of home occupants' behavior when striving towards a sustainable renovation (Van Hal, 2014, p. 38).

Van Hal (2014, p. 53) claims that current cooperation efforts in the built environment are primarily focused on improving products. However, sustainable innovation requires the improvement of the effectiveness of processes, products and services. Taking in mind that the interest of people here and now and those of there and later are met. This especially requires collaboration, and this is the collaboration that produces innovation (Van Hal, 2014, p. 53).

Personas

Personas allow for a more targeted and tangible representation of owner-occupiers, which is useful for change agents who are curious how policy interventions regarding sustainable renovations might be interpreted by different sectors of the population. The personas could give clear insight into the success of future policies, provided they are supported by quantitative market segmentation data (Haines & Mitchell, 2014). Following this reasoning, the policies regarding the sustainable renovations of LCHB owners could be tailored to fit the personas, making the support of sustainable renovations better targeted and thus more likely to be successful.

Furthermore, developers of technology can use personas in the early stages of development, to ensure they have a real target user in mind. This prevents the blind development of energy technologies without the potential users in mind (Haines & Mitchell, 2014).

Briene et al. (2020, p. 19) mentions that LCHB owners can be categorized into two groups based on involvement. The first type of LCHB owner is very involved with the LCHB and well informed about technological possibilities, laws and regulations. And the second type is not that involved, and instead just happens to live in a LCHB, possessing less knowledge about it.

Adopter categories

Adopter categories can be used to bridge the gaps between innovators and early adopters, between early adopters and early majority and so on.

First, the differences between the innovators, early-adopters and majority need to be understood, these adoption categories also represent the innovativeness of adopters (literature subchapter 3.1.1.6).

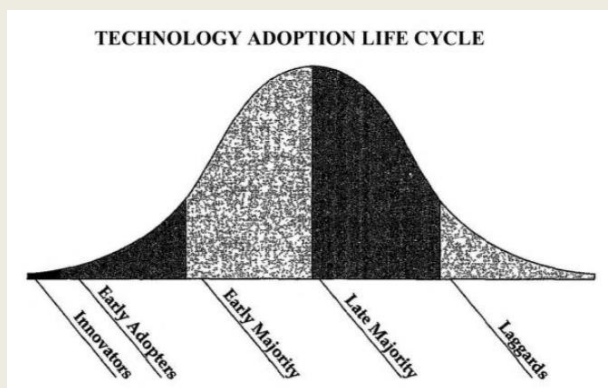


Figure 6. Technology adoption life cycle (Moore, 2014, p. 15)

The adoption of an innovation follows a bell curve (Rogers, 2003, p. 281, Moore, 2014, p. 15). According to Moore (2014, p. 15) the adopters can be categorized along divisions in the curve that are roughly equivalent to where standard deviations would fall. The early majority and the late majority fall within one standard deviation of the mean, the early adopters and the laggards within two and the innovators within three. Each group has a different profile, from a psychology and demographics point of view, making its marketing responses different from those of the other groups. Understanding each profile and its relationship to its neighbors is critical for high-tech marketing (Moore, 2014, p. 15).

In short, early-adopters inform themselves with information of innovators, and the early-majority with information of early-adopters, and so on. This information flow between the adoption categories is very important, and trying to increase it may be part of a strategy. To propose a strategy, change agents need to know to what extent owners have adopted full sustainable renovations, i.e. when doing more would be unnecessary. Because this will determine where sustainable renovations of LCHBs are in their adoption life cycle. And knowing this is key, because the key to success is to focus on the dominant 'adoption type' in the current market phase and adjust the strategy and tactics accordingly (Moore, 2014, p. 34). And laggards may simply not be interested, due to personal or economic reasons, and are thus mainly regarded as not worth pursuing (Moore, 2014, p. 17).

3.3.9.4 Empathy with potential adopters

The change agent's empathy with potential adopters.

Reliable information is only useful when it is brought in a trusted way. For example, information provision about using a thermostat by a boiler engineer does not necessarily reduce energy consumption of households, since not all households perceive the engineer as trustworthy. The personality or the friendly behaviors of the engineer has a significant impact on the willingness of participants to accept the advice (Ebrahimigharehbaghi, 2022, p. 229).

Low-income households have less trust in government than higher-income households, and this lack of trust leads to inadequate communication by the government. Instead, when messages are received from peers, households tend to perceive them more pleasantly compared to the interventions by policy makers or utility companies, leading to less energy consumption (Ebrahimigharehbaghi, 2022, p. 229).

Opportunities regarding empathy with potential adopters

Briene et al. (2020, p. 37) recommends providing good information so that the permit application contains the correct proposed sustainable renovation measures.

A lot of resistance can be overcome by taking individuals' wishes and objections into account when it comes to a neighborhood approach to promoting sustainable renovations. Because what is often seen by municipalities and market parties as a secondary issue may be a key issue for residents (De Koning et al., 2020, p. 69).

3.3.9.5 Change agent similarity to potential adopters

The change agents' similarity to potential adopters.

A problem that often arises with the diffusion of innovations is that change agents are different than potential adopters, which leads to ineffective communication. For example, a change agent is more technically competent than potential adopters. However, when two individuals are identical regarding

their technical grasp of an innovation, diffusion cannot occur as there is no new information to exchange (Rogers, 2003, p. 19).

Opportunities regarding change agent similarity to potential adopters

Change aides can be enlisted to bridge the non-similarity gap between professionals and potential adopters, plus provide safety and credibility. Change aides are less than fully professional change agents who intensively contact potential adopters in order to influence their decision to adopt an innovation. Aides provide lower cost contact with potential adopters than is possible with professional change agents (Rogers, 2003, pp. 400-401). Using change aides can influence many of this chapter's variables.

3.3.9.6 Credibility in the eyes of potential adopters

The credibility of the change agent or agency in the eyes of potential adopters.

Reliable information is a barrier towards the adoption of sustainable renovations (Ebrahimigharehbaghi, 2022, p. 76).

Opportunities regarding credibility in the eyes of potential adopters

Briene et al. (2020, p. 37) recommends increasing building technical and cultural-historical knowledge regarding sustainable renovations among permit authorities. This would enhance the credibility of the change agent and also lead to providing more reliable information to- and creating trust with LCHB owners.

De Koning et al. (2020, p. 68) recommends that research that analyzes decision-making behavior should include trust.

3.3.9.7 The use of opinion leaders

The extent to which the change agent works through opinion leaders

The most common way to use a network is to identify and utilize opinion leaders (Rogers, 2003, p. 321). In Germany, collaboration and the transfer of knowledge by households was found to be an effective approach for motivating them in realizing a sustainable renovation (Stieß & Dunkelberg, 2013, as cited in Ebrahimigharehbaghi, 2022, p. 104)

Opportunities regarding the use of opinion leaders

Use the right opinion leaders who resonate with potential adopters in the social system. This is a common error made by change agents, they select individuals to be opinion leaders who are too innovative. The norms of the system determine the adopter category in which opinion leaders in a system are found. If an opinion leader becomes too innovative, or adopts a new idea too quickly, followers may begin to doubt his or her judgement (Rogers, 2003, p. 319).

3.3.9.8 Improving the evaluation ability of potential adopters

The extent to which the change agent improves the ability of potential adopters to evaluate innovations.

Opportunities regarding improving the evaluation ability of potential adopters

Briene et al. (2020, p. 38) recommends including implementing parties/contractors in a quality register and increase the knowledge about the effectiveness of sustainable renovation measures. These recommendations also lower transaction costs (literature subchapter 3.3.1.9), and help overcome

complexity (literature subchapter 3.3.3).

To enhance homeowner evaluation ability, municipalities can improve their information provision by developing better online information at the municipality website. This has been done by developing new web models specifically intended to create awareness amongst homeowners. Local authorities put a lot of effort in developing them, and they can also be used by other authorities (Mlecnik, 2021). Mlecnik (2021) stresses that whether this information is found by homeowners really depends on the active communication by the local authorities about the existence of this web module.

Another way to increase the evaluation ability of homeowners is to distribute home energy monitoring systems that provide effective feedback, which could also act as a way to convince homeowners to sustainably renovate. However the implementation and the distribution of these home energy monitoring systems to the citizens by the municipalities can sometimes be problematic (Mlecnik, 2021). According to other studies, the provision of information through in-home displays and smart meters diminished electricity consumption in comparison with houses without such information (Ebrahimigharehbaghi, 2022, p. 102). This is only a basic measure, but it could lead to a sustainable renovation because owners are more able to evaluate their energy consumption. This recommendation also improves observability. Observability is the degree to which the results of an innovation is visible to potential adopters (Rogers, 2003, p. 258). Therefore, in this report observability is also aligned to the degree to which the results of not doing a sustainable renovation is visible by potential adopters.

3.3.10 Factors and variables that influence the rate of adoption

All of the identified factors and variables that influence the rate of adoption of sustainable renovations among LCHB owners are shown in **table 35**.

Relative advantage				
Monetary costs	Financial incentives	Energy cost savings	Comfort	Environmental
Real estate value	Social status	Waiting for improved technology	Transaction costs	
Compatibility				
Cultural heritage value	Listed cultural heritage status	Values and beliefs	Previously introduced ideas/past experiences	Needs of potential adopters
Complexity				
Easiness to apply	Knowledge about sustainable renovation measures	Need for information	Need for support	Credibility of experts and information
Trialability				
Observability				
Visibility				
Types of adoption decision				
Optional	Collective	Authority		
Communication channels				
Mass media	Interpersonal	Internet	Localite/cosmopolite	
Nature of the social system				
Social structure	Norms of the social system	Opinion leaders and change agents	Types of innovation-decisions	The consequences of innovations
Extent of change agent promotion efforts				
Effort in contacting potential adopters	An orientation on potential adopters	Compatibility with the needs of potential adopters	Empathy with potential adopters	Change agent similarity to potential adopters
Credibility in the eyes of potential adopters	The use of opinion leaders	Improving the evaluation ability of potential adopters		

Table 35. Variables influencing the decision-making process (author, based on Rogers, 2003, p. 222)

3.4 Theoretical framework

The theoretical framework shows an overview of all the literature aspects. If change agents want to promote sustainable renovations, then the options for policy interventions present themselves within the brown rectangles, especially the drivers, barriers & opportunities, since the prior conditions & characteristics are not easily changed. This theoretical framework will be adjusted with the finding of the empirical research to create a new decision-making process and slightly modify how everything influences it (subchapter 4.2.3).

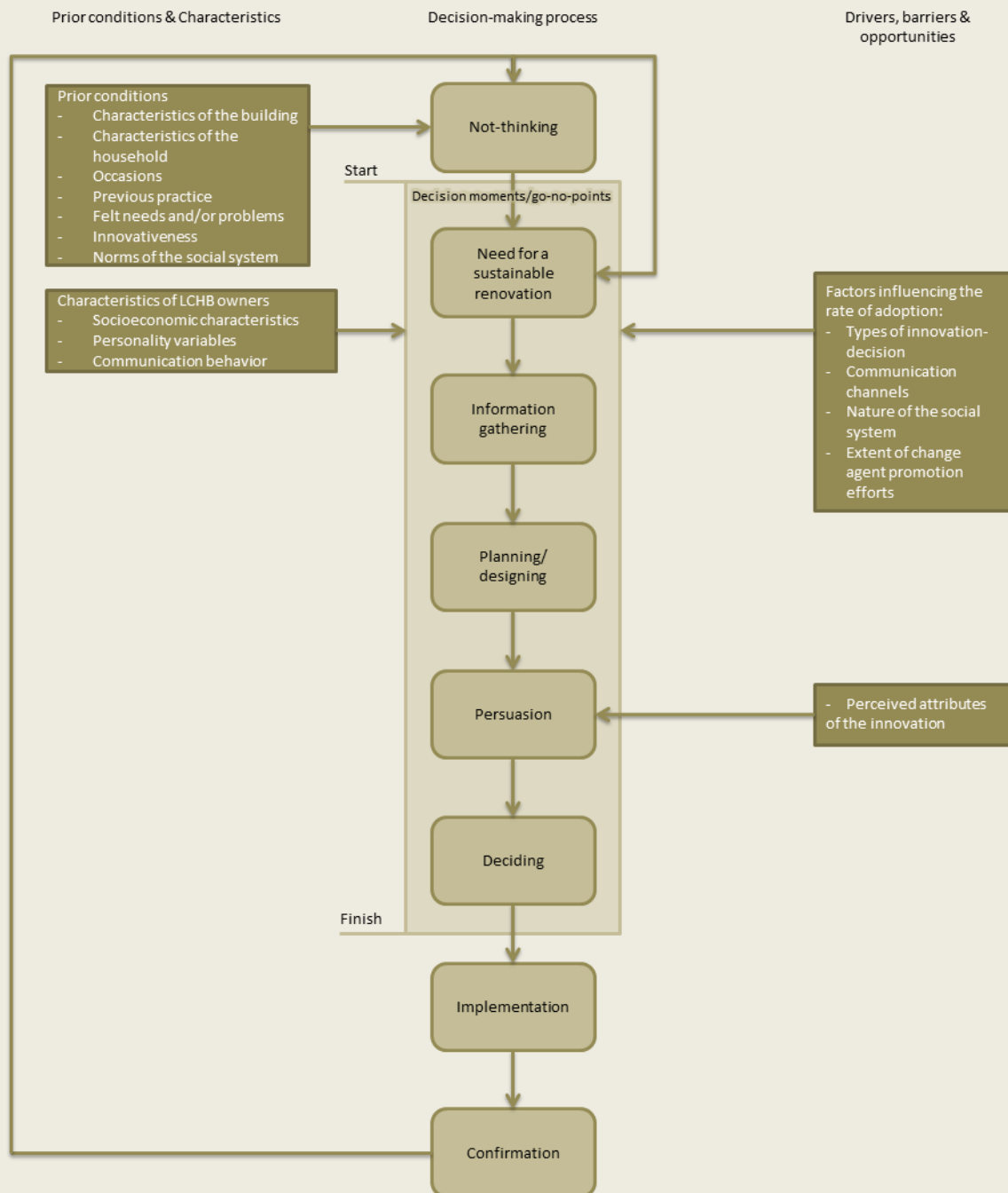


Figure 7. Stages of the decision-making process in the literature and influences on it (author, based on Rogers, 2003)



4. Results

The results chapter includes the results from the interviews with 9 LCHB owners, the first and second round of interviews with 2 rounds of 7 professionals and the workshop with 25 professionals. The results are systematically categorized along the structure of the theoretical background, **table 35**. This makes the results clear and easy to compare to the same factors and variables of the theoretical background. The LCHB owners are quoted as the interviewees with a number that links back to their LCHB and sustainable renovation, **table 5**, and the professionals are not quoted or directly referenced.

The results chapter consists of:

- Prior conditions and characteristics
 - o Prior conditions
 - o Characteristics
- Decision-making process
- Drivers, barriers and opportunities
- Personas

4.1 Prior conditions and characteristics

This chapter presents the prior conditions of the decision-making process for LCHB owners and the characteristics of LCHB owners. And thus only makes use of the results of the interviews with LCHB owners.

4.1.1 Prior conditions of the decision-making process

4.1.1.1 Characteristics of the building

The characteristics of the LCHBs of the owners, as described in the theoretical background (3.1.1.1), are listed in **table 36**. The variables of the theoretical background and results are: age, location, typology, size, government regulations and condition. Technical restrictions are covered in the research method 'sustainable renovations of the LCHB owners' (3.2.8) just like many other characteristics of the building.

Participant	1	2	3	4	5	6	7	8	9
Characteristics of LCHBs									
Age (year of construction)	17 th century	~1900	19 th century	20 th century	17 th century	19 th century	18 th century	~1700	19 th century
Location	Centrum	Village	Centrum	City	Village	Village	Centrum	Village	Village
Typology (function of origin)	House	Parsonage	House	House	Country estate	House	House	Farmhouse	Train station
Size (floor area, m2)	200	300	400	300	500	300	200	200	500
Government regulations (function)	House	House	House	House	House	House	House	House	House
Government regulations (LCHB type)	National	Municipal	National	Municipal	National	National	National	National	National
Condition	Good	Reasonable	Good	Good	Good	Good	Good	Reasonable	Good

Table 36. Characteristics of the LCHBs (author)

The LCHBs of the owners from the interviews are on average very aligned with the results of LCHBs in general from Hamstra and Kommer (2022) and Hamstra (2023). Except, the LCHBs of the interviewees were bigger, with more floor area than the average LCHB.

National LCHBs were overrepresented when compared to the whole, however they are similarly overrepresented in the reports of Hamstra and Kommer (2022) and Hamstra (2023), **table 9**.

4.1.1.2 Characteristics of the household

The characteristics of the household consists of many variables that could have an influence on the decision-making process, the ones researched are: household composition, household lifecycle, length of expected stay in the home and use of the house. Attitude towards housing/lifestyle and perceived energy consumption were not researched.

The household composition aligns with Hamstra and Kommer (2022, p. 40) who found that most LCHB addresses are inhabited by 2 people, **table 11**. 57% of LCHB owners are 60 years or older and 43% is older than 65, **table 18**, inferring a high percentage of retirees. It seemed like none of the owners had any plans to move. And some owners only used a part of the LCHB, leaving some rooms empty, because of different reasons.

Participant	1	2	3	4	5	6	7	8	9
Characteristic of the household									
Household composition	Couple	Couple	Single	3 people	Couple	Couple	Couple	Couple	-
Household lifecycle	Working	Working	Retired	Retired	Retired	Partly retired /working	Retired	Retired	Working
Length of expected stay in the home	As long as possible	As long as possible	As long as possible	As long as possible	As long as possible	As long as possible	As long as possible	As long as possible	As long as possible
Use of the house (the rooms)	All	Partly	All	All	Partly	All	All	All	Partly

Table 37. Characteristics of the household (author) (- means no information)

4.1.1.3 Occasions

The occasions LCHB owners encountered that were of influence on the decision-making process are presented in **table 38**. The theoretical background about occasions in subchapter 3.1.1.3 identified the variables of occasions, they are: extensions/alterations, maintenance, purchase of a building, restorations, extraordinary advice, attractive financial incentives, something breaks down, having changes in the household composition, moving, taking out a mortgage, uncertainty about the remaining time living in the house, wanting to combine the sustainable renovation with other construction work, making use of the organization of implementation measures of the municipality and the decision by homeowner association (VVE) to sustainably renovate.

The variables ‘uncertainty about the remaining time living in the house’, ‘decision by homeowners association’ and ‘taking out a mortgage’ did not arise during the interviews. It seems like none, or very few, of the interviewees were part of a homeowner association, no one had plans to move and no one indicated that taking out a mortgage played a role.

Occasion	Participant	1	2	3	4	5	6	7	8	9
Extensions/alterations		X	X	X	X	X	X	X	X	X
Maintenance		X	X	X	X	X	X	X	X	X
Purchase of a building		X	X	X		X	X	X	X	
Restorations		X	X	X	X	X	X	X	X	X
Extraordinary advice		X	X	X		X	X			
Attractive financial incentives			X			X		X	X	
Something breaks down			X	X		X	X		X	X
Having changes in the household composition						X		X	X	
Moving			X	X			X		X	
Wanting to combine the sustainable renovation with other construction work		X	X	X		X	X		X	
Making use of the organization of implementation measures of the municipality						X				

Table 38. Occasions (author)

‘Extraordinary advice’ was an occasion that could work both ways. In the case of interviewee 1, 2 and 3 the advice they got was an occasion that created a significant barrier, instead of a driver, for the sustainable renovation decision-making process, in the end realization did still occur.

Interestingly, a need to sustainably renovate can be that the building has turned into a degraded version of itself. 4 out of 9 participants bought a house that was completely degraded (interviewee 2, 3, 5 and 6), and 3 of those had making it future proof and beautiful again as their main motivation behind realizing the sustainable renovation. Thus, the prior condition ‘purchase of a degraded building’, an occasion, was the main driver. Which could be a newly identified sub variable of the prior condition ‘purchase of a building’.

The variable ‘making use of the organization of implementation measures of the municipality’ was only a real prior condition for interviewee 5, who had the opportunity to make use of a significant municipal subsidy that was about to be eliminated.

Just like in the literature, maintenance is a very important prior condition. The variables ‘extensions/alterations’ and ‘restorations’ are also unanimously regarded as prior conditions to the sustainable renovation, since all the sustainable renovation of the LCHBs occurred together with some form of extension/alteration and restoration.

4.1.1.4 Previous practice

Previous practice has some overlap with characteristics of the decision-making unit. Still, all of the variables of the theoretical background (subchapter 3.1.1.4), are addressed in **table 39**. They are: a past investment in a sustainable renovation, knowledge, technical skills, do-it-yourself, skills and dealing with sustainability at work or a technical job.

Skills was a bit hard to quantify, all LCHB owners had their own set of skills. Only two participants, as of the information gathered by the interviews, had done previous investments in sustainable renovation at another LCHB before starting a sustainable renovation in their current LCHB.

Participant	1	2	3	4	5	6	7	8	9
Variables of previous practice									
A past investment in a sustainable renovation			X				X		
Knowledge	X				X				X
Technical skills	X		X		X			X	X
Do-it-yourself	X	X				X			X
Skills	X	X	X	X	X	X	X	X	X
Dealing with sustainability at work	X	X			X		X	X	X
Technical job	X	X			X		X	X	X

Table 39. Previous practice (author)

4.1.1.5 Felt needs and/or problems

Table 40 shows the felt needs and/or problems of before the sustainable renovations of interviewees started. Some LCHB owners may have experienced more needs and/or problems, however these did not clearly arise during the interviews.

Participant	1	2	3	4	5	6	7	8	9
Felt needs and/or problems									
Lack of heating	X	X		X	X	X	X	X	X
Lack of cooling							X		
Ventilation/moisture/mold		X			X	X		X	X
High energy costs	X	X			X				X
Environmental concerns	X			X	X		X	X	
The LCHB is a dump (or not beautiful at the time)			X		X	X			
The LCHB is not future proof		X	X	X	X	X			X

Table 40. Felt needs and/or problems (author)

LCHB owners who want a sustainable renovation state the reasons: lowering the energy bill 92%, improving living comfort 80%, making the LCHB future proof 79%, because of the environment 72% (**table 24**), moisture in the home 17% and mold 9% (**table 17**). Lack of heating and making the LCHB future proof align with these statistics, ventilation/moisture/mold may be higher among the interviewees of this thesis and lack of cooling may not very important in the Dutch context. The statistics about high energy costs and environmental concerns are from 2022, and the sustainable renovations of the interviewees all started before 2022, thus their views on these felt needs and problems may have been different back in the day. During the interviews, almost all LCHB owners had environmental concerns in some way or another, from different perspectives, however for only about half it was a prior condition with actual influence on their choice, which are the above indicated participants.

‘The LCHB is not future proof’ and ‘the LCHB is a dump’ may also have been some of, if not, the most important variables of felt needs and/or problems for sustainable renovations in LCHBs, Hamstra and Kommer (2022, p. 19) already showed that 79% of LCHB owners want to make the LCHB future proof. But questions about these two topics have not been properly asked, instead interviewees naturally brought this up during the interviews themselves from different perspectives.

4.1.1.6 Innovativeness

LCHB owners can be categorized based on their innovativeness. This innovativeness is described in the theoretical background chapter 3.1.1.6, as the degree to which an individual is relatively earlier in adopting new ideas than other members of the same system.

An attempt has been made to gauge the innovativeness of LCHB owners in **table 41**; by comparing them to each other based on their timing between purchasing the LCHB and realizing a sustainable renovation. The variable ‘years between purchase and sustainably renovating’ is however a flawed indicator for innovativeness, because it does not take into account: the condition of the LCHB, whether a sustainable renovation was necessary, the quality of the sustainable renovation and contemporary events, since the renovations started between 1980 and 2021. Still, this variable could possibly indicate some aspect of innovativeness when a large sample of LCHB owners would be surveyed with these same questions.

Participant	1	2	3	4	5	6	7	8	9
Innovativeness									
Years between purchase and sustainably renovating	0	0	3	19	0	0	1	0	0
Date of first sustainable renovation	1995	2021	2009	2019	2008	1980	1993	2015	2018
Ownership years	28	3	11	23	15	43	29	8	5

Table 41. Innovativeness (author)

Most owners started right away after the purchase of the LCHB with a sustainable renovation, and some waited a few years. Interviewee 3 was delayed due to advisors, interviewee 7 due to family living with him and interviewee 4 waited a long time and then realized a large holistic sustainable renovation.

4.1.1.7 Norms of the social system

The norms of the social system, as described in the theoretical background subchapter 3.1.1.7, can be inferred from the behaviors of the whole social system of LCHB owners. These norms have not been explicitly researched in this thesis, but they are influencing the LCHB owners behind the scenes (subchapter 3.1.1.7).

An example of how a social norm influences the process comes from Interviewee 5: “we told the installation consultant: remember, it has to be sustainable, innovative, and so on. And he replied: madam, just put a HE boiler in the attic, just act normal, that’s already crazy enough.” (In Dutch: mevrouw, zet maar een Hr-ketel op zolder, doe maar gewoon dan doe je gek genoeg.) This was 15 years ago, and the owner still got an innovative sustainable renovation, however the social norms of certain professionals in the built environment could still act as a barrier to sustainable renovations today.

This barrier may also have arisen due to a lack of knowledge on the part of the consultant, which is partly fueled by the fact that taking risks is not always good for business. And the owner’s recommendation was to help out the contractors by taking on more risk as the client, and thus creating innovation.

4.1.2 Characteristics of the decision-making unit

4.1.2.1 Socioeconomic characteristics

The socioeconomic characteristics of LCHB owners, as described in the theoretical background (3.1.2.1), are listed in **table 42**. The variables that determine the socioeconomic characteristics of the decision-making unit are: age, years of LCHB ownership, building size, household income, household wealth, education and occupation. And two new variables were addressed, 'LCHB acquired by means of' which did not only include income and wealth, but also inheritance and sold house. And the other variable was the network of LCHB owners, some knew the right people to make the sustainable renovation process much easier, indicated with high, and others did not know the right people that could help them at all, and were thus indicated with low.

Participant	1	2	3	4	5	6	7	8	9
Socio-economic characteristics									
Age	56	50	70	64	69	77	74	71	55
Age during 1st renovation	28	48	56	60	54	34	44	63	50
Date of first sustainable renovation	1995	2021	2009	2019	2008	1980	1993	2015	2018
Ownership years	28	3	11	23	15	43	29	8	5
Building size (m2)	200	300	400	300	700	300	200	200	500
Household income now	Above medium	Medium	Pension	Pension	Pension	Pension (only AOW)	Pension	Pension	Above medium
Household income during first s. renovation	Above medium	Medium	Above medium	Above medium	Above medium	Medium	Above medium	Pension	Above medium
Household wealth now	Above medium	Above medium	Above medium	Above medium	Far above medium	Medium	Above medium	Above medium	Medium
Household wealth during first s. renovation	Medium	Above medium	Above medium	Above medium	Far above medium	Medium	Medium	Above medium	Medium
LCHB acquired by means of	Income	Sold house	Income & sold house	Income and inheritance	Sold house and inheritance	Income	Income, inheritance	Income, sold house	Income
Education	Higher education	Higher education	Higher education	Higher education	Higher education	Higher education	Higher education	Higher education	Higher education
Occupation (current or retired from)	Building technology professor	Software engineer	Physio therapist	Anesthetist	Architect	Restoration advisor / contractor	Mathematician	Chemical engineer	Restoration architect
Network (knowing the right people)	High	Low	Low	High	High	Low	High	Low	High

Table 42. Socioeconomic characteristics of the decision-making unit (author)

Age

The ages of the participants were between 50 on the low end and 77 on the high end, averaging an age of 65. The participants were in possession of their LCHB for 3 years on the low end and 43 years on the high end, 18 years on average.

