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BARRIERS TO BUILDING BIOLOGY IN THE NETHERLANDS

A comparative analysis of the popularity of building biology: The Netherlands vs Germany

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Abstract: The following research aims to understand why a sustainable method of construction such as building biology is not as popular in the Netherlands as it is in Germany. The study conducted is a comparative study based on the Dutch construction sector, through the consultation of experts, and the German construction sector with specific regards to building biology and its popularity. Through qualitative research (semi-structured interviews), the study demonstrates relevant beliefs and attitudes existing in the Dutch system towards building biology and the implementation of the latter as a way to have a more sustainable and healthier environment in the Dutch territory.

Keywords: circular economy, green buildings, building biology, sustainable construction.

INTRODUCTION

Future generations of humanity are facing problems due to anthropogenic climate change as a result of massive environmental pollution (Sachs, 2012). This urgent matter has prompted the development of measures that aim to improve both human beings' welfare and the Earth. These measures are called sustainable development goals (SDGs) and there are 17 of them. The SDGs have quickly gained ground due to their urgency, such as goal number 11: the development of sustainable communities and cities (Sachs, 2012). Environmental degradation is becoming an issue of increasing importance around the world, since it is caused by several polluting industries, such as the building sector (Tam, Vivian, Hao & Zeng, 2012). In the 1990s, the building sector was already responsible for 40% of the material and a third of the energy consumed globally (Pomponi & Moncaster, 2017). After two decades the situation has not changed and it has become clear that businesses are failing to address critical concerns related to sustainability, such as over-use of natural resources and ineffectual responses to global warming (Murray, Skene & Haynes, 2017). One of the strategies developed in different countries within several businesses as well as the building sector is the theory of Circular Economy (C.E.) (Murray et al., 2017). Circular Economy entails restoring sources to their natural levels, trying to reduce the excessive removal and release of materials belonging to a cycle (Murray et al., 2017). This particular type of economy has become more and more crucial when it comes to achieving the SDGs established and improving very polluting businesses such as the building industry (Schroeder, Anggraeni & Weber, 2019).

The combination of SDGs, Circular Economy, and the concerns for the environment in general, has brought some companies and entrepreneurs to develop solutions within the building sector. One of them is the rise and growth of green buildings. Green buildings are built with keeping in mind to reduce the use of resources such as electricity, gas, and water, which is done by using energy-efficient appliances and systems that make materials that are re-usable and long-lasting (Geng, Dong, Xue & Fu, 2012). Within this sector other

possibilities have been developed, making buildings more and more sustainable and closer to circular logic. One of these sectors concerns building biology. Building biology represents an innovative method that is applied in the building sector to develop buildings that are made of sustainable materials and that also brings social benefits such as better health (Nurgul, 2018). Research on these types of buildings is still recent and there are not many sustainable entrepreneurs and companies engaging with this science so far. For instance, in the Netherlands, only a few companies are supporting this type of construction, one of them is Dijkhuis eco. This company has gone through a transition period that has made it entirely sustainable and engaged with the construction of biological buildings. However, the lack of popularity of these types of buildings makes it hard for enterprises such as Dijkhuis eco to spread awareness about this beneficial way of building and creating a collaborative network here in the Netherlands. It is interesting to see how building biology is instead more popular in countries such as Germany, which might be due to more favorable factors and circumstances helping this type of construction grow. Since these factors are not yet well-known, this research will be aimed at investigating: *What are the factors influencing the slow expansion of building biology in the Netherlands in comparison to Germany?*

Answering this question could bring insights into the current situation of companies and entrepreneurs within the construction sector and their thoughts about building biology. It would contribute to understanding the factors slowing the growth of building biology in the Netherlands in comparison to Germany, and how working on these factors could help further develop companies and small entrepreneurs such as Dijkhuis eco in the sustainable construction sector. Therefore, this study will entail a comparison between the current situation in the Netherlands and the situation in Germany to explore the causes behind the slow spread of building biology in the Netherlands. This research will be structured in the following way. First, a framework of theories will be presented, and the application of these theories will frame this study and help answer the research question. Second, the methods

will be explained. Following, the results will be presented and finally, the results will be discussed, and final remarks about future research and limitations will be examined.

THEORY

To answer the research question, several theories were taken into account. From the introduction, it was shown a clear relationship among different fields to which the research is connected: Sustainable development, Sustainable Development Goals (SDGs), Circular Economy, and the Green building sector which in the end leads to building biology (Nurgul, 2018). These aspects will be elaborated consecutively in this theory section.

Sustainable development & the SDGs

The first framework that connects to this research concerns sustainable development (Murphy, 2012). The origin of this term dates back to the 1972-conference held in Stockholm, where 113 states and representatives from 19 international organizations devoted their attention to environmental issues (Paul, 2008). From that moment onwards, more conferences were held, and reports were created, such as the Brundtland Report, making salient the need for sustainable development in our globalized society. In this particular commission report, sustainable development was defined as: *“development that meets the needs of the present without compromising the ability of future generations to meet their own needs”* (Asefa, 2005:1). Sustainable development, thus, identifies development as an activity that should take into account society, economy, political needs, and above all satisfying the needs of the present generation without negatively affecting the needs of future generations (Robert, Parris & Leiserowitz, 2005). This concept indicates achieving a balance between the environmental and social pillars of sustainability (Murphy, 2012). After establishing an official definition of it, sustainable development started being used to explore more the relationship between economic development and environmental quality (Asefa, 2005).

A key feature of sustainable development is the awareness of sustainability. Research shows that sustainable development has been associated with policy objectives that are aimed at

raising public awareness of sustainability through the encouragement of more sustainable consumption patterns (Murphy, 2012). Besides the application in the consumption field, sustainable development has been directly linked to production patterns and sectors such as construction, and specifically, green buildings (Sinha, Gupta & Kutnar, 2013). The prior mentioned research shows how sustainable development practices are implemented within the green building sector and how this has had an impact on the construction sector. Green buildings are identified as such because the implementation of sustainable development practices has prompted the use of renewable building materials (e.g. wood) (Sinha et al., 2013).

