TU Delft Department of Architecture
BK Bouwkunde

Graduation papers

Alaa Alden Alhamad

aE graduation studio
Research tutor: Andy Jenkins
Design tutor: Mo Smit
Building technology tutor: Paddy Tomesen
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CONTENT:

APPENDIX:

The implementation of a double-skinned façade and its influence on health and well-being in intergenerational residential buildings?

Investigating the impact of the double skin facade system and exploring whether the implementation of a double skin facade to an
existing vacant buildings will enhance the health and wellbeing of the building’s residents.

Introduction

The Netherlands is experiencing a significant housing shortage (Value, 2022). The housing shortage in the Netherlands is worse than previously assumed, and it is projected to decrease in the coming years. The housing shortage will peak at 415,000 homes in 2024, according to the most recent estimates. This is about 100,000 additional homes than at the end of 2019, accounting for 5.1 percent of the total housing stock. According to the Dutch government's 'The State of the Housing Market,' the current housing shortage is now estimated to be around 331,000 homes. This is about 15,000 more homes than the forecast in Capital Value's research report from earlier this year. The increase in the housing shortage is partly due to a decrease in the number of new homes being built. (Value, 2022)

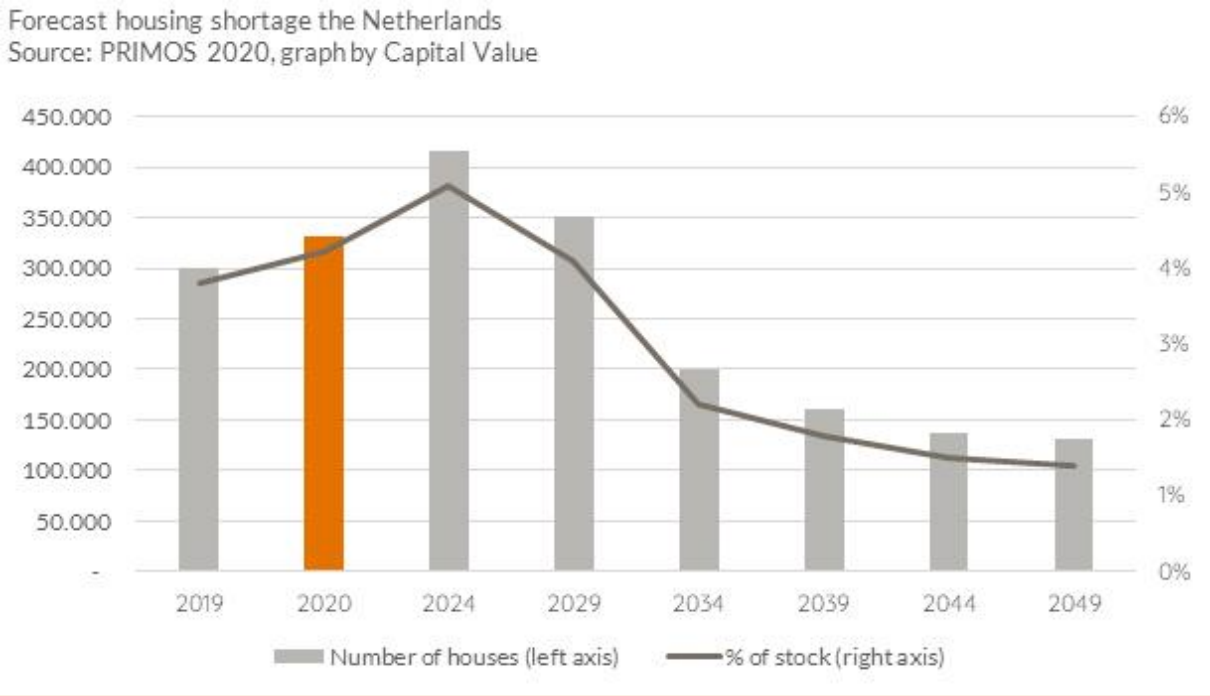


Figure (1)

Due to the housing crisis, prices are continuing to increase across the country, and the housing market is becoming increasingly competitive, with many people who needed to overbid to get their ideal home. As a result, an entire generation is in danger of losing connection to the housing market. (Séveno, 2022)
Housing prices are increasing rapidly. As we can see below in the Percentage change on previous year of housing prices in the Netherlands from January 1996 to August 2021 graph. It is becoming almost vertical, what you see that in August 2021, house prices in the Netherlands increased with approximately 18 percent when compared to the same period a year before. (Stipp, 2022). That is indeed sounding the alarm and requesting serious intervention.

Figure (2)

As a result, a group of people, including officials from the housing and insurance industries, has presented a strategy that will allow the Netherlands to build one million new homes over the next ten years. (Stearns, 2022)
The plan also emphasizes the fact that the quality of life in various neighborhoods across the country is declining, and the groups would like to see an improvement in sustainable infrastructure and quality housing for all: "We are concerned about vulnerable neighborhoods and residents who sometimes need other forms of help and care than that which is available to them," said Martin van Rijn, chairman of housing corporation lobby group Aedes. (Stearns, 2022)
Building 1 million homes in ten years would most certainly require a lot of resources and energy. As a result, it would be far more cost-effective and environmentally responsible to adapt and renovate existing structures.
Since the 2008 economic crisis, new issue has arisen in the Netherlands, essentially vacant unused buildings. Over the last decade, vacancy levels in international office markets have reached a record high. In the Netherlands, about 400 thousand residences are uninhabited; 190 thousand (2.5 percent of the dwelling stock) have been vacant for more than eighteen months. (Groen, Mateboer & van Daalen, 2022)
On one hand, the majority of the vacant buildings are among the "least appealing buildings" in the present stock. Apart from their lack of architectural quality, most buildings do not meet current energy efficiency criteria. In terms of cost and energy use, leaving buildings unoccupied is a waste of resources. (Remøy & van der Voordt, 2014)
Nevertheless, and on the other hand, the vacant building issue could be turned into an advantage to participate in solving the housing crisis in the Netherlands, by transforming the vacant structure to usable homes for people.
However, different concepts should be realized in these interventions especially sustainability concepts which leads to another issue mentioned in “Design for social sustainability” paper, which needs to be considered. According to the “design for social sustainability” paper, in popular sustainability debates, social sustainability is usually ignored. Economic and environmental sustainability have been prioritized in planning, housing, and communities, with policy and investment focusing on renewable resources, low-carbon communities, and encouraging pro-environmental behavior in households. As a result, there are few practical materials that directly address the subject of how to develop socially and environmentally sustainable locations and infrastructure. (Woodcraft, Bacon, Caistor-Arendar & Hackett, 2022)

Overall Proposals

According to the Tu-Delft professors Marja Elsinga and Thijs Asselbergs, new construction is certainly necessary, but existing space can also be used better, and a critical analysis of the housing system is in order. (Asselbergs, Elsinga, 2022)
“Actually, all the cubic meters are already there, all kinds of business premises and offices, but also churches and farms can in principle be made suitable for habitation,” said Thijs. (Asselbergs, 2022)
One of the reasons for the current housing problem, according to more than 50 percent of 191 municipalities, who surveyed by the national broadcaster and regional media outlets, is the difficulties of senior inhabitants to comfortably transition to another home. This can subsequently lead the housing market to stall, as municipalities in Gelderland, Limburg, Overijssel, and Zuid-Holland have highlighted. (NL times, 2022)
Moreover, and according to the NOS, the inadequate availability of smaller homes into which older people can move when there is less of a demand for a larger living area is a major driver of the housing problem in the Netherlands. (NL times, 2022)
The municipality of Zwijndrecht emphasized: “Senior citizens moving from a single-family home to an owner-occupied apartment designed for older people could kick-start a chain reaction that opens up the housing market” (NL times, 2022)
As proposal, a vacant building would be transformed into an intergenerational healthy living community. This complex's target audience includes the elderly, students, and starters. The elderly in this case will depart reasonably large dwellings, which would be used to host larger families, by developing new attractive homes for the elderly, as shown in the diagram below.