The average age of the 9 interviewees for doing their first sustainable renovation was 49 years. This aligns with Nair et al. (2010) who found that Swedish homeowners under the age of 55 were more likely to realize a sustainable renovation measure.

Household income

The household income of the owners before, during and after the renovation was in 7 out of 9 cases above the medium for Dutch households.

Household wealth

Household wealth ranged from the medium to far above medium, this includes real estate value.

LCHB acquired through means of

All owners, except one, were in some way depended on their income to buy and sustainably renovate their LCHB. 6 out of 9 owners sold their previous home to both buy the LCHB and to be able to renovate it. For 2 out of 9 owners the LCHB was the first home they ever bought and they still lived in it. 3 out of 9 owners substantiated the purchase and/or sustainable renovations of their LCHB with inheritances.

Education

All the LCHB owners went through higher education. Most participants had a household that comprised a spouse, the spouse was often, if not always, the co-owner of the LCHB and also went through higher education.

Occupation

The participants were all current or retired professionals in different fields. Only three owners had a building technical background before starting with renovations, namely: a building technology professor, an architect and a restoration architect. The profession of the other interviewees were or had been: a physiotherapist, an anesthetist, a mathematician, a chemical engineer, a software engineer, an industrial design engineer and lastly an artist who became a renovation advisor and/or contractor.

Network (knowing the right people)

Socioeconomic status is also about your network, who you know, and people with a higher socioeconomic status have more and better connections. For example, interviewee 5 was often seeking advice from her sparring partner, who was a restoration architect, she probably also gave him advice from her own architectural experience, however knowing the right people remains a huge advantage.

4.1.2.2 Personality variables

The personality variables, that were researched by directly asking owners, are in **table 43**. These personality variables are used to create the personas (subchapter 4.4).

Some variables from the theoretical background (subchapter 3.1.2.2) are left out, these are: ‘attitude towards a sustainable renovation’, ‘interest in technology’ and ‘involvement’. These are left out because they can be inferred from the questions about the decision-making process. For example, most, if not all, LCHB owners were very positive towards sustainable renovations, had much interest in technology and were very well informed about technological possibilities, laws and regulations.

Participants Personality variables	1	2	3	4	5	6	7	8	9
Innovator or restorer	Innovator	Both	Restorer	Both	Both	Both	Restorer	Both	Both
Motivation for DIY	Middle, DIY to an extent, no time for bigger projects	High (extremely)	Low	Low	Low	High	Low	Low	High
Architectural design	Own	Own/contractor	Own/contractor	Architect	Own/architect	Own/contractor	Architect	Own/contractor	Own
Trust in professionals	High, the ones he knows are good	Low	High	High	High	High, the ones he knows are good	High	High	Middle
Trust in civil servants	Low	High	Low	Low	Middle (lack of expertise a.t.m.)	Low	High	Middle	Middle
Tolerance for disruption	High	High	High	Low	High	High	Low	High	Low
Hunger for information	High	High	High	Middle to high	High	High	Middle	High	High
Interest in energy saving	Middle to high	High	Middle to high	High	High	High	High	High	High
Price sensitivity	Middle, optimal ratio price/quality	Middle	Low	Low	Low	Middle, quality leads over price	Low	Middle	High
Concern for climate related issues	Middle to high	High	Middle	High	High	High	High	High	High
Preference for a challenge	High	Middle to high	High	Middle to high	High	High	Low	Middle	Middle
Comfort expectation after the s. renovation	High (most important, 22,5 °C)	Low to middle	Low	Middle	Middle	High	Low to middle (18,5 °C)	Middle	Low (17 °C)
Household income	Above medium	Medium	Above medium	Above medium	Above medium	Medium	Above medium	Above medium	Above medium
Possession of wealth	High	Middle	High	High	Very high	Middle	High	High	Middle

Table 43. Personality variables LCHB owners (author, inspired by Haines & Mitchell, 2014)

4.1.2.3 Communication behavior

The communication behavior of LCHB owners, as explained in the theoretical background (3.1.2.3), has been researched to some extent by touching on the variables: social participation, seeking information and degree of opinion leadership. Social participation has been researched by finding out if LCHB owners were a member of the Monumentguard association, **table 46**. The intensity of seeking information by asking LCHB owners about their hunger for information, **table 43**. And the degree of opinion leadership has been researched by asking owners' intensity of sharing information, **table 52**. **Table 44** puts these three variables together for convenience.

Participants \ Communication behavior variables	1	2	3	4	5	6	7	8	9
Member of the Monumentguard	X	X	X	X	-	X	X	X	-
Hunger for information	High	High	High	Middle to high	High	High	Middle	High	High
Intensity/extent of sharing information	High	Middle	Low	Middle	High	Middle	Low	Middle	High

Table 44. Communication behavior of LCHB owners (author) (- means no information)

At least 7 out of 9 LCHB owners were a member of the Monumentguard (in dutch: monumentenwacht), which is above average compared with the 43% of LCHB owners who are members among the respondents of Hamstra and Kommer (2022, p. 42), **table 23**. 7 out of 9 LCHB owners also indicated they had a high hunger for information, and 7 out of 9 owners had a middle or high intensity of sharing information. Thus, the communication behavior of LCHB owners interviewed for this thesis seems to be above average.

4.2 Decision-making process

The decision-making processes resulted from combining the literature version, i.e. stages of the decision-making process (**figure 4**), interviews with professionals and interviews with LCHB owners.

One cycle (all at once)

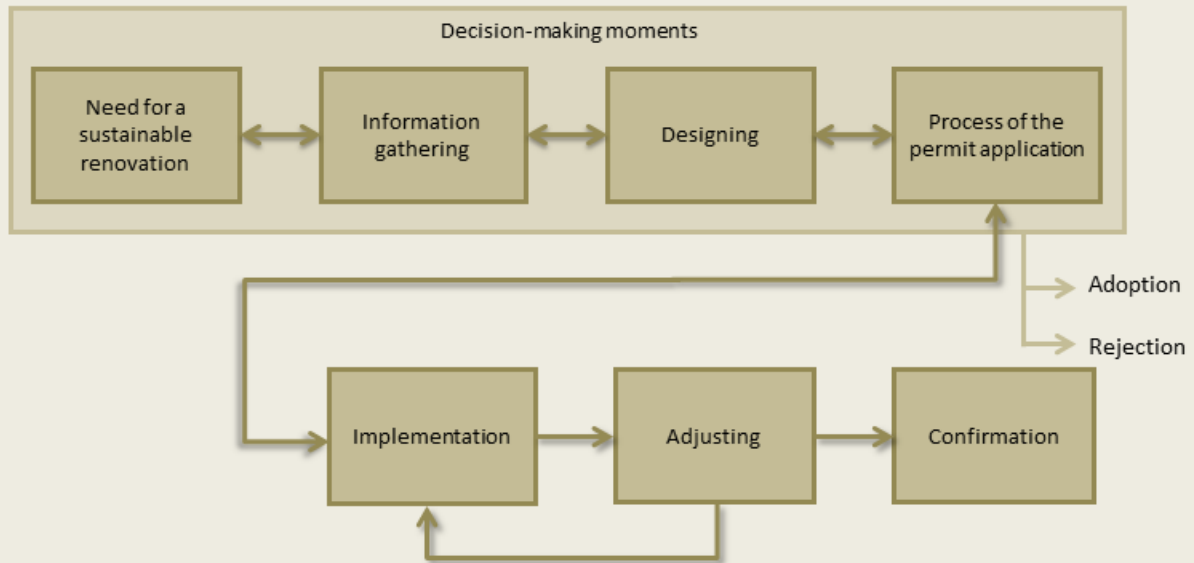


Figure 8. One cycle (all at once) decision-making process for a sustainable renovation (author)

Multi-cycle (step-by-step)

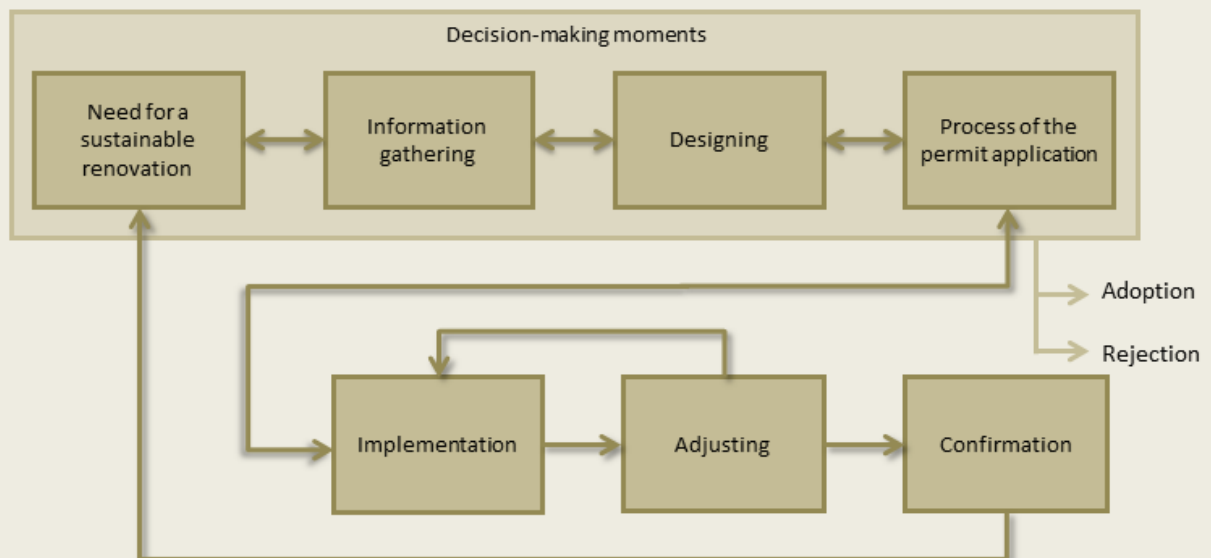


Figure 9. Multi-cycle (step-by-step) decision-making process for a sustainable renovation (author)

4.2.1 Decision-making process explanation

One or multiple cycles

Two different decision-making processes were identified; one cycle (all at once) and multi-cycle (step-by-step). One cycle means that a LCHB owner realizes an integral sustainable renovation, that includes multiple complementary measures, all at once in one decision-making process. Multi-cycle, or step-by-step, means that a LCHB owner decided to take the measures of the sustainable renovation, or multiple sustainable renovations, one at a time, thereby cycling through the decision-making process more than once for each measure or sustainable renovation.

Participant	1	2	3	4	5	6	7	8	9
Sustainable renovation process	Multi-cycle	Multi-cycle	Multi-cycle	One cycle	One cycle	Multi-cycle	Multi-cycle	Multi-cycle	Multi-cycle
How many sustainable renovations	3	2	>1	1	1	>1	>1	>1	>1

Table 45. Sustainable renovation decision-making processes of participants (author)

2 out of 9 owners realized a sustainable renovation in one cycle. The other 7 out of 9 owners realized their sustainable renovation in multiple decision-making process cycles, their decision-making process was often ongoing without any pauses (interviewee 2, 6, 8 and 9), with some owners taking up to 10 years without stopping in between (Interviewee 6).

Interviewee 4: “We actually did most of it in one go, at least the largest intervention was the roof and the balanced ventilation.”

Interviewee 2: “Almost all subsidies from the central government come with the condition that you must take two measures at the same time. If you want to take things a bit easy as a LCHB owner, you are not going to do two things at the same time, applying step by step is difficult enough.”

Interviewee 6: “I tackled the process in steps. There was not a central design. New information was needed for each part of the building and each time a solution had to be found.”

Whether a LCHB owner tackles the sustainable renovation decision-making process in one or multiple cycles may be influenced by socioeconomic characteristics, such as their wealth and income. To illustrate this, interviewee 4 and 5 were well of, and they realized a large integral sustainable renovation, cycling through the decision-making process just once. Meanwhile, interviewee 2, 6 and 9 had less financial resources, and tackled their sustainable renovation step-by-step, going through the decision-making process multiple times for each separate sustainable renovation and/or measure. For example, interviewee 2 had done a lot of work on his LCHB, but in the week he was interviewed he was also applying for a new job to be able to continue with his sustainable renovation.

About the arrows

Progressing to a next stage is not an irreversible step, instead owners can go back and forth and revisit any previous stage, stages also overlap and can easily occur simultaneously. All of this is illustrated by the double arrows. The arrows become points of no return after the implementation stage has been finalized, because now the sustainable renovation can only be adjusted or a new sustainable renovation decision-making process has to start, this is indicated with a single arrow.

Proof of the possibility of going back and forth between the stages comes from interviewee 5, who even during the 'implementation' stage went back to the 'design' and 'process of the permit application' stage to alter their plans. This altered plan got approved by the municipality. Subsequently, the 'implementation' stage went on with this updated design.

Decision-making moments

A decision-making moment is a moment where it is decided to go ahead with the implementation of a sustainable renovation. The decision-making moment was already found to not be a fixed stage or point in time (Thuvander et al., 2012, Arning et al., 2020, Ebrahimigharehbaghi, 2022, p. 66). Instead, the decision-making moment overlaps the first four stages, ending when the implementation stage starts. Because the implementation stage sees the overt realization of the sustainable renovation, while everything prior has been a strictly mental exercise of thinking and deciding (Rogers, 2003, p. 179). Interviewee 8, a life-long chemical engineer, explained the decision-making moment perfectly: "There is a go/no-go moment in each stage up until the implementation stage". Rogers (2003, p. 177) substantiates that the decision to adopt takes place when an individual engages in activities that lead to a choice to adopt or reject the innovation. Thus, the decision-making moment should be addressed in plural since there are multiple decision-making moments, and the decision-making moments are not linked to one stage, although Rogers (2003, p. 177) does link it to his decision stage.

To fix this dilemma, the decision-making process of this thesis presents the decision-making moments not as a stage but as an element overlapping, or being part of, the initial four stages. Thus, the decision-making moments element portrays Rogers (2003)' persuasion stage, by including the formation of an attitude during every stage until implementation, and decision stage, by including the decision to adopt or reject. And the decision to adopt or reject is shaped with go/no-go moments that occur constantly in each stage until the implementation. Which is substantiated by the fact that individuals can leave the decision-making process at any time (Rogers, 2003, pp. 189-190).

Prominent decision-making moments/go-no-points

Based on the interviews with LCHB owners, it seemed like their important decision-making moments were all quite different.

Interviewee 3, 5 and 6 immediately knew that a complete sustainable renovation was necessary when they bought their LCHB.

Interviewee 5: "The decision to go for a sustainable renovation was present at the very beginning. I just wanted to make a building sustainable, modern, historical, that was the starting point. So what we had developed in those 7 years of searching for a building was this idea of: well, that is the way in which you help such a monument for the future."

Interviewee 6: “Well, the house was so badly neglected that it was uninhabitable. New floors and windows had to be installed, everything had to be adjusted and it had to be made more sustainable, because it was not possible to heat such a house with its 50 cm thick walls. It takes a while before they are warm. So yes, that seems like enough motivation to me, to become more sustainable.”

Interviewee 1 and 7 both illustrate a go/no-go moment before implementation. Interviewee 1 explains this from the perspective of his work as an advisor, and it can be inferred from the process of interviewee 7.

Interviewee 1: “I have developed renovation plans for many people, then they put it out to tender, and then they say: well no, I'm not going to do that anymore, because I think this is way too expensive! So they do have a plan, but they say: this doesn't support the house budget, so they drop out, or they only do parts of the sustainable renovation.”

Interviewee 7 disagreed with that the decision-making moment overlaps the first four stages. He instead explained that his decision-making moment occurred in the ‘information gathering’ stage, and that realization of the sustainable renovation becomes inevitable when you apply for an environmental permit. However, after obtaining the permit for his latest sustainable renovation he decided to put the process on hold, due to personal circumstances. Meaning he had already been through both the ‘designing’ and ‘permit application process’ stages, and he may decide to adopt later on, but he still found himself at a go/no-go point that is more connected to starting the ‘implementation’ stage.

Lastly, interviewee 8 experienced, as mentioned in the previous section, that each stage requires a decision moment (go/no-go point) to progress to the next stage until implementation. Which makes a lot of sense, since external influences, e.g. costs, personal circumstances and more, can always result in a no-go decision. The processes of interviewee 2 and 9 concurred with this, because they experienced a lack of funds for their sustainable renovation measures, which could occur at different stages of the decision-making process, thus putting the decision-making process to a halt.

4.2.2 Decision-making process stages

This subchapter describes the stages of the decision-making process, how the stages went and who was involved besides the LCHB owners, i.e. the stakeholders.

The decision-making process is a model that can be useful for gathering the results by taking LCHB owners along through the stages of their decision-making process. Therefore, it was shown during all the interviews with LCHB owners of this thesis. And 8 out of 9 owners could really recognize themselves in the proposed decision-making process.

The influential factors on the decision-making process are shown in the next subchapter (4.2.3), here the influence of the prior conditions, characteristics of the decision-making unit, drivers, barriers and opportunities are given its place in relation to the decision-making process.

Stage specific drivers and barriers are not included here, they are interspersed in the 'drivers, barriers and opportunities' chapter (4.3), since that chapter organizes everything systematically according to the theoretical framework of the factors that determine the rate of adoption (**table 35**).

4.2.2.1 Need for a sustainable renovation

Before the decision-making process can start there needs to be a need or a wish to sustainably renovate. The reason for a sustainable renovation could be: a need for or lack of comfort, lower heating costs and/or improving the environment. Multiple other reasons were also discovered in this thesis, like the wish to make it beautiful, increase the durability and/or make the building future proof. Reasons of LCHB owners will be discussed in the 'main drivers' (subchapter 4.3.1.3).

4.2.2.2 Information gathering

The 'information gathering' stage is about: gathering information about what could be possible, what is already present and finding the current problems, i.e. inventorying the building or getting to know the house. Owners unanimously agreed this was part of their information gathering stage. For example, interviewee 4: "On the one hand, collecting information is based on technology. What is possible? What's available? And on the subsidies that were possible at the time. And on the other hand, looking at the old construction drawings. What about the cavity? What about the floor? Is there a crawl space or not? Yes, all those things that are directly related to gathering information about the sustainable renovation options." And interviewee 2 painstakingly described how getting to know his newly acquired LCHB was a huge hurdle, which is of course part of the information gathering stage.

Knowledge consists of 3 types of knowledge: awareness (knowing an innovation exists), how-to (knowing how to appropriately use an innovation) and principles (knowing why the underlying principles work) (Rogers, 2003, p. 173). The 'information gathering' stage involves the first one, and the second one to a large extent. The designing stage involves the second type of knowledge to a more detailed extent.

According to a professional: the 'need for a sustainable renovation' stage is more of a feeling. While the 'information gathering' stage is about finding objective information to substantiate the feeling. And the professional added that involving the municipality in this stage is helpful, for example with a preliminary consultation (vooroverleg). Interviewee 7 substantiates this by explaining that searching information about the preconditions of the 'process of the permit application' is also part of the 'information gathering' stage, since it is not logical to put much effort into a process that leads to a sustainable renovation that will not be allowed.

Ways of information gathering

The ways in which information is gathered during the ‘information gathering’ stage was researched by asking owners questions about where they got their information from, the results are shown in **table 46**.

Participant	1	2	3	4	5	6	7	8	9
Ways of gathering information									
Monumentguard	X	X	X	X		X	X	X	
Municipality		X			X		X		X
Cultural Heritage Agency of the Netherlands	X				X	X			
Internet	X	X	X	X	X		X	X	X
Consulting experts	X	X		X	X		X		X
Consulting contractors		X	X		X	X		X	
Books, journals and magazines	X		X			X			X
Visiting other LCHB owners		X	X		X		X	X	
By working	X				X				X
Visiting information gatherings				X		X	X		
Visiting a restoration/sustainable renovation fair					X				X
Watching contractors						X			

Table 46. Ways in which LCHB owners gathered their information (author)

Monumentguard

At least 7 out of 9 LCHB owners were a member of the Monumentguard (in dutch: monumentenwacht), who visited them yearly, or every other year, to give tips and make a small report about how to restore/preserve the LCHB. Advice about how to tackle a sustainable renovation can also be requested.

Municipality

8 out of 9 owners (except interviewee 6) had to go to their municipality for information about the ‘process of the permit application’. But only 4 out of 9 LCHB owners indicated that they got useful information about their sustainable renovation plans from the municipality. Owner 2 was visited by a municipal official who helped with plans, owner 5 also got helped well, owner 7 was brought into contact with another LCHB owner who really helped him and owner 9 was helped with his specific situation.

Cultural Heritage Agency of the Netherlands

Interviewee 6 realized his sustainable renovation when the permit application was still supervised by a predecessor of the Cultural Heritage Agency of the Netherlands. Interviewee 1 and 5 were really helped with their sustainable renovation plans by civil servants from the Cultural Heritage Agency of the Netherlands, and owner 6 by a civil servant from the predecessor of this organization.

Internet

8 out of 9 owners used internet sources. For example, interviewee 2 consulted the website of the Cultural Heritage Agency of the Netherlands often. Interviewee 1, 6 and 7 already started their first sustainable renovation before the internet became popular, i.e. before 1996. More recent sustainable renovations of interviewee 1 and 7 did of course include gathering information through the internet. Only interviewee 6 who sustainably renovated from 1980 to 1990, did it without using the internet.

Consulting experts

5 out of 9 LCHB owners relied mainly or partly on consulting an expert for gathering information, for example an architect (interviewee 4, 5 and 7). At least 3 out of 9 owners, interviewee 1 and 2, commissioned a rapport and/or advice from an energy advisor or another organization that was not the Monumentguard or an architect. Interviewee 1 had a DuMo advice commissioned. Interviewee 2 had a quickscan from the National Restoration Fund (NRF) commissioned. And interviewee 9 commissioned advice from the organization De Groene Grachten.

Consulting contractors

At least 5 out of 9 LCHB owners gathered information by consulting contractors. In 4 out of those 5 cases it was advice from contractors they hired, and owner 6 got advice from a contractor he did not procure.

Interviewee 6: "I had no money to hire people to build it, I had to do everything myself. But I was already a little bit in contact with a small contractor from a nearby city, who occasionally had good advice, and he was present at that insulation meeting for the people in the area, and gave good advice. Plus he also thought along with me and others."

This must have been very helpful to a lot of LCHB owners who visited this insulation meeting.

Books, journals and magazines

At least 4 out of 9 owners read books, journals and magazines to gather information. Interviewee 6 had to read books, since it was before the age of the internet. Interviewee 1 used old books, because there was no database for the right products and the right detailing, so he made his own. Interviewee 9 read professional journals. And interviewee 3 had a way of learning, getting inspired and to consider whose services to hire, which was by reading magazines of 'Monumentenzorg' about beautiful renovations.

Visiting other LCHB owners

At least 5 out of 9 owners visited other LCHB owners to learn from them and/or to look at their LCHB. Interviewee 2, 7 and 8 were in touch with and visited neighbors, owner 8 to a larger extent than the others. Interviewee 3 visited other LCHB owners in other provinces who were also enthusiasts that he got to know over time. Interviewee 5 was searching 7 years to find a suitable old building to sustainably renovate, which must have included many LCHBs as well.

However not everyone sees the use in information gatherings. For example, interviewee 9 was a restoration architect, and lived in a small village with not many LCHBs, and thus did not seek any contact with other local owners.

Interviewee 9: "Usually there is someone in the LCHB who, at best, knows as much as I do. And when they do visit and look at my LCHB they do not have appropriate advice for me."

By working

3 out of 9 owners already gathered useful information before their sustainable renovation by working in their profession (interviewee 1, 5 and 9). Interviewee 6 gathered information as well by working, but this was after he already realized the sustainable renovation of his own LCHB, so that does not count.

Visiting information gatherings

3 out of 9 owners visited local information gatherings which were useful for them. Interviewee 4 and 7 visited different local energy cooperatives, and interviewee 4 even gave a presentation there.

Interviewee 4: "I am part of an energy cooperative and an acquaintance there gave me advice. One such advice was how a radiator was not properly constructed because it hindered the passage of warm air. He played a very essential role. Because he also had a thermal camera. And that actually made me think and take action even more than an extensive energy advice I commissioned earlier, which did not include thermal images. These images actually really shocked me."

Interviewee 6: "There are now a group of people in my town doing information evenings about insulation, because there are a lot of LCHBs in my town. So they want to encourage people to participate in better insulating their homes. And they are now thinking about the possibility of purchasing a joint heat pump. And I must say the evenings are well attended, there have been two now, they were full, people are interested. For example, following such a meeting, I even installed a draft door in the hall, even though it had not been here all that time, and that immediately made a difference."

Interviewee 7: "I am in a neighborhood association group that held discussions and information meetings about sustainable renovations for the neighborhood. Thus, not only for LCHB owners other homeowners were also talking about sustainable renovations. And later on there were information meetings from other organizations, but I didn't go there anymore, because I thought I knew enough to be able to move on. And I regularly check the 'Monumenten Community', the forum where your call was on, and they also regularly have national meetings. But I think it's too much work to go there. The LCHB owner that do visit these often own farmhouses, and that is something completely different."

Interviewee 7: "I think the neighborhood meetings helped at the time. Not that I can say: well, I did that because I went to the meeting. But it's just a way of gathering information, and for making contacts, that you know who is a good installer for example. Finding the right contractors is quite a concern. For example, solar panels have an incredible number of suppliers. And then you never know whether that is some kind of cowboy who started installing solar panels yesterday, or whether it is someone who has already covered hundreds of roofs. And then there is some sort of certification of those clubs. But I didn't find it easy to pick out a good person there. And if you have a recommendation from someone, that's fantastic!"

Visiting a restoration/sustainable renovation fair

2 out of 9 owners visited fairs about restoration and sustainable renovation measures for LCHBs. Interviewee 9 spoke with representatives of sustainable renovation measures to figure things out. And interviewee 5 spoke with contractors to assess them and find the right contractors for their renovation.

Watching contractors

Interviewee 6 mentioned he watched contractors work and learned a lot by doing this, so he could later on do it by himself (DIY).

4.2.2.3 Designing

The ‘designing’ stage is about making a sustainable renovation design for the LCHB, according to professionals this includes: coordinating all the sustainable measures, the costs, the involved parties and a plan on how to execute the design. The difference with the ‘information gathering’ stage is that the ‘designing’ stage necessitates solution-oriented thinking according to a professional.

The ‘designing’ and ‘process of the permit application’ stages will together result in a design that is favorable or unfavorable to be implemented.

The designing stage of LCHB owners was shaped by: an architect 3 times, contractors at least 5 times, a monument guard of the Monumentguard association at least 2 times, a municipal official at least 1 time, an official from the Cultural Heritage Agency of the Netherlands 2 times, another advisor at least 3 times and searching the internet 8 times.