Another important factor concerning sustainable development is the creation of sustainable development goals (SDGs) (Sachs, 2012). Scholars have developed and researched what is needed to manifest the idea of sustainable development that can be achieved through these goals. These 17 goals try to tackle problems related to economic development and its consequences on environmental sustainability, social inclusion, and special problems located in underdeveloped countries (e.g. access to clean water) (Sachs, 2012). The aim of this research will be focused on goal number 11 which concerns 'The creation of sustainable cities and communities' (Sachs, 2012). Sustainable development cannot be reached if we do not transform the way we build and manage our urban spaces in a more sustainable way (Robert, Parris & Leiserowitz, 2005). This particular goal relates to the aim of this research and the correlation of sustainable development to the sustainable construction sector. Thus, this framework is necessary to understand the approach that the Netherlands have towards building biology and, moreover what sustainable development practices are already being applied within the construction sector in comparison to Germany.

Circular economy

Since the urgency of reaching the SDGs is increasingly recognized among governments and businesses, several scholars and practitioners have developed and are working according to

more sustainable economic standards such as the circular economy (Schroeder, Aggraeni & Weber, 2019).

The concept of circular economy has existed since 1848 when R. W. Hofman, the first president of the Royal Society of Chemistry, stated: '*the better a real factory makes use of its waste, the closer it gets to its deal, the bigger is the profit*' (Lancaster, 2002). From this quote, it is evident that circular economy was born as a logic aimed at making waste usable. Nowadays, the term has evolved, and it is seen as a way to diminish the negative effects on the environment and restore any damage done in resource acquisition while ensuring that little waste is generated (Murray et al., 2017). This has therefore acquired more advanced nuances that companies try to follow through a loop-cycle production style by re-using materials and evaluating what is considered 'waste' as an opportunity to exploit. Other scholars have referred to circular economy as the ability industrial activities have to be restorative by using renewable resources and reducing the amount of waste through the implementation of innovative strategies (Kirchherr, Reike & Hekkert, 2017). This circularity has been seen in companies that extend or intensify the use of their products recycling materials and using more what is to be considered 'unusable' waste (Moreau, Sahakian, Van Griethuysen, & Vuille, 2017).

The application of this concept, as well as sustainable development (Murphy, 2012), has been related to the construction sector and more specifically to the green building sector. Research by Adams, Osmani, Thorpe & Thomback (2017) demonstrates that circular economy has been applied to the construction since its logic entails waste minimization and recycling. This correlation is confirmed by Blomsma & Brennan (2017) who emphasize these qualities as beneficial for the construction sector, which is characterized by high amounts of pollution and the exploitation of many essential resources. About 60% of the material extracted out of the Earth's crust ends up in the built environment and has a specific lifecycle which is related to the time when the building is in operation, making durability and reusability of the resources

very important (Sinha et al., 2013). This clear connection between the circular economy and construction makes this framework essential to understand the current situation in the Netherlands concerning sustainable construction and building biology. In addition to that, several scholars have already provided a rich analysis of the main characteristics of the building sector in the Netherlands and the implementation of strategies based on circular economy logics (Schut, Crielaard & Mesman, 2016). This research shows that more than half of all the materials present in the Netherlands are used in the construction sector (Schut et al., 2016). Fortunately, this material already goes through recycling systems, but this research has proven that the connection to circular economy can be key when it comes to problems of scarcity of resources and CO₂ emissions within the construction sector. The analysis conducted of the construction sector through the circular economy as a framework shows the logic application of it to analyze the current situation in the Netherlands concerning the sustainable construction sector. However, it is important to point out some limitations of this concept. Circular economy lacks considering the social dimension, but it concentrates more on reducing the environmental impact (Murray et al., 2017). Yet, this concept results still valid to identify the patterns present in construction businesses in the Netherlands and the challenges present in this sector preventing it from becoming as popular as it is in Germany.

Green building

As previously mentioned, a particular sector that has used circular economy as a guide to improve production and pollution is the construction sector. This has created impactful changes in the industry considering that the construction sector is responsible for 38% of the carbon dioxide, which is the primary greenhouse gas associated with climate change (Geng et al., 2012). The result of the circular economy implemented within the building sector has given rise to the implementation of green buildings. The green building field concerns with techniques regarding design, construction, or operation that help to reduce the negative impact and instead create positive impacts on our natural resources, improving our welfare (Geng et

al., 2012). The objective of this field is therefore focused on understanding how these new buildings, which are characterized by efficient use of sustainable resources and renewable energy, can provide benefits for society and therefore connect to the achievement of the sustainable development goals mentioned prior (Keitsch, 2012). Within this field, some countries have distinguished themselves when implementing green building techniques in their countries. China, Germany, and Sweden are just a few of them and are considered an example for their efficiency, when it comes to the flow of material and energy and how they use it in the construction sector (Adams et al., 2017). For this reason, the research present in this field is mainly focused on what has been done in the Chinese territory and how they have integrated green buildings and made it successful within their community (Geng et al., 2012; Murray et al., 2017; Mathews & Tan, 2011). Furthermore, research conducted by Pomponi & Moncaster (2017) also highlights the concentration of studies of green and circular buildings only on a macro-level and none about what is happening on the meso and individual level, which lacks identifying what entrepreneurs might be doing in regard to sustainable construction.

Green building has also been used concerning sustainable development. Global sustainability goals have led the construction sector to develop green building movements that take into account the environmental impact that buildings entail and implement sustainable development practices to lower it (Sinha et al., 2013).

Concerning the theories that have just been discussed, new research and practitioners have developed more innovative ways of building that respect both the environment and human beings' health. This type of sustainable construction goes under the name of *building biology* (Nurgul, 2018). Indeed, the sources present define building biology as a practice that does not only use environmentally friendly materials but that also concerns guaranteeing house or building owners with safe and healthy spaces (Nurgul, 2018). Unfortunately, the number of academic sources that discuss the implications of building biology is minimal or

mainly coming from the German Institute for Building Biology, ‘Institut für Baubiologie Nachhaltigkeit’, where ‘baubiologie’ is used only in practical terms in the construction sector in Germany (Institut für Baubiologie, 2020). This indicates the need to analyze, academically, the benefits and applications of building biology in the construction sector.

This theory section has shown the main concepts that will be implemented in this research and how they have been connected in previous research. Additionally, Górecki et al. (2019) express the urgency of implementing an ecological perspective that contains sustainable development practices and circular economy logic to analyze the problems that the construction sector is facing (e.g. scarcity of resources). Additionally, the impact it has on the environment (e.g. pollution, smog) will be analyzed with the aim of avoiding them in the future.

METHODS

The following section presents the methodological choices made to find out *what are the factors influencing the slow expansion of building biology in the Netherlands in comparison to Germany?*

The section contains an explanation of the case study taken into account, the sample selection and the operationalization and analysis of the data collected.