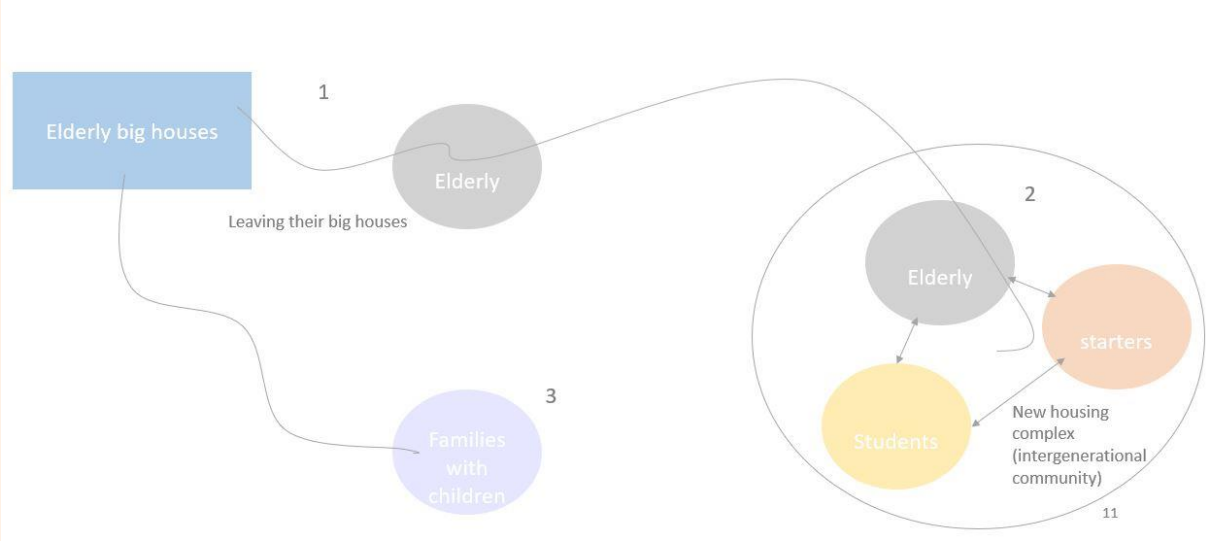


Figure (3)

Objective

Making 1 million homes is a very unfortunate framing of the housing shortage problem, this is not about the figure 1 million homes, this is about a system that makes sense in relation to what the current needs of the population are. Therefore, just building new homes is not a sensible solution, indeed new homes must be created, however, that does not mean building from ground up. Especially with considering the opportunity of transforming and repurposing old vacant buildings into new suitable homes. First, certain aspects such as sustainability, healthy environment affordability level of the newly created homes should be realized.

Overall design question

How to transform an old vacant office building into a healthy intergenerational living environment, while enhancing the healthy living and wellbeing of the target group?

As aforementioned, most vacant buildings do not meet current energy efficiency criteria, there is a need for a technical and architectural solution to make the building suitable for habitation and to provide a high quality of life for its residents. Secondly, in Modern architecture, building design has changed substantially in response to evolving needs for comfort, functionality, and energy efficiency. This progress has resulted in a variety of design innovations, ranging from the use of new materials to the incorporation of smarter design components. The double-skin façade, for instance, is a standard single-skin façade that has been doubled up with an additional exterior layer that covers all or part of the building within. (CASSANDRA, 2022)

this thematic research paper will be investigating the benefits of this type of facade system and if the implementation of a double skin façade (DSF) to an existing vacant building will enhance the health and wellbeing of the building's residents, emphasizing at maximizing natural daylight without overheating, playing a role in the building ventilation whilst improving the air quality and noise attenuation. As same as exploring other potentials of the double skin façade (DFS), for instance, providing extra spaces that could be used as communal balconies to enhance social sustainability between different target group or winter garden with the experience of an outdoor space, connecting the residents with nature for which will reflect positively on their mental health.
Thematic Research Question

Thematic Research Question:
How can a double skin façade (DFS) improve the health and wellbeing of the inhabitants of a building, focusing specifically on access to natural light, ventilation, noise attenuation, and providing social spaces?

Sub-questions:

What is the impact of natural light, ventilation, noise attenuation, and social spaces on the health and wellbeing of building inhabitants?
How can a double skin façade (DSF) improve access to natural light without overheating?
How can a double skin façade (DSF) contribute to building ventilation while improving air quality?
How can a double skin façade (DSF) contribute to building noise attenuation?
What are the specific social spaces provided by the double skin façade, and how do they enhance the building's social sustainability?

Methodologies:

This research will be carried out in the following phases:

1st: I will conduct case studies on existing realized projects that incorporate a double skin façade. These case studies will evaluate the success of the key elements of natural light, ventilation, noise attenuation, and social spaces. The criteria used to evaluate the success of the case studies will be based on the specific needs and preferences of the target group of inhabitants for whom the building is being transformed.
2nd: Then technical analysis: I will conduct a technical analysis of the building to identify the specific challenges and opportunities of implementing a double skin façade. This will include an evaluation of the building's size, shape, orientation, location, and existing energy efficiency measures.
3rd: proposal: Based on the findings from the case studies and technical analysis, we will develop a design proposal for implementing a double skin façade in the old vacant office building. The proposal will include specific design solutions for addressing the health and wellbeing features being investigated, as well as an evaluation of the feasibility and cost-effectiveness of the proposed solutions.

Chapter 1:

literature study

The impact of indoor air quality on health and wellbeing

Indoor Air Quality (IAQ) has become a rising issue in recent decades, as people spend 90% of their time indoors, in places like homes, schools, gyms, and workplaces. Poor indoor air quality can have a significant effect on the health and well-being of building occupants. Ventilation, pollutant sources, and construction materials all have an impact on IAQ.
Several studies have found that IAQ changes qualitatively and quantitatively over time, with pollutants and their levels increasing. This has prompted several countries, including the United Kingdom and Germany, to create non-industrial building IAQ standards, regulations, policies, and monitoring plans. Poor indoor air quality can be especially dangerous for vulnerable populations such as infants, young adults, the elderly, and those suffering from chronic respiratory and/or heart disease. (Cincinelli and Martellini, 2017).
The impact of air quality on subjective well-being (life satisfaction, happiness, and optimism) is examined in the book "Wellbeing and Quality of Life." The results show that air pollution has an effect on subjective well-being, with a significant link between life satisfaction and happiness. When there is good air quality, people are happier and more hopeful. Poor air quality can cause negative feelings and a decrease in well-being. Mollaolu (2017).
Furthermore, IAQ can influence cognitive performance and productivity in the workplace. Improved IAQ has been shown in studies to improve cognitive function, decision-making skills, and productivity. Furthermore, poor indoor air quality has been related to respiratory diseases, allergies, asthma, and even lung cancer. (Milton, 2014)
In conclusion, indoor air quality (IAQ) is an important factor in the health and well-being of building occupants, with possible effects on cognitive performance, productivity, and subjective well-being. To improve IAQ and reduce health risks associated with indoor air pollution, it is critical to maintain proper ventilation, identify pollutant sources, and use suitable building materials.

The impact of natural lights on health and wellbeing

Natural light is essential for maintaining human health and happiness. Natural light exposure has been shown in studies to improve well-being, productivity, and cognitive function, whereas insufficient sunlight exposure can be harmful to health. The intensity and wavelength of natural light, on the other hand, are essential factors to consider when designing spaces to optimize their health and well-being benefits.
According to research, the intensity and wavelength of natural light change throughout the day and can have varying effects on human physiology and health-related concepts. For example, morning light contains more blue wavelengths, which are known to be essential in regulating our circadian rhythms and promoting alertness and productivity. Evening light, on the other hand, contains more red wavelengths, which can aid in relaxation and a feeling of calm. (Figueiro & Rea, 2016).
Good daylighting is defined as "the controlled admission of natural light into a space to provide appropriate and sufficient illumination for the occupants' visual needs while minimizing undesirable effects on the space and occupants" as defined by the Illuminating Engineering Society (IES). (IES, 2019). The IES recommends that designers consider factors such as window location and orientation, glazing type, and the use of shading devices to control glare and heat gain to achieve effective daylighting.
The IES suggests that interior illuminance levels range between 300 and 3,000 lux to ensure that occupants receive sufficient exposure to natural light, depending on the task at hand and the time of day. (IES, 2019). Furthermore, the IES suggests that designers consider the color temperature of natural light, which can affect occupants' mood and well-being. Warmer light (lower color temperature) can, for example, promote relaxation and peace, whereas cooler light (higher color temperature) can promote alertness and productivity.

To summarize, natural light is critical for human health and pleasure. Designers should consider factors such as the intensity, wavelength, and color temperature of natural light, as well as the location and orientation of windows, the type of glazing used, and the use of shading devices, to optimize the health and well-being benefits of natural light. Designers can help support occupant well-being and create healthier, more productive environments by designing spaces that emphasize natural light.

