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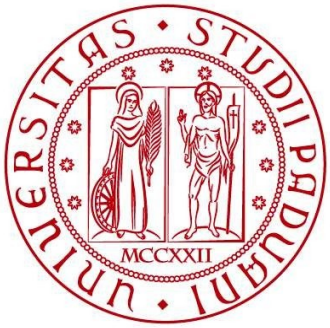


**MASTER THESIS**

# Living on the water.

# Sustainability assessment on a project of student housing in Padua

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# ABSTRACT

Given the expanding population and environmental concerns, the idea of "living on water" provides a compelling solution to the issues related to urban development. This thesis uses Padua, a city that hosts more than 7,000 foreign exchange students a year, as a case study to investigate the benefits and feasibility of constructing water-based housing as a sustainable alternative.

This study examines the environmental effects of living near water by examining urban areas and ecological factors including water and land use. The study clarifies the possible environmental advantages of embracing aquatic ecosystems as a fundamental form of urban living by comparing these indicators to conventional land-based buildings, focusing on improving social cohesion.

The Padua case study provides a stimulating perspective for assessing whether or not water-based homes are appropriate for addressing specific urban problems, such as accommodating an increasing number of international students. By creating three case studies as a model for housing and student housing, this initiative aims to minimize the load on the current infrastructure, improve the shortage of affordable housing, and enhance the general quality of student life.

This thesis declares that living on water is a sustainable urban development strategy that will mitigate environmental degradation and increase social cohesiveness as an approach for dealing with the growing housing shortage in rapidly urbanizing areas. An interdisciplinary study and an abundance of evidence support the significance of this innovative strategy for creating the cities of the future.

# PREFACE

Padua offers a unique environment for researching innovative approaches to student life, thanks to its vibrant student population and extensive historical context. This thesis has inspired me to live a sustainable life and address the serious environmental issues in urban areas.

My objective in conducting this research was to determine if living on water could be a viable substitute for traditional student housing. The ecological indicators used in this study to assess how such housing solutions affect the environment, and the student opinions acquired via a thoughtfully created questionnaire are essential components of the research. I would like to express all my sincere gratitude to Prof. ALESSANDRO BOVE, my thesis supervisor, whose advice and knowledge have been crucial throughout my entire process.
I am also very grateful to the Padua students who took the time and gave their opinions on the survey.

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# 1. Introduction

## 1.1 Overpopulation

What's this issue? Because of a low death rate and a consistently high birth rate, the population is rising rapidly. Overpopulation occurs when there are more people on the earth than can live in a way that is comfortable, happy, and healthy while also leaving enough space for future generations to live. Some individuals today consider that overcrowding is the biggest threat to the future. It was not until about 1810 that the human population reached one billion. This increased to 2 billion people in 1930, just 120 years later; 45 years later, in 1975, it passed 4 billion people.

Population growth is predicted to be substantial, with predictions of up to 10.9 billion by the end of the twenty-first century and roughly 8.5 billion by 2030. The US Geological Survey estimates that around 29% of the earth's surface is unsuitable for human habitation, and 71% of the Earth's surface is occupied by water and around 96% of this percentage is contained in oceans, seas, and bays (USGS, 2017).

This rapid growth exacerbates environmental degradation, with urban areas expanding rapidly and straining resources. Innovative solutions, such as floating structures, offer potential for sustainable urban expansion with minimal ecological impact. Padua exemplifies the pressures of overpopulation, with its historic city center and prestigious university attracting more students annually, leading to housing shortages, rising rents, and strained infrastructure. Thus, to address these challenges, Padua and similar cities must adopt integrated urban planning, sustainable development, and innovative housing solutions to ensure a balanced and livable environment for all residents.

To build a future perspective, it is essential to first investigate the need for floating structures and their potential for urban growth and extension. In the past, river boat bridges were among the first types of floating buildings. Certainly, building such structures will have a less negative impact on the ecosystem, and because of lack of research on such things, the construction of such buildings has been prohibited, but today and in the near future this idea will become an ideal and creative idea.