Participant	1	2	3	4	5	6	7	8	9
Help with designing from									
An architect				X	X		X		
Contractors	-	X	X	-	X	X	-	X	
A monument guard			X		-	X			-
A municipal official		X						-	-
The Cultural Heritage Agency of the Netherlands					X	X			
Another advisor	X				X				X
Searching the internet	X	X	X	X	X		X	X	X

Table 47. Designing stage of LCHB owners (author) (- means no information)

4.2.2.4 Process of the permit application

The ‘process of the permit application’ is the process of going through the permit application and being granted the permit. The owner has to meet the requirements of the municipality and cultural heritage committee.

Sometimes a decision-making process does not require the ‘process of the permit application’ stage. This could be the case when the designed sustainable renovation measures do not require a permit, e.g. solar panels in some municipalities. Or it could be because the owner decides to not go through the ‘process of the permit application’ stage, this might be illegal, but it occurs.

The ‘designing’ and ‘process of the permit application’ stages are characteristic to the decision-making process by owners of sustainable renovations. Since other innovations do not necessarily require an extensive designing stage or require a permit. And the ‘process of the permit application’ stage is especially characteristic for sustainable renovations in LCHBs, since LCHBs are subjected to more government regulations and often require a more extensive process for the permit application.

The ‘process of the permit application’ stage was traversed by LCHB owners while getting help from: an architect 2 times, a municipal official at least 1 time and an official from the Cultural Heritage Agency of the Netherlands 2 times. Searching on the internet for information about the process of the permit application is probably an important source for most owners, but is not researched. Another advisor/contractor/etc. who helped with the process of the permit application was not identified.

Participant	1	2	3	4	5	6	7	8	9
Help with the process of the permit application									
An architect				X			X		
A municipal official		X							
The Cultural Heritage Agency of the Netherlands	X					X			

Table 48. Process of the permit application stage of LCHB owners (author) (- means no information)

4.2.2.5 Implementation

The ‘implementation’ stage is the part of the sustainable renovation process where the spatial realization takes place. It is either the owner executing the work on their own (DIY) or a contractor or supplier that does it. Rogers (2003) explains that implementation occurs when an individual puts a new idea into use, in other words implementation is when the sustainable renovation is realized.

Table 49 shows the participants who, in addition to hiring contractors, also largely or partially realized the sustainable renovation by themselves (DIY). Interviewees 3, 4, 5, 7 and 8 only hired contractors.

Participant	1	2	3	4	5	6	7	8	9
Realizing the sustainable renovation largely or partially DIY	X	X				X			X

Table 49. Implementation of the sustainable renovation largely or partially DIY (author)

Attitude towards the implementation

Table 50 goes over how the implementation stage was perceived by LCHB owners. 7 out of 9 LCHB owners were positive about the sustainable renovation, and 2 had mixed results. Interviewee 1 had contractors who installed some glass inside out, but came and fixed it later. He also thought the municipal supervisor for his sustainable renovation did not do his work properly. And interviewee 7 had a roof that was insulated by a contractor, but this did not turn out to be of the quality he expected.

Participant	1	2	3	4	5	6	7	8	9
Attitude towards the implementation stage	M	P	P	P	P	P	M	P	P

Table 50. Attitude of LCHB owners towards the implementation stage (author) (N = negative, P = positive, M = mixed)

4.2.2.6 Adjusting

Some sustainable renovations can be adjusted. The ‘adjusting’ stage involves the adjustments of installations, e.g. solar panels, heating systems, ventilation, etc., this is what is shown in the decision-making process. Adjustments can also involve an optimized design, which may have to go through the process of the permit application again. In this case it does not go to the adjustment stage, it just goes back to the ‘designing’ and the ‘process of the permit application’ stages, similar as to how interviewee 5 went back to these stages and then forward to the implementation again (‘About the arrows’ 4.2.1).

Interviewee 4 and 5 both had to adjust their heating system, which takes one year following the sustainable renovation to account for all the seasons.

4.2.2.7 Confirmation

During the ‘confirmation’ stage, the implemented sustainable renovation(s) are monitored on their usefulness, efficiency, quality and/or costs. And it is about confirming that the right decisions have been

made. Rogers (2003) explains: “Confirmation, takes place when an individual seeks reinforcement of a decision to implement that has already been made, but he or she may reverse this previous decision if exposed to conflicting messages about the innovation.”

When the ‘confirmation’ stage results in the owner confirming that the sustainable renovation was a positive one to the building, a new sustainable renovation may be started to get more of these positive outcomes. Or the owner confirms that the sustainable renovation was negative or neutral to the building, which may lead to the owner feeling a need for a new sustainable renovation. Starting a new sustainable renovation after the previous one has been illustrated in the multi-cycle decision-making process with an arrow coming from the ‘confirmation’ stage to the ‘need for a sustainable renovation’ stage. The confirmation that the sustainable renovation has been or will be successful, and that more sustainable renovations are needed, can also overlap and occur anywhere in the process, but after the implementation is the most logical place.

An owner could also become an ambassador after going through the process and confirming that it has been positive. The owner would likely advise other LCHB owners to sustainably renovate in the same way just as mentioned in the Triple-A model of Mlecnik (2021). Therefore analyzing the confirmation stage is important when it comes to increasing the adoption of sustainable renovations.

Confirmation of LCHB owners

The confirmation of LCHB owners is added in **table 51**, all the LCHB owners mentioned an increase in energy performance and comfort after their sustainable renovation(s). Owner 1, 5 and 7 did have contractors who delivered results that did not meet their expectations. Interviewee 1 and 5 fixed this quite quickly, interviewee 7 still deals with some issues regarding insulation.

Table 51 also addresses the extent of monitoring; i.e. how often owners checked whether everything is working properly. Many interviews did not yield specific information about monitoring (-), however all LCHB owners did still monitor a lot by living in the house, e.g. temperature, ventilation, moisture and draft.

Participant	1	2	3	4	5	6	7	8	9
Energy performance improved	X	X	X	X	X	X	X	X	X
Comfort improved	X	X	X	X	X	X	X	X	X
Extent of monitoring	Daily (PV panels and heat pump), once (infra-red camera)	Weekly (PV panels, pressure (solar boiler)	-	Often (electricity and gas consumption)	-	-	-	Sometimes (energy consumption and CO2 meter), yearly (PV panels)	-

Table 51. Confirmation or attitude towards the realized sustainable renovation (author) (- means no information)

Sharing information on about the sustainable renovation

All interviewees shared information on about sustainable renovations. Some interviewees shared a lot of information, other participants were mainly professionals in the fields of medicine and engineering, so they knew their expertise was limited and so did not share much (Interviewee 3 and 7), this intensity or extent of sharing information is also added in **table 52**.

Participant	1	2	3	4	5	6	7	8	9
Ways of sharing information									
Neighbors		X			X		X	X	
Working with clients	X					X			X
Teaching and/or giving lectures	X			X	X				
Monumenten Community	X	X							
Featured in a book					X				
Friends who were LCHB owners			X						
Intensity/extent of sharing information	High	Middle	Low	Middle	High	Middle	Low	Middle	High

Table 52. Sharing information (author)

Neighbors

At least 5 out of 9 owners shared information about sustainably renovating with their neighbors. Interviewee 2 was a software engineer, but also worked on his own home, and actively shared his knowledge with neighbors. For example, after going through an extensive research and experimentation process of finding the right type of plaster. He tried to share his knowledge with two other owners in his village, this resulted in one owner who was not interested and the other who took his advice.

Interviewee 5: “After we first installed this innovative boiler, our neighbor with a similar LCHB installed the same kind of boiler. We have had a lot of visitors pass by, for example customers of the contractor and customers of the installer who came to have a look. And I have given many lectures about sustainable renovations and restoration. And many have been referred to because we were also mentioned in a book.”

Working with clients

3 out of 9 owners shared information in their work with clients. Interviewee 6 had been educated as an artist, but became an advisor and contractor in the field of renovating old buildings after finishing a 10 year renovation of his own home. And interviewee 9 was a practicing restoration architect.

Teaching and/or giving or lectures

3 out of 9 owners shared information by teaching and/or giving lectures. Interviewee 1 was a building technology professor who still taught students and gave lectures. Interviewee 4 shared his information by giving lectures at a local energy cooperation meeting. Interviewee 5 had been an architect and still gave lectures to other owners of LCHBs, this owner was however embarrassed with the limited amount of other owners that could give a lecture of the same quality, therefore she was still asked to lecture after her pension.

Interviewee 4: “I recommend sustainable renovation in the conversations I have. I am also active at an energy cooperative where I have given a lecture about making our building more sustainable. This includes feasibility because many people have doubts about whether sustainable renovations are even feasible in a LCHB. And the improvement in comfort, which was a real surprise for myself.”

Monumenten community

2 out of 9 LCHB owners shared information on by making forum posts on the ‘Monumenten Community’. One of them interviewee 2 shared his acquired knowledge after sustainably renovating.

Featured in a book

1 out of 9 owners their sustainable renovation was included in a book.

Sharing with friends who are LCHB owners

At least 1 out of 9 LCHB owners liked to share information with fellow LCHB owners and enthusiasts.

4.2.3 The decision-making process and influences on it

The decision-making process with its influences consists of the decision-making process (4.2) combined with the influence of the prior conditions and characteristics (4.1) and the drivers, barriers and opportunities (4.3). The empirical results are used to adjust the theoretical framework, which led to some parts being removed, and the gold colored stages and arrows are added or altered. Interventions in the influential factors of the drivers, barriers and opportunities side can increase the rate of adoption.

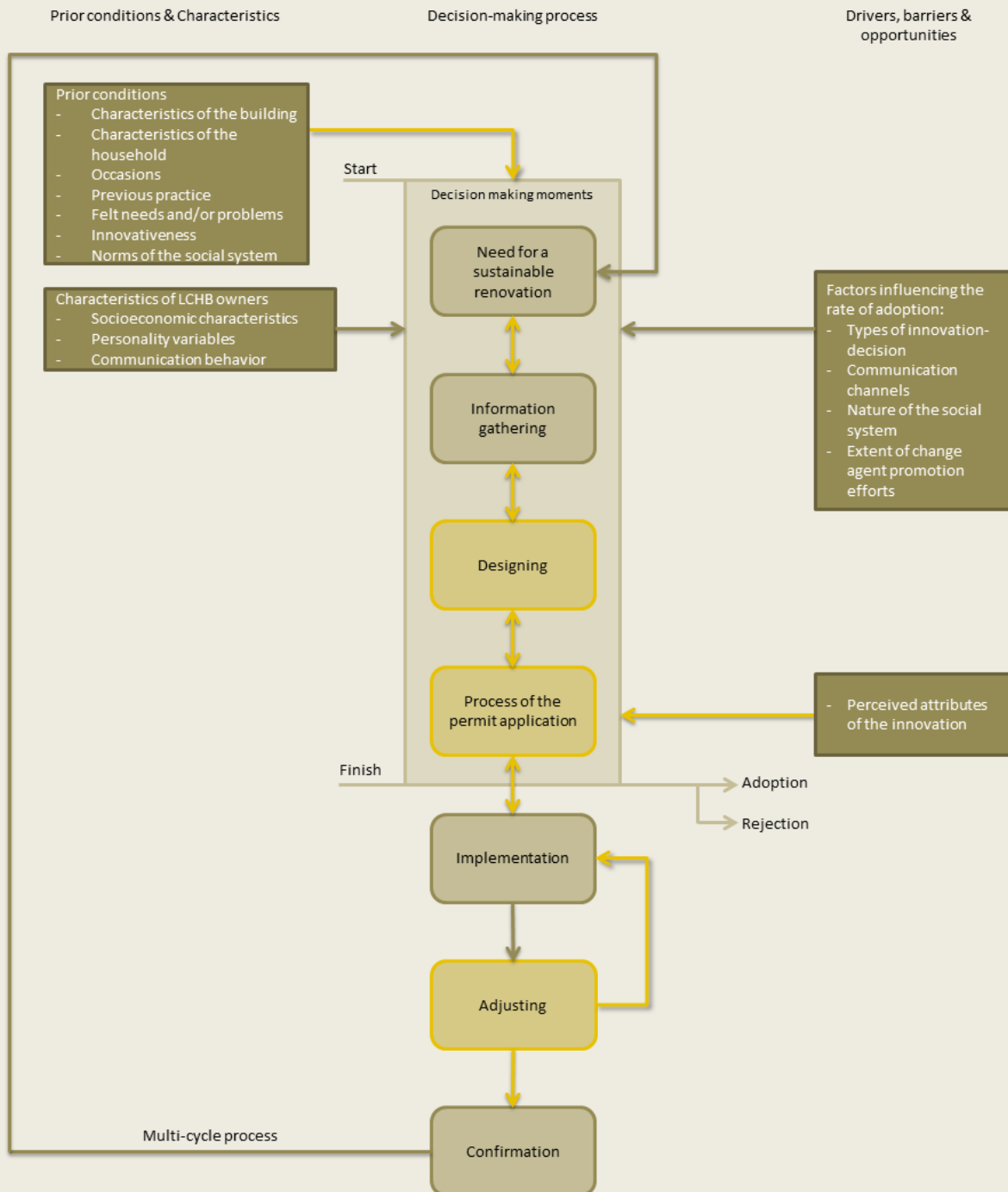


Figure 10. Decision-making process and influences on it (author)

4.3 Drivers, barriers and opportunities

This chapter lists the results about the drivers, barriers and opportunities regarding increasing the rate of adoption. The results are gathered from the interviews with LCHB owners and the interviews and workshop with professionals. And they are structured according to the factors and variables that influence the rate of adoption (**table 35**). An overview of the main identified drivers is shown in **table 53** and the main barriers in **table 54**. When owners have explicitly stated that one main driver or main barrier was more important than the others it is indicated with a bold X in **table 53** and **table 54**.

Main drivers and barriers

Before starting the interviews with LCHB owners, the researcher interviewed 7 professionals about the sustainable renovation process of LCHB owners, which also included the drivers of LCHB owners. From these primary interviews it was assumed that the main drivers would be energy cost savings, comfort and to some extent the environment. The drivers of the LCHB owners in this thesis did include comfort, energy cost savings and for the environment, but there were also two other main drivers discovered: making it beautiful and adjusting the LCHB to this time period (both may be related to future proof). And the environment also seemed to play a bigger role than expected in this small sample of LCHB owners than the professionals expected. The main drivers did overlap with the theoretical background, **table 24**.

Participant	1	2	3	4	5	6	7	8	9
Main drivers									
Energy cost savings	X	X		X				X	X
Comfort	X	X			X	X	X	X	
Environment				X	X		X	X	
Making it beautiful			X		X	X		X	X
Adjusting the building to the current time period	X				X				
Financial incentives		X							

Table 53. Main drivers of LCHB owners to realize their sustainable renovation (author)

All of the main barriers of **table 54**, which are derived from the empirical results of interviews with LCHB owners, appeared much more frequent than with the LCHB owners of Hamstra (2023, p. 22), **table 25**.

Participant	1	2	3	4	5	6	7	8	9	Workshop
Main barriers										
Costs of a sustainable renovation as a barrier	X	X				X			X	X
Waiting for improved technology	X	X			X					
Time and effort it takes to apply for subsidies and loans		X								X
Finding a reliable contractor for the work			X		X			X		X
Knowledge and skills required for the work										X
Examining the reliability of the information		X								X
Mess and nuisance because of the work							X			X
Communication of the municipality		X	X							
Permit application of the municipality/cultural heritage committee	X		X		X	X		X	X	
Information about a vision for energy policy (subsidies/type of energy)		X						X	X	

Table 54. Main barriers of LCHB owners (author)

And a few new barriers, in comparison with **table 25**, popped up: waiting for improved technology, mess and nuisance of the work and information about a vision for energy policy (subsidies/type of energy).

4.3.1 Relative advantage

4.3.1.1 Monetary costs

The 1st and most important barrier that professionals in the Haarlem workshop agreed upon is money, lacking it slows down sustainable renovation plans in LCHBs substantially. 4 out of 9 LCHB owners also had to deal with money as a barrier, 3 of those owners feel like money is the main barrier obstructing their sustainable renovation and 2 of these owners still deal with this barrier today. The other 5 LCHB owners did not have money as a barrier, but did still mention that money was a barrier for others.

Participant	1	2	3	4	5	6	7	8	9
Costs of a sustainable renovation as a barrier	X	X				X			X

Table 55. Monetary costs as a barrier (author)

Interviewee 1: “We paid for it ourselves, and of course we weighed everything up, so maybe I should have insulated more if I had more money or could have come up with slightly fancier solutions.”

Interviewee 2: “Yes, and money is a barrier too, because part of why I have to figure things out myself is because we don't have the budget to do it in the process that keeps being promoted by government bodies, i.e. including advisors.”

4.3.1.2 Financial incentives

The financial incentives that LCHB owners made use of are shown in **table 56**, and owners were questioned about their attitude towards the financial incentives. When the text is in brackets it only concerned an attitude and the interviewee did not actually use the financial incentive.

Participant	1	2	3	4	5	6	7	8	9
Financial incentives									
Home subsidy/tax dedu.	Neutral	-	Negative	-	Positive	Positive	Positive	Positive	Neutral
Municipal subsidy	-	Negative	-	-	Positive	-	-	-	(Negative)
ISDE	-	(Negative)	-	Neutral	-	-	Neutral	-	(Negative)
No VAT on PV panels	-	Positive	-	-	-	-	-	Positive	-
Low interest loan	-	-	-	-	-	Positive	-	-	-

Table 56. Owners' attitudes towards financial incentives (author) (- means not applicable or no information)

Home subsidy/tax deduction

4 out of 9 interviewees were positive about the home subsidy (woonhuissubsidie)/tax deduction, 2 out of 9 were neutral, 1 out of 9 was negative, because of the limitations on what work was eligible, and 2 out of 9 had a municipal LCHB and were thus not eligible.

Municipal subsidy

Municipal subsidies were used by interviewee 2 and 5. Interviewee 5 was positive, their household met the requirements for a generous, but no longer available, municipal subsidy. Interviewee 2 was negative because their household received only a small municipal subsidy that required both a large amount of

paperwork and a plan from a professional which already took up most of the subsidy. Interviewee 9 was negative because his municipality did not provide a municipal subsidy and he knew of other municipalities that did. The other 6 out of 9 owners did not bring it up. A professional explained that municipal subsidies were introduced in her municipality to compensate municipal LCHB owners, since they cannot make use of the home subsidy, and thus this municipal subsidy levels the playing field.

ISDE

2 out of 9 LCHB owners made use of the ISDE subsidy, 1 for a heat pump and 1 for vacuum glass. Interviewee 4 may have been positive about his subsidy for a heat pump, but he remained neutral. Interviewee 7 remained neutral about his subsidy for vacuum glass, by explaining that the ISDE subsidy did not make that much of a difference in costs, i.e. 750 euros on a total of 11.000 euros. And interviewee 7 would have preferred to combine the vacuum glass with another measure to receive more subsidy, but was not able due to personal circumstances. Interviewee 2 and 9 were negative about the ISDE, because combining two or more different measures was not realistic in their situations as well.

No VAT on PV panels

At least 2 out of 9 LCHB owners made use of the no VAT on PV panels. Both interviewee 2 and 8 were positive about this. Interviewee 2 and his partner were self-employed, and since 2023 individuals who are self-employed can easily make use of the no VAT on PV panels, thus they bought them immediately in 2023. Therefore, the financial incentive of no VAT on PV panels was definitely a main driver to install PV panels for interviewee 2. Financial incentives may also have played a pivotal role for other LCHB owners, however this has not been investigated.

Low interest loan

Only one owner made use of a low interest loan, which are provided by the National Restoration Fund (NRF). Interviewee 6 responded to the question whether he had a positive attitude towards the low interest loan with: "Every little bit helps, right? It takes a lot of administration, but it is worth it. You have to justify everything and submit everything." It seemed like the other 8 LCHB owners did not use a low interest loan because they had enough funds available (interviewee 3, 4, 5, 7, 8), because of personal preference (interviewee 1 and 2) or due to a lack of knowledge about it (interviewee 9). In interviewee 9's case lack of knowledge means: not knowing if the loan is applicable for a sustainable renovation and if it can be combined with a current mortgage.

Ontzorgingsprogramma

None of the LCHB owners was in the 'ontzorgingsprogramma' and did thus not receive this subsidy. Interviewee 9 was almost in it, but there were no spots left with the Groene Grachten, but he did not really need the guidance, just some design advice.

Opportunities regarding financial incentives

The ISDE could take people's individual circumstances into account, since sometimes only one measure is possible (interviewee 2, 3 and 9), especially in LCHBs, or due to personal circumstances (interviewee 7). This would make the higher variant of the ISDE subsidy available for some owners who only had the lower variant available to them, due to the restrictions that come with their LCHB.

At this point multiple financial incentives, like the ISDE, are only valid if the work is carried out by a company and not if LCHB owners realize the sustainable renovation by themselves. Another opportunity is to get rid of this requirement and also compensate owners that are doing it themselves. This not only helps with solving the shortage of contractors, since they would no longer be subsidized to do work that the owner could have done. It is also more realistic to expect doing it yourself (DIY) regarding LCHBs, because LCHB owners are more skilled in DIY then non-LCHB owners. This also relates to the home subsidy (woonhuissubsidie), because here the hours owners work on their own LCHB are non-eligible for subsidy, whereas the hours a company makes are eligible for subsidy. So this subsidy also disincentives owners from DIY. Interviewee 2, 6 and 9 experienced this barrier, and a professional also had some insight about this. More about this in the persona results chapter (4.4).

Interviewee 2: “I have been helped by subsidies, except that almost all subsidies from the central government are subject to the condition that you need to have it carried out by a professional party, for example an installer or a contractor.”

Interviewee 9: “What does disappoint me is that installing sustainable renovation measures myself is not allowed, which is very whiny when it comes to insulation subsidies. After all these years, I think I can estimate much better what this LCHB needs; where insulation should be provided and how. But I can’t get a subsidy. No, only if I hire a meatball to smash it on the wall here I will get a subsidy!”

Professional: “Some owners decide to realize their sustainable renovation/restoration with the help of a company, while they are perfectly capable and willing to realize it themselves. This is because the subsidy (ISDE) provided by the state equalizes the costs of doing it yourself (DIY) and hiring a contractor. So why spend the time on DIY if you can do it for the same amount of money without putting in the work? I am a LCHB owner myself and it made almost no difference in my situation; so I decided to hire a contractor. It must however be noted that DIY may be more susceptible to fraud. So you have to organize something for it so that the risk is sufficiently covered with also costs for the state. This may require more activity on the controlling side, not just paperwork, but visiting LCHBs or video calling.”

And lastly, loans are undervalued, only interviewee 6 used one. Interviewee 1, 2 and 9 lacked the money for a complete sustainable renovation as well, and the opportunity to get ahead with a loan may have been present but was not used.

Professional: “Some owners cannot make the investment, however paying disproportionately high energy costs is possible. A loan from the ‘wamtefonds’ or getting a building depot on a mortgage from their bank could work in their situation, because this allows you to realize the sustainable renovation yourself and does not come with an obligation to hire a contractor like many subsidies do.”

In other words, loans are not seen as interesting, because some owners think they cannot afford the investment. Even though loans can result in saving energy costs in the long run, which saves money just like a subsidy but in another time frame.

The ‘Warmtefonds’ provides attractive loans to owner-occupiers up until 27.000 euros, which they can use to invest in their building, leading to energy cost savings. This includes sustainable renovation measures such as: PV panels, a heat pump, insulation of doors and façade panels, and more.

This could help interviewee 9 who had plans for an integrated heating system that included PV panels, a heat pump, and heating of another neighboring building. Interviewee 2 did not have a mortgage and did not want a new loan, but was interested in a heat pump because he had PV panels already.

4.3.1.3 Energy cost savings

Saving on energy costs was a driver for 5 out of 9 owners, a driver for interviewee 1, 4 and 8, and the most important driver for interviewee 2 and 9, since they would not be able to live there otherwise and have to sell it. Interviewee 3, 5 and 7 had enough money, so costs did not really play a role. And at the time when interviewee 6 was in his sustainable renovation decision-making process, costs did not really play a role yet.

Interviewee 1: “In recent years, my motivation has shifted from comfort to reducing energy consumption, due to price increases of course.” and “Saving energy has become a sport. I had an energy bill in the spring below €50, I always liked telling that. But I would like to go further. In any case, I am now proud that I have gotten rid of gas.”

Interviewee 7: “I am very interested in saving energy. You always have two considerations when it comes to saving energy, one is for the climate and the other is for your wallet. For my wallet it is not very important, but to me it is very important for the climate.”

Interviewee 9: “The heating costs have become astronomical in this building and the tax on gas is getting higher and higher for me, living in this building is becoming increasingly difficult. So there are two options, it's either sell it and buy something new somewhere else. Or I should look at how I can reduce those heating costs that keep increasing.”

4.3.1.4 Comfort

Comfort was a driver for 6 out of 9 owners, a driver for interviewee 2, 5, 7 and 8, and the most important driver for interviewee 1 and 6. Interviewee 4 was already comfortable before implementation, thus it was not a driver, but their household was really pleased with the increase in comfort after realization. And interviewee 3 and 9 were mainly concerned about the comfort of their guests. For example, interviewee 9 was averaging 17 degrees in his living room and 13°C in his kitchen.

Interviewee 1: “Comfort is the most important thing. Energy saving is also important. I'm sitting here wearing a cardigan. It is 22.9 degrees, so that is quite warm. My wife thinks it's good this way, my wife is the indicator. The wood stove is on, so now the boiler is not running, but comfort is simply the most important thing.”

Interviewee 2: “When I listen to my wife the most important reason is comfort. Thus, if I don't want any nagging, it is the comfort. But the energy costs are certainly important when it comes to being able to continue living here. Otherwise we really couldn't afford it in the long term.”

Interviewee 6: “Energy saving was not so important at the time, but it was already becoming very clear that it made sense. But comfort was above all. I wanted to live in a comfortable house.”

4.3.1.5 Environment

The environment was a driver for 4 out of 9 owners, a driver for interviewee 4, 5, 7 and 8. Interviewee 1, 2, 3, 6 and 9 were also concerned at some level about the environment, but this was not a direct driver for their household's sustainable renovation.

Interviewee 2: "In the past, I would have said that the environment is my main motivation, and that is still just as important, but daily life often takes precedence. On the other hand, environmental reasons do coincide nicely with saving energy and increasing comfort."

Interviewee 5: "I think payback time is a non-concept. People say: I will only put PV panels on my roof if it, on balance, will benefit me after 7 years. Then I think: But that has nothing to do with me being able to say that I have done as much as possible for the environment so that I can look at my grandchildren and say: grandma did her best for you. And the value in that is never included in a payback period. The fact that you have had a house like this, comfortable and heated for 14 years now, is not counted. That cannot be quantified. So I find that payback period really annoying, because people don't learn where they do it for, namely for the environment and for the future of your children. And for the biodiversity, and all the nettles we see here, and the blackberries and so on."

Interviewee 8: "For me, the financial picture is not paramount, because changing something here now will have a payback period that is probably more than 10 years, so that is not something to get incredibly excited about. Instead I am convinced that we must all do our best to reduce energy consumption and reduce the carbon footprint of our existence to zero. And if we don't do that, then we are not doing the right thing for our children and grandchildren. We have an important responsibility and that is an important motivation."