The impact of noise on health and wellbeing

Over 170 million people in the European Union are exposed to noise levels between 55 and 65 decibels, and an estimated 80 million people in the European Union experience noise levels of 65 decibels or greater, which is considered to be unacceptable. (COMMISSION, 1996). Environmental noise has negative health effects, but it also has negative economic effects, costing industrialized European nations between 0.2% and 2% of their GDP. (Impairment, 1997).
According to research, noise levels over 55 dB are considered harmful because they conflict with hearing comfort, and prolonged exposure to noise between 65 and 80 dB can impair hearing capacity. Additionally, the most obvious and well-known type of urban noise pollution, traffic noise, alters physiology and cognition, disrupts sleep, and increases psycho-social stress (Ohrström, 2004).
An estimated 18% of people in the EU-28 record exposure to neighborhood noise, which includes noise from streets and neighbors that is not documented through the Environmental Noise Directive (END). The Netherlands, Malta, and Germany are among the nations that are most affected by noise pollution. Hearing loss, tinnitus, annoyance, disturbed sleep, cardiovascular events, cognitive impairment, metabolic effects, poor emotional health and well-being, and poor birth results are some of the health effects of excessive noise exposure. (Health Organization, 2017).
In addition to these effects, study has shown that buildings' ability to attenuate noise can significantly reduce the detrimental effects of environmental noise on occupants. The negative effects of ambient noise on health and wellbeing can be significantly reduced by using noise-attenuating techniques like insulation, sound-absorbing materials, and acoustic windows.

The impact of social spaces on health and wellbeing

The effect of social spaces in a building on health and well-being has been widely researched in architecture and environmental psychology. According to the study, communal areas, courtyards, and gardens in a building have a positive effect on the health and well-being of the occupants. These areas encourage social interaction, relaxation, and physical exercise, all of which contribute to better mental and physical health.
According to one research, access to outdoor spaces and views of nature in buildings is associated with lower levels of stress and greater levels of overall well-being. (Hartig et al., 2014). Another study found that social interaction in communal areas can reduce loneliness and boost social support among residents. (Yan & Yildirim, 2020). Access to communal spaces can also encourage physical activity and reduce sedentary behavior, both of which are linked to better physical health. (Sugiyama et al., 2014). Furthermore, the design of social places can influence health and well-being. The use of natural materials and colors in communal spaces, for example, has been shown to have a calming impact on occupants. (Ulrich et al., 1991). Furthermore, the size and layout of social areas can impact the frequency and quality of social interactions between occupants. (Ou et al., 2020). Overall, social spaces in a building play an important part in supporting occupant health and well-being. As a result, architects and building designers should think about including these spaces in their designs to create buildings that support the health and well-being of their occupants.

Chapter 1 Conclusion:

We can conclude from research on the impact of natural light, ventilation, noise attenuation, and social spaces on the health and well-being of building occupants that each of these factors plays a significant role in promoting or deteriorating individuals' physical and mental health. Indoor air quality is critical to building occupants' health and well-being, with potential impacts on cognitive function, productivity, and subjective well-being. To improve IAQ and reduce health risks associated with indoor air pollution, it is essential to maintain proper ventilation, identify pollutant sources, and use appropriate building materials. Natural light is important for human health and happiness, improving well-being,

productivity, and cognitive performance, whereas insufficient sunlight exposure can be harmful to health. To maintain human health and well-being, adequate access to natural light should be guaranteed. Noise pollution is harmful to one's health and can cause hearing loss, sleep disruption, and brain impairment, among other things. Noise levels above 55 decibels are deemed dangerous, and noise reduction measures should be implemented to guarantee a healthy and peaceful living environment. Social spaces are critical for encouraging social interaction, reducing loneliness and social isolation, and improving mental health and well-being. Finally, building design should take these factors into account in order to support the health and well-being of building occupants.

Chapter 2:

Case studies:

In recognition of their potential to increase energy efficiency and indoor comfort, double skin façades are becoming increasingly common in building design. The success of such integration, however, is contingent on a number of variables, including natural light, ventilation, noise reduction, and social spaces. Case studies on existing realized projects that incorporate a double skin façade will be conducted in this research, with an emphasis on evaluating the success of these key elements.
The criteria for evaluating the success of the case studies will be based on the specific requirements and preferences of the target population for whom the building is being transformed. (Elderly, students, and starters).

Research criteria	1	2	3	4	5
1- Natural light:	Amount of natural light entering the building's interior space.	Quality of natural light (e.g., direct, or indirect, diffuse, or harsh)	Distribution of natural light throughout the building	Impact of natural light on the inhabitants' mood, productivity, and overall well-being	
2- Ventilation:	Amount of fresh air circulating through the building's interior spaces.	Distribution of air flow throughout the building	Temperature and humidity levels within the building	Effectiveness of ventilation in reducing indoor pollutants (e.g., CO2, VOCs)	Impact of ventilation on the inhabitants' health, comfort, and overall well-being
3- Noise attenuation	Sound insulation properties of the double skin façade	Reduction in exterior noise levels within the building	Reduction in interior noise levels (e.g., echoes, reverberation)	Effectiveness of noise attenuation in promoting a peaceful and quiet living environment	
4- Social spaces	Quantity and quality of social spaces provided by the double skin façade (e.g., communal balconies, winter gardens)	Accessibility and usability of social spaces for different age groups and physical abilities	Impact of social spaces on promoting social interaction, community building, and overall well-being of the inhabitants		

1- Transformation of 530 dwellings - Grand Parc Bordeaux:

The project involves the transformation of three social housing complexes totaling 530 apartments.
They were built in the early 1960s and required rehabilitation after demolition was ruled out. (Lacaton, Vassal, Frédéric and Hutin, 2019)

Figure (4)

Access to Natural Light:

As part of the renovation of the Grand Parc Bordeaux, a double skin facade was installed, which increased the building's energy efficiency while letting plenty of natural light enter the interior areas. Both the living spaces and the circulation areas have access to natural light thanks to the facade's mix of full-height windows and sliding doors. (Lacaton, Vassal, Frédéric and Hutin, 2019)

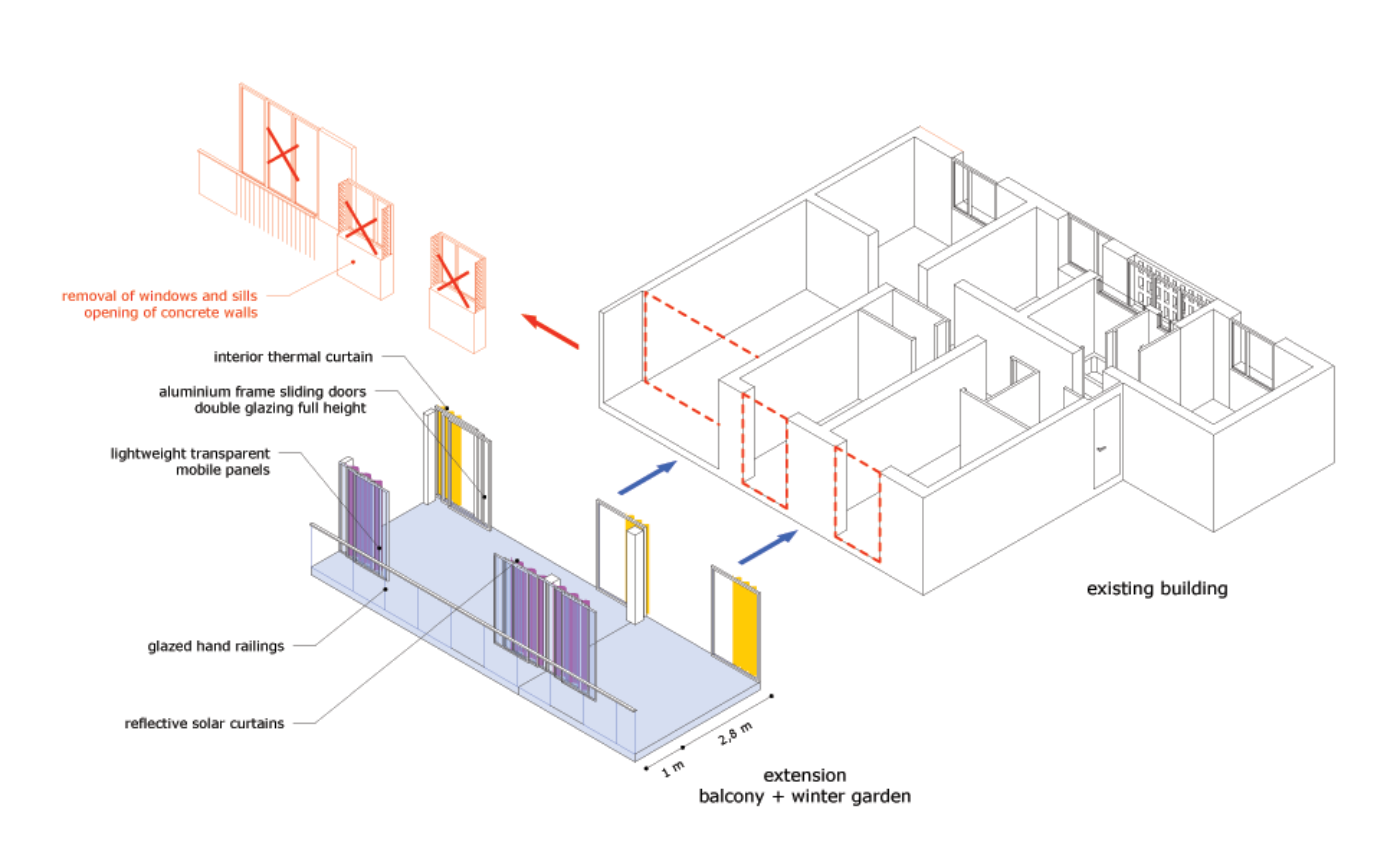


Figure (5)