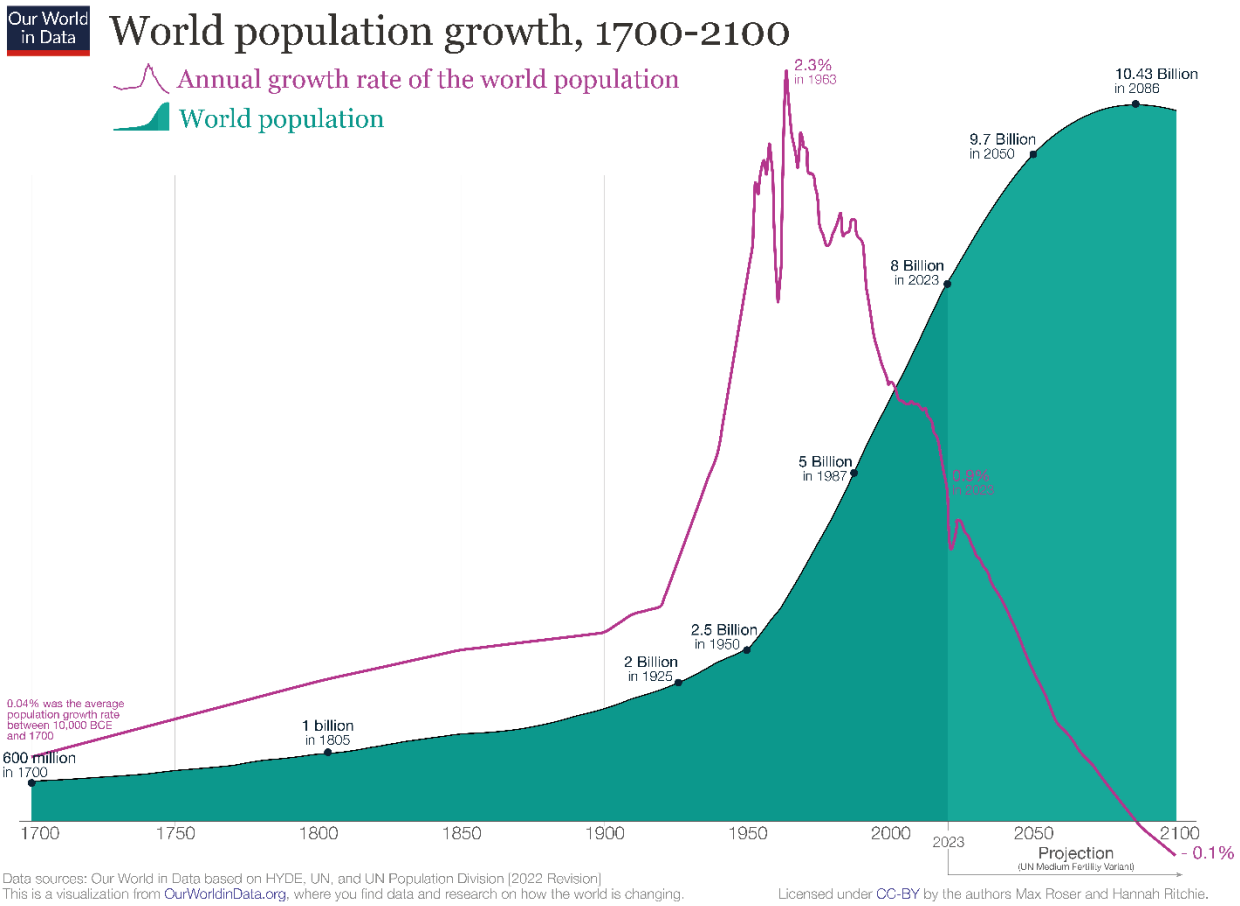



*Figure 1 World Population Growth*

## 1.2 Sea Level Rising

Global mean sea level, or the average height of the entire ocean surface, is often regarded as a helpful indication for assessing the state of the climate both today and potentially in the future (Understanding Sea Level, n.d.). For almost a century, tide gauge scores and long-term data from locations all over the world have been utilized as an integrated indicator of the health of the climate system. More recent data have also been obtained via satellite altimeters since the early 1990s. These instruments measure the ocean's height by measuring the strength and return speed of a radar pulse aimed at the water's surface. These techniques can offer observations that encompass both the ocean and cryosphere (the areas of Earth covered in ice) since melt water from glaciers and ice sheets and thermal expansion of seawater as it warms are the main factors causing long-term changes in sea level. Scientists use satellites, moored and drifting buoys, and water samples taken by ships to estimate the rise in sea level caused by thermal expansion (using different approaches if temperatures are obtained in the upper half of the ocean or in deeper parts). Experts use both direct measurements (field surveys of melt rates and glacier elevations) and satellite-based measurements, which are able to capture minute changes in Earth's gravitational field when water shifts from land to ocean, to determine how much of the rise in sea

level should be attributed to actual mass transfer (the movement of water from land to ocean) (Climate Change: Global Sea Level, 2022). The rising water level is mostly due to a combination of melting water from glaciers and ice sheets and thermal expansion of seawater as it warms. In 2022, global mean sea level was 101.2 millimeters (4 inches) above 1993 levels, making it the highest annual average in the satellite record (1993-present), (NOAA).

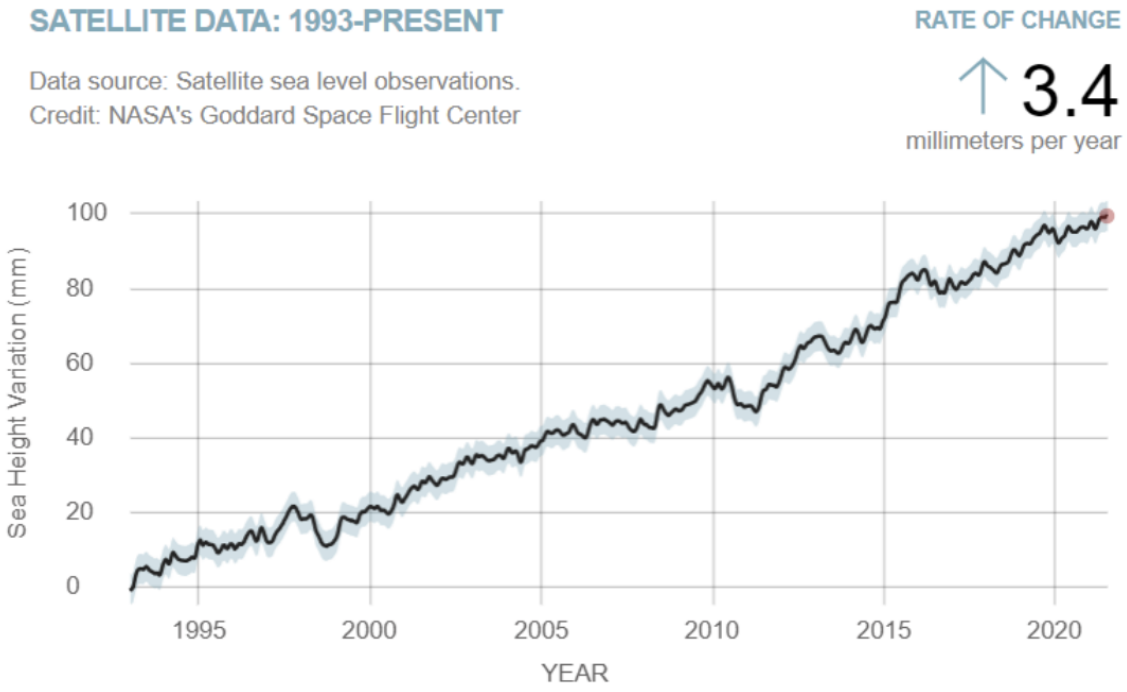



*Figure 2 Sea Level Rise and Coastal Flooding (recent) - Climate in Arts and History*

❖ **Future sea level rise**

According to NOAA, as global temperatures continue to warm, additional sea level rise is inevitable. How much and by when depends mostly on the future rate of greenhouse gas emissions. But another source of uncertainty is whether big ice sheets in Antarctica and Greenland will melt in a steady, predictable way as the Earth gets warmer, or whether they will reach a tipping point and rapidly collapse.

Every four or five years, NOAA leads an interagency task force that reviews the latest research on sea level rise and issues a report on likely— and 'unlikely but plausible'— amounts future sea level rise for different greenhouse gas and global warming pathways. In the 2022 report, the task force concluded that even on the pathway with the lowest possible greenhouse gas emissions and warming (1.5 degrees C), global mean sea level would rise at least 0.3 meters (1 foot) above 2000 levels by 2100. On a pathway with very high rates of emissions that trigger rapid ice sheet collapse, sea level could be as much as 2 meters (6.6 feet) higher in 2100 than it was in 2000.