Interesting was that interviewee 3, 4, 5, 7 and 8 had a higher income and wealth, so they had less worry about energy cost savings, thus they may have had the luxury of worrying about the environment more than others, which they also addressed themselves. In comparison, the payback period of each decision was very important for interviewee 2 and 9.

4.3.1.6 Making it beautiful

Making the LCHB beautiful again, or more beautiful, was a driver for 5 out of 9 owners, a driver for interviewee 5, 6, 8 and 9, and the main driver for interviewee 3.

A desire to make the building beautiful may have acted as a driver for realizing the sustainable renovation. This coincided with maintenance, however the driver was more than just maintenance and did therefore no longer constitute maintenance.

Interviewee 3: "The first time I renovated, when the LCHB was neglected, it was an emotional decision, because I like beautiful things. I like something monumental, when I look at my ceiling it makes me happy, for example a beautiful plastered ceiling. And when I look at the space, stained glass, layout of the house, it makes me happy. So of course that cost me a lot, so cost wasn't much of a factor because I had that, so I could do it."

Interviewee 8: “The comfort and energy consumption were not what they should be. And there was a need to tackle maintenance. But not only that, we also renovated to make it more beautiful. It was a mess in here; we just didn't think it was nice enough and wanted to embellish the building.” “My wife's needs are very important. She must think that it is beautiful.”

Interviewee 9: “A huge amount of money has been spent on maintenance. I will never earn that back. If I sell it, I will never get it back, so you don't do it to earn money. Sustainability is for the greater good or because it is a beautiful building that people enjoy, that it is something special.”

Making it beautiful also aligns with restoring the cultural heritage value, which owners also indicated as a driver. Restoring the cultural heritage value can just constitute maintenance, but the researcher concluded from the interviews that it meant more than only maintenance, since they realized a sustainable renovation which was not present before they started.

Interviewee 6: “Yes, I was very aware from the beginning of the fact that it was a nationally listed heritage building, and I also loved the building. I wanted to preserve the building's historic value.”

Opportunities regarding making it beautiful

The driver ‘making it beautiful’ is new and quite prevalent, since 5 out of 9 owners mentioned it. Therefore LCHB owners may be convinced to realize a sustainable renovation if ‘making it beautiful’ is taken into account in the information provision.

4.3.1.7 Adjusting the building to the current time period

At least 2 out of 9 owners had a desire to adjust the building to the current time period with a sustainable renovation. Interviewee 1 and 5 indicated this as a driver by themselves, but others may have had this desire and it was probably a driver for them as well but they were not questioned about it. The second most important driver as identified by Hamstra and Kommer (2022, p. 19), **table 24**, is making the building future proof which may be related to adjusting the building to the current time period.

Interviewee 1: “A LCHB is a thing that has grown over many time periods and I think that growth should continue. This perhaps includes that in 100 years people will look back at the period that was the beginning of the 21st century, and that it was a period of making LCHBs more sustainable. We may not be happy with that, because things may have been executed badly, or we may be happy, I have no idea. But I'm not into stopping time and keeping everything as it is, because that's just not possible.” “There have also been television antennas on LCHBs. When suddenly we all wanted television. There are now solar panels on it and at some point they will be taken off again, and then there will probably be a new technology with which you can generate energy. I have no idea, but I'm in favor of growing with the times.”

Interviewee 5: “It was a dump (in Dutch: krot).”, “If you want to preserve such a house for the future, it must have a future, it must be relevant in its time.” and “I am absolutely convinced that you should keep a building like this up to date.”

4.3.1.8 Real estate value and social status

Owners did not bring up real estate values and social status. Increasing the real estate value of the LCHB and owners their social status could have been factors for the sustainable renovation decision, however as stated in the literature study about social status: “Adopters may be reluctant to admit that they adopted a new idea for the status conferral (Rogers, 2003, p. 230).” Also no questions were asked directly about the increase in real estate value and opinions about that. However some things can be derived from the interviews. For example, interviewee 2 explained that the LCHB was his households pension, thus the sustainable renovation must have been aimed at increasing or at least maintaining the real estate value, assuming this owner acted wisely. Interviewee 3, 4, 5, 7 and 8 had a good pension and acquired enough wealth, and they did not seem like, or told anything about, an increase in their real estate value or social status was important to them. Interviewee 7 stated that he lived in a well to do area, but this had everything to do with the location, and less with the sustainable renovations of their household.

4.3.1.9 Waiting for improved technology

At least 3 out of 9 interviewees were waiting or have waited in the past on improved technology to implement more sustainable renovation measures. Interviewee 1 and 2 were waiting on an improved heat pump that could meet the needs of their LCHB and be powered with his PV panels. Interviewee 5 had waited with introducing double glass because it had a green tinge in 2010. Later on, double glass (in Dutch: monumentenglas) with xenon filling became available, which led to her implementing it.

The other 7 out of 9 interviewees are likely to also have had times where they were waiting or they are still waiting on improved technology. All the interviewees did realize a sustainable renovation. So they made the decision to implement the sustainable renovation that was available for them at the time, regardless of the improved technology they were waiting on; meaning other factors were more important.

Interviewee 8 emphasized that waiting for improved technology has a direct influence on policy.

Interviewee 8: “Sustainable renovation options in LCHBs are not yet sufficiently available. It certainly needs to be taken into account that these should be developed, because people generally talk about: we have to all get rid of gas, or install a hybrid boiler. And all kinds of rules are being laid down for the energy transition, however these rules are not all valid for LCHBs.”

4.3.1.10 Transaction costs

The barriers to sustainable renovations that professionals in the Haarlem workshop agreed upon could all be classified as transaction cost barriers according to Ebrahimigharehbaghi (2022, p. 81). The barriers of the workshop were ranked by the professionals based on importance with a number from 1 (the largest barrier) to 10 (the smallest barrier). The barriers of the workshop and results of the interviews with owners that are also transaction costs are categorized in **table 57**, the order of transaction costs is based on Ebrahimigharehbaghi (2022, pp. 80-81).

Participant	1	2	3	4	5	6	7	8	9	Workshop
Transaction cost barriers										
Time and effort it takes to apply for subsidies and loans		X								X
Finding a reliable expert for the work			X		X			X		X
Knowledge and skills required for the work										X
Examining the reliability of the information		X								X
Mess and nuisance because of the work							X			X

Table 57. Transaction cost barrier (author)

The barriers of the Haarlem workshop were surprisingly similar to the barriers of Ebrahimigharehbaghi (2022, p. 81). The more prevalent barriers of Ebrahimigharehbaghi (2022, p. 81) fit the barriers that the professionals of the workshop determined to be important. Except for the transaction cost barriers ‘the time and effort it takes to apply for subsidies and loans’ and ‘the time and effort that the work takes’ which seem to be less important for LCHB owners and did not arise in the workshop results, while these are main barriers in Ebrahimigharehbaghi (2022, p. 81).

The least important transaction cost barriers of Ebrahimigharehbaghi (2022, p. 81) ‘time and effort of finding information’, ‘expectations of helping from friends’, ‘discouragement by media reports’, ‘past experiences’ and ‘experiences of those around you’ did not come up as barriers in the results of the empirical research, which shows that the results align with the theoretical background. For example, all LCHB owners that were interviewed put significant time and effort into finding information, but none experienced this as a real barrier for themselves.

The workshop results do highlight the importance of designing from several perspectives (workshop barriers 3, 4, 5, 7, 8 and 10), this is probably because some architects were present among the group of professionals. And the extra knowledge and skills required for the sustainable renovation of a LCHB also differs from normal buildings. ‘Cost of the sustainable renovation’ and ‘limited/no subsidies’ are also transaction costs according to Ebrahimigharehbaghi (2022, p. 81) but they are already addresses in 4.3.1.1 and 4.3.1.2 to fit according with the theoretical background.

The time and effort it takes to apply for subsidies and loans

Only 1 out of 9 LCHB owners addressed this as a barrier. Interviewee 2 had to spend much time and effort on applying for municipal subsidies.

Interviewee 2: “Eventually you will get that subsidy and that plan may not have to be that complicated, but don't add all of that cumbersome paperwork. Because you express a distrust of what I want. But first I have to go through a professional party, a plan must be made, because the resident cannot do it himself. That's basically what they say, and it makes me rebellious. And then I think, well, how much is it? Ah yes, 3000 euros a year, a month of work, then I also have 3000 euros.”

Finding a reliable expert for the work

The 2nd most important barrier that emerged from the workshop was that owners do not know how to start with a sustainable renovation in their LCHB. The questions they have are: who can help with drawings? Or help with realizing the work? Similarly, 3 out of 9 LCHB owners have also struggled with finding good contractors, interviewee 3, 5 and 8.

The time and effort that the work takes

0 out of 9 owners had the time and effort the work takes as a barrier. All of the LCHB owners who were interviewed put significant time and effort in realizing their sustainable renovation, but it was never seen as a barrier. For example, interviewee 1 made his own shutters for the inside of the windows. He said he did that once in his life and he will never do that again, because of the time and effort it took to make them. The sustainable renovation of interviewee 6 took 10 years of continued time and effort. On the other hand, interviewee 5 was sad when her sustainable renovation was finished, because she really liked the challenge. Still her household put a lot of time and effort into it which cannot be understated.

Knowledge and skills required for the work

The 3rd biggest barrier that emerged from the workshop is not making an integral design. Because sustainable renovations can be viewed as too one-sided. A recommendation would be to look at opportunities together, an integral/total approach to renovation, restoration, sustainable renovations and more.

The 4th biggest barrier is a lack of knowledge about materials, their data and their monitoring. It is difficult to choose which materials to use and how to use them, for example, for insulation.

The 5th biggest barrier are the cultural heritage values that indicate the limits of what is possible regarding a sustainable renovation. Finding this out and dealing with it represents another transaction cost.

The 7th biggest barrier is the difficulty of choosing between a design of a sustainable renovation of the entire LCHB or just a few select rooms or parts of the building.

The 8th biggest barrier is that each LCHB is in a different condition and requires a different sustainable renovation. This makes it difficult to make plans for groups of LCHBs, that are for example grouped based on typology, because each LCHB is still in need of a tailor made design.

The 10th and least important barrier that emerged in the Haarlem workshop, is that the technical knowledge of many LCHB owners is inadequate, therefore the threshold to start can be too high.

When it came to the LCHB owners who were interviewed, they all had enough knowledge and skills required for the work.

Examining the reliability of the information

The 9th biggest barrier that emerged in the workshop is that certain organizations and professionals in the LCHB sector perceived government frameworks as unclear, this makes it difficult for anyone making long-term plans with large clusters of LCHBs. This can also already be complex for single LCHBs in general.

Interviewee 2 also dealt with the reliability of the information which he found hard to examine when it was not shared by government authorities.

Mess and nuisance because of the work

The 6th biggest barrier that emerged in the workshop, is that the habitation of the LCHB makes it difficult to implement a sustainable renovation. This can be seen as mess and nuisance because of the work, and this has been the biggest barrier for interviewee 7, and was the main reason interviewee 7 did not realize another sustainable renovation. The hassle of living in the LCHB during a sustainable renovation was too much for interviewee 7, his partner could not deal with the noise and business due to a medical

condition. Here the transaction cost is the barrier, but the household characteristic (prior condition) is the causal reason behind it.

Interviewee 7: “The biggest barrier and uncertainty was the hassle, because the demolition work and things like that are annoying. ... And I happen to have a very good pension, so the financial barrier is not that big. I don't think it's a hassle at all to sort something out, but I do find it a hassle and so does my wife if there is all the demolition work involved. For example, we had a flood, and the edges of the tiles had to be removed, and that man came and drilled those holes, and it just made a terrible noise, and everything was covered in dust, that was the biggest barrier. And people have to etch (in Dutch: vrezan) the window frame to make space for the vacuum glass, and that etching is no fun either, makes terrible noise, only lasts a day or two, but still.”

Interviewee 5 gave lectures and talked with many LCHB owners some of whom also visited her, she found that other LCHB owners face very different barriers than they do. For example, some owners live in a LCHB and can therefore not take out their furniture for a sustainable renovation or don't want to. This also falls under the transaction cost barrier ‘mess and nuisance because of the work’.

Opportunities regarding transaction costs

Interviewee 5 addressed a new transaction cost barrier, which is the uncertainty about when to start. This seems to be more prevalent in LCHBs, because of the cultural heritage and history that is involved.

Interviewee 5: “And when do you start? Other LCHB owners told me: I mean my family has been here for 400 years. And when do you decide to do something about it? It's always been that way.”

4.3.2 Compatibility

Each LCHB owner had a very different LCHB and sustainable renovation, as shown in **table 5**. The variables ‘cultural heritage value’ and ‘listed cultural heritage status’ are objectively covered to a small extent in **table 5**. But this compatibility chapter is about the perceptions of LCHB owners about these two variables, and the compatibility of the sustainable renovation with the municipality/cultural heritage committee on its own as a third variable.

The other variables of compatibility: ‘previously introduced ideas/past experiences’, ‘needs of potential adopters’ and ‘values and beliefs’, have been covered in the results of the prior conditions and characteristics, subchapters 4.1.1.4 (**table 39**), 4.1.1.5 (**table 40**) and 4.1.2.2 (**table 43**), respectively.

4.3.2.1 Cultural heritage value

Compatibility of the sustainable renovation with the cultural heritage values was important to most if not all LCHB owners, none made it clear that they did not care about the cultural heritage value. The interpretation of the cultural heritage values could however differ from those of the municipality and/or cultural heritage committee as discussed in the next section.

4.3.2.2 Listed cultural heritage status

The 9 LCHB owners, who were interviewed, indicated how the listed cultural heritage status was enforced in a few ways that were incompatible with the sustainable renovation of the LCHB. This is not

to say that a sustainable renovation has to happen, it is more an exploration of how owners perceive and deal with the rules, permits and enforcement and how current policy manifests itself in practice.

This chapter firstly covers the ways in which incompatibility expressed itself in practice: illegality, adapting to the system and a feeling of not being trusted. And secondly, the way in which the municipality/cultural heritage committee falls short according to LCHB owners is addressed. The opportunities are addressed in the last compatibility subchapter 'municipality/cultural heritage committee'.

Illegality

Professionals explained that it happens several times a year in municipalities with many LCHBs, that LCHB owners have realized sustainable renovations without a permit. LCHB owners end up claiming that they did not know, subsequently some municipalities make them pay a large fine and demand everything to be restored back to the original state, and other municipalities just leave it be with a small fine.

None of the interviewees of this thesis were out to harm the cultural heritage value of their LCHB, instead they held great love for their building. Furthermore, if they did have malicious intent they would not partake in such an interview, since why would anyone voluntarily expose their illegal deeds. Instead, some LCHB owners may have crossed into the illegality, but it is not clear, since every municipality has different rules.

For example, two interviewees installed PV panels without a permit, one of those is no longer illegal, since the municipal policy changed. And one interviewee stated that he was forced into the illegal circuit, since he could not get the permission of the cultural heritage committee, no matter how long and hard he tried, and ended up hiring contractors to do the work without a permit. However, most of this work did not require a permit.

Illegality may also be fueled by advisors, one interviewee mentioned: "What strikes me is that many advisors we were in contact with whispered: don't apply for a permit for everything, because that doesn't work."

Adapting to the system

Another problematic area is how individuals try to adapt to the system in a legal way. For example, interviewee 1 and 6 both provide support to other LCHB owners as a service, this includes helping with the realization of restorations and sustainable renovations in the LCHBs of their clients. In their work they came across well-functioning cultural heritage committees, but they also experienced strange situations, which led to both of them independently developing a strategy that most effectively serves the needs of their clients but may interfere with open communication and a constructive assessment. Interviewee 1 did this by applying for each measure independently and interviewee 6 by exaggerating.

Interviewee 1: "The municipality makes it incredibly difficult to approve the permit for a total and integral approach of sustainable renovations in LCHBs. So I learned years ago to apply for each of the sustainable renovation measures in small steps, i.e. step-by-step. They hate that, but for me it's the way to get it done, so I apply that with my customers as well. I am an architect, I make building plans to make LCHBs more sustainable, so I do it in the same way for all my clients, otherwise you will never get through."

Interviewee 6 described how during the renovation of the LCHB of one of his clients, the municipal officials had taken a very official position. Thus, he advised his client, who wanted skylights in his roof, to ask for 10 skylights so he would get 5. And that turned out to be true.

Not feeling trusted

At least 2 out of 9 LCHB owners did not feel trusted by the municipal authorities. Interviewee 2 and 3 may have trusted the government but were of the opinion that the government distrusted them.

Interviewee 2: “During the conversation with the cultural heritage committee, questions arose that showed a distrust of me: you are only a private individual so how can you have it all figured out?”

Interviewee 3: “Well, I can tell you from my own experience, and most other LCHB owners I have met also notice it now; you are approached with a kind of distrust, and it is not a common goal that you and the cultural heritage committee stand for.”

Attitude towards limitations because of the listed status

The limitations that come with the listed cultural heritage status depend on the (1) the cultural heritage value, which can be partly derived from **table 5**, and (2) the way in which the municipality/cultural heritage committee enforces the listed cultural heritage building status. The attitude towards this second point, the government regulations, does show some similarities among LCHB owners. And are presented here.

Participant	1	2	3	4	5	6	7	8	9
Attitude towards limitations because of the listed status	Negative	Positive	Negative	Positive	Negative	Negative	Positive	Positive	Negative

Table 58. Attitude towards limitations because of the listed cultural heritage building status (author)

4 out of 9 owners were positive about the limitations on LCHBs in their municipality, interviewee 4 and 7 were very positive. Interviewee 2 experienced some restrictions, but in the end he thinks these restrictions may have turned out for the better.

Interviewee 2: “I have the first cove moldings in place, and I must say the cultural heritage committee was right. They are beautiful, so that's nice. It still remains that I think it is a shame that they paid little attention to the constructive part and the moisture part, but it could of course be that we got it all right at once, so there was nothing to comment on. So actually I have nothing to complain about the permit process, there has been an adjustment and it has been approved.”

Interviewee 4: “I would not want to change the policy regarding sustainable renovations. There are restrictions related to the interior and exterior of the LCHB that I am happy with. Because we live in a building that has quite a family history. And in our street we see all kinds of houses with similar construction years. And they are all being seriously ruined by young people with a lot of money. We don't want that to happen to our house.”

5 out of 9 owners were negative about the limitation on LCHBs in their municipality, interviewee 1 and 3 were very negative. Interviewee 5 and 6 had been positive with the limitations during the time they

realized their main sustainable renovation, but the municipal organization has changed and now they are negative.

Interviewee 1: “I've been dealing with the cultural heritage committee of my municipality for 30 years. I am not at all against cultural heritage or aesthetic committees, because I think they fulfill a very useful function in the whole process. And they may also be knowledgeable in the field. But in the case of my municipality, this has been incredibly difficult. In fact, at one point I received so many letters with reasons why a building should not be made more sustainable, including reasons that went beyond the aesthetic memorandum of the time (2007). That at one point I was really desperate and sent a letter to the then Ministry of Housing, Spatial Planning and the Environment, which dealt with LCHBs. And they helped me to convince the municipality that they were outside their legal framework of municipal policy. So the ministry then said to the municipality: you are demanding too much from this gentleman than what you are legally allowed to demand. And in the end, the municipal officials must have been angry, but I did get a permit the next day.”

Interviewee 9: I first went to the aesthetics department (similar to the cultural heritage committee) of the municipality to discuss the plans. They were of the opinion that the slope of the roof should be adjusted, because it should look more like a station. But that is extremely unfavorable for the yield on my PV panels. So I became furious, and thought well greetings, I'm really not going to do that. I then had a conversation with the municipality about this, and they wanted the solar panels to be sunk into the roof, which is very expensive. I don't have the money for that, but I do want to make my LCHB sustainable, anyway, I ended up putting the plans on hold.

The reasons where owners based their attitude towards the listed status on are shown in **table 59**.

Participant	1	2	3	4	5	6	7	8	9
Reasons for the attitude									
Credibility of the cultural heritage committee	X		X		X	X			
Permit requirements for PV panels									X
Nothing was particularly negative		X		X			X	X	
The LCHB status could protect the building				X					
The LCHB status allowed for all that was desired							X		

Table 59. Reason for LCHB owners their attitude towards limitations because of the LCHB status

4.3.2.3 Municipality/cultural heritage committee

The municipality acts as a barrier from a few other perspectives as well, and the cultural heritage committee is only a barrier that applies to the listed cultural heritage building status. If the municipality/cultural heritage committee are put together as a barrier on its own, then 7 out of 9 LCHB owners were of the opinion that the municipality and its organization was not properly structured to facilitate LCHB owners and think along, which they wanted to see changed. **Table 60** shows from which perspectives LCHB owners perceived the organizational structure of their municipality to be positively or negatively compatible with the needs of LCHB owners.

Participant	1	2	3	4	5	6	7	8	9
Credibility of the municipality/ cultural heritage committee regarding the permit application	Negative	Positive	Negative	-	Negative	Negative	Positive	-	-
Communication of the municipality	-	Negative	Negative	Positive	-	-	Positive	-	-
Policy for PV panels	Positive	Positive	-	-	-	-	Positive	-	Negative
Permit period for PV panels	-	-	-	-	-	-	-	Negative	-

Table 60. Current attitude of LCHB owners towards the policy in their municipality (author) (- means no information)

Credibility of the municipality/cultural heritage committee regarding the permit application

At least 4 out of 9 owners were convinced that the cultural heritage committee did not have the right expertise.

Interviewee 1: “Many years later it (the permit process) still haunts me, I have pleaded twice to the Municipal Council to put the right practical instead of theoretical people in the cultural heritage committee. The current cultural heritage committee consists of architectural historians who know everything about architectural styles, but do not know how this can be adapted in practice to the requirements of the modern times.”

Interviewee 5: “The principle in this municipality is that the permit application for the LCHB is not assessed by a building technical municipal official, instead there is a set of rules which are enforced by a lawyer. And it is precisely those permit application rules for LCHBs that require a tailor-made solution. We made all design decisions per room, from what can be done here, because this floor was broken. That lawyer absolutely cannot deal with that, and she cannot follow those arguments at all.” This advice was echoed by a professional interviewee who was part of multiple cultural heritage committees close by.

Interviewee 6: “What would help is a cultural heritage committee with expertise, I missed that a few times. And it is important to think along creatively with the owner, because sometimes you have to come up with a creative solution, because you have to live in a LCHB. And you can rigidly maintain that something is allowed and something else is not, but sometimes a solution has to be found and then you have to think along as a civil servant. It has nothing to do with time or money, there are too many people who don’t have a heart for it and therefore don’t understand it.”

One of the core issues seems to be a non-negotiable decision, where the input of the owner is not taken into account.

Interviewee 1: “The cultural heritage committee is not open to suggestions and even if they have made a decision that is not allowed you can move heaven and earth. Presenting new arguments, trying to adjust things and you still get a no... Of course it could be that I am going to come up with all kinds of crazy things to get through the procedure. But if, for example, I find out during the process with a client that there are historical photos that show that certain windows were not there in the past and they labeled the larger 1970s panes of glass as historical, making it impossible to replace the glass of the window, then they are not going to say: Replacing the glass is allowed, because we made a mistake. No, I make mistakes, they never make mistakes and I find that a very irritating attitude.

The researcher spoke to multiple members of cultural heritage committees, and most agreed that a building technical expert would really help and is not always present, especially installations may not be properly assessed, since real expertise about installations can be lacking. But they also hold other perspectives. For example, one professional explained that in their municipality they do have the expertise in the cultural heritage committee that these 4 out of 9 LCHB owners were lacking. Interviewee 1 did also add that the procedures he encountered when helping clients in other municipalities were open, transparent and pragmatic.

Communication of the municipality

Interviewee 2 and 3 did not get the communication with the municipality that they had desired. Interviewee 2 would have liked more advice. And interviewee 3 was extremely negative with how the communication went.

Permit period for PV panels

Interviewee 8 got a 10 year permit for PV panels on his land, since a 20 year permit was much more costly and took more time, but PV panels do have a 20 year life cycle. So he was not pleased that he had to renew his permit. Therefore, he was of the opinion that the municipality did not think along with him. Which is similar to how interviewee 1, 2, 3, 5, 6 and 9 felt, **table 60**.

Opportunities regarding the municipality/cultural heritage committee

A few solutions were proposed by owners to deal with the barrier of the cultural heritage committee. One solution was a more personal approach, that focuses on giving advice. However professionals explain that this is already the case in many municipalities. Another idea is to reduce the amount of people that make the decision about a certain LCHB, this idea also overlaps with Rogers (2003, p. 221) who explains that less people involved in decision-making leads to the decision being made more easily.

Interview 1: If you reduce the number of members of the commission, there will simply be fewer opinions, because there is usually a competition of who's the strictest? So then someone says, well, I don't know, then another would say, well, I wouldn't do this at all, and then they start to overlap each other in strictness, while if I sit with one, then at least I know I'm getting an opinion, because I always get two stories, two perspectives, which is not what I am looking for as a customer. I am waiting for sound advice if necessary.

However, another advice, which is counter to less people in the cultural heritage committee, is to add a building technology expert or expertise to the cultural heritage committee, this was supported by a few professionals that were asked about the validity. And a professional explained that adding an expertise to the committee could be done by having a building technology expert join the assessment of permit applications in multiple cultural heritage committees, only for sustainable renovation plans that require expertise about installations.

One professional added that this expert should have a broader knowledge than just installations, knowledge about cultural heritage is necessary as well. And additionally, the whole cultural heritage committee needs knowledge about sustainability and awareness of the need to realize sustainable renovations in LCHBs. Another professional had a similar opinion and specified that ideally a cultural heritage professional should be trained as an installation and sustainability expert.

4.3.3 Complexity

Table 61 shows a quick overview of some variables of complexity as discussed in this results chapter.

Interviewee	1	2	3	4	5	6	7	8	9
Variables of complexity									
Need for information	X	X				X	X	X	X
Need for support	X	X	X	X	X	X	X	X	X
Consulted regularly				X	X		X		
Credibility of experts and information	X		X	X	X	X	X	X	X

Table 61. Complexity of the sustainable renovation decision-making process (author) (- means no information)

4.3.3.1 Easiness to apply

All of the LCHB owners had their own barriers and it is not really doable for the researcher to compare the easiness to apply a sustainable renovation in each LCHB meaningfully, you ought to be at least an expert in designing sustainable renovation and visit all the homes and know the details. Instead **table 5** can give some indications and so can the results of the prior conditions (4.1.1). 3 out of 9 LCHB owners were certified experts themselves, and their opinion regarding the easiness to apply of the sustainable renovations differed. But for none it was easy, sometimes because of the necessary costs (interviewee 9), and other times because of the time and effort and the knowledge and skills required (interviewee 1 and 5).

4.3.3.2 Knowledge about sustainable renovation measures

The LCHB owners of the interviews knew the sustainable renovation measures that were possible, since they already achieved a big, or multiple, sustainable renovation(s). Some owners had more sustainable renovation plans and thus knew what was possible, otherwise they would not be able to plan it.

4.3.3.3 Need for information

Opportunities regarding need for information

6 out of 9 owners indicated that they were still in need of information. However most were in need of different information. One need for information that did overlap was mentioned by interviewee 2, 8 and 9, which was information about energy policy, i.e. a strong vision from the government, so they could make plans for a long time ahead, instead of being uncertain about the future. This covers energy policy regarding subsidies, but also the future energy direction towards gas, electricity or hydrogen power.