Ventilation: By incorporating a system of automated vents that promote natural air movement, the double skin facade also assisted in enhancing the building's ventilation. A central system manages the vents and regulates the apertures in response to temperature and humidity readings. Additional possibilities for natural ventilation are provided by the facade's use of sliding doors. (Lacaton, Vassal, Frédéric and Hutin, 2019)

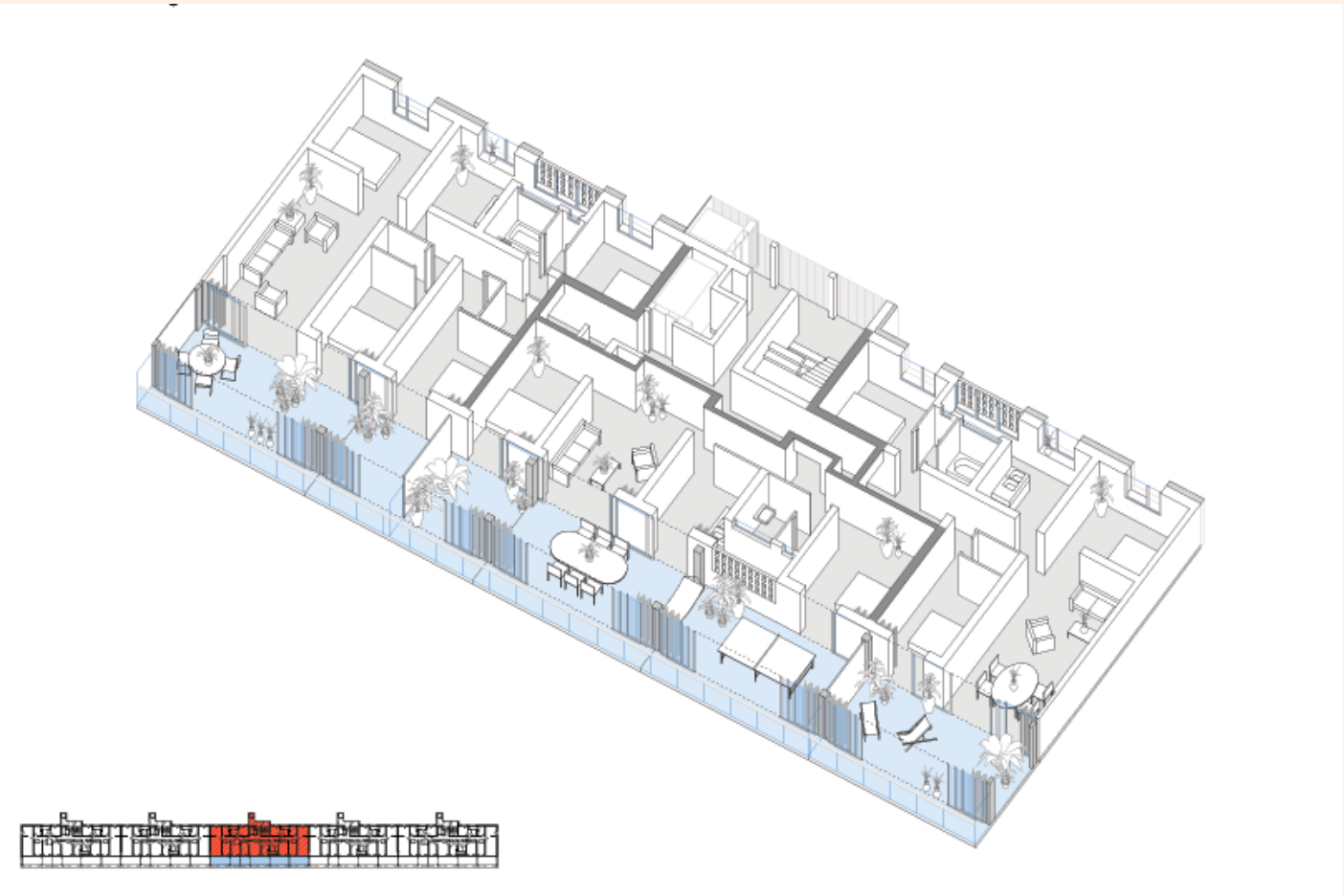


Figure (6)

Noise attenuation: Because of the Grand Parc Bordeaux's proximity to a bustling road, noise attenuation was a crucial factor in the renovation of the structure. The double skin facade separates the living areas from the street, which serves to lessen outside noise. Due to the air gap between the two levels of glass that make up the facade, sound waves are absorbed and attenuated.

Figure (8)

Providing social spaces: As part of the Grand Parc Bordeaux's transformation, new communal areas for the neighborhood's inhabitants were created, including a rooftop terrace and a shared garden. These areas encourage social interaction between residents and strengthen the feeling of belonging to the building. Furthermore, having full-height windows in the living areas gives residents views of the neighborhood, which may help to strengthen their feeling of community.

The implementation of a double-skin facade in residential buildings has beneficially affected the criteria of access to natural light, ventilation, noise attenuation, and providing social spaces, according to research done on the Grand Parc Bordeaux project. The need for artificial lighting and air cooling has decreased as a result of improved ventilation and light control provided by the double-skin facade. Additionally, the façade has offered a reliable noise buffer, lowering the levels of noise pollution inside the units. Furthermore, the building features a number of communal areas that promote social interaction among the residents, like gardens and playgrounds. Overall, the case study indicates that adding a double-skin facade to residential buildings can be an effective way to increase their livability.

2- Agbar Tower Barcelona, Jean Nouvel

Torre Agbar building was designed by French architect Jean Nouvel in association with the firm B720. Arquitectos, headed by Fermin Vásquez, is the headquarter of **Ag**ua de **Bar**ceona, has thirty-five floors and an overall height of 142 meters. The building is located in Barcelona, next to Plaça de les Glòries, between Avingua Diagonal and Carrer Badajos.

The construction responds to a request made by the Barcelona Water Company (Agbar), who wanted a structure that is modern and fits the needs of their present growth. (WIKIARQUITECTURA, 2022)

Figure (9)

The design integrates many architectural approaches, generating an outstanding reinforced concrete structure with a glass exterior and over 4,500 window apertures cut out of the structural concrete. It was the third tallest building in Barcelona when it was finished. (WIKIARQUITECTURA, 2022)

Figure (10)

Access to Natural Light:
Innovative double-skin glass is used in the Agbar Tower's facade to optimize natural light while reducing heat gain and glare. A dynamic and reflective appearance is produced by the 60,000 triangular metal and glass plates that make up the outer layer. A metallic layer is applied to the inner layer of glass to reduce the quantity of heat that enters the structure. Additionally, the skyscraper has a central atrium that lets natural light flood the entire interior of the structure. The tower also has a sun protection system that adapts to the location of the sun to maximize natural light and reduce glare. (WIKIARQUITECTURA, 2022)