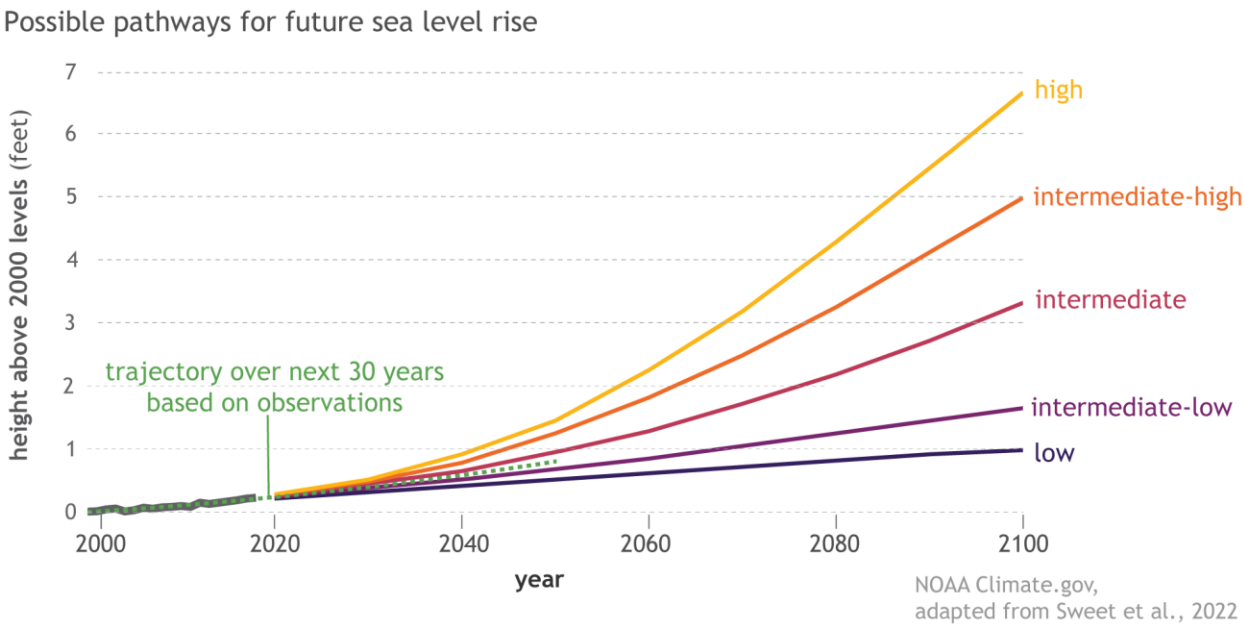



*Figure 3 Observed Sea Level with a Prediction from 2000- 2100*

## 1.3 Background

Humans have always been extraordinarily adaptable in their living situations, and the practice of water-based habitation has been one of the most inventive solutions to the challenges caused by geography and climate. One of the ancient societies who utilized reeds to construct stable, habitable surfaces on the water to create floating islands was the Uros people of Lake Titicaca in Peru and Bolivia.

Similar examples of traditional water-based living are the floating markets of the Mekong Delta in Vietnam and the stilt houses of the Bajau Laut in Southeast Asia. These historical examples demonstrate the adaptability and creativity of using aquatic areas for residential purposes.

Living on the water is becoming a more and more popular concept in modern times due to the demands of urbanization, climate change, and rising sea levels (Richerson & Kittel, 1977). Modern floating architecture has emerged as a flexible and sustainable solution that incorporates innovative designs with environmentally friendly practices. This renewed interest aims to meet the increasing demands of coastal and susceptible to flooding populations and upgrade urban development in harmony with aquatic ecosystems.

The idea of living on water has drastically changed in the modern era due to the rapid advancement of technology and the urgent need to address environmental issues. Modern floating communities and structures are being planned as both long-term, sustainable living options and emergency response systems.

Climate change-related rising sea levels and more frequent floods have encouraged innovation in floating homes.

For example, the Netherlands, with its extensive experience in water management, has been a pioneer in floating architecture. Projects such as Schoonschip in Amsterdam and the Floating Pavilion in Rotterdam showcase advanced engineering techniques and sustainable design principles. These floating structures, which are outfitted with modern facilities, renewable energy sources, and waste management systems, serve as models for future water-based urban development.

In light of recent developments in sustainable construction, meetings have been undertaken with private agents and student housing organizations such as Specialized Supported Housing (SSH) to gain an understanding of the present market conditions and their requirements and standards. This provides context and analysis of the evolving topic of building floating structures. In the Netherlands, some firms are currently developing individual floating houses, and research on previous projects has been conducted to assess the various completed structures and their effectiveness.

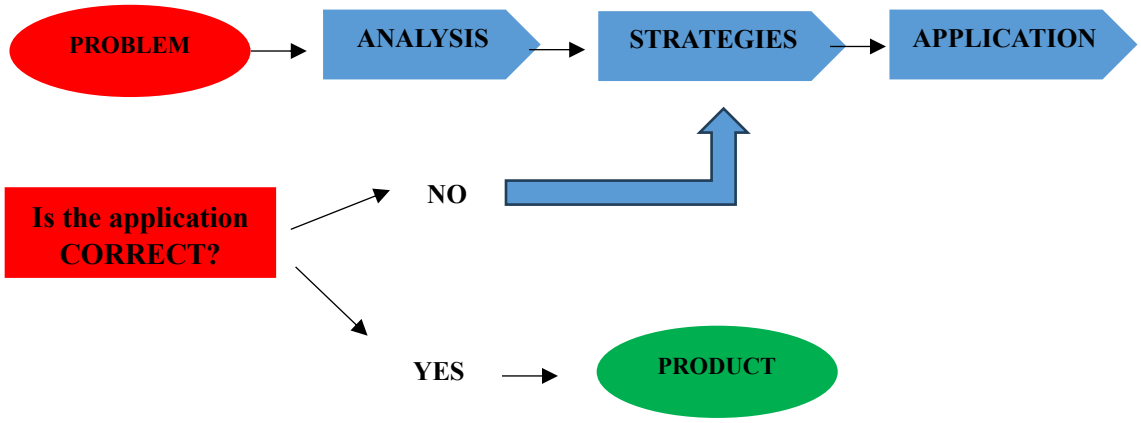



*Figure 4 Process Based Thinking*

After the background has been established, the project will evolve into four themes that will be further examined before coming together as a finished result. Figure 2 depicts the established method based on technical competencies. An investigation order is established through this method. Initially, the requirements statement serves as the foundation, defining the parameters for the project. This covers boundaries, design requirements, and client needs. Following this,

research into various subjects is conducted while keeping in mind the prior specifications in order to provide a variety of design options that will then be assessed, computed, and illustrated. Following an explanation of each option, the best option will be chosen and further discussed. All four of the technical competencies are attained during this procedure.
The foundation, supply networks, building materials, and modularity are these four subjects. These themes are derived from the ideas of bioclimatic and sustainable architecture in an effort to address several sub-questions associated with each theme (Ignasi Gironés Cádiz, 2017).