Interviewee 2 is very uncertain about the direction of energy policy, when it comes to choosing an installations based on electricity and gas. According to him this is a choice that you have to make for about 20 years, and the industry is not aligned with government messaging. The lack of a strong long-term vision of the government is the greatest uncertainty for interviewee 2 and 9, and tackling this would greatly improve the evaluation ability of LCHB owners. Interviewee 3 did solve this complexity with a to do list with all the points that needed to be tackled from the Monumentguard, this worked very well for him and is also some sort of long term plan.

Interviewee 2: “The industry is making hybrid heat pumps, so that suggests that some form of gas will remain. Furthermore, heat pumps are really efficient in spring and autumn, but in the winter their efficiency is very low, plus the winter has a shortage of electricity from solar panels. So the industry and I think that the winter will always involve a the existing gas network. But when I listen to the government they act as if we only go electric. And I once read somewhere that 10 times as much energy goes through the gas network as goes through the electricity network. Suppose we reduce energy consumption to a quarter by insulating, we still have not yet replaced all the energy that is currently being used by the gas network with electricity. So, how can the government pretend that we are all going electric, while the industry and my own home do not see it as feasible. I would like it. I’m really not one of those people who uses every argument to say that wind turbines will never be profitable, because it takes more energy to build such a thing than it every produces. That’s not me. So we really need to get clarity from the national government at some point, and I honestly think they have known it for a long time, and I think the answer is hydrogen, but make it clear. Because then I know what kind of device I should install.”

Interviewee 9: “No one ever thinks: where do we want to be in 20 years? No long-term vision is developed about subsidies, which I think is very bad. Where I am now with making a plan for the LCHB took years of thinking in my head, about how can I deal with everything? That has been going on for 5 years now, and in those 5 years the government’s environmental policy and subsidy policy have changed many times.”

It also needs to be clear what parts of the LCHB can be touched and what cannot be touched. Making it clear what is off limits in LCHBs was important to at least 2 out of 9 owners. The most important advice interviewee 1 received was confirmation about what he could actually do with his building (quote in subchapter 4.3.3.4). Interviewee 3 also struggled with what was off limits regarding his LCHB, he was convinced that the municipality was expanding the parts that were off-limits, thus restricting his possibilities.

When it comes to knowing what the need for information is, it may be useful to structure everything. Interviewee 5 completely mapped out the LCHB and the sustainable renovation with a dot cloud (in Dutch: puntenwolk).

4.3.3.4 Need for support

A need for support from others with information about sustainable renovations was common among all LCHB owners. Even interviewee 1, 5 and 9, who were current or retired professionals in architecture and building technology, needed support.

Interviewee 1: “The most influential information came from two experts. I don’t remember the names, but one was a sustainability man who looked at the possibilities of the building, and the other was a LCHB expert. So the report that came from Nijenrode about that DuMo model was the most important source of information for me, because it stated what the potential of the building was and what could and could not be touched in the LCHB.”

Interviewee 5: “Well I had a sparring partner who is a restoration architect, and 10 years younger than me. He was actually more conservative than me, much more conservative. But I really discussed heavily with him. Saying: I want it that way. And those wall heaters and things like that, they came from me. But I have had a lot of discussions about everything, to confirm that we are doing the right thing.”

Interviewee 9: “I have now drawn up a plan together with the Groene Grachten, but that is mainly for the installation side.” and “So I asked the Groene Grachten, because they sustainably renovate a lot of buildings so they have a broad scope of view, and this includes only LCHBs as well. So I have reasonable confidence that they take all the factors that exist into account.”

Opportunities regarding need for support

A need for support can be overcome by hiring professionals. All LCHB owners consulted with advisors. And 3 out of 9 owners hired or consulted regularly with an architect for their sustainable renovation. For example, interviewee 4 indicated that he did not perceive much uncertainty during the sustainable renovation process, because he had the support of the architect he hired. Interviewee 5 recommended to always hire a professional if, for example, you and your partner have a well-paying job not related to the sustainable renovation at hand.

Interviewee 5: “If you do not have the expertise, you should provide yourself with a good architectural advisor, a good restoration architect or something like that. And that is why even I still relied on a friend of mine, my sparring partner, because I lacked architectural knowledge about restorations and he was an actual restoration architect.”

However, this was not an option for at least 2 out of 9 owners due to financial constraints. And 3 other owners also did not procure or consult with a professional often, one of them was a building technology professor and another a restoration architect. Some owners went about it by just watching, talking with and requesting quotes/invoices from, contractors.

Interviewee 6 was an artist when he started. And indicated that he was never uncertain about the sustainable renovation not working out. He always worked hard, and managed to get by with an average income of him and his partner, and they completely fixed up the LCHB. It did take them 10 years, but it is possible with modest means and without an expert.

Monumentguard

A similar way that LCHB owners can be supported, which may be less costly than hiring the support of a restoration architect or energy advisor, is by becoming a paying member of the Dutch Monumentguard association. The Monumentguard visits owners yearly, or every other year, to provide information about how the LCHB can be optimally preserved, but they also offer other services. At least 4 out of 9 owners were only positive about the ‘monumentenwacht’ (interviewee 1, 3, 4 and 6). However, at least 3 out of 9 LCHB owners expected more from the Monumentguard.

Participant	1	2	3	4	5	6	7	8	9
Attitude towards the Monumentguard	Positive	Negative	Positive	Positive	-	Positive	Neutral	Neutral	-

Table 62. Attitude towards the Monumentguard among LCHB owners (author)

Interviewee 6: “I think it is a very useful organization, with real professionals. I recommend every LCHB owner to join the Monumentguard.”

Interviewee 2: “We had a kitchen table conversation, with someone from the Monumentguard, but that was very disappointing. The Monumentguard has been around for a long time, but they had just started these sustainability conversations. And I think I was just dealing with someone who didn't have that much experience.”

Thus, interviewee 2 was negative, because he did get sustainable renovation advice, but not of the quality he expected. And 2 out of the 7 owners were neutral about the Monumentguard, because they were in need of certain advice that the Monumentguard could not offer them.

Interviewee 7: “The Monumentguard of my province comes every other year to check whether I have overlooked anything, which is helpful. However, they do not give advice. And I asked them if they could act as supervisor for a certain renovation, but they didn't do that either. So all they do is come here and make a report: there is a roof tile crooked and you really need to replace that piece of lead.”

Interviewee 8: “In practice the Monumentguard did not contribute much; everything was ok. And they did not advice on any real innovations.”

Thus, at least 3 out of 9 owners would have benefitted from good sustainable renovation advice from the Monumentguard. Regarding interviewee 2, a professional explained: “The expectations of people are different for sustainability advice. The Monumentguard asks in advance what a customer expects, and tells in advance if this can or cannot be offered, but sometimes this goes wrong. Yet, if customers are disappointed, the advice really did not match, then customers do not have to pay.”

Furthermore, the 3 out of 9 owners who would have liked good sustainable renovation advice were most likely in need of a level 2 or 3 advice sustainability advice, according to the guidelines of the ERM Foundation, and not a level 1 which mostly covers the basic measures (**table 2**). According to a professional the level 1 advice is often offered by Monumentguards, and a level 2 or 3 is also offered by several Monumentguards, but the latter one does constitute tailor made work which is reflected in the price and needs to be specifically commissioned and is not always possible.

Another service the Monumentguard could offer more of may be sustainable renovation supervision, which interviewee 7 requested and was turned down for. A professional explained that in every Dutch province the Monumentguard is a different independent organization that is free to determine the services they offer, which is often determined by limitations such as capacity. Thus, the Monumentguard in one province may offer supervision, while another may offer a more detailed sustainability advice instead. But in the provinces where the Monumentguard does offer supervision they have a good approach for it.

One professional explained that there are plans in the Monumentguard of at least one province to eventually accommodate the level 1 sustainability advice, i.e. mostly basic measures, in the standard service, which now only consists of restoration/maintenance advice. Accommodating the sustainability advice in the standard service would subsidize the level 1 sustainability advice, because the provinces supplement hourly wages of Monumentguards that execute the standard service, and the work of the

standard service does not require VAT.

The professional also explained that at this moment the level 1 sustainability advice is on the price list. And they are planning on putting the level 2 or 3 sustainability advice on the price list when the level 1 sustainability advice is included in the standard service. But pricing a level 2 or 3 sustainability advice still requires tailored work, so those plans are still being developed, and providing the level 2 or 3 does not happen very often at the Monumentguard, so monumentguards need to be trained.

Collaboration

Interviewee 5 overcame complexity, uncertainty and need for support was with extensive collaboration.

Interviewee 5: “As long as you talk about it and don't hide things away. An open building team (bouwteam) means that you are honest, if you just discuss what you are facing and how we can solve it, then things will improve.”

4.3.3.5 Credibility of experts and information

8 out of 9 owners managed to find credible experts and information, except for interviewee 2 who could not find a reliable experts nor credible information about what he needed, he was also the most recent LCHB owner of the interviewees.

Credibility of architects

6 out of 9 owners had the help of an architect to varying degrees. 4 out of 9 owners hired an architect and in 2 of those cases that turned out positive and for 2 interviewees it turned out negative, one as a one and a half year waste of time, and the other just not as expected. 2 other owners had architects in their personal network that were consulted, one extensively and the other just for reassurance.

Credibility of energy advisors

Interviewee 2, 4 and 7 were negative about the credibility of energy advisors in their municipality when it came to LCHBs. Others were not asked, but most owners would agree, because LCHBs just require a different approach that an energy advisor for more generic buildings cannot offer.

Interviewee 2 and 5 were negative about energy advisors they hired. Interviewee 2 was negative about an energy advisor who did not deliver the quality he expected, because she was not skilled in designing and more focused on the realization side. And interviewee 5 was negative due to the limited expertise and courage to create new solutions. Whereas interviewee 1 and 9 were very positive about the energy advisor that helped them.

Credibility of the municipality

Opinions of LCHB owners regarding the ‘process of the permit application’ were divided. 5 LCHB owners were positive about their permit application process when they went through it, and 4 were negative. Currently 6 LCHB owners are negative and 3 are positive about the process of the permit application in their municipality. The most important reason has to do with the credibility of the municipal officials (4.3.3.5 for more information).

Opportunities regarding credibility

Credible stakeholders, advisors or sources of information could convince LCHB owners to realize a sustainable renovation.

4.3.4 Trialability

Opportunities regarding trialability

The municipality could play a role in increasing trialability, this happened with interviewee 7. Interviewee 7 was planning on installing a heat pump, so he asked the municipality and they connected him with another homeowner who already installed the same heat pump (water to water) that interviewee 7 was interested in.

Interviewee 7: “I emailed a man from the municipality, because I found that they provided money for projects regarding extracting heat from the canal water and so on. The municipality send me the address of someone who had done the same project I was interested in; a heat pump based on water to water. Subsequently, I visited his address once on a Sunday morning. And he showed me a large well cover in the street, and I thought; that is very doable. Beforehand I didn’t know how that was possible in a city, and the owner also gave me a design agency and an installer. I only haven’t gotten around to it yet due to my wife’s illness.”

Regarding the traveling exhibition as discussed in the theoretical background about trialability (chapter 3.3.4), a professional explained that the hope behind the traveling exhibition was also that the municipality where it was located could organize additional things, like for example a kitchen table conversations, which is a level 1 sustainability advice about basic measures LCHB owners could take.

4.3.5 Observability

4.3.5.1 Visibility

Many interviewees visited other LCHBs before starting a sustainable renovation to get a sense of how it could look like. At least 6 out of 9 owners indicated that they had gained knowledge by visiting other LCHBs where they must have observed sustainable renovations.

Interviewee	1	2	3	4	5	6	7	8	9
Variables of visibility									
Visited other buildings for inspiration	Yes	-	Yes	-	Yes	-	Yes	Yes	Yes
Invited guests who may have got inspired	-	Yes	Yes	-	Yes	Yes	Yes	Yes	Yes

Table 63. Visibility of sustainable renovations (author) (- means no information)

Interviewee 8: “My new circle of acquaintances, which I have built up here, has many people with outside homes that have the same type of problems I do. And it is true that I try to learn from these people I know in the area and about what they have done.”

Naturally, all of the LCHB owners who had visitors after their sustainable renovations were completed, created an observation of their sustainable renovation to their visitors. Interviewee 5 probably had the most visitors who were in later stages of the decision-making process, and she thereby increased the visibility of the sustainable renovation.

Interviewee 5: “We have had a lot of visitors pass by, for example customers of the contractor and customers of the installer of the innovative boiler who came to have a look.”

Opportunities regarding visibility

Thermal images / infra-red camera (warmtebeelden)

A way in which observability of sustainable renovations in buildings can increase is by the showing thermal images to potential adopters. At least 3 out of 9 owners made use of an infra-red camera for different reasons. The reasons LCHB owners used thermal imaging where:

Interviewee 1 had a contractor install laminated glass, glass with a painted metal layer on the inside, in his façade. Interview 1: “I would strongly advise against laminated glass, because two windows were placed inside out. I found out with an infra-red camera, and the contractor had to come back to adjust them and install them properly. Additionally, new glass had to be ordered, because laminated glass breaks by definition due to how it is secured.”

Interviewee 4 who got thermal images of his LCHB from an acquaintance who he met at an energy cooperative information meeting was very positive about them, interviewee 4: “Thermal images were taken in the beginning that shocked me so much. And those thermal images were made again after the sustainable renovation, because our municipality wanted to draw its residents' attention to the possibilities of sustainability. They have taken free thermal photos at a large number of buildings, and we also receive a report of this. So I think thermal images are an essential part of collecting information.”

Interviewee 5 did a lot of monitoring, one such way was using thermal cameras to monitor the roof to find out its dew point. Interviewee 5: “Because you can only make a roof very sustainable if the attic is not too intensively used. If the attic holds the dormitory of a youth hostel, you will have a completely different moisture level”, which makes insulation more risky.

In all of the interviews where the topic arose, which was 4 out of 9, owners were convinced that thermal images are useful. One of these owners had not yet seen any companies in his area that could make thermal images for detecting heat transmission leaks for him. However, using infra-red cameras to detect heat transmission leaks or thermal bridging, is not extremely reliable for finding the underlying problem that causes it. A professional explained: “An upper floor may transmit a lot of heat to the attic, and the attic to the roof, which may result in the main heat exchange already occurring in the attic, which is not visible in the thermal image, because the heat exchange on the roof may seem not that significant.” Nevertheless, the professional agrees that the thermal images from before and after a sustainable renovation work very good as a source of inspiration for owners of other homes. Besides interviewee 1' use for checking whether laminated glass was installed inside out and interviewee 5' use for moisture, which are also good applications of thermal images.

Infra-red imaging could thus be used by the municipality for not only marketing, by showing other

LCHB owners the before and after, but it will also immediately be a confirmation of whether the sustainable renovation measures are installed properly and to find moisture points where owners should pay attention. And it may not be particularly useful for finding heat leaks.

Zien verduurzamen doet verduurzamen

A professional recommended the documentary seeing sustainability makes sustainable renovations (in Dutch: zien verduurzamen doet verduurzamen). Which is a video series on youtube to show what is possible regarding sustainable renovations, and also makes the viewers want to realize a sustainable renovation for their LCHB.

4.3.6 Type of adoption decision

4.3.6.1 Optional versus collective

The decisions to realize a sustainable renovations was made in most cases together by couples, i.e. a collective decision of two people, and sometimes by an individual homeowner as was the case with interviewee 3.

Sometimes collective ownership, with a subsequent collective adoption decision for the implementation of a sustainable renovation in a LCHB, can be a barrier, but this does not necessarily have to be the case. This was not a barrier in the decision-making process of any of the LCHB owners, but owners did bring up examples of this phenomenon:

Interviewee 5: “Some families have to deal with 10 heirs who all own a piece, and you just have to agree. And I just had to agree with my partner here.”

Interviewee 7 had a claim to a house with multiple of his family members, and he still managed to put solar panels on a neighboring sports halls to save on energy costs.

4.3.6.2 Authority

Opportunities regarding an authority adoption decision

A sustainable renovation obligation is a decision made by government authorities and will increase the rate of adoption, since the LCHB owner has no choice. To research the attitude towards a sustainable renovation obligation, seven owners were asked the following question: Would you still have bought the LCHB if the contract stipulated that you must get the LCHB to energy label A within three years, given the municipality was cooperative?

Interviewee 3: “That would be my wish. Because I think the LCHB should be brought into the contemporary time frame to preserve it for the future. Because after me someone needs to want to live here as well. However your questions is unrealistic, because my municipality does not allow me to realize a sustainable renovation of that kind, otherwise they would have to transform the cultural heritage committee. If someone in the cultural heritage committee says to me: come on interviewee 3, we are going to make your LCHB ready to enter the 21st century, then I am all for it!”

Interviewee 4: “Well that wouldn’t hinder me. Because I already wanted to do it and spend my money on it.”

Interviewee 5: “That wouldn't be a problem for me, that was just my goal. Actually it was just my mission to show that it is possible.”

Interviewee 6: “I think it's difficult for a LCHB to get energy label A, especially within three years. And I wouldn't have been able to do it financially either. Then you need to have a bag of money, I didn't have that. Within 10 years I think it can be achieved, maybe not label A, but B. I am convinced that this is possible with a LCHB without affecting its LCHB status, because that is always the starting point.”

Interviewee 7: “Oh that seems like a great idea. Of course, it must be possible financially. But look, I would have that done in three or six months. Have the work carried out without living there. It would also be a challenge for me to buy a LCHB with a bad label and improve it, I think I would do very well. The point is that if you don't live there yet; then the hassle won't be a problem. And the hassle was the biggest objection.”

Interviewee 8: “If that was a prerequisite here, it would have cost between 200.000 and 300.000 euros. And I don't think that's realistic. So the answer is: no, that won't work and I wouldn't have bought the LCHB. And with financial support and the right advice it still would not have worked, because I wasn't mentally ready to strip the whole house and realize a big sustainable renovation. I also did not have the experience 8 years ago and could not have handled it back then, since we came from a new-built house.”

Interviewee 9: “This is a very large building. It is 500 square meters, it would cost me half a million to go to label A. I can't afford that. However, if it can be done with simple interventions than yes, it depends on what it costs.”

Interviewee 1 & 2 were not asked. But inferring from their situation, interviewee 2 would not have been financially ready for such an obligation, since he expects a full sustainable renovation to cost 500.000 euros which he did not have, and thus would not be able to have bought the LCHB. And interviewee 1 maybe neither due to being a young homeowner at the age of 28.

Concluding; at least 4 out of 9 owners were very positive towards a sustainable renovation obligation, and at least 3 out of 9 owners, but probably 5 out of 9, would not have been able to buy the LCHB with this obligation in place. If the obligated time of the contract would change from three years to ten, then one owner was convinced he could meet the condition and others may find it more realistic as well. These findings strongly correlate with owners’ income and wealth during their first sustainable renovation, **table 64**.

Participant	1	2	3	4	5	6	7	8	9
Attitude and wealth and income during 1 st s. renovation									
Attitude towards a sustainable renovation obligation in 3 years	Negative	Negative	Positive	Positive	Positive	Negative	Positive	Negative	Negative
Household income during first s. renovation	Above medium	Medium	Above medium	Above medium	Above medium	Medium	Above medium	Pension	Above medium
Household wealth during first s. renovation	Medium	Above medium	Above medium	Above medium	Far above medium	Medium	Medium	Above medium	Medium

Table 64. Attitude towards a sustainable renovation obligation in 3 years and wealth and income (author)

Planning obligation

One interview question asked to multiple owners was whether a sustainable renovation design of the municipality would help owners' decision-making process, this is probably not feasible in practice. It may have been better to ask owners' attitude towards sending in an obligatory design for a sustainable renovation, not all LCHB owners, only those that are in the right stage of the decision-making process, for example a new owner who just bought a property. This may help the LCHB owner actively engage with the design stage and go through the process more quickly.

This idea came up with interviewee 9 who advised anyone to come up with a plan regarding their LCHB for the next 20 years.

Interviewee 9: "I think the most difficult thing is having a vision. And you need to have a vision, and government policy does not help you with that. You want to be able to look 20 years ahead, because it is almost unaffordable to live in such a building. You just want to know. Because everything that I put in now has to yield something. Do you understand? In politics they look 4 years ahead, but as a LCHB owner you simply cannot afford that unless you are very rich."

4.3.7 Communication channels

All forms of communication channels, which includes the variables 'mass media', 'interpersonal', 'the internet' and 'localite vs. cosmopolite' are investigated in the decision-making process results about the information gathering stage (subchapter 4.2.2.2).

4.3.8 Nature of the social system

The variables 'norms of the social system' and the 'type of adoption decision' have already been covered in the results, subchapter 4.1.1.7 and 4.3.6 respectively. The variable 'consequences of innovations' was not properly investigated in the empirical research and is thus left out.

4.3.8.1 Social structure

The social structures of LCHB owners have also not been properly investigated. Only a few examples can be inferred from the interviews, but of course LCHB owners have their own networks that did not come up during the interviews.

Interviewee 7 was connected with his neighbors to some extent, he knew what was going on, and he knew some things about the buildings of his neighbors as well. He also went to the neighborhood information gatherings.

Interviewee 8 had a network of friends who had similar buildings and lived closeby, he had built up this network of friends in the past 8 years he lived in the area.

4.3.8.2 Opinion leaders and change agents

The degree of opinion leadership of LCHB owners has been explored in ‘sharing information’, which is part of the confirmation stage (subchapter 4.2.2.7). And who the opinion leaders are has been covered in the information gathering stage (subchapter 4.2.2.2). And change agents are covered in the next results chapter (4.3.9).

4.3.9 Extent of change agent promotion efforts

Change agents can be advisors, architects, government officials and many more. The focus in this results chapter is mainly on policy makers, on municipal and national levels, as the change agent.

The variable ‘change agent similarity to potential adopters’ was not properly covered in the empirical research. The variable ‘compatibility with the needs of potential adopters’ is already addressed in chapter 4.3.2, which is about compatibility. And the variable ‘improving the evaluation ability of potential adopters’ is already addressed in chapter 4.3.3, which is about complexity. The remaining five variables do get addressed in this ‘extent of change agent promotion efforts’ chapter.

4.3.9.1 Effort in contacting potential adopters

At least 2 out of 9 owners were negative about the amount of contact they received from the municipality while tackling the sustainable renovation, and at least 2 were positive. More contact from the municipality would be helpful to some owners.

Participant	1	2	3	4	5	6	7	8	9
Attitude towards effort in contacting of the municipality	-	Negative	Negative	Positive	-	-	Positive	-	-

Table 65. Attitude towards effort in contacting of the municipality (author) (- means no information)

Interviewee 2: “Ultimately, more collaboration than a formal permit application process. This does not have to be with the cultural heritage committee, and this would make the permit process more cooperative.”

Opportunities regarding effort in contacting

There are owners who think that the a listed cultural heritage building status means that the buildings cannot undergo sustainable renovations. Well, this is not the case (Ministerie van Onderwijs, Cultuur en Wetenschap, 2022), because the LCHB owners interviewed in this thesis could do it. An opportunity would be to spend more effort in making the possibilities more widely known among potential adopters.

Interviewee 5: “Everyone says: yes, but nothing is allowed by the Cultural Heritage Agency of the Netherlands. And: do you have a LCHB? Oh, then you're certainly not allowed to do anything! And that is

not true at all. Just start talking to the Cultural Heritage Agency of the Netherlands and ask: how can we get this LCHB back on track? And that is actually very interesting, because they have a completely different perspective, but they also want to improve the LCHB. So it often seems that being a LCHB only constitutes a limitation, but if you have a good story then that is not the case.”

A professional also addressed that the idea that nothing is allowed in LCHBs is quite persistent. He explained that if a LCHB owner can explain from personal experience to another LCHB owner that it is not the case that nothing is allowed, and that the owner is much more relaxed after the sustainable renovation, this persistent idea may get resolved. This opportunity borders on interpersonal communication channels (chapter 4.3.7) and the use of opinion leaders (subchapter 4.3.9.5).

Another opportunity would be to connect potential adopters with LCHB owners who already adopted the particular sustainable renovation measures that the potential adopters are interested in, as discussed in trialability, chapter 4.3.4, and the use of opinion leaders 4.3.9.5.

4.3.9.2 An orientation on potential adopters

The results of this thesis already help with putting the orientation on potential adopters, rather than a change agency orientation. Most important for putting the orientation on potential adopters is looking at the main drivers of LCHB owners (subchapter 4.3.1.3). Special attention should be paid to addressing the main drivers in the information provision to owners. For example, putting the focus on ‘making it beautiful’ may be helpful because this is one of the motives behind sustainable renovation decisions of LCHB owners, that also may not be sufficiently addressed.

4.3.9.3 Empathy with potential adopters

Opportunities regarding empathy with potential adopters

A way to increase empathy is to look at other European countries with many well maintained LCHBs. Interviewee 3 was mainly bothered with a lack of connection between the municipality and him and reflected on how it is done properly in France.

Interviewee 3: “Things are going better in France, the government connects with the owner of a LCHB, e.g. a castle. Both the owner and the official have a common interest, namely preserving the LCHB, but the owner can no longer manage it on his own. So something has to be done, together they come up with an idea; we are going to turn that castle into a museum. How great! So the owner turns his castle into a museum, the government helps out with further decorating the museum and making the LCHB as beautiful as possible. So both the owner and the government contribute in terms of effort and money, and it is important to involve the community as well, in that way you have made a kind of connection.”

More municipal cooperation (gemeentelijke samenwerking)

When speaking with a professional about inequalities between different municipalities, the researcher came to the conclusion that municipalities with smaller amounts of LCHBs should be able to make use of the organization of close by municipalities with more LCHBs (grote monumenten gemeentes). Because the amount of money that is available through municipal subsidies is lower, the information that can be gathered is lower, since municipal officials in municipalities with small numbers of LCHBs may not have the right type of knowledge to help owners. It is difficult to be a LCHB owner in a municipality with a small amount of LCHBs. And this allows these LCHB owners to consult with knowledgeable municipal

officials regarding their problems.

The professional explained: “Municipalities with land that is more expensive incur more revenue, and can thus provide more extensive municipal subsidies.” In some way the municipal subsidy gives owners some of their taxed money back. But you could also argue that LCHB owners of peripheral municipalities with lower land values could share in this subsidy. Because one way of increasing the rate of adoption of sustainable renovations is to redistribute wealth, guidance and knowledge to owners who have less of it.

4.3.9.4 Credibility in the eyes of potential adopters

And 4 out of 9 LCHB owners did not believe the right people made the decisions regarding permit in the municipality (interviewee 5) and the cultural heritage committee (interviewee 1, 3 and 6). The quote of interviewee 1 is in subchapter 4.3.2.2, and interviewee 6 in subchapter 4.3.9.3.

Interviewee 5: “That first cultural heritage building official of the municipality, who really had a heart for the LCHBs and was also an architectural expert, was replaced by a lawyer who only read small print.”

Opportunities regarding credibility in the eyes of potential adopters

An opportunity lies in adding a building technology expert, or sustainability advisor, who knows a lot about both installations and listed cultural heritage buildings in the cultural heritage committee. Because this is what at least 3 out of 9 owners lacked, interviewee 1, 5 and 6. Multiple professionals also verified this problem. And the workshop results also reflect this opportunity, by recommending an integral approach to sustainable renovations.

The credibility of change agents can also be improved regarding supervision. For example, one owner pointed out that supervision was not up to standard.