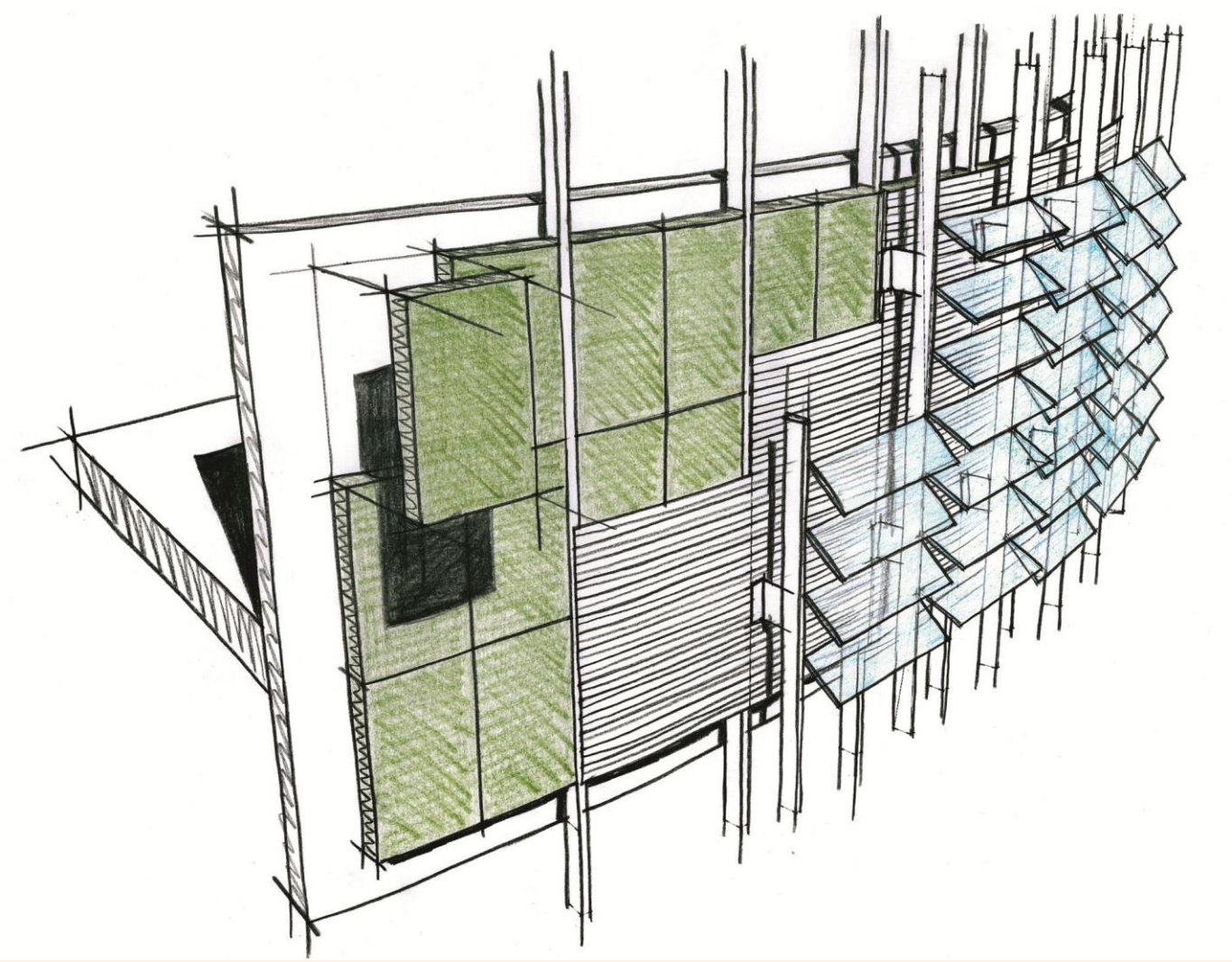


Figure (11)

Ventilation:
A hybrid ventilation system that blends mechanical and natural ventilation is used in the Agbar Tower. Natural ventilation is permitted by the tower's double-layered facade, while a mechanical ventilation system guarantees that the air is consistently of a comfortable temperature. In order to save energy, the ventilation system also has an energy recovery system that warms incoming fresh air using warm air from the inside of the structure. (WIKIARQUITECTURA, 2022)

Noise Attenuation:
Soundproofing technology in the Agbar Tower lowers amounts of ambient noise. The double-layered glass facade serves as a soundproofing barrier, and carpeting and acoustical ceilings in the interior areas absorb sound.

As a conclusion the implementation of a double skin facade can significantly affect the building's energy efficiency, access to natural light, and ventilation, according to the study of the Agbar Tower in Barcelona. When used in conjunction with other energy-saving technologies, an intelligent facade system can greatly lower the building's energy use and carbon footprint. Agbar Tower's double skin facade design also improves user comfort and the quality of the interior environment. It offers thermal insulation and a noise barrier, which lowers thermal variations and noise pollution. The ventilation system keeps a cozy indoor temperature while enhancing the quality of the air inside.
The case study does, however, also point out some difficulties that must be taken into account when putting a double skin façade into practice. For instance, the system's initial investment cost may be high, and regular maintenance is necessary to guarantee proper operation. Additionally, careful consideration of numerous variables, such as wind loads and solar radiation, is necessary for the design and installation of a double skin facade.

Overall, the case study of the Agbar Tower in Barcelona shows the possible advantages of a double skin facade on a high-rise structure, including increased energy efficiency, access to natural light, and indoor air quality.

3- KMC Corporate Office:

Located in Cyber City, Hyderabad. The KMC Corporate Office's double skin facade is intended to provide natural light and ventilation while also reducing noise levels from the neighboring region. This facade system is made up of an outer layer of tinted glass and an interior layer of clear glass, with a cavity in between for natural ventilation. (RMA Architects, 2013)

Figure (12)

Social spaces:
In terms of communal areas, the KMC Corporate Office has several throughout the building, including a big atrium with seating and greenery, a rooftop terrace, and a coffee store. These areas are intended to encourage social interaction and community building among building workers and visitors.

Natural light:
The KMC Corporate Office prioritizes natural light, with large windows and skylights giving ample natural light throughout the building. This emphasis on natural light has been shown to improve building occupants' mood, productivity, and general well-being. (Hartig et al., 2014; Flores-Villa et al., 2020).

Figure (13)

Ventilation:

The KMC Corporate Office's double skin facade provides for natural ventilation, reducing the need for mechanical ventilation systems and enhancing indoor air quality. This has the potential to improve the health and comfort of structure occupants. (Ou et al., 2020; Ulrich et al., 1991).