- **Foundation:** Taking into account every client's requirement, what kind of foundation can be constructed?
- **Materials:** Which materials meet the needs of the project?
- **Modularity:** What methods are there for creating a modular structure?
- **Supply Systems:** How can a building become self-sufficient?

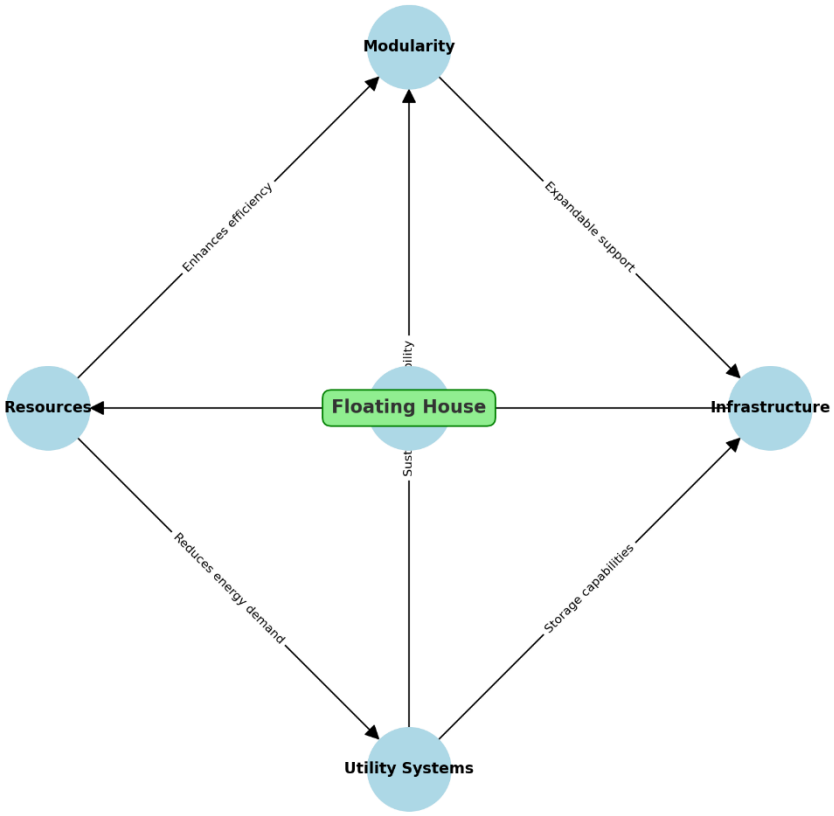



*Figure 5 Interaction Diagram*

### ❖ Passive house standards

A building standard that is extremely energy efficient, comfortable, and reasonably priced is called a passive house. A sustainable and flexible home can be guaranteed by adhering to its

principles. The following are the most important guiding principles of a passive house: minimal requirements for each method differ depending on the climate zone in which the building is located.

- **Thermal insulation:** The outer envelope of the home needs to be extremely well-insulated throughout for all opaque construction components.
- **Windows in passive houses:** Low-e glazing and enough insulation are required for the window frames.
- **Heat recovery ventilation:** Effective heat recovery ventilation is essential for maintaining healthy indoor air quality and reducing energy use.

❖ **European Regulations**

- **Directive 2010/31/UE on the energy performance of buildings:**
  This Directive promotes the improvement of the energy performance of buildings within the Union. Here is a summary of the main ideas extracted from each article and their relation to the project:
  - Article 6 explains the necessity of using energy from renewable energy sources for the supply systems.
  - Article 9 states the obligation for every State member to increase the number of nearly zero-energy buildings until 2020, when every new building should have this characteristic.
  - Article 11 enacts the need to create an energy certification system that evaluates every building in terms of energy efficiency.
  - Annex I explains the methodology to assess every building in matters of energy performance.

- **244/2012/UE supplementing Directive 2010/31/EU**
  The methodology framework is specified in Annex I and III. In Annex III there are several tables as models to assess the energy performance. The framework is used in much software to evaluate the energy efficiency in buildings.

In addition, in the future, the most popular cities are planning as a creative response to some of the most important problems facing the world. For example, the Sea Steading Institute is exploring the possibility of creating self-sustaining floating cities that can adapt to high levels and provide new opportunities for social organization and innovative management. The Oceanix City project of the Bjarke Ingels group aims to create an expandable floating city and divide the dependence into ten thousand people. With elements such as water systems and renewable energies, this project starts with sustainability.

## 1.4 Objectives

This thesis's main goal is to assess how the floating student housing project in Padua will affect the environment. This entails a thorough evaluation of the project's resource consumption, and impact on nearby ecosystems, and urban spaces. Through an analysis of these variables, the study seeks to ascertain the housing project's overall environmental sustainability and pinpoint areas in need of improvement. Also, Examining the floating buildings' material appropriateness and structural soundness is another crucial goal, ensuring that the floating structures are safe and resilient is essential for the long-term success and sustainability of the project.

Evaluating the floating student housing's energy efficiency is another goal of the study, evaluating how energy-saving technologies are being used, and how renewable energy sources are being used. The project aims to find ways to lower the floating buildings' running expenses and environmental impact by concentrating on energy efficiency.

Moreover, we are going to further look at the floating student housing project's social effects. This entails analyzing the advantages and difficulties pertaining to accessibility, affordability, community integration, assessing the inhabitants' perceptions of the floating student housing's livability and level of satisfaction. Potential or present student residents will be surveyed or interviewed in order to learn more about their comfort level, level of happiness, and general impression of living in floating housing. Understanding the human element of the project and pinpointing areas for development depend heavily on this input.

The thesis will also list recommended techniques and lessons discovered from various floating construction projects worldwide. The research will ascertain how effective tactics can be implemented or modified for the Padua student housing environment by examining three case studies. The creation and use of floating buildings will benefit greatly from the comparison analysis's insightful recommendations. Thus, the thesis will suggest architectural and operational changes to improve the floating student housing project's sustainability, effectiveness, and livability based on the research's findings, to guarantee that they are applicable and efficient, these suggestions will be based on the information gathered, and the best practices found in other projects.

## 1.5 Methodology

In order to assess the sustainability of Padua's floating student housing project, a comprehensive literature review, a rigorous questionnaire design, and substantial data analysis were employed in this thesis. The research began with a comprehensive review of the literature, integrating data from numerous scholarly articles and investigations on floating architecture, sustainable housing, and related environmental impacts.