Interviewee 1: “And once the municipality went to have a look with a supervisor. But yes, that young man could see. But he either couldn't read drawings, or he didn't understand exactly what was shown. So he has just been on the scaffolding because of formality. And he didn't see at all that we executed the construction plan differently than I had been allowed to do. And I'm still amazed that someone can do their job like that, but good it is fine.”

4.3.9.5 The use of opinion leaders

Opportunities regarding the use of opinion leaders

Opinion leaders can be the LCHB owners themselves, and they can be used if information gatherings of local groups of LCHB owners are organized. As seen in subchapter 4.2.2.2, at least 3 out of 9 owners gathered information by attending information gatherings.

A professional explained that a lot of information gatherings are already being organized for LCHB owners, for example: social gatherings, sustainable LCHB home routes, open LCHB day (open monumenten dag), which did have a sustainability theme two years ago, and a sustainable LCHB home route was also tried during open LCHB day. This all helps with showing an image of what is possible.

Furthermore, these information gatherings are not useful for owners who already know a lot, but they can still share information. At least 7 out of 9 owners already had a middle to high interest in

sharing information on about sustainable renovations (**table 52**), and these LCHB owners do not all have to give lectures, but they could tell about their sustainable renovation experience to other LCHB owners who are in earlier stages of their sustainable renovation decision-making process.

Information gatherings can also help with setting up energy hubs, when people know each other in the neighborhood, and they want to work together. Thus exploring the possibility of sharing residual heat. Interviewee 9 was exploring together with the Groene Grachten how they could create an energy hub with two neighboring buildings, one of which is a distillery.

4.3.10 Identified opportunities

Table 66 Shows an overview of the variables (marked light grey) and the variables that have opportunities (marked golden). These opportunities are turned into the recommendations in chapter 5.

Relative advantage				
Monetary costs	Financial incentives	Energy cost savings	Comfort	Environmental
Real estate value	Social status	Waiting for improved technology	Transaction costs	Making the LCHB beautiful
Adjusting the LCHB to the time period				
Compatibility				
Cultural heritage value	Listed cultural heritage status	Values and beliefs	Previously introduced ideas/ past experiences	Needs of potential adopters
Complexity				
Easiness to apply	Knowledge about sustainable renovation measures	Need for information	Need for support	Credibility of experts and information
Triability				
Observability				
Visibility				
Types of adoption decision				
Optional	Collective	Authority		
Communication channels				
Mass media	Interpersonal	Internet	Localite/cosmopolite	
Nature of the social system				
Social structure	Norms of the social system	Opinion leaders and change agents	Types of innovation-decisions	The consequences of innovations
Extent of change agent promotion efforts				
Effort in contacting potential adopters	An orientation on potential adopters	Compatibility with the needs of potential adopters	Empathy with potential adopters	Change agent similarity to potential adopters
Credibility in the eyes of potential adopters	The use of opinion leaders	Improving the evaluation ability of potential adopters		

Table 66. Variables and variables with opportunities (author, based on Rogers, 2003, p. 222)

4.4 Personas

The results of the interviews with LCHB owners about their prior conditions, characteristics and drivers & barriers can now be used to create personas.

Sub question 4: What are the personas of LCHB owners and how can they be used to increase adoption of sustainable renovations?

This question is answered by creating 2 personas out of the characteristics of the 9 LCHB owners (4.4.1), linking the drivers and barrier to the personas (4.4.2) and discussing opportunities (4.4.3).

4.4.1 Characteristics of the personas

Two types of personas have been identified based on the characteristics of participants (**table 67** and **table 68**) and can be seen in (**photo 6** and **photo 7**). First, there are LCHB owners that are: highly motivated for DIY, a bit younger on average, younger on average when they first started with their first sustainable renovation and reliant on an average not far above medium income and/or wealth. Secondly, there are LCHB owners that are: less motivated for DIY, a bit older on average, older on average when they started with their first sustainable renovation and reliant on a far above medium wealth and/or income. Interviewees that fit the first persona are: 1, 2, 6 and 9 (marked golden) in **table 67** and **table 68**. Interviewees that fit the second persona are: 3, 4, 5, 7 and 8.

Persona 1

Making ends meet, younger and DIY

- Interviewee 1 (28), 2 (48), 6 (34), 9 (50)
- Average age of first sustainable renovation: 40
- Main barriers:
 - Costs of a sustainable renovation (2, 6, 9)
 - Less positive about current subsidies (2, 9)
- Key variables:
 - Trust in professionals: average
 - Tolerance of disruption: high
 - Price sensitivity: high
 - Income: average
 - Wealth: average
 - Hired contractors: yes, sometimes
 - Hired architects: none
 - It wouldn't have been possible with a sustainable renovation obligation



Persona 2

Affluent, middle-aged and clients of professionals

- Interviewee 3 (56), 4 (60), 5 (54), 7 (44), 8 (63)
- Average age of first sustainable renovation: 55
- Main driver and barrier:
 - The environment as one of the main drivers: (4, 5, 7 and 8)
 - Finding the right contractors as a main barrier: (3, 5, 8)
- Key variables:
 - Trust in professionals: high
 - Tolerance of disruption: average
 - Price sensitivity: low
 - Income: above average
 - Wealth: above average
 - Hired contractors: yes, often
 - Hired architects: 3, 4, 5 and 7
 - Generally positive about a sustainable renovation obligation



Photo 6. Kastelic, M. (2016).

Photo 7. Rijksdienst voor het Cultureel Erfgoed. (2023).

The two personas also differ from each other in other personality variables.

The first persona, 'Making ends meet, younger and DIY, ' has: an average trust in professionals, a high tolerance for disruption, a high price sensitivity, sometimes hired contractors and did not hire architects. And this persona would also not have minded an obligation in their purchase contract of the LCHB to realize a sustainable renovation within three years. And also this persona would not have been able to buy the LCHB if there was an obligation in their purchase contract to realize a sustainable renovation within three years.

Then, the second persona, 'Affluent, middle-aged and clients of professionals' has: a high trust in professionals, an average tolerance for disruption, a low price sensitivity, hired contractors often and

hired an architect most of the time. And this persona would not have minded an obligation in their purchase contract of the LCHB to realize a sustainable renovation within three years.

Participants Personality variables	1	2	3	4	5	6	7	8	9
Innovator/restorer	Innovator	Middle	Restorer	Middle	Middle	Middle	Restorer	Middle	Middle
Motivation for DIY	Middle	High	Low	Low	Low	High	Low	Low	High
Architectural design	Own	Own/contractor	Own/contractor	Architect	Own/architect	Own/contractor	Architect	Own/contractor	Own
Trust in professionals	High	Low	High	High	High	High	High	High	Middle
Trust in civil servants	Low	High	Low	Low	Middle	Low	High	Middle	High
Tolerance for disruption	High	High	High	Low	High	High	Low	High	Low
Hunger for information	High	High	High	Middle to high	High	High	Middle	High	High
Interest in energy saving	Middle to high	High	Middle to high	High	High	High	High	High	High
Price sensitivity	Middle	Middle	Low	Low	Low	Middle	Low	Middle	High
Concern for climate related issues	Middle to high	High	Middle	High	High	High	High	High	High
Likes or dislikes a challenge	High	Middle to high	High	Middle to high	High	High	Low	Middle	Middle
Comfort expectation	High	Low to middle	Low	Middle	Middle	High	Low to middle	Middle	Low
Household income	Above medium	Medium	Above medium	Above medium	Above medium	Medium	Above medium	Above medium	Above medium
Possession of wealth	High	Middle	High	High	Very high	Middle	High	High	Middle

Table 67. Personality variables and persona identification (author, inspired by Haines & Mitchell, 2014)

Participant	1	2	3	4	5	6	7	8	9
Age	56	50	70	64	69	77	74	71	55
Age during 1st renovation	28	48	56	60	54	34	44	63	42
Date of first sustainable renovation	1995	2021	2009	2019	2008	1980	1993	2015	2010
Ownership years	28	3	11	23	15	43	29	8	13
Floor area	200	300	400	300	500	300	200	200	300
Profession (current or retired from)	Building technology professor	Software engineer	Physiotherapist	Anesthetist	Architect	Restoration advisor / contractor	Mathematician	Chemical engineer	Restoration architect
Household income (gross) now	Above medium	Medium	Pension	Above medium	Pension	Pension (only AOW)	Pension	Pension	Above medium
Household income during first s. renovation	Above medium	Medium	Above medium	Above medium	Above medium	Medium	Above medium	Above medium	Above medium
Acquired by means of	Income	Sold house	Income & sold house	Income and inheritance	Sold house and inheritance	Income	Income, inheritance	Income, sold house	Income
Subsidy, loans, tax deductions	Tax relief	Municipal subsidy	-	-	Municipal subsidy, tax deductions	low interest loan	Subsidy and tax deductions	Subsidy, tax deductions	Subsidy (woonhuissubsidie)

Table 68. Socioeconomic characteristics and persona identification (author, inspired by Haines & Mitchell, 2014)

Another persona

Another type of owner that could be a persona and that resulted from the interviews with LCHB owners, was that there are LCHBs that are owned by multiple heirs. Making this another persona a division of ownership among multiple owners. This persona has not been investigated fully, only interviewee 7 fell in this category, but for another LCHB where he was a part owner of, and thus not the LCHB he lived in and he was interviewed about. And interviewee 5 brought up the existence of this persona and the barriers that may come with it, i.e. a more collective adoption-decision, rather than an individual one.

4.4.2 Drivers and barriers of the personas

The two personas also differ when it comes to their drivers and barriers.

One main driver that LCHB owners have that belong to persona 2, 'Affluent, middle-aged and clients of professionals', is for the environment. LCHB owners that belong to persona 1, 'Making ends meet, younger and DIY' had this as a driver as well, but it was not their main driver.

Main drivers	Personas	
	1	2
Comfort	3	3
Energy cost savings	3	2
Environment	0	4
Making it beautiful	2	3
Future proofing/adjusting the building to the time period	1	1
Financial incentives	1	0

Table 69. Main drivers of the two personas (author, inspired by Haines & Mitchell, 2014)

The main barrier of LCHB owners that belong to persona 1, 'Making ends meet, younger and DIY', is the costs of a sustainable renovation. And the main barrier of LCHB owners that belong to persona 2, 'Affluent, middle-aged and clients of professionals', has to do with finding a reliable expert with the right expertise for the work.

Main barriers	Personas	
	1	2
Costs of a sustainable renovation as a barrier	4	0
Waiting for improved technology	2	1
Time and effort it takes to apply for subsidies and loans	1	0
Finding a reliable expert for the work	0	3
Examining the reliability of the information	1	0
Mess and nuisance because of the work	0	1
Communication of the municipality	1	1
Permit application of the municipality/cultural heritage committee	3	3

Table 70. Main barriers of the two personas (author, inspired by Haines & Mitchell, 2014)

4.4.3 Opportunities regarding the personas

Multiple opportunities that make use of personas exist, for example providing different information messaging to each persona. The main opportunity that has been explored in this thesis is a subsidy for the 'Making ends meet, younger and DIY' persona, that will be called the DIY subsidy.

4.4.3.1 DIY subsidies

The main barrier of the persona 1, 'Making ends meet, younger and DIY', was the costs that come with a sustainable renovation. And this persona is also less positive about the current subsidies. These two barriers alone would make a compelling case for introducing DIY subsidies to increase sustainable renovations. But there are some other reasons why a DIY subsidy may be excellent as well: it may reduce the labor shortage, it may reduce inequalities that are inherent to the diffusion of new innovations (Rogers, 2003, p. 159) and it aligns with the main agreement of the new Dutch government. And lastly, quality and fraud are addressed.

Labor shortage

Finding the right contractor is one of the main barriers for persona 2, 'Affluent, middle-aged and clients of professionals'. This may have something to do with a labor shortage of contractors that are specialized in sustainable renovations of LCHBs. This labor shortage is made worse by the financial incentives that are currently in place which is explained by a professional: "I am a LCHB owner myself, and it made almost no difference in my situation, so I decided to hire a contractor."

In this case it did not make a difference because the subsidy (ISDE) has the condition that a professional contractor needs to carry out the work, thus DIY is not eligible for subsidy. DIY is unpaid work, when you could have been working for money and realized the sustainable renovation by hiring a contractor.

Similarly, hiring a contractor to realize restoration/maintenance work, will be subsidized by the home subsidy (woonhuissubsidie), which is a 38% discount on all of the costs of a contractor. Meaning you get a sharp discount. DIY also involves a 38% discount on the materials that are used, however no tax money goes to a contractor in this situation. So DIY is heavily discouraged, because of the attractive discount on hiring professional labor, which contributes to the scarcity of contractors who can work with LCHBs.

Instead, DIY subsidies would encourage DIY, which will in turn lower the demand on contractors and not waste any tax money where LCHB owners could have easily realized it themselves. Two professionals were asked about this take, and they both agreed. The professional who could have done the sustainable renovation himself, but hired a contractor because of current subsidies added: "At this moment the subsidies work as an incentive for the building sector. I'll have it done for the same amount of money, and it costs society more money than it could have cost DIY; unnecessary state aid. Construction companies are working for people who can and want to do it themselves, only because of the financial incentives from the state."

Inequalities that are inherent to the diffusion of new innovations

A professional mentioned that the wealthier LCHB owners become wealthier because they invest in their LCHBs, while others who cannot afford it are not making any progress; e.g. towards a lower energy bill. This phenomenon where innovations and innovation diffusion programs cause inequality among

potential adopters is also extensively discussed by Rogers (2003). Rogers (2003, p. 159): “A consistent finding from past diffusion research is that individuals’ socioeconomic status is highly related to their degree of change agent contact. Status and change agent contact are in turn highly related to their degree of innovativeness. Thus, change agencies often cause increased socioeconomic inequality among their audience through their diffusion activities.” So, why not address this issue with incentives for persona 1, ‘Making ends meet, younger and DIY’? (Answered below, in: **fraud**)

Main agreement

A professional pointed out that DIY subsidies would be in alignment with the main agreement of the new Dutch government, which according to him shifted from sustainable renovations for the environment to sustainable renovations for tackling energy poverty and social inclusivity.

After some further investigation, an impetus for DIY subsidies can easily be found in the main agreement of the new Dutch government, since it states (Bureau Woordvoering Kabinetsformatie, 2024): “Financial resources for the climate will be partly used to help people with a low or middle income in the energy transition. This could include helping people make their homes more sustainable, which ensures a lower energy bill.” This opens the door for a sustainable renovation subsidy, or other financial incentive, for people with a low or middle income.

The same professional also explained that not everyone can participate with sustainable renovations and the energy transition, because it requires an investment. Wealthier owners can invest and often make a return on investment, while there are also owners whose budget does not allow the procurement of a contractor. If you give money to do-it-yourselfers, low and middle income owners may be more able to participate. Otherwise a reduced energy bill will mainly be reserved for wealthier owners, while less wealthy owners may spend the same or more on energy costs.

Quality of DIY

Two relevant professionals were asked about if LCHB owners could properly do it themselves, their answers were:

Professional 1: “There's nothing wrong with someone doing it themselves, a contractor doesn't necessarily do a better job. Gap sealing (kierdichting) and vapor tightness (damp dichtheid) in LCHBs are quite difficult, and professionals also deal with this creatively.”

Professional 2: “A contractor without bad intentions can treat a LCHB as a newly-build home due to a lack of specific LCHB knowledge, and may end up doing damage to the listed cultural heritage value. So in that case the owner realizing the sustainable renovation DIY is not any riskier.”

Thus, LCHB owners that realize sustainable renovations DIY, for example insulation measures, should not be the biggest concern.

Fraud

This whole chapter subchapter showed the positive side of A DIY subsidy, but there is a reason that DIY is not incentivized. A professional explained: “The point that they never did it (introduce incentives for DIY), is its susceptibility to fraud. An invoice is required from a construction company to see that it happened. A company that faces a problem with false invoices may have to close down. A LCHB owner

can just purchase insulation material and return it immediately afterwards, but keep the receipt. Now there are all kinds of things to solve this, a condition that you have to upload photos before and after, to check if you really applied it. This is also the case with the ISDE subsidy, the RVO (Agency of Entrepreneurship of the Netherlands) determines whether the photo was taken in the house where the subsidy was made. But fraud checks and balances make DIY subsidies difficult to implement.”

Another professional explained that it is in fact possible to organize DIY subsidies on a municipal level, because it already happened successfully in one municipality (Rheden). The first professional responded on this evidence: “So, it is possible. I reckon it may be successful if you send a municipal official to the LCHBs at the time they indicated they would install the interior wall (screw it shut), or have a video call at that very moment, and have that as a condition for receiving the subsidy. This requires more work on the controlling side of the subsidy, then what the ISDE subsidy is designed for. But every system can be cheated, you need to organize the aspects that are susceptible to fraud so that the risk is sufficiently covered, so this recommendation makes sense.”

One example of a subsidy for DIY in the Netherlands were green vouchers.

Professional: “Sometimes the risk of fraud is simply taken, green vouchers were a voucher that you could buy 75 euros worth of green products with (i.e. sustainable renovation materials). It was organized with 0% control on whether the products were really installed. 75% ends up well, the other 25% does not, this is a risk that was taken, because control also costs money. How much do we lose on fraud is inherent in the system”

So you could make the consideration whether losing money on fraud or the costs of controlling costs more for the same result, however green vouchers were a very small subsidy, and not something that would really help Persona 1, ‘Making ends meet, younger and DIY’. A larger subsidy would also be more easy to control, because less people need to be controlled, assuming there is a limited budget for the subsidy.



5. Discussion

- Theoretical reflection
 - o Rogers (2003)
 - o Adopter categories
 - o Personas
- Policy recommendations
 - o Drivers, barriers and opportunities
- Limitations of the research

5.1 Theoretical reflection

The discussion first presents a reflection on the theoretical background of this thesis.

5.1.1 Rogers (2003)

Suitability of Rogers (2003)

Rogers' theory is very applicable to sustainable innovations in housing, because the theory remains recognizable in practice (Van Hal, 2014, p. 13). And for the sustainable renovation process in buildings it is also appropriate, because Wilson et al. (2018), Pettifor et al. (2015) and Arning et al. (2020) used it, the last one in old buildings.

Van Hal (2014, p. 13) mentions that: "Rogers' theoretical model assumes that the adoption of an innovation is solely based on voluntary acceptance. This leaves out a degree of compulsion, e.g. in the shape of legislation. And the role of authorities and the importance of a long-term perspective among authorities is missing in Rogers' work." The researcher of this thesis comes to other conclusions; The 'authority decision' which is a type of adoption decision that influences the rate of adoption (Rogers, 2003, p. 222) does imply that compulsion is part of the framework. And the 'extent of change agent promotion efforts' from Rogers (2003, p. 222) does take into account: the shape of legislation, the role of authorities and the importance of a long-term perspective, the first two being represented in multiple variables and the last one can be included in 'improving the evaluation ability of potential adopters'.

Van Hal (2014, p. 13) found that trying to affect the diffusion of innovations is fairly limited, due to the considerable influence of external factors that are difficult to influence. This is why the prior conditions & characteristics have been included in this master thesis, since these account for several external factors. And even though these external factor are very hard to influence, it remains important to describe them if the goal is to understand the process.

One possible limitation to this thesis was brought up by Van Hal (2014, p. 37), which is that Mlecnik (2013, as cited in Van Hal, 2014, p. 37) concluded that Rogers' innovation diffusion approach is not always ideal when it comes to system innovations, like entire homes, and networks of entrepreneurs. In that case, Rogers (2003) should be combined with theory on system and specific building innovation, strategic niche management, environmental behavior and theories involving marketing and policy. Bringing these theories together is recommended for mapping the barriers and opportunities for the adoption of innovations. This master thesis may have contributed to connecting Rogers (2003) with other theory, such as the theory about personas from Haines & Mitchell (2014).

Organizing the theoretical structure of Rogers (2003)

One annoying thing about the factors that determine the rate of adoption of an innovation of Rogers (2003, p. 222) is that the factor 'type of innovation (adoption) decision' comes up twice, first as its own factor and second as an aspect of the factor 'nature of the social system'. Thus, the factors could have been structured more properly, by having the 'type of adoption decision' as just an aspect of 'nature of the social system' for example. Similarly, Rogers (2003, p. 170) is influenced by compatibility of the innovation. Compatibility was in this thesis perceived to have a lot of overlap with 'prior conditions' and 'characteristics', since compatibility depends on who adopts the innovation. The researcher also experienced some difficulty with organizing 'previous practice' because its meaning overlaps both 'prior conditions' and 'characteristics'. The researcher would recommend to include the prior condition 'previous practice' under the umbrella of the 'characteristics of the decision-making unit', since the variables 'previous practice' explains a lot about the decision-making unit.

Furthermore, the decision-making process of Rogers (2003, p. 170) was combined with the factors that influence the rate of adoption of Rogers (2003, p. 222) to get a holistic theoretical framework. However, combining these did create some confusion due to overlapping factors and variables, for example: The factor 'norms of the social system' comes up twice, first as a prior condition of the decision-making process and secondly as an aspect of the factor 'nature of the social system'. Compatibility arose twice as well, first under the factor 'relative advantage' and later under 'extent of change agent promotion efforts' as the variable 'compatibility with the needs of potential adopters'. Lastly, the 'opportunities regarding complexity' of the factor complexity had overlap with the variable 'improving the evaluation ability of potential adopters' of the factor 'extent of change agent promotion efforts'.

The researcher would therefore recommend caution in making use of the rate of adoption of Rogers (2003, p. 222), and to stick to Rogers (2003, p. 170) wherein the communication channels can be used as an umbrella concept with underneath it the other influences from Rogers (2003, p. 222). This is quite similar to how this thesis is structured, but the difference is that the communication channels were put on equal footing, whereas they should have included 'type of adoption decision', 'nature of the social system' and 'extent of change agent promotion efforts'. This could solve the dilemma of where to put factors and variables, since then everything that is double can just be erased since it is a custom theoretical model.

5.1.2 Adopter categories

Results of the empirical research were not combined with Moore (2014), whose work could be used to create a strategy based on adopter categories. The theoretical background did propose how to make a strategy that takes adopter categories into account in extent of change agent promotion efforts (3.3.9.3). However, adopter categories have their limitations when it comes to sustainable renovation in LCHBs, these are also discussed in the subchapter about innovativeness (3.1.1.6), it boils down to that every LCHB is different and requires a tailor made sustainable renovation, making it hard to compare the sustainable renovations that have been realized. The sustainable renovations of LCHBs could be made measureable by introducing an energy label for LCHBs, something like what has been done by Nibe (2021b) with the 'DuMo-label'. But not many LCHBs have this 'DuMo-label', only 72 (Nibe, 2021a).

What is found regarding adopter categories, is that at least 7 out of 9 LCHB owners were opinion

leaders. Opinion leaders are often early adopters, since they are more innovative than others in the social system, i.e. they adopt earlier (Rogers, 2003, p. 318), thus some, if not most, of the interviewed LCHB owners may also be early adopters. Especially for some sustainable renovation measures, but also for extensive sustainable renovations that were achieved by multiple interviewees. Whereas the average LCHB owner did not put so much effort into the LCHB, and does not share about it as much as the interviewees.

5.1.3 Personas

Briene et al. (2020, p. 19) mentions that: “The group of LCHB owners is highly heterogeneous, therefore analyzing the whole group may be difficult.” Rogers (2003, p. 19) echoes this statement: “one of the most distinctive problems in the diffusion of innovations is that the participants are usually quite heterophilous.” Nevertheless, the whole group of LCHB owners has been researched in this thesis, because it could result into personas that divide the whole heterogeneous group into smaller more similar groups that do have more similar characteristics. And these smaller groups can be used to create specific strategy to supports different types of LCHB owners with their sustainable renovation decision-making process to the fullest extent. The results of the interviews with LCHB owners identified two distinct personas (**Photo 6 & 7**) with their own characteristics and barriers.

Briene et al. (2020, p. 19) also mentions that LCHB owners can be categorized into two groups based on involvement. The first type of LCHB owner is very involved with the LCHB and well informed about technological possibilities, laws and regulations. And the second type is not that involved, and instead just happens to live in a LCHB, possessing less knowledge about it. None of the interviewees that were interviewed fell within the second category. This may be because the participants were actively searching or sharing information and found the researcher’s call on the ‘Monumenten community’ forum to participate with this thesis research, something a less involved LCHB owner would not do. Finding LCHB owners who just happen to live in a LCHB and are not actively gathering or sharing information may be quite difficult, which makes them probably underrepresented in most research.

Briene et al. (2020, p. 19) does allow for some speculation about the existence of two other types of personas. A third persona could also include LCHB owners with average income and wealth, but without much DIY knowledge; someone who just happens to live in a LCHB. And a fourth with more income and wealth, but without much interest in the LCHB or sustainable renovations.

5.2 Policy recommendations

5.2.1 Drivers, barriers and opportunities

Policy recommendations regarding all the factors and variables that influenced the decision-making process of LCHB owners, all are previously discussed in the 'drivers, barriers and opportunities' chapters. The recommendations are meant for policy makers, municipal officials, professionals, LCHB owners and other stakeholders. The recommendations are categorized according to **figure 5**.

5.2.1.1 Relative advantage

Financial incentives

4 out of 9 owners had costs as a barrier. The main recommendation regarding financial incentives is to introduce a, or change the, subsidy structure to facilitate DIY sustainable renovations among LCHB owners who fall into the category of persona 1 'Younger, DIY and making ends meet'. Because, persona 1 has decent knowledge of DIY and sustainable renovations but lacks income and/or wealth to realize it. Therefore this persona could be helped enormously by DIY subsidies, as long as the LCHB owners that conform to persona 1 can be easily identified for a program, and the program properly organizes possible susceptibilities to fraud. This would also reduce the contractor shortage, since the subsidies will shift to DIY homeowners to sustainably renovate by themselves; easing the demand on contractors. And it will give more people the opportunity to realize a sustainable renovation and lower their energy costs.

The DIY subsidy could be tackled by adjusting current subsidies or create a new one. If they would be adjusted then the home subsidy (woonhuissubsidie), should also compensate LCHB owners who DIY 38% for the hours it would take a contractor to realize the same restoration/maintenance, because owners that hire a contractor do receive this money and have free time on their hands. And the ISDE should not have the condition that only hiring a contractor results in the subsidy being granted.

Instead of changing the existing subsidies, a new subsidy could be made that would provide a discount on materials, like insulation materials, so that owners can install these themselves, this should be supervised with photos, a video call and/or showing up at the LCHB, and if they did not install it they should pay back the discount.

These are some ideas, the main recommendation is that DIY incentives should be investigated.

The home subsidy (woonhuissubsidie) is positively regarded by 4 out of 9 LCHB owners.

The ISDE subsidy could take people's individual circumstances into account, since it can occur that only one measure is possible due to the restrictions of the LCHB, as 3 out of 9 owners indicated.

Only 1 out of 9 owners made use of a low interest loan and was positive about it. Some owners did not need it, but others may have needed it. And if the low interest loan, mortgage building depot, Warmtefonds, etc. properly reduces the energy costs and has a return on investment, then it can be as good or better than a subsidy, which is not being recognized according to a professional. Plus, some loans do not have the condition of hiring a contractor; thus allowing for DIY.