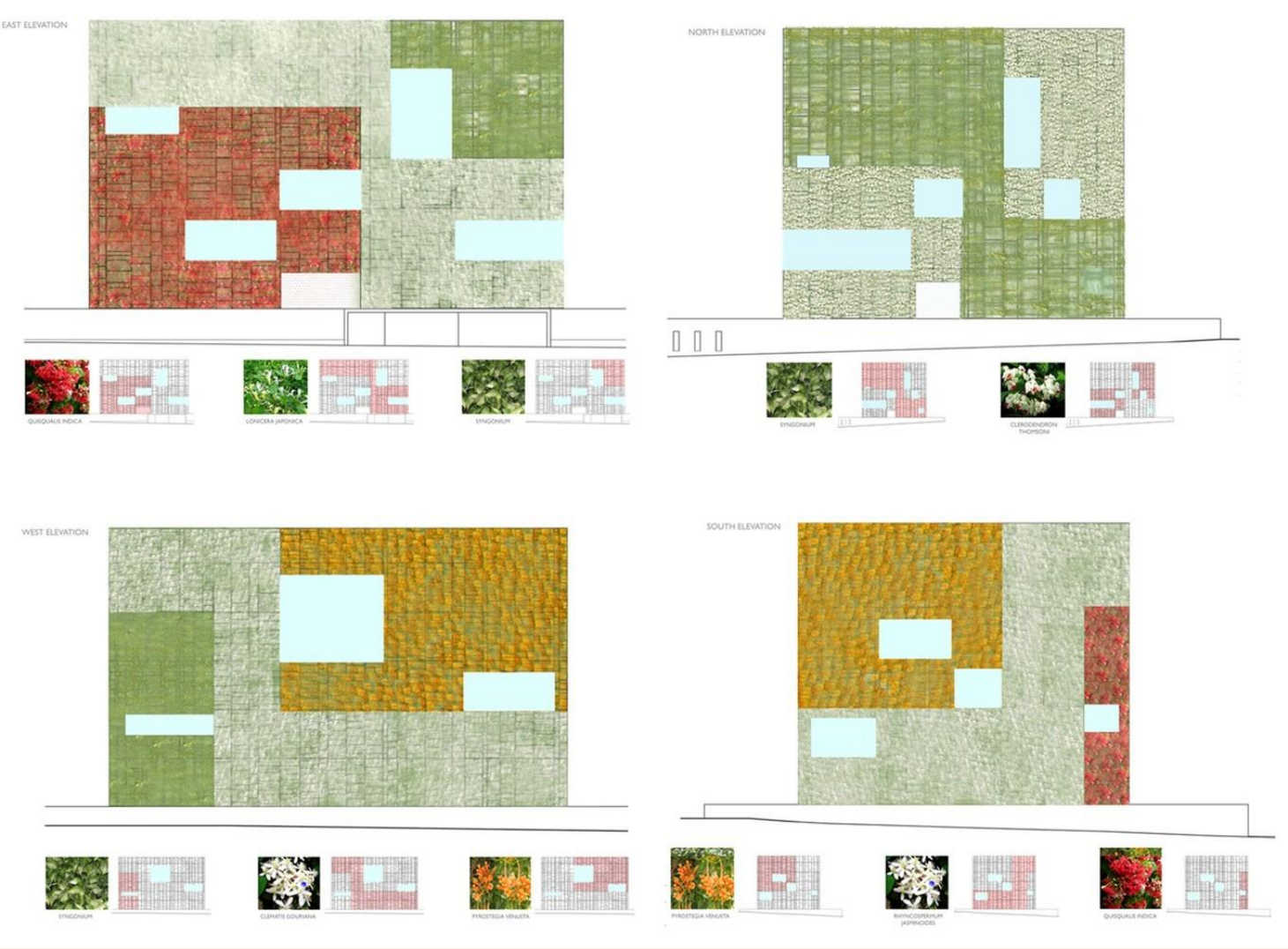


Figure (14)

Noise attenuation:

Finally, the KMC Corporate Office's double skin facade offers noise attenuation, lowering exterior noise levels within the building and providing a peaceful and quiet living environment. This can improve the well-being and efficiency of building occupants. (Sugiyama et al., 2014).

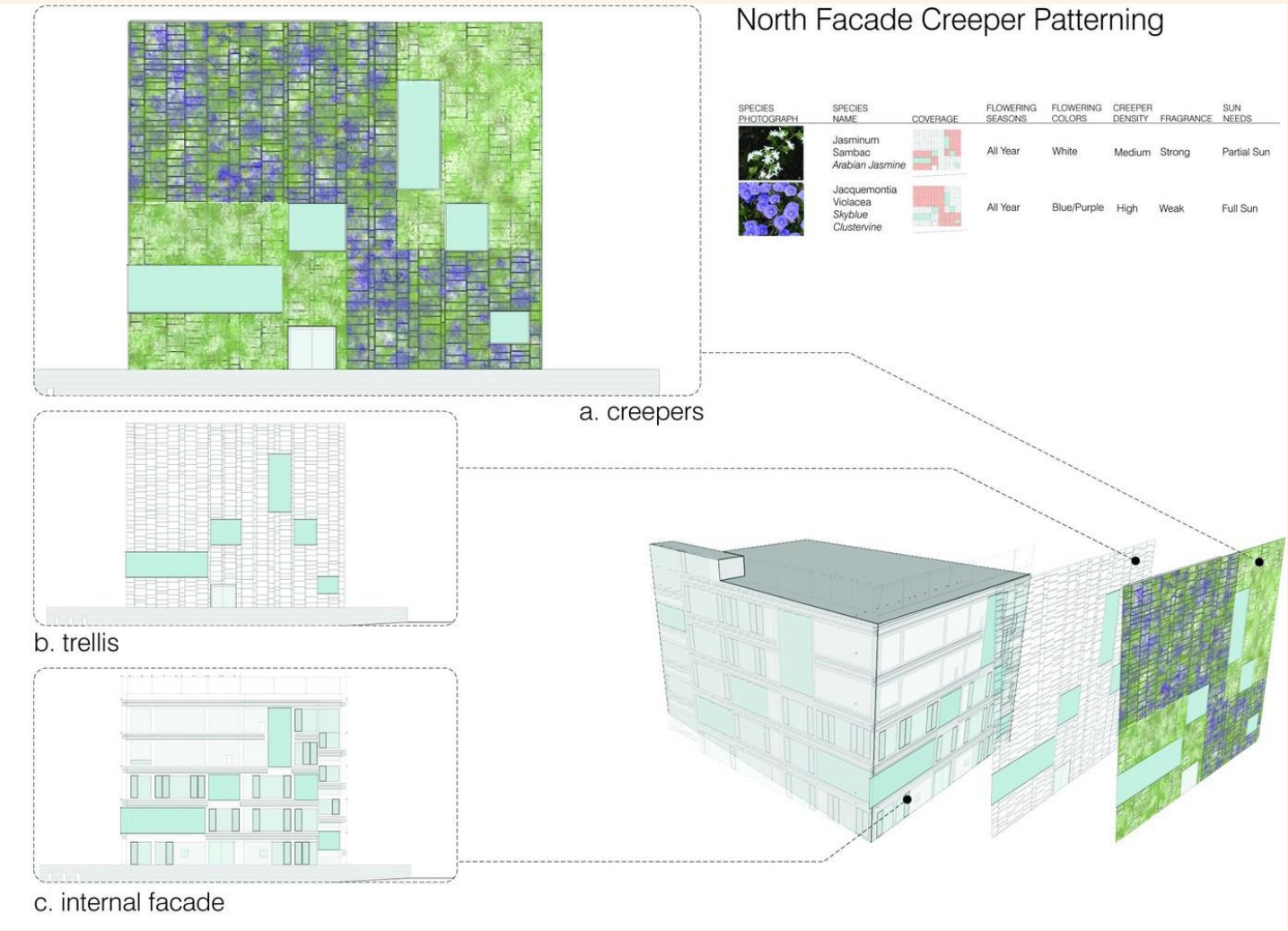


Figure (15)

As a conclusion, the installation of the double skin facade in the KMC Corporate Office has improved social areas, access to natural light, ventilation, and noise attenuation. The communal areas throughout the building encourage social interaction and community building, while the big windows and skylights allow for plenty of natural light and the double skin facade provides for natural ventilation and noise reduction.

Chapter 2 conclusion

To summarize, because most abandoned buildings do not fulfill current energy efficiency regulations, a technical and architectural solution is required to make the building fit for occupancy and to provide a high quality of life for its people. Taking this into account, building design has evolved significantly in response to changing needs for comfort, functionality, and energy efficiency. that has been considered, which is why innovation has resulted in a diversity of design innovations. This thematic research paper investigated the benefits of a double skin façade DSF system and whether its implementation in an existing vacant building will improve the health and wellbeing of the building's residents by maximizing natural daylight without overheating, contributing to building ventilation, and improving air quality and noise attenuation. Similarly, to investigating different possibilities for the double skin façade (DFS).
As a results, the double skin façade potentially plays a significant role in the heating, cooling, and shading system by optimizing natural light through its openings without overheating the buildings, as well as contributing to the ventilation