This basic review influenced not just the study's scientific framework but also the creation of a complex questionnaire. The survey was carefully designed to gather a variety of student viewpoints including overall satisfaction, environmental sustainability, and how livable the floating housing is. We conducted quantitative and qualitative data analysis on the questionnaire once we distributed it to a large portion of the student community.
The study used advanced statistical approaches to identify important trends, relationships, and variables influencing students' perspectives, and the thematic analysis provided a comprehensive understanding of the qualitative responses.

By combining real-world data with deep understanding, doing site visits to three proposal cases, and meeting with engineers and experts, this hybrid methodology ensures a comprehensive, multi-dimensional assessment that provides an accurate assessment of the sustainability of the floating student housing project.

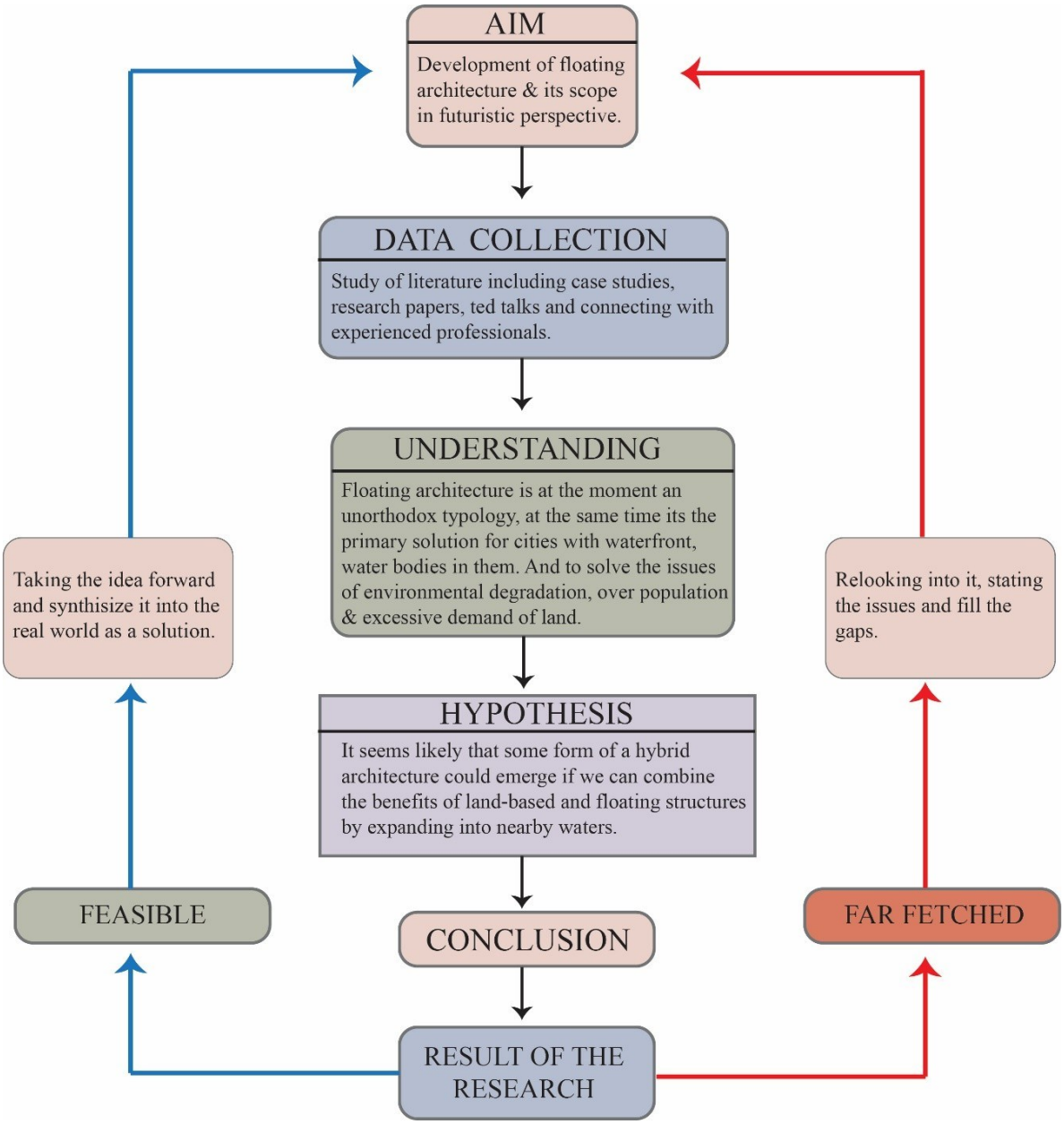



*Figure 6 Methodology Followed to Reach Conclusion*

# 2. Literature Review

## 2.1 Introduction

Initially, the World Economic Forum's 2016 Global Risks Report states that, beyond weapons of mass destruction and water scarcity, "the most effective hazard" that networks worldwide will face in the next ten years would be their inability to mitigate and adapt to environmental change. Place the spotlight on its spreading effects: environmental change impacts biological systems all across the world, affecting not just the places where people live but also the water and air they consume.

To properly understand floating architecture and all of its crucial elements, we need to understand the basic language that it uses:

Extreme climate: The composition of climatic patterns changes as a result of rising global temperatures, making desert regions drier and moist parts wetter as more water is pulled into, retained in, and released from the atmosphere.

**Overpopulation:** A low death rate and a consistently high birth rate are causing the population to rise swiftly. Overpopulation is the condition in which there are more people on Earth than can reasonably be maintained in a pleasant, happy, and healthy manner while yet providing a suitable environment for future generations to live in.

**Land reclamation**: Is the process of creating new land in the water so that port towns, coastal areas, and other areas can grow toward the water and meet their infrastructure needs. As the name implies, land reclamation is the act of turning waterways such as rivers, lakes, seas, and oceans into new land.

**Floating homes**: Some examples of these are Portland, Oregon, Aberdeen in Hong Kong, Ha Long Bay in Vietnam, and the Floating Neighborhood of Ijburg, Netherlands (New HSC, 2013). These constructions are supported by wooden logs, pontoons, or barges and float due to buoyancy; when there are heavy waves and high tides, these structures are quite vulnerable.

**Systems for Mooring**: Moorings serve as a structural anchor or barrier at a particular location. A specific mooring configuration, a mooring line, and an anchor system are the three main components of an offshore mooring system.

The offshore unit's purpose and the local environmental conditions determine the layout of the mooring system.