Making it beautiful

Making the LCHB beautiful, or beautiful again, was identified as one of the main drivers by 5 out of 9

LCHB owners who brought this up themselves. This was not identified in the theoretical background, it may be part of making the LCHB future proof, but it also concerns the aesthetic side. This may be more prominent for LCHBs than for other residential buildings, but it can also be something that needs to be highlighted more when it comes to promoting sustainability. Focusing information messaging on making the LCHB beautiful together with a sustainable renovation, or linking these two ideas, may convince homeowners who were previously not interested. Because you need to make the goal compatible with the needs of potential adopters.

This relates to Ebrahimigharehbaghi (2022, p. 245) who concluded that the word sustainability does not persuade homeowners to realize a sustainable renovation. Instead, the quality of life improvements, expected cost savings and integration of sustainable renovation with basic home maintenance may convince owners to sustainably renovate.

Future proofing/adjusting the building to the current time period

Another interesting way of information messaging was brought up by 2 out of 9 LCHB owners, which is that a sustainable renovation may add history of the current time period as a layer to the LCHB, just like many LCHBs are made up of several different layers in different time periods.

Transaction costs

The workshop results show that the transaction costs, as described by Ebrahimigharehbaghi (2022, p. 81), function as some of the most important barriers owners face in sustainable renovations of their LCHBs. For example:

- The knowledge and skills that are required for designing sustainable renovations in LCHBs from several perspectives, e.g. coming up with an integral design.
- Another important transaction cost barrier identified in the workshop and experienced by 3 out of 9 LCHB owners was finding good contractors.

More research about transaction costs should be undertaken. The ‘ontzorgingsprogramma’ tackles transaction costs as well, so the results of this program will be interesting.

5.2.1.2 Compatibility

The municipality and cultural heritage committee acted as a barrier for 7 out of 9 LCHB owners for different reasons. Which may be related to the theoretical background, **table 20**, which showed that the municipality has the lowest appreciation, or trust, among LCHB owners. Opportunities to increase sustainable renovations and better facilitate owners are:

- Reducing the amount of individuals involved in the decision for a permit for the sustainable renovation in a LCHB. Which overlaps with Rogers (2003, p. 221) who explains: when less people are involved in the decision-making process, it leads to the decision being made more easily.
- Or add a building technology/installations expert or expertise to the cultural heritage committee, this was supported by a few professionals that were asked about the validity. The new expert should have a background in cultural heritage as well.
- A professional added that the whole cultural heritage committee needs knowledge about sustainability and awareness of the need to realize sustainable renovations in LCHBs

- Open and honest communication, promoting integral approaches by also allowing for it if they make sense.

5.2.1.3 Complexity

Need for information

At least 3 out of 9 LCHB owners mentioned a need for information about energy policy, i.e. a strong vision from the government, so they could make plans for a long time ahead, instead of being uncertain about the future. This touches on energy policy regarding both subsidies and the future energy direction towards gas, electricity or hydrogen power.

At least 2 out of 9 owners thought it was very important to make it clear which parts of the LCHB can be touched and what is off limits (interviewee 1 and 3). This need for information about what is possible overlaps with the fact that 54% of LCHB owners do not know what sustainable renovation measures are possible in their LCHB, **table 30**.

Need for support – hiring professionals

A need for support can be overcome by hiring professionals. All LCHB owners consulted with advisors. And 3 out of 9 owners hired or consulted regularly with an architect for their sustainable renovation. One LCHB owner who had been a professional architect and been on cultural heritage committees recommended that you should always hire a professional who represents you if, for example, you and your partner have a well-paying job that is not related to the sustainable renovation at hand.

Need for support – Monumentguard

Another way for support is enlisting the Dutch Monumentguard (Monumentenwacht). At least 4 out of 9 owners were only positive about the Monumentguard. And, at least 3 out of 9 owners were not positive, because they would have benefitted from good sustainable renovation advice from the Monumentguard. Which may not be properly available in all provinces where the Monumentguard is active. The Monumentguard does stop by LCHB owners already for maintenance and restoration, and sometimes a level 1 sustainability advice, however LCHB owners of this thesis were in need of a level 2 or 3. Still, the Monumentguard offers a unique opportunity, because they may know the LCHB owners, and this creates trustworthiness and familiarity which is the most important attribute to increase the effectiveness of whether a household adopts a sustainable renovation (Ebrahimigharehbaghi, 2022, p. 245). The Monumentguard is also the second most trustworthy organization (**table 20**).

5.2.1.4 Trialability

Municipality as a network connector

The municipality could play a role in connecting LCHB owners who want to adopt a sustainable renovation (measure) with another LCHB owner who already installed of the interested party. This saves time, and acts as a trial.

Traveling exhibition

Municipalities who borrow the traveling exhibition of the Cultural Heritage Agency of the Netherlands should organize additional things besides it, like a sustainability advisor at the exhibition who can really help LCHB owners who are interested. Which is a similar recommendation as Mlecnik (2021) for pop-ups.

5.2.1.5 Observability

Thermal images / infra-red cameras

All owners that brought it up were convinced infra-red cameras are useful. And according to an expert, thermal images are most useful for marketing sustainable renovations by the municipality, which was already happening in the municipality of one of the owners. Do make sure the right expectations are met, because thermal images need a before and after photo at the same time of day with the same weather conditions to make the most sense, unless you are trying to find a moisture/dew point (dauwpunt).

Thus, this may be interesting to add to a subsidy arrangement, like the 'ontzorgingsprogramma' as a confirmation in the confirmation stage, because it can show the owner everything is installed properly.

5.2.1.6 Extent of change agent promotion efforts

More municipal cooperation (gemeentelijke samenwerking)

Municipalities with land that is more expensive incur more revenue, and can thus provide more extensive municipal subsidies. Having owners with LCHBs in municipalities with lower land value make use of the subsidies of the higher land value municipalities may help. And having LCHB owners of municipalities with smaller amounts of LCHBs make use of the municipal advice of municipalities with larger amounts of LCHBs that are close by could help owners with their sustainable renovation plans.

Table 10 shows that municipal LCHBs are in a worse condition than national LCHBs. Which highlights the importance of more attention to municipal LCHBs in some way shape or form by municipalities. A recommendation would be to investigate if the conditions of municipal LCHBs in certain municipalities are much better than in other municipalities. Which if true, may garner a reason for more municipal cooperation to bridge inequalities in funding and informational support. And this seems to be the case because **table 32** shows that 51% of LCHB owners do not get support from the municipality, while 20% do receive free advice and information and 9% are provided with subsidies.

Social gatherings

3 out of 9 owners who were less experienced with LCHBs benefitted from local social gatherings with other LCHB owners who were also interested in sustainable renovations. Benefits where finding recommendations for the right contractors, taking inspiration, gathering information that takes local conditions into account and making connections for setting up energy hubs, which can be sharing residual heat with neighbors who use their building differently.

Social gatherings could be subsidized by the municipality by providing a gathering room.

6. Conclusion

The conclusion involves the answers on the research questions and the limitations of this master thesis.

And the conclusion in short is as follows: There needs to be made better use of the drivers: comfort, energy cost savings, making it beautiful and for the environment, for the right personas. For example, for information messaging towards LCHB owners. And the following barriers need to be overcome: costs, municipality and cultural heritage committee, finding contractors and need for information about the vision on energy policy.

6.1 Answering the research questions

6.1.1 Sub question 1

What are the prior conditions of the decision-making process and the characteristics of the decision-making unit?

This question is answered with the tables of the prior conditions and characteristics results chapter 4.1.

6.1.2 Sub question 2

What is the decision-making process for private owner-occupiers of listed cultural heritage buildings to sustainably renovate?

Some owners just knew the right people, **table 42**. Thus, not everyone should buy a LCHB, but also it requires massive effort on the part of government bodies if you would want to equal the playing field in some way.

This question is answered with the decision-making process of the results chapter (4.2).

6.1.3 Sub question 3

What are the drivers, barriers and opportunities for LCHB owners during the decision-making process to sustainably renovate their listed cultural heritage building?

The literature review showed that only 1% of LCHB owners have other LCHB owners as their source of information, **table 34**. Meanwhile, 25% of LCHB owners are in need of information about the experiences of other LCHB owners, **table 31**. The interview results, **table 46**, showed that 5 out of 9 owners gathered information by visiting other LCHB owners, 3 out of 9 by visiting information gatherings and 3 out of 9 by working for other LCHB owners. Together making up all 9 LCHB owners. Thus this contact between LCHB owners is of utmost importance, and could be enhanced by actively promoting information gatherings so owners can get to know each other. Not only for experiences of other LCHB owners, but also for inspiration of what is possible, to share information about which local contractors have the right expertise, something municipalities themselves are not allowed to do, and to find other local people who are willing to create energy hubs, to share residual heat for example (subchapter 4.3.9.5 and 5.2.1.6).

The municipality and cultural heritage committee together, regarding permits and communication, were experienced as the largest barrier to realizing a sustainable renovation, i.e. among 7 out of 9 LCHB owners, **table 60**. One thing that may reduce this barrier would be to add an building technology/installation expert or expertise to the cultural heritage committee, slightly shifting the balance towards a permit application process that is more integral with installations, but also still maintaining a solid expertise regarding cultural heritage/history, subchapter 4.3.2.2 and 4.3.2.3.

Costs were a barrier for 4 out of 9 owners, **table 54**, and this barrier may be reduced with DIY subsidies for LCHB owners who fall into the category persona 1, 'younger, DIY and making ends meet', which is a persona whose main barrier are the costs. Because some owners can successfully realize sustainable renovations themselves but are not incentivized by the subsidy structure to undertake this, since it may leave them worse off financially, subchapter 4.3.1.2. DIY subsidies could also free up contractors that are now doing work for LCHB owners who could have realized it themselves (DIY), so they can be hired by persona 2, 'affluent, middle-aged and clients of professionals', whose main barrier is finding the right contractors. 3 out of 9 owners had finding a reliable contractor for the work as a barrier, which was also stipulated as a barrier by the workshop with professionals, **table 54**.

A need for information that was not yet researched by Hamstra (2023, p. 12), **table 31**, but did come up unexpectedly with at least 3 out of 9 owners, was the need for information about energy policy regarding subsidies and the future energy source, which may be: electricity, gas or hydrogen, preferably a vision for 20 years.

And loans may be undervalued

This question is mainly answered with the factors and variables tables of the drivers, barriers and opportunities results chapter (4.3).

6.1.4 Sub question 4

What are the personas of LCHB owners and how can they be used to increase adoption of sustainable renovations?

- Tailor made solutions
- More expensive but subsidy to address decay.

6.1.5 Sub question 5

How is the adoption of sustainable renovations different in LCHBs than in non-LCHB?

This answer of this question is interspersed between the answers of all of the other questions.

6.1.6 Main question

How to increase the adoption of sustainable renovations in listed cultural heritage buildings (by providing insight into the decision-making process of private owner-occupiers)? Recommendations:

This question is answered with the recommendations of the conclusion chapter (6.1).

6.2 Limitations (further research)

Personas

To confirm the prior conditions, characteristics and drivers and barriers of the distinctive personas, and thus find that they are real, they should be statistically researched with the raw data of Hamstra (2023). Furthermore, the group the personas is based on is 9 participants, 12 in total if you count partners who answered questions, and a sample size of 30, which includes the partners who answered questions, is suggested for single group observations by Robson (2011, as cited in Haines & Mitchell, 2014). So, the other way to make the proposed personas of this thesis more robust, without statistical data, would be to interview 18 more owner-occupiers. And according to Goodwin (2010, as cited in Haines & Mitchell, 2014), the number of final personas should be limited to between three and seven. This thesis had two, which may be too little.

In actuality I should do 20 more interviews with owner-occupiers to reach the recommended 30 participants. However I could just look at the statistical data of the reports of Hamstra (2023) and see the same patterns. I should ask for the raw data, to link the variables of the personas and look if they are indeed strongly correlated, e.g. are the young owners the ones with money as a barrier? What is the main barrier of young people, old people, DIY, etc.?

Evidence for the personas

The two personas found in this small sample of owners can be proven by doing more interviews, 30 participants is the recommended sample size to create personas. 12 participants of 9 households participated, thus 18 participants more could prove the personas. However, the raw data of the quantitative research of Hamstra (2023) could also prove the Personas. This can be done by showing that the younger LCHB owners make up a large percentage of the owners that experience money as the main barrier and are using less contractors. If these variables are strongly correlated a case can be made for the personas.

Adopter categories

Whether the interviewees fall inside the five adopter categories (innovators/early-adopters, early majority, laggards) was not determined in this research. Since there is not an easy way to determine the adopter categories for each interviewee without the correct data on how many people did a sustainable renovation and how many more could do a sustainable renovation in the future. It is also outside the scope of this research, since the main research question is about; how to provide more insight into the decision-making process to sustainably renovate. And not about creating more insight into the adopter categories of LCHB owners regarding sustainable renovations and where we are in the cycle. Still, research about adopter categories related to sustainable renovations could yield insight into how to make strategies for different adopter categories

How to deal with bias to reach valid results

The reasons why these owners of LCHBs participated in the interviews are complex, overlapping and not the main object of this study. However it is important to give context, here are a few reasons why the

interviewees participated: some owners had a feud to settle with a particular barrier in the process, the cultural heritage committee often came up. Some owners had the urge to share about their LCHB. Some owners wanted to help with the energy transition in the built environment because they were concerned about climate change. And some owners had a favorable attitude towards the idea they had about the research topic and/or the researcher and/or the institutions linked to his study, i.e. Delft University of Technology and the Cultural Heritage Agency of the Netherlands.

Cultural heritage committee

The cases regarding the cultural heritage committee and municipality may not be representable, since people with the biggest axe to grind will want to share their experience. This is illustrated with how the main barriers are experienced much more frequent among the LCHB owners in the empirical results, **table 54**, in comparison with the LCHB owners of the theoretical background, **table 25**.

DIY

More research should be done towards the results of homeowners that realize renovations themselves. To better comprehend whether the recommendation about DIY subsidies could turn out to have a meaningfully impact on sustainable renovation in LCHBs with taking the conservation of the listed cultural heritage status as a starting point.

Basic measures

The focus of this thesis was on sustainable renovations and not on basic measures. But interviewee 6 explained that after an information meeting he installed a draft door in a hallway, and this greatly improved the buildings conservation of heat. Furthermore, interviewee 8 had a Honeywell home system installed, which is also a basic measure, and this was programmed to only heat the home at the times the home was used, i.e. smart use, which was a great improvement. Other LCHB owners will have had these and other basic measures installed as well, and this was not the topic of this thesis, but should not be neglected and may need further research.

Future proof

Future proof did not get its own subchapter in relative advantage since it only came up in Hamstra and Kommer (2022) and future proof seemed to the researcher as an obvious thing that everyone wants. Yet, it may need further research because it can be used as a strong way of information messaging that works better than the term sustainability, since the word sustainability is not necessarily a good way to persuade homeowners to realize a sustainable renovation. Whereas quality of life improvements, expected cost savings and integration of sustainable renovations with basic home maintenance may be convincing to owners to realize a sustainable renovation (Ebrahimigharehbaghi, 2022, p. 245).

7. Reflection

Product, process, planning and method

The researcher is mostly content about the end products and the research method. However, the researcher could have asked questions that better covered all of the variables of the theoretical background. This happened to a limited extent, because the development of the theoretical background and conducting the interviews did partly occur simultaneously. And during the second round of professional interviews, a lot was learned, but the right questions about the variables and the concerns of owners were only partly addressed, because the interviews were not yet fully processed. So the important variables, e.g. barriers, that owners highlighted did not get the full attention, since the researcher had not yet systematically confirmed which variables were important. Still, some important variables did get addressed by the second round of professionals.

Goal

The ‘why’ behind this thesis research is that government services must appropriately support listed cultural heritage building (LCHB) owners properly in their sustainable renovation decision-making process. Making the process and the factors and variables that influence it insightful is the goal of this research.

This research achieved the goal of making the decision-making process insightful. Not in a quantitative way, but it showed the factors and variables that influence the decision-making process in a structured way. Following this thesis, a quantitative research can be conducted to really get to the core of the problems by means of a survey among a much higher number of LCHB owners.

Feedback

Tailor made feedback from the mentor team resulted in the master student always having enough to do. The whole master thesis is a result of guidance from both the mentor team of the TU Delft, and the more practical guidance of the Cultural Heritage Agency of the Netherlands. When the master student started his research internship with the Cultural Heritage Agency of the Netherlands the ball started rolling, and the practical problems could be channeled to the TU Delft mentor team, who came up together with the input of the master student with a theoretical approach to tackle these problems with the research.

The final part of the graduation period between the P4 and P5 will consist of finishing up the remainder of the results, since there are too many factors and variables to count, and a nice layout for the report is necessary.

Depth of the research

The master student covered many topics, because he set out to do justice to all the LCHB owners that responded to his call on the ‘Monumenten Community’ forum, thus all owners that applied were interviewed, and all interviewees could really open up about their problems. This did leave the researcher content since no stones were left unturned, and the researcher also enjoyed the research, but this approach did involve a massive workload. Some interviews went on for over 2 hours. Plus the amount of interviews is very high, with 12 professionals and 9 owner occupiers that were interviewed. Nevertheless, the researcher does not regret the amount of time invested in the interviews, since it is his

personal interest and much has been learned. On the contrary, the workshop did not take up much time, but did contribute with relatively good results. The workshop was very time efficient, so it does not necessarily have to be time consuming to cover a lot of topics.

The researcher also changed the research from an analysis of a program about relieving LCHB owners from much hassle related to sustainable renovations. To the fundamental analysis of LCHB owners and their decision-making process. Now with this fundamental level of understanding, the 'ontzorgingsprogramma' of the Cultural Heritage Agency of the Netherlands can be put into context, and the researcher can conclude whether the relief program is using all the factors and variables that are important to support LCHB owners. This change of research also had to do with the owner relief program still being in its beginning phase, meaning there were barely any LCHB owners that could be interviewed regarding the program.

Some LCHB owners should have been asked to share their attitude about all the topics that came up, some owners already did that on their own.



Reference list

- Agency for Culture and Palaces. (2023, March 10). *Listed buildings in Denmark*. Ministry of Culture. Retrieved December 21, 2023, from <https://slks.dk/english/work-areas/cultural-heritage/listed-buildings>
- Arning, K., Dütschke, E., Globisch, J., & Zaunbrecher, B. S. (2020). The challenge of improving energy efficiency in the building sector: taking an in-depth look at decision-making on investments in energy-efficient refurbishments. *Energy and Behaviour*, 2020, 129–151. <https://doi.org/10.1016/b978-0-12-818567-4.00002-8>
- Briene, M., Hek, M., Fikken, T., & Bos, D. (2020). Belemmeringen bij het verduurzamen van monumenten. In *Routekaart Duurzaam Erfgoed*. Ecorys. Retrieved April 5, 2024, from <https://www.duurzaammerfgoed.nl/initiatieven/belemmeringen-verduurzamen-monumenten>
- Broers, W., Vasseur, V., Kemp, R., Abujidi, N., & Vroon, Z. (2019). Decided or divided? An empirical analysis of the decision-making process of Dutch homeowners for energy renovation measures. *Energy Research & Social Science*, 58. <https://doi.org/10.1016/j.erss.2019.101284>
- Buchner, F., Koreman, I., Van Meeteren, H., Wolthuis, D., & De Witte, H. (2023). Afwegingskader verduurzamen monumenten. In *Brochure | Rijksdienst Voor Het Cultureel Erfgoed*. Ministerie van Onderwijs, Cultuur en Wetenschap. Retrieved October 16, 2023, from <https://www.cultureelerfgoed.nl/onderwerpen/duurzaamheid/documenten/publicaties/2023/01/01/afwegingskader-verduurzamen-monumenten>
- Bureau Woordvoering Kabinetsformatie. (2024, May 16). *Hoofdlijnenakkoord tussen de fracties van PVV, VVD, NSC en BBB*. Publicatie | Kabinetsformatie. Retrieved June 19, 2024, from <https://www.kabinetsformatie2023.nl/documenten/publicaties/2024/05/16/hoofdlijnenakkoord-tussen-de-fracties-van-pvv-vvd-nsc-en-bbb>
- Central Bureau for Statistics. (2013, January 21). *Statistics Netherlands: Two-thirds of all homes are single-family homes* [Data file]. Retrieved from <https://www.cbs.nl/nl-nl/achtergrond/2013/04/twee-derde-van-alle-woningen-eengezinswoning>
- Central Bureau for Statistics. (2022, July 28). *Statistics Netherlands: National monuments; region (classification 2020) 1965 – 2020* [Data file]. <https://www.cbs.nl/nl-nl/cijfers/detail/84998NED>
- CLO. (2023, March 28). *Energielabels van woningen, 2010 t/m 2022*. Compendium Voor De Leefomgeving. Retrieved November 26, 2023, from <https://www.clo.nl/indicatoren/nl0556-energielabels-woningen>
- De Bouw, M., Vanhellemont, Y., & Dubois, S. (2017). Innovatieve materialen, technieken en modellen voor de verduurzaming van erfgoedgebouwen. *Wetenschappelijke-Technische Groep Voor Aanbeveling Inzake Bouwrenovatie En Monumentenzorg*, 2. https://www.wta-international.org/fileadmin/user_upload/Nederland-Vlaanderen/syllabi/2017-11-17_Energetische_ingrepen_in_monumenten.pdf
- De Groene Grachten. (n.d.). *De Groene Menukaart*. De Groene Menukaart. Retrieved March 25, 2024, from <https://www.degroenemenukaart.nl/nl>
- De Koning, N., Kooger, R., Hermans, L., & Tigchelaar, C. (2020). Natural gas-free homes: drivers and barriers for residents. In *energy.nl* (TNO 2020 P11521). TNO. Retrieved February 29, 2024, from <https://energy.nl/media/downloads/Natural-gas-free-homes-drivers-and-barriers-for-residents.pdf>

- Dubbeld, J. (2022, 19 December). Steeds meer monumenten hebben duurzaamste energielabel. Stadszaken. Retrieved 15 December, 2023, from <https://stadszaken.nl/artikel/4817/steeds-meer-monumenten-hebben-duurzaamste-energielabel>
- Duurzaam Erfgoed. (2022, 13 September). Routekaart Verduurzaming Monumenten 2022. Duurzaam Erfgoed. Retrieved 5 June, 2023, from <https://www.duurzaamerfgoed.nl/actueel/routekaart-verduurzaming-monumenten-hoe-ze-zijn-we-2022>
- Ebrahimigharehbaghi, S. (2022). Understanding the decision-making process in homeowner energy retrofits: From behavioral and transaction cost perspectives. *A+BE | Architecture and the Built Environment*, 12(06), 1-302. <https://doi.org/10.59490/abe.2022.06.6573>
- Elbers, A., & Geurts, E. H. M. (2006). Onderzoek naar huurprijs van een rijksmonument. In *officielebekendmakingen.nl* (T0977.01.01). Ministerie VROM. Retrieved September 7, 2023, from <https://zoek.officielebekendmakingen.nl/blg-55591.pdf>
- European Commission. (2020). EUR-LEX - 52020DC0662 - EN - EUR-LEX. In *EUR-Lex* (No. 52020DC0662). Retrieved May 31, 2024, from <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020DC0662>
- European Commission. (2023). Directive - 2023/1791 - EN - EUR-LEX. In *EUR-Lex* (No. 2023/1791). Retrieved May 31, 2024, from <https://eur-lex.europa.eu/eli/dir/2023/1791/oj>
- European Commission. (2024a). Energy Performance of Buildings Directive. *Energy*. Retrieved May 31, 2024, from https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/energy-performance-buildings-directive_en
- European Commission. (2024b). Directive - EU - 2024/1275 - EN - EUR-LEX. In *EUR-Lex* (No. 2024/1275). Retrieved May 31, 2024, from https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L_202401275
- Federal Statistical Office. (2018, June 13). *Roughly 1 million monuments in Germany*. Retrieved December 21, 2023, from https://www.destatis.de/EN/Press/2018/06/PE18_208_216.html
- Federal Statistical Office. (2019). *Switzerland's built heritage: initial findings* (No. 1859–1600). Retrieved December 21, 2023, from <https://www.bfs.admin.ch/bfsstatic/dam/assets/6949764/master>
- Haines, V., & Mitchell, V. (2014). A persona-based approach to domestic energy retrofit. *Building Research and Information*, 42(4), 462–476. <https://doi.org/10.1080/09613218.2014.893161>
- Haitink, M. (n.d.). *Hoe verduurzaam ik een monument?* [Slide show]. rheden.nl. Retrieved 5 June, 2023, from https://www.rheden.nl/Bibliotheek/Documenten/Inwoners/Wonen_leefomgeving/Erfgoed/Presentatie_Duurzaamheid_en_Monumenten.pdf
- Hamstra, G. (2018). kwalitatief onderzoek monumenteigenaren 65+. In *Restauratiefonds.nl* (No. 3370–34). Right Marktonderzoek. Retrieved October 27, 2023, from https://www.restauratiefonds.nl/files/docs/2021-04/Kwalitatief%20onderzoek%20monumenteigenaren%20ouder%20dan%2065%20_%202018.pdf
- Hamstra, G. (2023). Resultaten onderzoek Monumenteigenaren (Q4 2022). In *Restauratiefonds.nl*. Nationaal Restauratiefonds. Retrieved October 16, 2023, from <https://www.restauratiefonds.nl/over-ons/publicaties/resultaten-onderzoek-monumenteigenaren>
- Hamstra, G., & Kommer, J. (2022). Monitor verduurzaming monumenten 2022. In *Monumenten.nl* (No. 3370–49). Routekaart Verduurzaming Monumenten. Retrieved April 7, 2023, from <https://www.monumenten.nl/files/2023-03/R3370-49%20Rapportage%20monitor%20verduurzaming%20monumenten%202022.pdf>
- Historic England. (n.d.). *What are Listed Buildings? How England's historic buildings are protected*. Retrieved December 21, 2023, from <https://historicengland.org.uk/listing/what-is-designation/listed-buildings>

- Hobma, F. A. M., & Jong, P. (2022). *An Instrumental Approach to Planning and Development Law in the Netherlands*.
- Kurmayer, N. J. (2023, May 4). EU buildings directive in Italy: Wrestling with cultural value. *www.euractiv.com*. Retrieved December 21, 2023, from <https://www.euractiv.com/section/buildings/news/eu-buildings-directive-in-italy-wrestling-with-cultural-value/>
- Magdelijns, H., Verheul, H., Ten Cate, G., Van den Bergh, S., Havik, W., Koster, G., Krauwer, M., Vos, A., Stöver, J., & De Vries, A. (2009). *Handreiking Gemeentelijke Monumentencommissies*. Vereniging van Nederlandse Gemeenten. Retrieved December 7, 2023, from <https://vng.nl/files/vng/2009-vng-handr-monumentencies.pdf>
- Ministerie van Algemene Zaken. (2017). Central government encourages sustainable energy. Retrieved June 1, 2023, from <https://www.government.nl/topics/renewable-energy/central-government-encourages-sustainable-energy>
- Ministerie van Algemene Zaken. (2022, April 4). *Energielabel woning*. Energielabel Woningen En Gebouwen | Rijksoverheid.nl. <https://www.rijksoverheid.nl/onderwerpen/energielabel-woningen-en-gebouwen/energielabel-woning>
- Ministerie van Algemene Zaken. (2023, February 27). *Welke lening of subsidie kan ik aanvragen voor onderhoud van mijn monument?* Rijksoverheid.nl. <https://www.rijksoverheid.nl/onderwerpen/erfgoed/vraag-en-antwoord/welke-lening-of-subsidie-kan-ik-aanvragen-voor-onderhoud-van-mijn-monument>
- Ministerie van Economische Zaken en Klimaat. (2019, August 21). *Klimaatakkoord*. Publicatie | Klimaatakkoord. <https://www.klimaatakkoord.nl/klimaatakkoord/documenten/publicaties/2019/06/28/klimaatakkoord>
- Ministerie van Economische Zaken en Klimaat. (2020, January 22). *Wat is het klimaatakkoord?* Klimaatverandering | Rijksoverheid.nl. <https://www.rijksoverheid.nl/onderwerpen/klimaatverandering/klimaatakkoord/wat-is-het-klimaatakkoord>
- Ministerie van Onderwijs, Cultuur en Wetenschap. (2022, December 5). *Veelgestelde vragen energiecrisis en erfgoed*. Duurzaamheid Van Historische Gebouwen | Rijksdienst Voor Het Cultureel Erfgoed. Retrieved February 26, 2024, from <https://www.cultureelerfgoed.nl/onderwerpen/duurzaamheid/energiecrisis-en-erfgoed/veelgestelde-vragen-energiecrisis>
- Ministerie van Onderwijs, Cultuur en Wetenschap. (2024, January 8). *Over ons*. Rijksdienst Voor Het Cultureel Erfgoed. Retrieved July 2, 2024, from <https://www.cultureelerfgoed.nl/over-ons>
- Ministère de la Culture. (2022). *Protection under Historic Monuments*. culture.gouv.fr. Retrieved December 21, 2023, from <https://www.culture.gouv.fr/en/Aids-Procedures/Protections-labels-and-names/Protection-under-Historic-Monuments>
- Mlecnik, E. (2021, January 27). *Triple-A methodology*. triple-a-interreg.eu. Retrieved February 29, 2024, from <https://www.triple-a-interreg.eu/triple-a-methodology>
- Monumenten.nl. (2024, May 16). *Ontzorgingsprogramma verduurzaming monumenten*. Retrieved June 25, 2024, from <https://www.monumenten.nl/ontzorgingsprogramma>
- Monumentenwacht. (n.d.). MonumentenwachtNL. Retrieved 23 June, 2023, from <https://www.duurzaamerfgoed.nl/deelnemer/monumentenwacht-nl>
- Moore, G. A. (2014). *Crossing the chasm: marketing and selling disruptive products to mainstream customers* (3rd ed.). Harper Business.