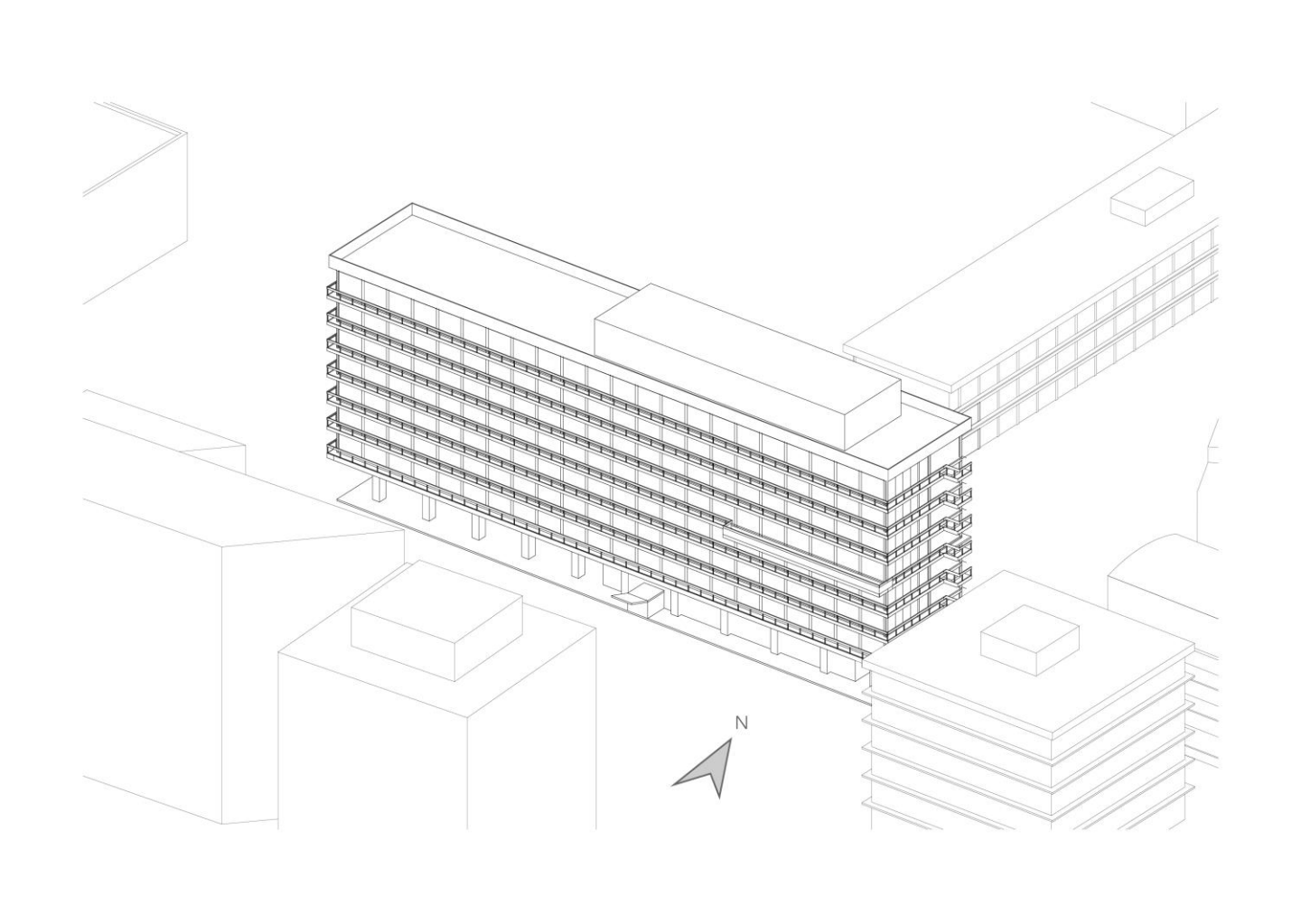
system and establishing a buffer zone for noise reduction. Furthermore, it could give extra spaces that could be used as communal terraces to improve social sustainability among diverse target groups or a winter garden with the experience of an outdoor space, connecting inhabitants with nature, which will have a beneficial impact on their mental health. As stated in the results, all of these findings have a positive impact on the health and wellbeing of the building residents. As a result, the DFS system directly contributes to the health and wellbeing of the building residents.

Chapter3
2nd Technical analysis

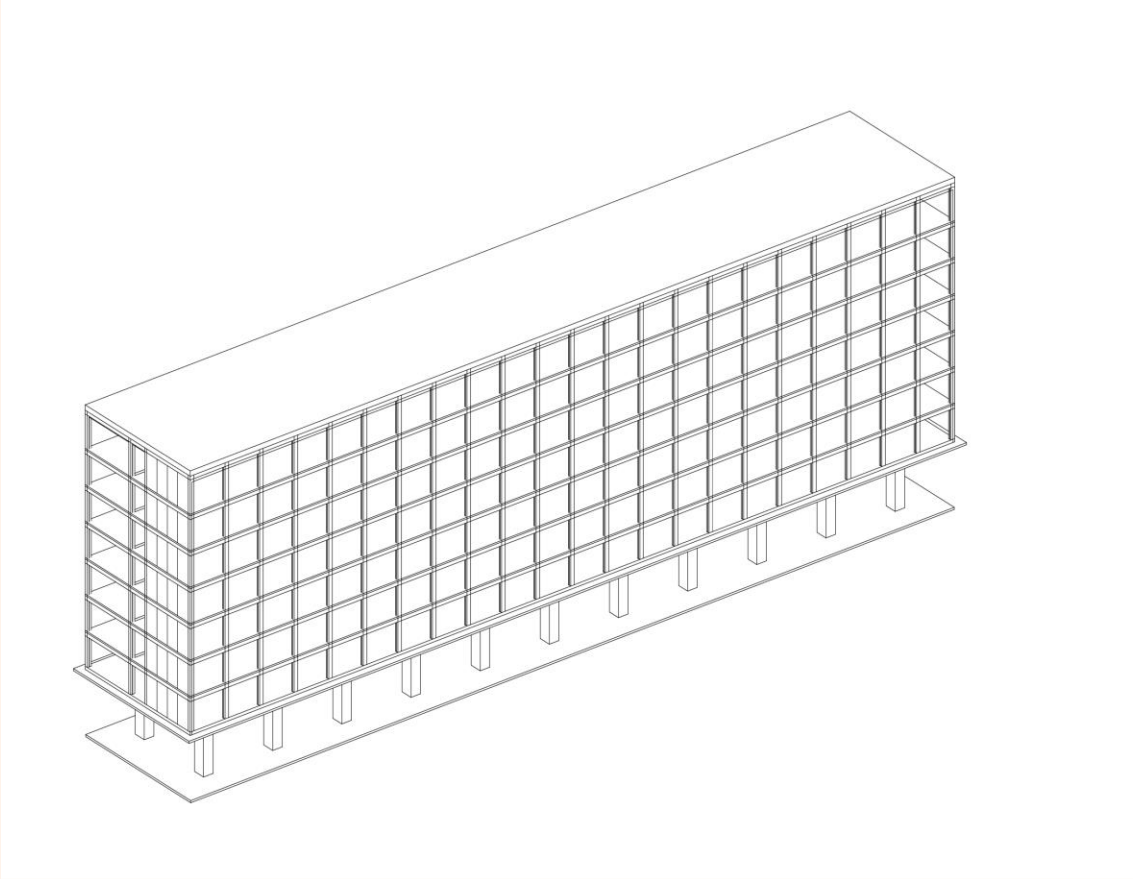
The former Tax Office building in Leeuwarden, the Netherlands, presents a number of challenges and possibilities for the implementation of a double-skin façade.

Size and Shape: The structure has a unique form, with a triangular footprint and a nine-story height. The façade is made of concrete slabs, which may make retrofitting a double skin system difficult. The building's total floor area is roughly 16,000 square meters.

Orientation and Location: The building is in an urban setting and faces southeast, with unobstructed views of the ocean. The direction allows for plenty of daylighting and passive solar heating. However, because the structure is in a dense urban area, access to implement and maintain a double-skin façade system may be limited.