**Very Large Floating Structures (v.l.f.s)**: These are artificial islands, which are usually made as floating airports, bridges, piers and docks, storage facilities, solar and wind power plants, or to create industrial space and emergency bases. Sometimes these act as mobile offshore structures and even for habitation.

## 2.2 Sustainable development

The 1987 Brundtland Report, "Our Common Future," provided additional guidance for all-encompassing global solutions. Development that "meets the needs of the present generation without compromising the ability of future generations to meet their own needs" is what was termed as sustainable development. Since then, people frequently cite this term. The 1992 Earth Summit expanded the term (UN, 1992a). It resulted in 40 chapters totaling more than 150,000 words for Agenda 21.

The concept of the three pillars—social, environmental, and economic—as represented by the summit motto "People, Planet, Prosperity," was finalized at the World Summit on Sustainable Development in 2002 (UN, 2002). The phrase and its meaning are now so commonplace that we could consider them to be common sense.

Furthermore, it is inextricably included in all significant business, governmental, and other strategic documents (such as the majority of the foundational agreements of the European Union, such as the most recent Lisbon Treaty) (EU, 2007).

It goes without saying that, although having essentially the same meaning, the terms sustainable development and sustainability are not used interchangeably in quoted publications or in many other contexts (e.g., Bell and Morse, 1999).

### 2.2.1 Economic sustainability

However, the other two pillars have been covered in greater detail little by little. Economists concentrate on several forms of "capital" that ought to be preserved, including natural, man-made, human, and social capital (World Bank, n.d.)). An alternative method relies on the sustainable development definition developed by Goodland and Ledec in 1987. The use of natural resources that are renewable in a way that does not deplete, eliminate, or otherwise lessen their value for future generations is known as sustainable development.

It also means using non-renewable (exhaustible) mineral resources in a way that doesn't needlessly hinder future generations' easy access to them. Lastly, to guarantee the high likelihood of a smooth society transition to renewable energy sources, the depletion of non-renewable energy supplies must occur at a sufficiently moderate rate. The main emphasis of this definition is on the tangible components of sustainable development. Some methods that concentrate on managing resources as efficiently as possible suggest, for instance, the definition put forward by Markandya and Pearce (1988). In light of the fact that sustainability necessitates that the requirements for each succeeding generation to have equitable access to the resource base be met, sustainability may need to be redefined in order to prevent the use of resources today from decreasing real incomes in the future. Alternatively, "The environment and natural resources are the ultimate basis around which all future economic activity must be shaped. This means that maintaining the integrity of the environment and resource base will become more and more important for future economic growth, (Hamrin, 1983).

It has recently come to light that the concept of well-being is crucial to sustainable development. Any act of consumption, including the enjoyment of any commodities or services, is understood to contribute to well-being. Products and services can include items that nature freely offers, like

a stunning sunset. According to its broadest economic interpretation, sustainable development entails long-term, steady increases in "consumption" (OECD, 2008a).

The financial and economic crises of today make the economic components of development more important. The current economic crisis demonstrates that the public considers maintaining economic growth to be a fundamental and widely shared goal. It should be recalled that for the past 50 years, growth has been the primary policy objective worldwide. This explains why striking a balance between national economic growth and sustainability has proven to be challenging. Hopefully, the current economic crisis will serve as an example of how to think about a new economy in terms of sustainable development and how to rethink the way we approach economic growth. A possible example of this kind of research is the paper "Prosperity without Growth?" by(Tim Jackson 2009) or "Managing Without Growth" by (Peter A. Victor 2008)

### 2.2.2 Social sustainability

The methods used to address the social aspect of sustainable development are just as varied as those used to address the economic pillar.
A precise description of the social dimension of sustainable development is less certain, as Martin pointed out (Martin, 2001).
Naturally, it is quite difficult to come up with a universal definition of social sustainability given the diversity of social, cultural, and economic settings present in many countries. Social sustainability was defined by Black (2004) as "the extent to which social values, social identities, social relationships, and social institutions can continue into the future".

According to Torjman (2000), "from a social perspective in particular, human well-being cannot be sustained without a healthy environment and is equally unlikely in the absence of a vibrant economy." This is how he defines social sustainability. According to Gilbert et al., maintaining social cohesiveness and the capacity of society to strive toward shared objectives are essential to social sustainability. Individual needs should be satisfied, including those related to food, shelter, education, health and well-being, and cultural expression (Gilbert, 1996).
However, as observed by Colantonio (2007), these and other formulations are more or less statements of the overarching objectives of social policy rather than substantive attempts to define the social dimension of sustainable development. However, as demonstrated by Jared Diamond's perceptive analysis of historical and modern societies, the social "pillar" of sustainable development is likely the most significant and vital for the long-term survival of human civilizations (Diamond, 2005). The authors of The Wealth of Nations (World Bank, 2006; see below) found that human and social capital is the most significant component of national wealth, which provides another slightly erroneous basis for this viewpoint.
Even with this acknowledgment, the critical components of societal unsustainability remain unclear. Is there more or less inequality between individuals, groups, or countries?
Is it generally in good health? What does this mean for health care systems' sustainability? Is it the failure of national institutions as shown by Foreign Policy's 2009 Failed State Index? Are we to conclude that Zimbabwe, Sudan, or Somalia are not sustainable nations based on that document?

### 2.2.3 Environmental sustainability

In the past, sustainable development was generally thought to mean social and economic advancement that would not negatively impact the environment. Since the introduction of the "three pillars" idea, there has been a progressive recognition that social and economic sustainability do have advantages of their own, in addition to having a clear and precise meaning as a component of political, social, and/or economic development. With this knowledge in mind, it is essential to examine the third pillar carefully, pay particular attention to the definition of environmental sustainability, and request a comprehensive explanation of its exact meaning.

Scientists at the World Bank most likely came up with the phrase originally. When this phrase was first used, it was "environmentally responsible development" (World Bank, 1992). Afterwards, "development that is environmentally sustainable" was implemented (Serageldin and Streeter, 1993). At last, Goodland (1995) created the idea of environmental sustainability.

"Seeks to improve human welfare by protecting the sources of raw materials used for human needs and ensuring that the sinks for human wastes are not exceeded, in order to prevent harm to humans," is how Goodland defines environmental sustainability.
Goodland's approach to environmental sustainability falls under the paradigm of "limits to growth," an ecological economic theory that considers resource limitations. Additionally, he defines environmental sustainability as a collection of limitations on "the use of renewable and nonrenewable resources on the source side, and pollution and waste assimilation on the sink side," which are the four main activities controlling the scales of the human economic subsystem. Environmental sustainability is defined by Holdren et al. (1995) with an emphasis on its bio geophysical components.
Biophysical sustainability refers to preserving or enhancing the integrity of Earth's life-supporting systems. Encouraging present and future generations to achieve economic and social advancement within a framework of cultural diversity and preserving (a) biological diversity and (b) the biogeochemical integrity of the biosphere through conservation and wise use of air, water, and land resources are two aspects of sustaining the biosphere with sufficient provisions for optimizing future options.