The Research

As stated in the introduction, the focus of this research departs from the current experience in the Dutch construction sector of the building biology company Dijkhuis eco in comparison with the current situation of building biology in Germany. The choice of undertaking this qualitative research was determined by the fact that it was possible to investigate the existing contextual factors within the Dutch building biology sector. Additionally, how sustainable building companies are interacting with this ecosystem.

The Sample

The sample selected for this research was of ten participants involved in the sustainable construction sector as consultants, entrepreneurs, suppliers, architects, and CEOs. From these ten participants, eight are currently operating in the Netherlands and the other two have expertise in building biology in the German territory. I considered it necessary to include companies striving for a more sustainable future in the Netherlands to understand why or why not they are engaging with building biology. Since building biology companies in Germany did not want to release interviews, due to privacy matters, this lack was compensated with two experts currently working at the Institute for Building Biology in Germany. They were able to provide me with an overview of the situation in Germany and the reasons why building biology companies there are rapidly expanding.

Company	Sector & Job Title	Duration
Dijkhuis Eco	Building biology - Owner & CEO	21:15
Dijkhuis Eco	Building biology - Engineer	23:41
Van Ginkel Holding	Sustainable Supply Chain - CEO	31:29
IsoHemp	Bio-based construction - Manager	32:28
Centrum Hout	Wood construction - Manager	39:10
Agrodome	Bio-based construction – Consultant	27:17
Oldenboom	Sustainable Supply Chain - Entrepreneur	29:57
Archiview	Circular Bio-based & building Architect	32:43
IBN	Building Biology - Employee	45:08
IBN - Ecowise	Building biology – Consultant, Entrepreneur	31:05

Participant 1 & 2: Dijkhuis eco

The first two participants are the owner himself and an engineer belonging to Dijkhuis eco. The reason why they have been selected concerns the significant activity they are undertaking with building biology in the Netherlands and the accurate overview they could give of the growth of building biology, its benefits, and some of the factors that are slowing down this sustainable way of building.

Participant 3: Van Ginkel Holding

The third participant selected was the CEO from a holding of companies specialized in the construction sector and more specifically in guaranteeing a greener supply chain. This CEO was selected due to his expertise concerning the combination of sustainability and construction and the efforts his company is making in spreading awareness about sustainable processes and materials among experts in the construction sector.

Participant 4: IsoHemp

The fourth participant selected is a manager at IsoHemp. This company is specialized in the use of bio-based materials such as hemp for the construction of buildings. The reason why I have selected this candidate concerns his expertise in stimulating the use of natural materials in the construction sector in the Netherlands, which could provide me with an overview of what the challenges are and the position of building biology in the Netherlands at the moment.

Participant 5: Centrum Hout

The fifth participant is one of the coordinators at Centrum Hout. This center has the goal of stimulating the use of sustainable materials such as wood and timber frame houses in the construction sector. Moreover, the coordinator selected is in constant collaboration with the Dutch government, being, therefore, a valuable candidate to understand what political institutions are stimulating the construction sector concerning sustainability and whether building biology is part of the agenda.

Participant 6: Agrodome

The sixth participant selected is a consultant and one of the directors at Agrodome, a knowledge center for bio-based natural materials and the application of circular economy in the building sector located in the Netherlands. His expertise related to the use of bio-based materials in addition to his experience in consultancy provided me with information about the sustainable practices that are growing among Dutch companies.

Participant 7: Oldenboom

The seventh participant selected is a member of a family company called Oldenboom specialized in supplying biological materials across sustainable construction companies in the Netherlands. Through his expertise in biological materials and the companies he is currently connected to, it was possible to have more information about Dutch companies in the Netherlands and their will to engage or not with building biology in comparison to Germany.

Participant 8: Archiview

The eighth candidate is an architect specialized in the creation of projects concerning buildings made of bio-based materials. His contribution to this research entailed knowledge related to the current trends among the construction sector and factors that do or do not attract clients to bio-based projects in the Netherlands.

Participant 9 & 10: Institut für Baubiologie Nachhaltigkeit (IBN)

To have a more complete overview of the reasons why building biology is one step further in Germany, I considered it necessary to include two members currently working at the institute of building biology located in Munich.

The first member selected is an expert in building biology and active in spreading awareness about the benefits of this type of construction, and constantly in contact with successful companies in the sector. The second member selected, is as well involved with the IBN and in addition to that is currently the owner of a small company, *Ecowise*, specialized in building biology in the Netherlands. Through these two participants, it was possible to obtain

information about the factors that are slowing down the Netherlands and the characteristics that are helping Germany advance in this sector.

Operationalization & analysis

The sample selected was analyzed through qualitative research that entailed the use of semi-structured interviews, containing questions enclosing the key concepts that frame the research question (e.g. sustainability, green building, circular economy, building biology). All the choices made concerning the operationalization and analysis of the data collected will be explained in the following paragraphs.

Before starting the interviews, I made sure all the participants signed a consent form authorizing to record the interviews (Appendix p.39). Audio recorded interviews helped me analyze the data more in-depth (Thomson & Bornat, 2017). Qualitative research was chosen since it was considered the best way by the key informants to share their expertise and express their opinion on the complex process that comprises the development of building biology in the Netherlands.

The interviews were semi-structured since they allowed me to have various degrees of adaptation of questions and their order to accommodate the interviewees (Rowley, 2012). A smaller number of fixed questions allowed me to go in-depth and to address specific questions topics where the interviewee showed more expertise and relevant insights. The amount of time set for each interview was 30 minutes, as I considered it enough to go through the fixed amount of questions and to make sure the interviewees would not lose focus. However, in certain cases, the interviews turned out to be longer or shorter than the time set. Due to the exceptional circumstances entailing the CO-VID 19 pandemic all the interviews were conducted electronically.

The questions asked revolved around the themes previously mentioned in the theory section. The first round of questions involved asking the interviewee about their vision on

sustainability and their expertise about it. They were asked questions such as: *'Could you tell me what you are currently doing in the construction sector concerning sustainability?'*

After getting an overview of their perception of sustainability, the questions were focused on green buildings and circular economy. Specifically, on how the building sector is engaging with these two logics. The interviewees were asked questions such as: *'How is the implementation of circular economy in the construction sector and who is supporting it at the moment?'*. All these questions were followed up by several that can be found in the appendix (pp.31-33).