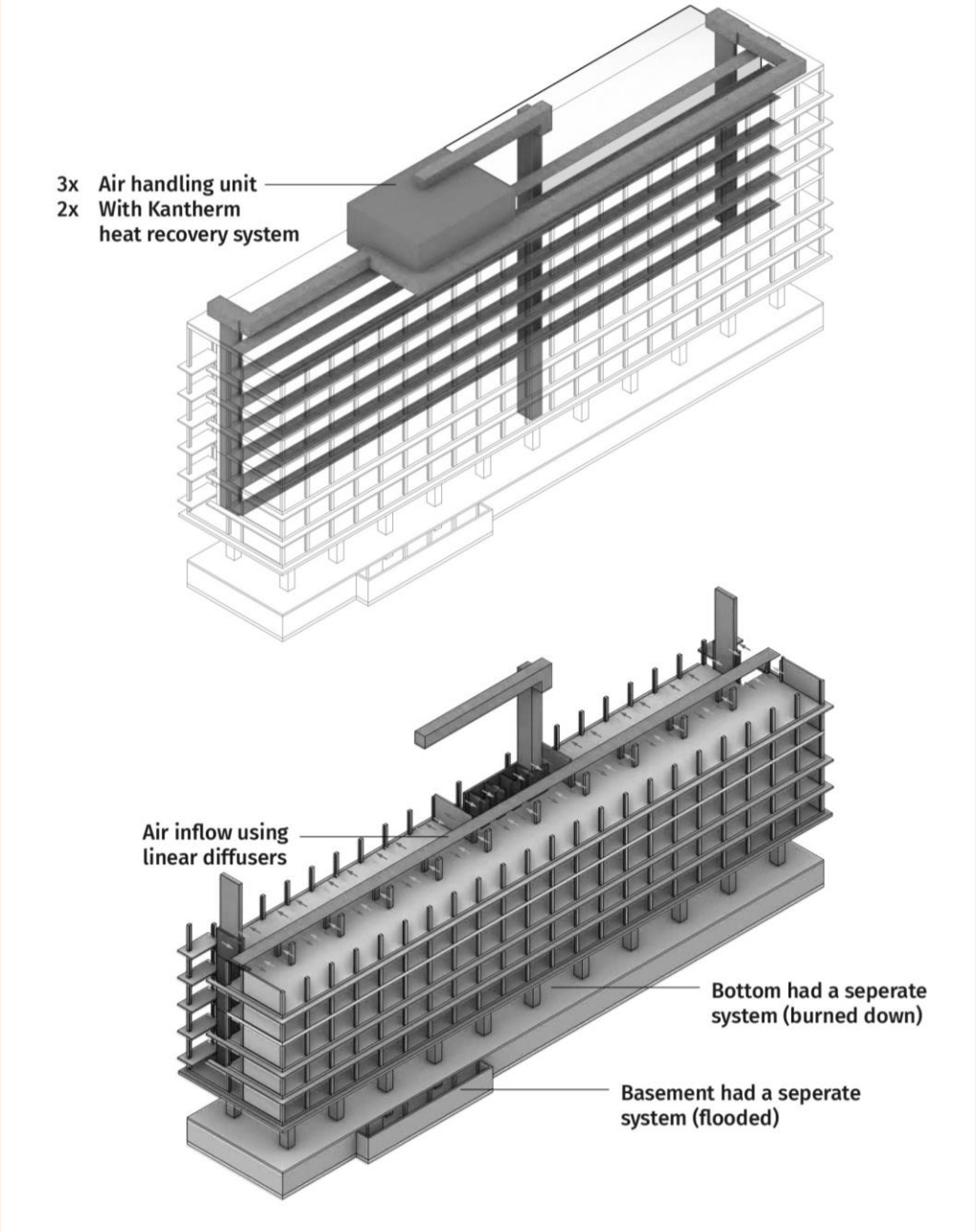


Existing Energy Efficiency Measures: The building's energy label is G, indicating that it has poor energy efficiency. Except for double glazing in some windows, the building has no major energy efficiency measures in place. As a result, implementing a double skin façade can significantly improve the building's energy efficiency.



Structural Considerations: Given that the building has a concrete frame construction with supports and beams, adapting a double skin system may be difficult. To guarantee structural safety, the weight and wind loads of the system must be carefully calculated and addressed during the design process.

Ventilation: The building's current HVAC system is outdated and inefficient, and retrofitting a double-skin façade may provide a chance to enhance the ventilation system. Natural ventilation can be provided by a well-designed double-skin façade system, decreasing the need for mechanical ventilation, and increasing indoor air quality.



Finally, the former Tax Office building in Leeuwarden presents a number of challenges and possibilities for incorporating a double-skin façade. While the building's unusual shape and concrete façade pose difficulties, its orientation and location allow for plenty of daylighting and passive solar heating. Installing a double skin system can significantly improve the energy efficiency and ventilation system of a building. In the construction process, structural safety, weight, and wind loads must all be carefully considered.

Conclusion:

Double-skin facades have emerged as a popular sustainable solution for contemporary buildings, with the potential to significantly impact energy efficiency, natural light access, ventilation, and noise attenuation. The Grand Parc Bordeaux project in France and the Agbar Tower in Barcelona are two prime examples of how double-skin facades have been successfully used to enhance building livability. These case studies show how installing a double-skin facade can improve a building's energy efficiency and comfort while also enhancing the quality of the interior environment.
Furthermore, installing a double-skin facade can provide substantial health and well-being benefits to building occupants. Double-skin facades can help to create a more comfortable and healthier indoor atmosphere by improving air quality and decreasing noise pollution. Furthermore, increased access to natural light via double-skin facades has been linked to positive health outcomes such as better sleep, mood, and productivity. Thus, incorporating double-skin facades into building design can benefit occupant well-being and support a healthier, more sustainable urban environment.

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APPENDIX

Appendix 1: P4 reflection paper

The Interplay of Architecture, Research, and Design in Creating a Healthy Living Community

Introduction:
In my journey towards completing my graduation project, I started on a path that intertwined my passion for architecture design with my studies in architectural engineering. Driven from the principles of sustainable design, human-centric architecture, and community development, my goal was to create a thriving and healthy living community within intergenerational residential buildings. This paper explores the link between my graduation project, my specialization in architecture, and my studies in architectural engineering. It investigates the reciprocal impact of research and design, evaluates the value of my approach and methodology, and examines the academic, societal, and ethical implications of my project. Furthermore, it explores the potential transferability of my project's results and their impact beyond the immediate context.

The Relationship between Graduation Project, Specialization, and Studies:
At the core of my graduation project is the implementation of a double-skinned façade in intergenerational residential buildings, with a specific focus on improving the well-being of elderly individuals transitioning from larger homes and other target groups. This project harmoniously aligns with my chosen specialization in architecture, which places a strong emphasis on sustainable design, energy-efficient building systems, and community-oriented architecture. By integrating a double-skinned façade, my aim was to enhance thermal comfort, natural ventilation, and acoustic performance, thus creating an environmentally friendly and sustainable living environment. The human-centric approach in architecture, which serves as the foundation for my project enables me to effectively address the unique needs and aspirations of the residents. Additionally, my studies in architectural engineering equip me with the technical knowledge and skills necessary to evaluate the feasibility and performance of the double-skinned façade system, ensuring its integration aligns with engineering principles and contributes to the overall well-being of the residents.

The Influence of Research on Design and Design on Research:
The interplay between research and design was a dynamic and iterative process, with each influencing the other throughout my project. Through a comprehensive analysis of reference projects such as the Grand Parc Bordeaux, Agbar Tower Barcelona by Jean Nouvel, and KMC Corporate Office, I gained valuable insights into the benefits of incorporating a double-skin façade and innovative façade systems in residential buildings. The research findings from these projects played a crucial role in shaping my design decisions and recommendations. I drew upon successful strategies employed in these reference projects to improve access to natural light, ventilation, noise reduction, and the creation of social spaces within the intergenerational residential building. Conversely, my design proposals and recommendations also influenced the direction of my research. The design process and proposed solutions guided me in refining and adjusting my research questions and methodologies, ensuring their practicality and applicability.

Assessing the Value of Approach, Methods, and Methodology:
Throughout my project, I adopted a user-cantered approach that took into account the diverse needs and preferences of the target groups, including the elderly, university students, and young professionals. This approach aimed to foster social integration, promote intergenerational interactions, and provide a supportive environment for all residents. My methodology was built upon a combination of research, case studies, technical analysis, and design proposals. These methods were highly relevant and informative for achieving my research and design objectives, providing a comprehensive framework for understanding and addressing the specific challenges of creating a healthy living

community. However, challenges such as accommodating the diverse target groups and determining the most suitable methods required careful consideration.

Transferability of Results and Potential Impact Beyond the Immediate Context:
Although my graduation project focuses on the design of intergenerational residential buildings and the implementation of a double-skinned façade, the knowledge and insights gained from this project have the potential for broader application and impact. The principles and strategies employed in creating a healthy living community, such as user-cantered design, sustainable architecture, and social integration, can be used to a variety of scenarios and building types. The knowledge acquired through this project can contribute to the development of future residential projects that prioritize the well-being of residents and foster a sense of community. By sharing my research findings, design proposals, and methodology, other architects, researchers, and developers can adapt and implement similar strategies in their projects, leading to the creation of healthier and more sustainable living environments on a larger scale. This transferability of knowledge is crucial in addressing the societal and environmental challenges we face today and striving towards a more inclusive and harmonious built environment.

Conclusion:
The interplay between my graduation project, specialization in architecture, and studies in architectural engineering showcases the intricate relationship between research and design. By integrating a double-skinned façade and applying sustainable and human-centric design principles, my project aims to create a healthy living community within intergenerational residential buildings. The reciprocal influence between research and design has allowed me to develop a comprehensive understanding of the challenges and opportunities associated with this objective. Through a user-cantered approach, supported by research, case studies, technical analysis, and design proposals, I have laid a solid foundation for addressing the unique needs of residents and fostering social integration. The transferability of my project's results expands its potential impact beyond the immediate context, serving as a valuable resource for architects, researchers, and developers striving to create healthier and more sustainable living environments. By combining the realms of architecture, research, and design, my graduation project contributes to the ongoing discourse on building communities that prioritize the well-being and happiness of their residents. As a reflection on my work, I have also identified key questions that can further deepen my understanding and extend the impact of my research.

As a reflection on my work, I explored some important questions that can deepen my understanding and expand the impact of my research. These questions will help me gain valuable insights and explore the significance of my project in a more focused way.

1- What are the potential challenges and opportunities in creating a healthy living community that accommodates a diverse mix of target groups, and how can architectural design principles and strategies be tailored to meet their unique requirements and foster a sense of inclusivity and community?

2- How can the integration of a double-skinned façade as a healthy envelope in potential residential buildings contribute to creating a sustainable, resilient, and adaptable living environment that fosters the overall health and well-being of its inhabitants?