Over time, the phrase "environmental sustainability" has gained widespread usage. For instance, P. Sutton, the Australian State of Victoria's Commissioner for Environmental Sustainability, described environmental sustainability as “the ability to maintain the qualities that are valued in the physical environment” (Sutton, 2004). In order to promote sustainably designed systems that support human well-being and are hence compatible with sustaining natural systems, the Environmental Sustainability Program of the U.S. National Science Foundation for 2009 funds engineering research.

Environmental sustainability is the explicit topic of one of the new journals: The first academic journal to analyze and synthesize research on sustainability and environmental change is Current Opinion in Environmental Sustainability. It gives its audience a new way to receive regular updates on scientific discoveries and research initiatives. It centers on six topics:

- **The systems related to climate** include climate and climate change, risk management, adaptation, and mitigation.
- **Human habitats** and settlements, encompassing cities, urbanization, and transportation.
- **Energy systems**, which comprise energy efficiency, bioenergy, renewable energy, and **conservation and consumption of energy.**
- In addition to managed and natural ecosystems, **terrestrial systems** also comprise food chains, forestry, biodiversity, and ecosystem services.
- **The nitrogen and carbon cycles** (sources, sinks, feedback processes, and links to other systems).
  • **Aquatic systems,** which comprise fresh and marine ecosystems, biodiversity, currents, and fisheries.

OECD (2001) Environmental Strategy for the First Decade of the 21st Century made a significant contribution to the idea of environmental sustainability. The Strategy lays out four distinct standards for environmental sustainability: substitutability (non-renewable resources must be used effectively and their use must not exceed levels that can be offset by substitution with renewable resources or other forms of capital), assimilation (releases of hazardous or polluting substances into the environment must not exceed their assimilative capacity) and avoiding irreversibility. This is because renewable resources must be used efficiently, and their use must not exceed their long-term rates of natural regeneration. It outlines five interconnected goals for improving operational and financially viable environmental policies within the framework of sustainable development:
It outlines five interconnected goals for improving operationally sound and economically sound environmental policies within the framework of sustainable development:

- preserving the integrity of ecosystems by managing natural resources effectively.
- separating the demands of the environment from economic expansion.
- enhancing data for decision-making by using indicators to track advancement.
- At the intersection of the social and environmental spheres: improving living quality.
- Global interdependence on the environment: enhancing cooperation and governance.

The Millennium Ecosystem Assessment Project helped refine the idea further. The Synthesis Report (Millennium Ecosystem Assessment, 2005) clarifies environmental sustainability in significant ways even though it does not use the term itself. It describes ecosystem services and divides them into four categories: provisioning (food, fuel, freshwater, wood and fiber, etc.); regulatory (water purification, flood control, temperature regulation, etc.); cultural (aesthetic, spiritual, educational, recreational, etc.); and supporting (soil formation, nutrient cycling, primary production, etc.). The concept of ecosystem services can be expanded to include goods and services offered by the geosphere (mineral resources), three-dimensional open space (the area above and below the Earth's surface as well as the land on it), and global life-supporting systems (the climatic system, hydrological cycle, and global biogeochemical cycles). We may

refer to all of these products and services as "nature's services," to borrow Daily's term (Daily, 1997).

Human well-being is inextricably related to the environment and the services provided by nature. It's crucial to preserve the ecosystem and nature's services at a suitable level in order to ensure well-being. Put differently, the preservation of nature's services to an appropriate degree might be considered an aspect of environmental sustainability.
The primary contribution of the Millennium Ecosystem Assessment Project is highlighting the inseparable link between these services and human well-being and pointing out any actual manifestations of this relationship.

Taking care of the systems that sustain life on Earth, such as ecosystems and global life-supporting systems, also referred to as environmental infrastructure, is necessary to preserve the appropriate quality of nature's services. Only in a situation of robust global ecological systems can essential services be provided. Concern for the products and services that nature provides entails concern for nature, that is, for biodiversity and global ecosystems. The most crucial component of environmental infrastructure and a general requirement for the majority of services is biological diversity.

Following its inception in the 1980s, the concept of sustainable development underwent a transformation, moving from its initial vague definition to more detailed guidelines including its core principles. These days, a lot of significant definitions are given in quantitative terms utilizing various indicators. It follows that a thorough examination of the indicators is necessary.

## 2.3 Sustainability indicators

In general, sustainability indicators are vital tools for evaluating the overall performance of a project in terms of various dimensions of sustainability. These metrics provide concrete standards to measure the impacts of initiatives on the economy, society and environment, ensuring their alignment with sustainable development goals. Sustainability indicators are usually classified into three main groups: social, economic and environmental, and each group has special metrics that contribute to providing a comprehensive assessment of the project’s sustainability when combined together.

Within the framework of the floating student housing project in Padua, sustainability indicators play a crucial role in evaluating the project’s performance. Economic indicators include cost-benefit analysis, affordability, and overall economic impact. Cost-benefit analysis involves comparing initial investment and operational costs to long-term financial benefits, such as energy savings and reduced maintenance costs. Affordability indicators aim to assess how well students can afford housing, taking into account rental prices relative to their income. The overall economic impact indicators measure the project’s contribution to local economic development, including job creation during the construction period and during ongoing operations.

### 2.3.1 Ecological Indicators

Ecological indicators are key to this study because it focuses on assessing the environmental impacts of a floating student housing project. These indicators include energy efficiency, water management, and material sustainability.
Energy efficiency indicators evaluate the effectiveness of energy use and reliance on renewable energy sources, which is crucial to reducing the environmental impact of a project. Similarly, indicators of water management evaluate the efficient use of water, the effectiveness of wastewater treatment, and the stormwater management systems which are essential for floating structures.

Moreover, material sustainability indicators evaluate the use of environmentally friendly and robust building materials, which contributes to reducing environmental impact. Through these environmental indicators, the study seeks to provide a detailed and comprehensive analysis of the environmental sustainability of the floating student housing project in Padua.