Finally, the interview focused exclusively on building biology and on the factors that could be changed to stimulate it more in the Dutch territory. Some of the questions used were: *'How are companies focused on building biology development in the Netherlands?'*, *'Are there any incentives given by the government to support building biology?'* and so on (Appendix p.32, 33).

After retrieving the data collected, the interviews were transcribed and coded according to thematic analysis (Bryman, 2016). This analysis entailed the creation of codes that identified the main themes and classified the factors influencing building biology that the experts pointed out (culture, policy, economy, construction sector, etc.) (Appendix p.33-36). Through the use of these themes, it was easy to obtain an overview of the most relevant insights given by each interviewee. Each theme was identified by color to make easily visible commonalities and the relevance of the responses given. After coding all the interviews according to the thematic code tree (Appendix p. 37), the data collected was structured according to the main findings and theories used in this research. The findings will be exposed in the following section.

RESULTS

This section presents an overview of the interviewees' responses and the new insights that helped to formulate an answer for the research question: *What are the factors influencing the slow expansion of building biology in the Netherlands in comparison to Germany?*

The findings obtained in connection to this question are divided according to the themes previously mentioned; sustainability, circular economy, green buildings, and building biology (Appendix p.33-36). Since the research question is focused on building biology, most of the findings and reflections are presented in that section.

Sustainability

This section was aimed at finding the connection between sustainability and sustainable goals in the construction sector. Furthermore, this category helped capture the general idea the participants had of how sustainability has been integrated into the construction sector in both the Netherlands and Germany. Since all the participants were already connected to sustainable practices, all of them showed a strong drive to change a sector that so far has been traditional and stuck on certain ideas. For instance, some of the interviewees defined construction companies that were trying to go for the easy way to look sustainable and go only for the mainstream sustainable options:

'For now, companies that try to be sustainable are mostly companies that use solar panels so that they look sustainable' – Engineer, Dijkhuis eco

Some of them stressed a problem related to the present regulations and therefore the tendency from professionals in the construction sector to do only the minimum instead of investing in more sustainable ways of construction:

'So, the builder, well, he wants to perform at the minimum level according to the binding regulations. And he's not interested in buying and selling comfort or well-being.' – Director & Consultant, Agrodome

Through the use of the sustainability theme it also emerged that almost all the participants noticed that people are becoming more aware of sustainability in different fields, and they are slowly connecting it to the construction sector as well:

[...] people are getting more aware like you also see this with the food. People are asking for more bio foods and, well, slowly it's going to change in the building sector - Director &

Consultant, Agrodome

Other experts, such as one of the members of the IBN, have pointed out the growth of awareness and sustainability among Germans that started from the food industry and slowly spread in the construction sector.

Circular economy

Besides sustainability, all the experts interviewed referred to the circular economy and their role in the construction sector at the moment. Several of them highlighted how this model is used in the construction sector and how it is particularly trendy in the Netherlands.

'But the third is, of course, as you mentioned it is circular building, which is the hype now'. - Manager, Centrum Hout

In connection to circularity, most of the participants emphasized that when it came to circular economy and government involvement, it all resulted in improving the energy efficiency of buildings. This focus on energy efficiency is also seen as an automatic lack of attention from Dutch institutions into considering other sustainable building practices that entail the use of biological materials.

'[...] the government is mostly focused on energy efficiency. So, the main purpose of the government is to get rid of oil so that they don't need anymore in their economy.

Oil-based products. But so that's why the focus is first on energy and recycling and not on biological building for instance' - Manager, IsoHemp

‘Because circular economy is considered important also by the government, an important issue. But they focus most of the time on energy and not on materials’ –

Director & Consultant, Agrodome

Green buildings

The use of the green building concept helped me identify whether the experts and company owners interviewed were somehow applying to their professions, practices, or techniques connected to green buildings (e.g. sustainable materials, sustainable supply chain, sustainable processes). Surprisingly, the concept was not explicitly used by the experts, like in the case of circular economy, but it was instead contained in their vision of how a sustainable building should be. A remarkable illustration of this was offered by one of the experts:

How clean is the air in the building, the materials used, the walls, and the ceiling conditions? If these things are bad, you have a bad building – Architect, Archiview

Building biology

Building biology was the theme with most recurrences that was discussed in the interviews, additionally, that provided me with insights on aspects that are influencing the growth of building biology. Since the factors are several the following section was divided into seven parts; culture, policy, economy, construction sector, awareness, and stimulation.

Culture

Culture was one of the aspects remarked in the interviews when it came to understanding the reasons why building biology has not grown as fast in the Netherlands as it is growing in Germany, was related to cultural differences.

Some Dutch experts who are part of the sample pointed out that one of the main obstacles for building biology is the price and how Dutch people opt for the cheapest option:

The problem is, I'm afraid we're Dutch and we always want the cheapest of the cheapest – CEO, Van Ginkel Holding

'[...] most people in Holland just choose the cheapest solutions.' – Engineer, Dijkhuis eco

Besides pointing out economical aspects within the Dutch culture, other participants located in Germany connected the lack of popularity of building biology in the Netherlands to a minor awareness of sustainability and its importance in everyday life:

'Well, I think compared to the rest of the world, in Germany, we are quite a bit ahead

[...] I think that the Germans are more aware of environmental problems and they have more consciousness about these things' - Member n.1, IBN

This quote points out a major level of environmental awareness among Germans in comparison to Dutch people.

Policy

A second factor discussed concerning building biology is the policy and in general what the government is doing in the Netherlands to promote more sustainability in the construction sector. As previously mentioned, there appears to be a close connection between circular buildings and the support of the government. The existence of incentives or loans for companies wanting to operate with bio-based materials or even building biology is less common. Besides the lack of support, the guidelines that companies should follow according to government regulation to be sustainable are still very general, undermining the effort made by companies who are going beyond energy efficiency processes and the installation of solar panels on the roof:

'it's like still quite general guidelines. They just need to follow those guidelines

because most information about sustainability is left out, so a lot of construction

companies are sort of making their own rules' -Engineer, Dijkhuis eco

Economy

Through this theme, it was possible to find out the impact that implementing sustainability in the construction sector has in the Netherlands. On one hand, some of the participants highlighted that the reason why the use of bio-based materials and building biology is slow is that it is considered too expensive for consumers and not immediately profitable for Dutch companies. Which in result, pushes companies to seek the fastest ways of making profit.