- Nair, G., Gustavsson, L., & Mahapatra, K. (2010). Factors influencing energy efficiency investments in existing Swedish residential buildings. *Energy Policy*, 38(6), 2956–2963. <https://doi.org/10.1016/j.enpol.2010.01.033>
- Nationaal Restauratiefonds. (n.d.). *Monumenten.nl*. monumenten.nl. Retrieved February 25, 2024, from <https://www.monumenten.nl/monumenten>
- Nibe. (2021a). *DuMo-Projecten | DuMo prestatie*. DuMo-Prestatiekaart. Retrieved July 1, 2024, from <https://www.dumoprestatie.nl/dumo-projecten/>
- Nibe. (2021b, August 30). *Duurzame monumentenzorg*. Retrieved July 1, 2024, from <https://www.nibe-sustainability-experts.com/nl/dumo-duurzame-monumentenzorg>
- Nielsen, A. N., Jensen, R. L., Larsen, T. S., & Nissen, S. B. (2016). Early stage decision support for sustainable building renovation – A review. *Building and Environment*, 103, 165–181. <https://doi.org/10.1016/j.buildenv.2016.04.009>
- Pettifor, H., Wilson, C., & Chrysoschoidis, G. (2015). The appeal of the green deal: Empirical evidence for the influence of energy efficiency policy on renovating homeowners. *Energy Policy*, 79, 161–176. <https://doi.org/10.1016/j.enpol.2015.01.015>
- Redres. (n.d.). *Erfgoed | Erfgoed in cijfers*. Retrieved October 16, 2023, from <https://www.redres.nl/nl/expertises/erfgoed-in-cijfers>
- Rijksdienst voor het Cultureel Erfgoed. (2019). Verslag Workshop RCE “Verduurzaming Monumenten Klantreis.” In *duurzaamerfgoed.nl* [Workshop report]. Verduurzaming Monumenten Klantreis, Amersfoort, Utrecht, Netherlands. <https://www.duurzaamerfgoed.nl/initiatieven/belemmeringen-verduurzamen-monumenten>
- Rijksdienst voor het Cultureel Erfgoed. (2022). Advies wegnemen obstakels voor het isoleren van monumenten naar aanleiding van Motie-Van Haga c.s. In *Rijksoverheid.nl*. Retrieved November 7, 2023, from <https://www.rijksoverheid.nl/documenten/rapporten/2022/06/23/advies-wegnemen-obstakels-voor-het-isoleren-van-monumenten>
- Rijksdienst voor het Cultureel Erfgoed. (2024, March 15). *Reizende expositie over verduurzaming van monumenten*. Cultureelerfgoed.nl. Retrieved April 16, 2024, from <https://www.cultureelerfgoed.nl/onderwerpen/duurzaamheid/handreiking-voor-eigenaren/reizende-expositie-verduurzaming-monumenten>
- Rogers, E. M. (2003). *Diffusion of Innovations* (5th ed.). Simon & Schuster.
- Saunders, B., Kitinger, J., & Kitinger, C. (2014). Anonymising interview data: challenges and compromise in practice. *Qualitative Research*, 15(5), 616–632. <https://doi.org/10.1177/1468794114550439>
- Saunders, B., Sim, J., Kingstone, T., Baker, S., Waterfield, J., Bartlam, B., Burroughs, H., & Jinks, C. (2017). Saturation in qualitative research: exploring its conceptualization and operationalization. *Quality and Quantity*, 52(4), 1893–1907. <https://doi.org/10.1007/s11135-017-0574-8>
- Sim, J., Saunders, B., Waterfield, J., & Kingstone, T. (2018). Can sample size in qualitative research be determined a priori? *International Journal of Social Research Methodology*, 21(5), 619–634. <https://doi.org/10.1080/13645579.2018.1454643>
- Stieß, I., & Dunkelberg, E. (2013). Objectives, barriers and occasions for energy efficient refurbishment by private homeowners. *Journal of Cleaner Production*, 48, 250–259. <https://doi.org/10.1016/j.jclepro.2012.09.041>
- Thuvander, L., Femenias, P., Mjörnell, K. N., & Meiling, P. (2012). Unveiling the Process of Sustainable Renovation. *Sustainability*, 4(6), 1188–1213. <https://doi.org/10.3390/su4061188>

- Van Hal, A. (2014). The Merger of Interests 2.0. *Nyenrode Business Universiteit*. <https://trcaca.s3.ca-central-1.amazonaws.com/app/uploads/2020/03/30121343/the-merger-of-interests-2-0.pdf>
- Van Vliet, B., & De Feijter, F. J. (2017). Smart Retrofitting of Urban Housing. *AMS Institute*. <https://library.wur.nl/WebQuery/wurpubs/fulltext/415176>
- Weet Je Dat Ook Weer. (2024, June 7). *Op zoek naar het Lelijkste Gebouw van Nederland 2024!* [Video]. YouTube. <https://www.youtube.com/watch?v=2zsCkMIei4c>
- Wettenbank. (2024, February 14). *wetten.nl - Regeling - Besluit vaststelling beleidsregels instandhoudingssubsidie woonhuis-rijksmonumenten - BWBR0041915*. Overheid.nl. Retrieved February 21, 2024, from <https://wetten.overheid.nl/BWBR0041915/2024-02-14>
- Wilson, C., Crane, L., & Chryssochoidis, G. (2015). Why do homeowners renovate energy efficiently? Contrasting perspectives and implications for policy. *Energy Research & Social Science*, 7, 12–22. <https://doi.org/10.1016/j.erss.2015.03.002>
- Wilson, C., Pettifor, H., & Chryssochoidis, G. (2018). Quantitative modelling of why and how homeowners decide to renovate energy efficiently. *Applied Energy*, 212, 1333–1344. <https://doi.org/10.1016/j.apenergy.2017.11.099>

Appendix

Appendices:

- **Appendix I: Haarlem workshop**
- **Appendix II: Briene et al. (2020) drivers and barriers**
- **Appendix III: Briene et al. (2020) Recommendations**
- **Appendix IV: Data management plan**
- **Appendix V: Consent form**

Appendix I: Haarlem workshop

On the 9th of February 2024 a workshop for professionals took place in Haarlem focused on the barriers owners of LCHBs face which are slowing down the sustainable renovation decision-making process. The top 10 barriers were identified and categorized according to prevalence by professionals and put into a small document about the work session, this document entails a list of participants and the 10 barriers:

1. Money. Bigger ambitions are more expensive, maintenance and sustainable renovations of LCHBs.
2. How to start? Who can help with drawings or realizing the work? The process is difficult from the start.
3. Integrality. Sustainable renovations are viewed too one-sided. Looking at opportunities together, integral/total approach to renovation, restoration and sustainable renovations, etc.
4. Material use. A lack of knowledge, data and monitoring. It is difficult to choose which materials to use and how to use them, for example, for insulation.
5. Cultural heritage values indicate the limits of the technical possibilities, i.e. sustainable renovation options.
6. The habitation of the LCHB makes it difficult to implement a sustainable renovation.
7. The difficulty of choosing between a uniform sustainable renovation in the entire LCHB versus determining a different level of sustainability for each space.
8. A similar approach to sustainably renovating LCHBs of the same typology is difficult because each LCHB is in a different condition.
9. Unclear frameworks. It is difficult to make long-term plans with large clusters of LCHBs.
10. The threshold to start is too high. The (technical) knowledge of many owners is inadequate.

The researcher also made a transcript of what was said by professionals during the workshop. This transcript can be shown on demand.

Appendix II: Briene et al. (2020) drivers and barriers

The Dutch Ministry of Education, Culture and Science together with the Cultural Heritage Agency of the Netherlands procured a study by consulting firm Ecorys about the barriers that inhibit sustainable renovations for owners of LCHBs. The barriers, categorized per stage of the decision-making model, are (Briene et al., 2020, pp. 33-34):

Inspiration stage:

- The multitude of information sources about sustainable renovation measures makes the search for information confusing.
- It is difficult to estimate the reliability of information; there is little independent information.
- The idea that the approach of LCHBs is often tailor-made hinders the inspiration to become more sustainable.

Orientation and decision stage:

- Legislation is focused on preserving the cultural heritage value. Sustainably renovating LCHBs is therefore more complex than regular buildings, partly because of the permit required to change a LCHB.
- Technological developments are moving so quickly that many owners are inclined to wait a while until other or better solutions are developed.
- Sustainable renovation measures are more expensive for LCHBs than for non-LCHBs, making financial feasibility more difficult to achieve.
- For LCHBs that are in a good condition, it is inefficient to sustainably renovate them now. Here it involves waiting for the 'right' moment.
- Some municipalities lack the knowledge and capacity to support owners in the orientation process.
- The Cultural Heritage Agency of the Netherlands is not yet fully focused on the demand for sustainable renovations. This creates uncertainty among municipalities and owners.

Permit application process stage:

- The effect of the law may differ for each municipality, making it more difficult to look for sustainable renovation solutions that can be applied on a larger scale or everywhere.
- Municipalities can only grant a permit for the sustainable renovation measures that have been applied for.

Realization, implementation and aftercare stage:

- Sustainable renovation measures undesirably or unexpectedly affect the cultural heritage value.
- The right contractors are not available.
- The feedback of information to implementers and government agencies is limited.

Appendix III: Briene et al. (2020) Recommendations

How to solve or lessen barriers for sustainable renovations regarding laws and regulations in three categories (Briene et al., 2020, pp. 35-38).

Knowledge and communication:

- Increase the communication capacity of municipalities.
- Make technical knowledge and experiences available through a central and independent platform.
- Sharing information proactively with the public or information meetings.
- Organize a national public campaign about sustainable renovations.
- Steer more actively on the use of preliminary consultation (vooroverleg).
- Make the preliminary consultation more accessible.
- Facilitate consultations with experts.

Permit application:

- Increase building technical and cultural-historical knowledge regarding sustainable renovations among permit authorities.
- Investigate the possibilities to standardize sustainable renovation measures.
- Provide good information so that the permit application contains the correct proposed sustainable renovation measures.

Realization, implementation and aftercare:

- Make it more attractive for owners to finance a sustainable renovation.
- Stimulating product development at companies or technical universities.
- Include implementing parties/contractors in a quality register.
- Increasing knowledge about the effectiveness of sustainable renovation measures.

Plan Overview

A Data Management Plan created using DMPonline

Title: Appendix IV: Data management plan - How to increase the adoption of sustainable renovations in listed cultural heritage buildings by influencing the decision-making process of private owner-occupiers?

Creator: Fabian Castenmiller

Affiliation: Delft University of Technology

Template: TU Delft Data Management Plan template (2021)

Project abstract:

There are about 120.000 municipally and nationally listed cultural heritage buildings in the Netherlands. In 2006, 80% of nationally listed cultural heritage buildings were homes, a large part of these are privately owned and inhabited by the owner (Elbers & Geurts, 2006). Meaning, more than 50% of listed cultural heritage buildings are owner-occupied. An impact for the energy transition can be made by analysing and influencing the behavior of owners to sustainably renovate their building. It helps that individuals make decisions to adopt an innovation more rapidly than organizations (Rogers, 2003). Rogers (2003) decision-making model is used and adapted for the owners listed cultural heritage buildings to sustainably renovate.

The methodology for data collection is to first gather some initial data about the participants for the interviews by letting them fill in a survey. Secondly, the in-depth interviews with the owners of listed cultural heritage buildings. Lastly, additional in-depth interviews with other stakeholders in the process of sustainably renovating the listed cultural heritage buildings of the owners. The in-depth qualitative interviews are audio recorded and later transcribed to repeat the data for better memorisation and to more accurately quote the data.

ID: 136598

Start date: 01-11-2023

End date: 16-01-2024

Last modified: 27-06-2024

Appendix IV: Data management plan - How to increase the adoption of sustainable renovations in listed cultural heritage buildings by influencing the decision-making process of private owner-occupiers?

0. Administrative questions

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

Deepshikha Purwar and Janine Strandberg

2. Date of consultation with support staff.

2023-10-26

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
<p>Quantitative.</p> <p>Owners: Name, email, age, adress, years of ownership, type of building, condition of the building.</p> <p>The survey is distributed to contact interviewees and for research data.</p> <p>Added for HREC: Age, address, email address, residence type, information about their residence, an estimation of their income, an estimation of their wealth, a renovation-personality, i.e. personality when it comes to how the participant renovates their home.</p> <p>This data is obtained by a form distributed by the cultural heritage agency of the Netherlands, a governmental organization. This data is transferred to the responsible researcher, i.e. the master student. The email will be deleted, and the data will be deleted from the servers of the cultural heritage agency of the Netherlands.</p>	Excel file .xlsx	<p>An online survey, made by the Cultural Heritage Agency of the Netherlands, distributed by the student.</p> <p>Added for HREC: The survey has a final question: I read and understand the terms and conditions? This needs to be answered with yes, otherwise the form will not be finalized. This is common practice in the Cultural heritage agency of the Netherlands. The terms and conditions are the terms and conditions of the Cultural Heritage Agency of the Netherlands. Lastly, everything has been approved by my Data steward.</p>	To process, select and contact the participants for the study. Contact details of participants are processed to obtain informed consent.	Servers of the CHAN and TU Delft storage drive	The master student and the Cultural Heritage Agency of the Netherlands (CHAN). The supervisors could ask the student and be granted access to the data.
<p>Qualitative.</p> <p>Decision-making process of owners with information about other stakeholders, barriers, and drivers. Owners occupation, household type and personality regards renovations</p>	Audio file .mp3	Interviews are conducted online and in person. Audio recordings are made with a mobile phone.	To remember and check whether the data is accurate. And to answer the research question: How to increase the adoption of sustainable renovations in listed cultural heritage buildings by influencing the decision-making process of private owner-occupiers?	TU Delft storage drive	The master student and supervisors could ask the student and be granted access to the data.
<p>Qualitative.</p> <p>Decision-making process of owners with information about other stakeholders, barriers, and drivers. Owners occupation, household type and personality regards renovations</p>	Text file .docx	Transcribing the interview audio files manually. Files are pseudonymised with a chronological number.	The data is repeated to better understand and remember it, and the meanings and quotes are clear and easily accessed. To show the results	TU Delft storage drive	The master student and the supervisors could ask the student and be granted access to the data.

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

- < 250 GB

Not more than 1 GB

II. Documentation and data quality

5. What documentation will accompany data?

- README file or other documentation explaining how data is organised

Readme file: there are 20 audio files of each interview accompanied with 20 transcripts of these interviews. The name of each audio file and text file is changed to a pseudonymised number, the name that corresponds to each number is written down on a physical paper, i.e. a readme file. The readme also contains the other personal data that is pseudonymised, like age, income, years of ownership, type of building, consent forms etc.

The readme file with the key to the pseudonymised audio-recordings and transcripts is stored in the project TU Delft storage drive.

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
- Project Storage at TU Delft

The phone of the master student will have an audio file, this audio file will be removed from the phone and stored on a university recommended storage drive. The laptop is only used as storage so that the student can work on the thesis. A regular data back up is done to the TU Delft storage drive.

The Cultural Heritage Agency of the Netherlands will hold the contact information and some personal data like age, name, years of ownership and type of building in their storage.

The consent forms will be stored on the online TU Delft storage drive. Physical consent forms will be scanned and made into soft copies that are stored on the TU Delft storage drive as well.

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

It's about people their homes.

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, data which could lead to reputation/brand damage (e.g. animal research, climate change, personal data)
- Yes, politically-sensitive data (e.g. research commissioned by public authorities, research in social issues)

It's about how owners of certain buildings can sustainably renovate their building. This is a social issue, related to the energy transition.

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 master student owns the gathered data of the interviews. The Cultural Heritage Agency of the Netherlands has access to the participants that signed up for the interviews, including: name, address, email, age, type of home, years of ownership, and the condition of the home. The mentors at the TU Delft will not have access to the data of the interviews or the data of the survey. The master student owns the research data. The supervisor may ask access to data, if so, the master student may or may not grant access to the data.

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

- Names and addresses
- Email addresses and/or other addresses for digital communication
- Gender, date of birth and/or age
- Other types of personal data - please explain below
- Signed consent forms
- Data collected in Informed Consent form (names and email addresses)

Information about the houses of owners, who are the participants, and their personality regarding their willingness to sustainably renovate their house. All this data is necessary to contact the participants, choose the right participants and to find correlations between research data.

Years of ownership of the building. Condition of the building. Income approximately. Funds available for renovations.

11. Please list the categories of data subjects

Owner-occupiers of listed cultural heritage buildings in the Netherlands.

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:

All study participants will be asked for their written consent for taking part in the study and for data processing before the start of the interview. I will have the participants sign the informed consent form in person on a printed A4 or online with a pdf. The physical signed documents are scanned and made into soft copies and stored together with the online pdfs on the TU Delft storage drive.

17. Where will you store the signed consent forms?

- Other - please explain below

I will convert paper based signed consents into soft copies to store them digitally. These consent forms are stored on the TU Delft storage drive. The physical copied of the informed consent form will be stored securely in a locked cupboard in a locked office.

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 [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 only one of the options listed below applies, your project might need a DPIA. Please get in touch with the privacy team: privacy-tud@tudelft.nl to get advice as to whether DPIA is necessary.

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

- None of the above applies

There is personal data gathered, however non of the personal data is sensitive personal data.

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?

- Not all non-personal data can be publicly shared - please explain below which data and why cannot be publicly shared

Only the meta data relevant for the results will be shared, this data will be anonymised. The meta data is the information that overlaps in multiple interviews.

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

- My data will be shared in a different way - please explain below

My data, especially the personal data and the transcripts, will not be shared in a repository. I will only share the anonymised results. Parts of the data will be anonymised and included in the report, only the relevant parts.

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?

- Other - please explain

The data that includes the interviews will not be shared, they will be destroyed. Results that are concluded from multiple interviews are used and put in the report, however the participants are anonymised.

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

- Other - Please explain

The data won't be released.

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

The Cultural Heritage agency of the Netherlands is also involved when it comes to finding the participants for the study. The Cultural Heritage Agency of the Netherlands will have responsibility and ownership of the personal data from the survey that is on their servers. The master student owns the interview data.

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

There is no data in the TU Delft. It is all still with the then graduated master student, who will always be available on his personal email.

The Cultural Heritage Agency of the Netherlands will not have access to the research data of the interviews. Only the results of the interviews and the survey data to contact the interview participants.

The supervisors can see the data if they ask the masters student.

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)?

A readme manual is made in case of memory loss or the passing of the owner of the data, i.e. the master student. In case the master student is deceased, the family members living at the same adress as the master student will be able to recover the data since they will know the passwords. The data management is strictly adhered to and the devices the data is stored on are securely looked after. There are no regulations set by the Cultural Heritage Agency of the Netherlands that not allow data access to my supervisors or the TU Delft.

The supervisors can see the data if they ask the master student.

Appendix V: Consent form

[14/11/2023] U wordt uitgenodigd om deel te nemen aan een onderzoek genaamd: "Hoe kan de adoptie van duurzame renovaties in monumentale cultureel erfgoedgebouwen worden vergroot door het besluitvormingsproces van particuliere eigenaar-bewoners inzichtelijk te maken?" Dit onderzoek wordt uitgevoerd door Fabian Castenmiller van de TU Delft en de Rijksdienst voor het Cultureel Erfgoed.

Het doel van dit onderzoek is om het verduurzamingsproces van monumenteigenaren inzichtelijk te maken door te kijken naar barrières, invloedrijke informatie, de motivatie van de eigenaar en de renovatie-persoonlijkheid van de monumenteigenaar. Het interview zal ongeveer 60 minuten in beslag nemen. De data zal gebruikt worden voor de master scriptie van Fabian Castenmiller. U wordt gevraagd om uw verduurzamingsproces te beschrijven hierbij komen ook persoonlijke vragen kijken, maar geen gevoelige persoonlijke vragen.

Zoals bij elke online activiteit is het risico van een databreuk aanwezig. Wij doen ons best om uw antwoorden vertrouwelijk te houden. We minimaliseren de risico's door u zo goed mogelijk te informeren, de data te anonimiseren/pseudonimiseren, data op te slaan op een door de TU Delft goedgekeurde data opslag drive en alle handelingen met data structureel uit te voeren volgens het data management plan goedgekeurd door de TU Delft.

Uw deelname aan dit onderzoek is volledig vrijwillig, en **u kunt zich elk moment terugtrekken zonder reden op te geven**. U bent vrij om vragen niet te beantwoorden.

Fabian Castenmiller
f.p.c.castenmiller@student.tudelft.nl
fabiancastenmiller@hotmail.com (persoonlijke email)

Gelieve de juiste vakjes in te vullen	Ja	Nee
A: Algemene Overeenkomst – Onderzoeksdoelen, taken van deelnemers en vrijwillige deelname		
1. Ik heb de informatie over het onderzoek gedateerd [14/11/2023] gelezen en begrepen, of deze is aan mij voorgelezen. Ik heb de mogelijkheid gehad om vragen te stellen over het onderzoek en mijn vragen zijn naar tevredenheid beantwoord.	<input checked="" type="checkbox"/>	<input type="checkbox"/>
2. Ik doe vrijwillig mee aan dit onderzoek, en ik begrijp dat ik kan weigeren vragen te beantwoorden en mij op elk moment kan terugtrekken uit de studie, zonder een reden op te hoeven geven.	<input checked="" type="checkbox"/>	<input type="checkbox"/>
3. Ik begrijp dat mijn deelname aan het onderzoek de volgende punten betekent dat: <ul style="list-style-type: none">• De audio van het interview wordt opgenomen.• Deze audio opname wordt getranscribeerd naar een tekst bestand.• De audio opname wordt verwijderd nadat de informatie in tekst is omgezet.	<input checked="" type="checkbox"/>	<input type="checkbox"/>
4. Ik begrijp dat mijn deelname aan het onderzoek als volgt niet wordt gecompenseerd	<input checked="" type="checkbox"/>	<input type="checkbox"/>
5. Ik begrijp dat de studie in januari eindigt.	<input checked="" type="checkbox"/>	<input type="checkbox"/>
B: Potentiële risico's van deelname (inclusief gegevensbescherming)		
6. Ik begrijp dat mijn deelname in het slechtste geval kan betekenen dat er persoonlijk identificeerbare informatie en onderzoek data in de verkeerde handen valt, met het risico dat ik hieruit geïdentificeerd kan worden waar mijn publieke of professionele reputatie onder zou	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Gelieve de juiste vakjes in te vullen	Ja	Nee
kunnen lijden.		
7. Ik begrijp dat om het risico van een databreuk te minimaliseren en om mijn identiteit te beschermen alle interview data zoals namen, adres en karakteristieken worden geanonimiseerd met pseudo namen, en deze data daarna wordt opgeslagen in de data storage van de TU Delft.	<input checked="" type="checkbox"/>	<input type="checkbox"/>
8. Ik begrijp dat de persoonlijke informatie die over mij verzameld wordt en mij kan identificeren, zoals naam en woonplaats, niet gedeeld worden door het studieteam.	<input checked="" type="checkbox"/>	<input type="checkbox"/>
9. Ik begrijp dat de persoonlijke data (naam, adres, karakteristieken die terug te herleiden zijn naar de persoon) die over mij verzameld wordt, vernietigd wordt zodra het onderzoek op de TU Delft Repository staat eind januari.	<input checked="" type="checkbox"/>	<input type="checkbox"/>
C: Onderzoek: publicatie, verspreiding en toepassing		
10. Ik begrijp dat na het onderzoek de geanonimiseerde informatie gebruikt zal worden voor het onderzoeksrapport, i.e. de master thesis die gepubliceerd wordt op de TU Delft Repository.	<input checked="" type="checkbox"/>	<input type="checkbox"/>
11. Ik geef toestemming om mijn antwoorden, ideeën of andere bijdrages anoniem te quoten in resulterende producten.	<input checked="" type="checkbox"/>	<input type="checkbox"/>
D: (Lange termijn) Data opslag, toegang en hergebruik		
12. Ik geef toestemming om de geanonimiseerde data, onder andere inzicht in het proces van de monumenteigenaar, die over mij verzameld worden gearhiveerd worden in de TU Delft Repository, opdat deze gebruikt kunnen worden voor toekomstig onderzoek en onderwijs.	<input checked="" type="checkbox"/>	<input type="checkbox"/>
13. Ik begrijp dat de toegang tot deze repository open is voor iedereen.	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Handtekeningen

Naam deelnemer

Handtekening

Datum

Ik, **de onderzoeker**, verklaar dat ik de informatie en het instemmingsformulier correct aan de potentiële deelnemer heb voorgelezen en, naar het beste van mijn vermogen, heb verzekerd dat de deelnemer begrijpt waar hij/zij vrijwillig mee instemt.

Naam onderzoeker

Handtekening

Datum

Contactgegevens van de onderzoeker voor verdere informatie: Fabian Castenmiller,
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