‘There’s still a tendency of thinking about getting quick money rather than long term goals and your body, your health. It’s still in the economy. People think about quick wins.’ – Architect, Archiview

On the other hand, some of the experts based in Germany showed a more optimistic side of the growth of building biology and reflected on the added value that biological buildings bring to the table. Buying a biological house was considered an investment in your future and cost-saving for your health and the environment.

‘if you make the whole calculation, it’s 50 euros extra a month during the mortgage period for 30 years [...] and you get to have a safe house for your family for the rest of your life’ – Member n.1, IBN

Construction sector

From the thematic analysis, it emerged that the construction sector in the Netherlands is still very traditional and profit driven. Big Dutch companies still have control over government decisions which mainly results in the stagnation of sustainable construction companies and, therefore, building biology. Besides being traditional, construction companies have been classified as too slow and afraid of going for change because of the risks involved.

‘most building systems, building companies are ... They’d like to do the thing they always have done. And when they get something new... they are a little bit afraid’.

– Supplier & Entrepreneur, Oldenboom

Another interesting aspect concerns the lack of connection between the final customer and the construction project. Most of the companies in the Netherlands build a certain number of houses according to the ground they buy. The final project is then put on the market and sold to clients, who are not aware of the materials used to build the house or have not had the opportunity to decide for themselves.

'Most of the buildings are built for anonymous customers. In other countries such as Germany, it's more a one to one relationship'. - Manager, IsoHemp

Awareness

When the participants were asked to give their opinion on the reasons why building biology is not mainstream in the Netherlands yet, all of them addressed to the problem of lack of awareness and what they are personally doing to change this tendency:

'For example, the director of the school wanted to get the teachers at my home, at my office so I could tell them about healthy sustainable building and the teachers could then tell the students because it is needed. So, it starts from things like this ...'

- Owner & CEO, Dijkhuis eco

Another aspect highlighted by the majority of the participants is the need for more official forms of education to provide new professionals entering the construction sector with knowledge. The Engineer from Dijkhuis eco pointed out the lack of focus on learning how to use sustainable material during his studies. In contrast, Germany presents already a solid educational system focused on building biology, which is growing every year and that has been established in Germany for over 40 years:

'I think we have now over 10000 students taking the course, you know. And there is a much higher awareness'. - Member n.1, IBN

Moreover, the availability of building biology courses in the Netherlands are hardly any and primarily online, as affirmed by the other member from IBN, which is currently handling one of these online platforms.

This lack of education has consequently caused a lack of building biologists who do not have a platform to refer to in case they need help such as the IBN in Germany. This has prompted a lack of collaboration in the sector which is considered quite crucial for its expansion in the Netherlands.

Stimulation

To stimulate the growth of building biology in the Netherlands taking example from what Germany has done, the experts have given suggestions that apply to every field discussed in the previous sections.

Education

The first is certainly the need for solid education systems in the Netherlands such as the IBN, which is an institute specialized in building biology operating in Germany.

Another aspect concerns, raising awareness among ordinary people through the use of marketing or social media like the IBN is doing:

'We are having our Building Biology magazine that you can find on the Internet or on Facebook. We are on Instagram and there we are posting regularly some kind of articles.' - Member n.1, IBN

Building trust

An important insight that goes beyond awareness concerns building trust by certifying the quality of bio-based materials in the construction of buildings. Some of the participants have pointed out an existing prejudice towards the use of wood, hempcrete, and timber frame houses among consumers. The use of certifications and official sources to communicate the benefits and safety of building biology and sustainable construction, in general, can be a starting point to build trust.

'you have to build trust so that they are not afraid of using it. To do so, then you're entering in the field of certifications or investments. – Director & Consultant,

Agrodome

All these changes should help reshape the bigger picture, stimulating, for example, more political institutions and companies to incentivize and encourage building biology, rather than focusing only on circular buildings and energy efficiency.

DISCUSSION

This section discusses the results that emerged from this research, and their relation to the research question: *What are the factors influencing the slow expansion of building biology in the Netherlands in comparison to Germany?*

The first part presents the conclusion that can be drawn. Following this, a section containing theoretical and practical implications is presented. Finally, the limitations of this research are exposed, and future research possibilities are outlined.

Conclusions

The results obtained gave useful remarks on the factors determining the slow expansion of building biology (e.g. education, culture policy, economy) and how experts in the construction sector are facing this issue.

Regarding the educational aspect, the results show that the Netherlands lacks a solid education system dedicated to building biology. Several authors confirm in their research the need for education to guarantee long-term benefits for the environment and human beings through implementing sustainability education across different sectors (Tilbury & Stevenson, 2002; Huckle, 1991; Gadotti, 2010; Tilbury, 1995). Education is claimed to play a crucial role when reorienting practices towards a more sustainable path (Gadotti, 2010), which in this case involves the construction sector.

Another relevant finding concerns the level of awareness in the Netherlands compared to Germany. In connection to previous research (Hunting & Tilbury, 2006), the responses given by the experts confirm the need of spreading awareness as a key element to help the expansion of sustainability in the building sector and ultimately building biology. The addition provided

by this research in comparison to previous research is a specific focus on building biology and ways to do so in this sector that go from educating regular consumers (e.g. social media campaigns, seminars, knowledge centers) to professionals in the construction sector (e.g. official educational platforms, implementation of building biology in current professions). This research also provides more insights on not only how to spread awareness, but also how to overcome the current quality prejudice towards the integration of sustainability in the construction sector. The experts interviewed highlighted the urgent need of creating more certifications to enhance consumers' trust in the use of biological materials in the building sector.

The last two remarkable findings concern the current ecosystem in the Netherlands (policies, economy) and the construction sector as such. In comparison to Germany, the amount of building biologists operating in the Netherlands is not even a third of the ones operating in Germany. This is likely connected to the lack of official educational structures in the Netherlands but also to the need for policies that incentivize and reward small entrepreneurs willing to engage with building biology, as expressed by some of the experts in this research. Research indicates that the Netherlands is struggling to harvest the potential of sustainable construction due to the lack of policies encouraging environmental innovation in the building sector (Faber & Hoppe, 2013). This research is, therefore, trying to point out changes that need to be taken into account in the Dutch political system to stimulate building biology, which has, once again, been overlooked.

Concerning the construction sector, the findings reveal a still very traditional and profit-driven market, characterized by small entrepreneurs and big companies that do not collaborate. This finding is congruent with the research of Dorée et al., who also state the profit-driven nature of the construction sector (2003), and with Breme & Kok's (2000) research highlighting the need for more collaboration to integrate new sustainable practices.

Theoretical implications

The current study has brought some theoretical implications concerning education and its relation to sustainability, awareness of building biology in the Netherlands, and new theoretical insights that emerged during the research process.

Regarding education, a clear connection was made between the encouragement of building biology and educational platforms. Through the experts' opinions, it was possible to point out how current research on education and sustainability, such as Tilbury & Stevenson (2002), is still very general and does not explore the effects that solid educational building biology structures could have on the growth on this sector.

Another implication concerns the level of awareness of building biology in the construction sector and how it can be enhanced through the use of certifications. This research brings new insights to current research about the influence of green building certifications to enhance innovation processes (Herazo & Lizzaralde, 2015) and how research has overlooked the reasons why these certifications are being created in the first place (e.g. overcoming consumers' prejudice towards sustainable construction).

This study also brings implications to research focused on policy in the construction sector. The lack of policies aimed at stimulating building biology in the Netherlands highlights the needs of research on how to enact more building biology-related policies in a Dutch system, where circular practices and energy efficiency are currently the main sustainable focus in the building sector (Faber & Hoppe, 2013; Adams et al., 2017).

Finally, the importance this research has given to the social benefits of building biology (e.g. better health), through the use of biological materials. This goes against current research tendencies to solely focus on the environmental benefits of this type of construction (Nurgul, 2018).

Furthermore, capturing this finding was difficult, through the lenses of the circular economy framework, due to the lack of a social sphere of it (Murray et al., 2017), implying that the

inclusion of a social sphere should be enhanced in research concerning circular economy in the construction sector.

Practical Implications

This research also presents practical implications of what could be done with regards to the slow expansion of building biology in the Netherlands. Education, culture, policy, economy were factors considered crucial by the experts interviewed.

Regarding education, the findings can have implications on the current Dutch educational system with respect to the construction sector, specifically the integration of building biology in Dutch educational programs. Therefore, educational institutions in the Netherlands should work on the creation of a solid education system dedicated to building biology. Research by Tilbury & Stevenson has confirmed a significant relationship between education and the increase in sustainability (2002). This official platform should follow the successful structure of the '*Institute fur Baubiologie Nachhaltigkeit*' which has guaranteed a reliable knowledge center in Germany during the past forty years. As confirmed by the interviewees, having official educational systems focused on building biology would improve the preparation of experts to engage with biological materials and would automatically increase the number of building biologists more willing to cooperate. Thus, to speed up the growth of building biology in the Netherlands, it is essential for the parties involved such as the government, companies, the public, and experts, to develop a physical platform aimed at educating people on building biology. The actions involving the collaboration among the parties just mentioned is identified as one of the key drivers towards the increase of sustainability and its benefits (Tilbury & Stevenson, 2002).

Other implications concern the current policies in the Netherlands within the construction sector. The clear lack of policies aimed at incentivizing building biology can be used as a stimulus by Dutch institutions to introduce more supporting policies. This could be done

through funds to building biology companies and incentivize the overall use of bio-based materials in the building sector. As expressed by Bremer & Kok, enacting effective policies is an effective way to go against the current profit-driven and traditional tendencies dominating the construction sector (2000).

As for the construction sector, the findings reveal this sector is still very traditional and reluctant to innovation. This highlights the problem of having such a traditional construction sector and the progress of sustainability as discussed by Dorée et al (2003). Considering the very traditional nature that is currently slowing down sustainable construction in the Netherlands, the Dutch government's priorities and the ways in which they help (e.g. grants, subsidies, legislation) sustainable companies to engage with building biology could be affected.

The final implication entails improving awareness spread among Dutch consumers and professionals. The experts have suggested several ways of achieving this objective. Besides improving the educational system, it is essential to overcome the existing prejudice towards building materials and their supposedly inferior quality. Such as, through the major use of quality certifications, especially of biological materials in construction. The relevance of this finding and its possible implication is reinforced by Herazo & Lizarralde's research (2015) which considers the use of quality certifications as an important tool to support sustainable construction. Another implication to achieve more awareness connects to the experts' advice about the creation of campaigns both online (e.g. Facebook, Instagram) and offline (e.g. workshops, annual meetings). This recommendation has also been mentioned and supported in Gadotti's research advocating for the use of media online and offline as a way to reorientate consumers towards a more sustainable mindset (2010).

Limitations

Like any other study, this study has some limitations connected to the research process. Due to time constraints, the sample selected was narrowed but still meaningful considering the level of expertise and the crucial role of the interviewees in trying to change a very traditional construction sector. However, this sample could have been expanded to bigger companies, since they are key figures in the construction sector and have particular power in the market, as stated by Bremer & Kok (2000). Moreover, the use of solely qualitative data did limit the possibility of obtaining responses from a higher number of companies, possibly working in Germany. This would have helped by giving a better overview of what German companies do and complement it with the results obtained in this research regarding education, culture, and politics.

Besides these limitations, this study still represents a start to enrich the lack of academic literature concerning building biology, its development in the construction sector and the stimulation of building biology. Furthermore, the fact that it is written in English could help increase the accessibility and the number of English publications concerning building biology and its development.

Future research

As for future research, the focus could be on some of the aspects considered to be the key factors that are blocking the growth of building biology (culture, policy, education, etc.). For instance, looking more in-depth into the policies that are encouraging sustainability in the construction sector can be a way to explore further how to stimulate building biology in the Netherlands. Bearing in mind that ongoing research has made a crucial connection between sustainability and policymaking to succeed in creating a more sustainable future (Tàbara & Chabay, 2013). Further research could also focus on the impact of culture on building biology, which has been partially covered in this research. This could be done by understanding better how companies and other relevant subjects in the growth of building biology can develop a

strategy to create a so-called culture of sustainability (Galpin, Whittington & Bell, 2015) in the Netherlands.

Finally, an interesting insight concerns the sample. All the interviewees were males between 40 and 60 years old. Future research could focus on the impact that gender could possibly have on building biology by taking into account research that has considered the impact of gender diversity in the construction sector with regards to innovation (Galea, Loosemore, Powell & Chappell, 2014).

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APPENDIX

The following section contains the main tools used in this research to answer the research questions. Since the research entailed semi-structured interviews, an interview guide was created to have questions aimed at finding out: *What are the factors influencing the slow expansion of building biology in the Netherlands in comparison to Germany?*

Another tool used to conduct a thematic analysis on the data collected through the semi-structured interviews was the use of codes related to the theoretical frameworks mentioned in the theory section and based on the most relevant topics and themes mentioned by the interviewees.

INTERVIEW GUIDE

The following section presents the set of questions that were used in the interviews conducted in this research and the codes that were applied to analyze each interview and outline the most relevant findings. The goal of this interview guide is to review the main questions that were asked, and the type of analysis conducted on them to answer the research question: *What are the factors influencing the slow expansion of building biology in the Netherlands in comparison to Germany?*

Introduction

This section simply contains one question, which has been to have an overview of the interviewee and why he or she was relevant and connected to this research:

- *Could you tell me a little bit about yourself and your expertise in this sector at the moment?*

Sustainability

This set of questions relates to the connection between the construction sector and sustainability in the Netherlands:

- *How is sustainability seen in this sector?*
- *Is it hard to integrate sustainability in construction?*
- *Is it hard to retrieve sustainable materials in the Netherlands?*
- *Could you tell me what you are currently doing in the construction sector concerning sustainability?*

Circular Economy

This question is directed to companies working with more circular processes and buildings in the construction industry.

- *When talking about circularity how do you apply this within your company to be more sustainable? Is it hard?*
- *How is the implementation of circular economy in the construction sector and who is supporting it at the moment?*

Green building

This question was aimed at finding what the priorities in the Netherlands are when it comes to building buildings that are considered to be 'green'.

- *When it comes to greener buildings, what are the factors that the Netherlands is prioritizing to make them sustainable?*

Building biology

These sets of questions are aimed at finding possible answers that explain why building biology is not a mainstream practice yet and how it could be eventually stimulated in the Netherlands.

- *Have you ever thought of engaging with building biology construction?*
- *What are the reasons you have done it or not?*
- *What are the challenges/ benefits? (culture, knowledge, technology)*
- *Are there any particular political challenges?*
- *Are there any particular economical obstacles?*
- *Other types of obstacles? (incentives, culture, lack of awareness)*
- *How do you think this type of construction could be stimulated in the Netherlands?*
- *How could expanding building biology be beneficial for the Netherlands?*
- *How are companies focused on building biology development in the Netherlands?*
- *Are there any incentives given by the government to support building biology?*

It is important to stress that not all the questions were used since the interviews conducted were all semi-structured. Therefore, the questions were used according to the interviewee's expertise and his or her involvement with building biology.

INTERVIEW CODES

This section illustrates the codes used to analyze the interviews. The following codes are divided into four sections that follow the theory section and in subsections of different colors that are more specific about themes that were currently brought up in the interviews.

The sections are four: sustainability, circular economy, green buildings, and building biology. Each of these categories contains subcategories that helped me capture relevant elements for each theory and new nuances not yet explored.

Sustainability: this category includes all the codes that refer to sustainability in the construction sector and how it is perceived but determined key subjects in society.

- ***Sustainability in the construction sector:*** this code identifies the statements where the interviewees simply refer to the construction sector and the main trends related to sustainability.
- ***Sustainability among dutch and german consumers:*** this code identifies the perception of trying to be sustainable according to Dutch and German consumers.

Circular economy: this category includes all the codes that refer to the implementation of circular economy in the construction sector through determined ways.

- ***Energy efficiency (incentivized through loans and allowances):*** this code was used to see when the interviewees referred to the application of circular economy especially with regards to energy efficiency.
- ***Government involvement and stimulation of circular building:*** this code was used to highlight all the statements referring to the connection between governmental support and circular economy.

Green buildings: this category encloses all the statements that connect to the green building logic in terms of sustainability, materials, and supply chain.

- ***Sustainable materials:*** this code was used to identify the statements referring to the efforts made within the construction sector to promote the use of more sustainable materials (ecological, bio-based, wood, hemp, etc.)
- ***Sustainable supply chain:*** this code was used to identify the companies that are trying to create a more sustainable supply chain within their company.

Building biology: this category includes all the codes related to building biology, its implementation, existing policies, its perception among the construction sector, and the current level of awareness among people about building biology and its benefits.

Culture: this code encloses all the statements that refer to cultural factors as a crucial matter in the growth of building biology.

-Dutch people: this code highlights all the statements referring to Dutch people and their behavior towards sustainability in their lives and about the construction sector.

-German people: this code was used to identify the perception among German people of building biology itself and the integration of sustainability in their lives.

- **Policy (incentives, local support, subsidies, trends):** this code was used to spot all the statements referring to the enactment of policies favoring the use of more biological materials in the construction sector.

- **Construction sector:** this category identifies the responses describing the construction sector in connection to building biology and how it is perceiving, in general, the transition to more sustainable ways of building.

-Slow: this code was used to identify the statements describing the construction sector as slow when it comes to integrating new changes and innovative practices.

-Not ready: this code was used to indicate the responses where the construction sector was defined unprepared in terms of techniques, knowledge, and tools to embrace a more sustainable way of building such as building biology.

-Traditional: this code was used to identify the responses where the construction sector was still seen as very traditional or driven by big companies that are profit-driven etc.

-Trying to drive change: this code identifies all the statements where experts believed that the current situation in the construction sector is made up of companies that are thriving for change.

- Economy: this category refers more to all the codes where a relationship between building biology and the costs that it requires is made.

-Cost-saving: this code includes the responses that see engaging with building biology as an investment in the future, avoiding future extra costs of demolition, health problems, and so on.

-Too expensive: this code indicates the responses where interviewees believed the economy is avoiding building biology because it is expensive and still trying to

-Awareness: this category identifies the responses where the slow growth of building biology lies in a lack of knowledge problem:

-Education: this code was used to identify the responses where the participants referred to the need for education among professional in the construction sector and

-Knowledge gap:

-Trust on quality: this code indicates the current lack of trust from both professionals and consumers in the use of materials different from the traditional construction sector.

Stimulation: this category illustrates all the responses related to how building biology can be stimulated in the construction sector.

- Collaboration: this code includes all the responses where the experts saw collaboration, with the government or among companies, as a way to stimulate building biology.

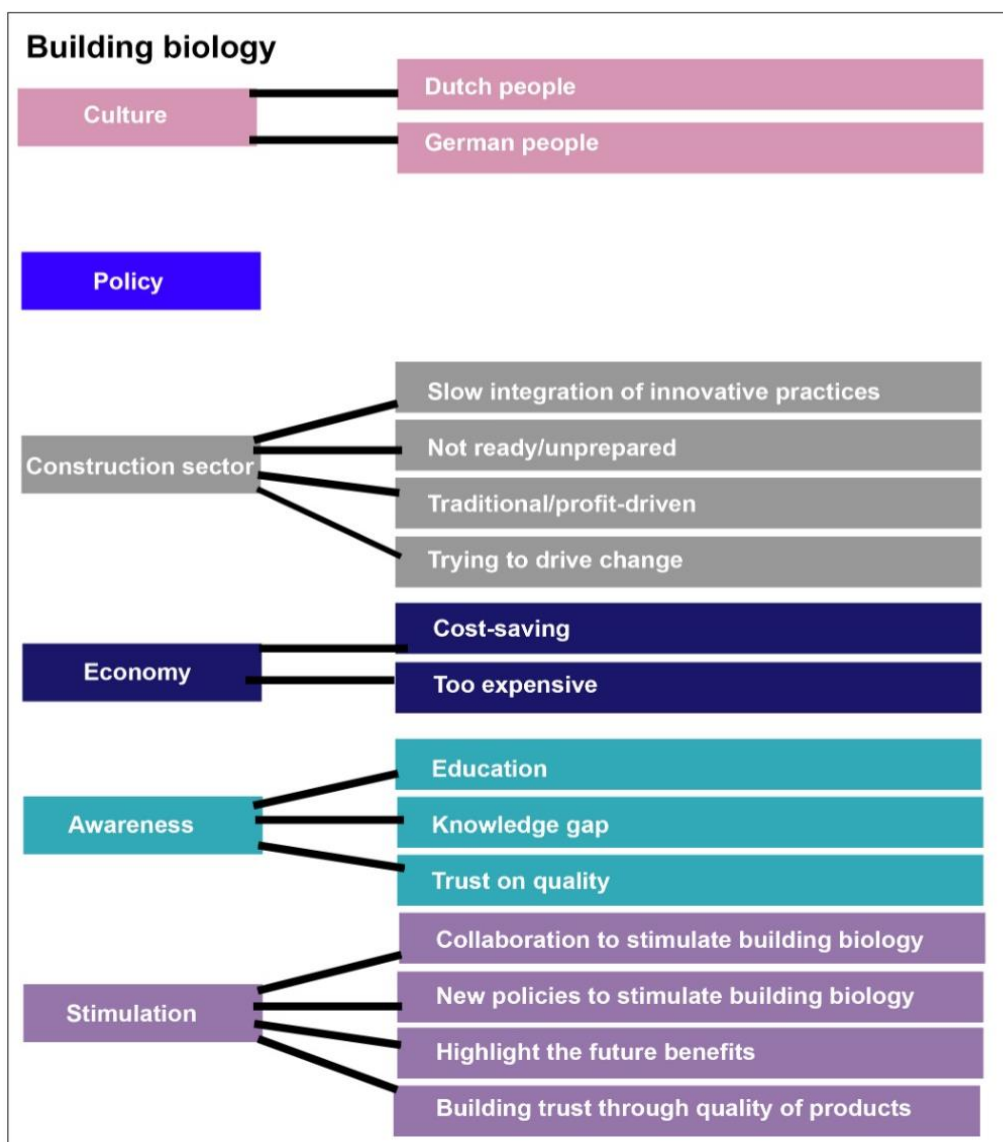
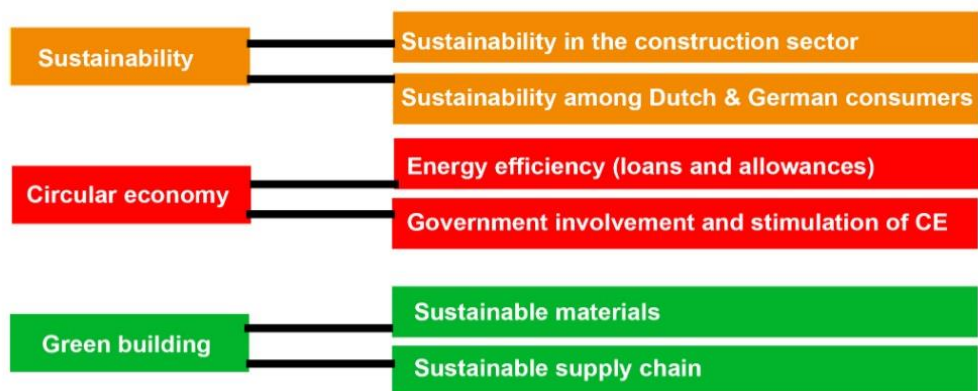
- *New policies*: this code includes all the responses where the experts saw the creation of new policies as a way to stimulate building biology in the Netherlands.

- *Highlight the future benefits*: this code includes all the responses where the experts saw the spread of awareness and the benefits of the growth of building biology as a way to accelerate its growth. (cost-saving, healthier environment, sustainable, marketing)

- *Building trust*: this code includes all the responses where the experts saw building trust as a key element to stimulate building biology. The ways of doing so were: building trust through the quality of the products (certifications, marketing, awareness).

CODE TREE

The codes previously discussed are hereby summarized:



INTERVIEW CONSENT FORM MODEL

Interview Consent Form

The purpose

The purpose of this interview is to analyze the approach and ideas of building biology among experts in the sustainable construction sector to explore the current advantages and challenges of engaging with this sustainable practice. The study will proceed with introductory questions to then go around the idea of sustainability in the construction sector. Finally, the idea of circular economy will be discussed in relation to green building and more specifically, building biology. As part of this study you will be asked to participate in an interview with semi-structured and open-ended questions. This study will take approximately 30 minutes.

Participants' Rights

- I understand that my responses will be kept in the strictest of confidence and will be available only to the researcher.
- The research will contain my name and/or company name under my consent.
Yes/No
- I also understand that I may skip any questions or tasks that I do not wish to answer or complete.
- I understand that the consent form will be kept separate from the data records to ensure confidentiality.
- I may choose not to participate or withdraw at any time during the study without penalty.
- **I agree to have my responses film recorded and transcribed for further analysis** with the understanding that my responses will not be linked to me personally in any way.
- After the transcription is completed, the recordings will be destroyed

Consent to Participate

I understand my rights as a research participant as outlined above. I acknowledge that my participation is fully voluntary.

Signature: _____ Date: _____