### 2.3.2 Social indicators

Social indicators are used to assess three fundamental factors: residential quality of life, community engagement, and resident satisfaction. Livability indicators assess the quality of life in residential units by accounting for elements including comfort, safety, and accessibility to essential services.
On the other hand, community integration indicators focus on how closely housing is connected to the neighborhood, including improving social connections and providing access to community services. Also, to better understand the overall student experience, Resident Satisfaction Indicators assess how well accommodation meets students' daily requirements and expectations. In addition, integration with the community is particularly important in the terms of floating student housing, because it can enhance the complete living experience of students and student opinions regarding their residential experience are collected through Resident Satisfaction Indicators, which provide insight into comfort, safety and overall satisfaction with living conditions. Thus, by evaluating these social indicators, the project seeks to improve its social and environmental elements by striking a balance between environmental sustainability and the happiness and well-being of its residents.

## 2.4 History of Floating structures

Initially, the concept of developing floating structures was not new; it has existed since ancient times. Using two rows of floating bridges constructed on boats, King Xerxes I of Persia led his army across the Dardanelles in 480 BC. Later, many bridges were built in this way by connecting boats and ships together and placing wooden decks on top of them, and these bridges began to appear in different places around the world. Over time, these floating decks evolved into floating residences. There are many countries with floating villages containing markets and fully functioning residences. With the development of technologies and the emergence of new ideas, the idea of floating homes emerged, which later evolved to form entire neighborhoods and cities.


*Figure 7 Timeline for the Floating Structures*

Floating human settlements date back to ancient times and have appeared throughout history in many countries around the world. In the early 16th century, Cambodian lakes contained large communities practicing aquaculture and fishing, and these communities then developed into floating villages. In addition, countries such as China, Thailand, the Netherlands, and Bolivia have a long history of floating villages.

*Figure 8 Chong Kneas Floating Village*

Water canals have been a key element of urban development in Amsterdam, where landscapes serve as a hydraulic system. The concept of floating homes first appeared in the seventeenth and eighteenth centuries, during the height of Dutch maritime trade. This age brought not only wealth to build the country, but also the dependence of traders on housing and work on their ships and boats.

Traders in waterfront cities have turned canals and rivers into comfortable residential environments. After the 19th century, many merchant ships were transformed into dwellings that were docked in canals and waterways, resulting in a widespread pattern of living in floating houses that still exists today.

In addition to the large number of retired vessels and boats, the shortage of housing after the Second World War was a major factor making floating houses a desirable option for housing (Blaustein 1979). A survey conducted between 1972 and 1975 among residents of floating homes in the Netherlands province showed that the main causes of living on water were lack of housing (48%), easy and friendly lifestyle (22%) and low cost of living (8.5%). Besides proximity to work and economic motives, housing on water has attracted individuals seeking a free and expressive life thanks to the lack of laws and the unique experience of living on water (Korte 2007).
At present, floating houses often function as housing substitutes and tourist attractions. In India, floating lake houses in Lake Dahl in Kashmir and backwater in Kerala are among the most prominent tourist attractions.

*Figure 9 Simple Case*

De Graff suggests using the surface water for floating urbanization. Some innovative housing experiments have built houses in the flood plains using specific construction methods. Although living in floating houses is thousands of years old, Dutch society was one of the first to adopt a positive attitude towards living on water (Graaf 2009).
A new type of floating housing such as floating houses and neighborhoods has emerged in spatial planning. These houses have been developed mainly as stand-alone or semi-segregated houses, ranging from one to three floors.

The types of water that may be sites for such floating dwellings include the seas, lakes, shallow lakes, water channels, watercourses and flood-mitigation areas.
For rivers, there is a risk that water levels will fluctuate frequently during heavy rains or droughts. Thus, river basins face a constant risk of flooding if preventive measures are not taken. In this case, floating and amphibian houses are an alternative to these areas. Water-based housing can be classified into three categories: land-based houses (based on the edge of water/land), floating houses (which fall entirely on water and are connected to piers or bridges) and amphibian houses (which float in water during periods when the water level rises and settles on land for the rest of the time), (Singelenberg, 2011).

*Figure 10 Floating Home Development in Amsterdam*

# 3. Critical reading

## 3.1 Concept of sustainability

According to Wikipedia, sustainability is defined as the ability to survive. Sustainability is about improving the quality of human life while remaining within the absorptive limits of supporting ecosystems. Although the sustainability of architecture has been primarily discussed from the perspective of physical issues such as energy and the environment, the concept of sustainability must be expanded to include non-physical aspects such as the mental health of the population and social life. For man, sustainability represents the ability to maintain long-term well-being, which has environmental, economic and social dimensions. In this paper, we will not discuss the sustainability of traditional buildings on Earth but will focus on analyzing and studying the sustainability of floating buildings by looking at environmental, economic and social dimensions.

## 3.2 Environmental dimension in floating buildings

A building floating on water can withstand a continuous slow rise in sea or river level as a result of climate change such as global warming, as well as a sudden rise in water level caused by natural disasters such as floods and hurricanes. Floating and buoyant buildings are available depending on the location conditions between banks and water. Floating or buoyant architecture is very useful in floods in coastal, riverine and low-lying areas.

The floating building can be relocated by barge and relocated to different locations as needed, allowing for long-term use by different people. Long-term use in a variety of places by different individuals contributes to environmental conservation through the provision of resources.

For example, the Four Seasons Hotel (Great Barrier Reef) was built in Singapore in 1988, moved to work in Australia, then to Vietnam in 1989 and continued to operate until 1997, then refurbished in Singapore in 1997, and in 2006 purchased by Hyundai Asan and relocated to North Korea. This floating hotel has been relocated four times and has operated in three different countries for more than 20 years, see figure 11 below.

*Figure 11 The Four Seasons (Great Barrier Reef)*

“The floating building has easy access to diverse renewable energy sources due to the lack of obstacles in the sea or river.” More solar and wind power can be obtained on water than on urban land. In particular, the use of hydrothermal energy for sea or river water under a floating building can be a significant advantage, as water temperature is lower than air temperature in summer and vice versa in winter. Hydrothermal energy can be used for air conditioning in tropical regions and heating in cold regions.

In the case of the International Construction Platform (IBA) in Germany, the International Building Expo IBA had the slogan "City in Climate Change" with the aim of developing a CO2-neutral city, and many possibilities were tried to save energy from the water temperature of the Elbe River as it was combined with solar energy such as solar panels and photovoltaic power, see figure 12 below.


*Figure 12 International Construction Platform (IBA) in Germany*

At the Salt & Sill Hotel in Sweden, heating power is actually generated from warm water under the floating building in the winter. The Salt & Sill Hotel was built using local raw materials such as pine wood from the forests of Sweden, and they used only eco-friendly paint. They even used stone left over from quarries to build a new reef under the concrete pavement for the environment, see figure 13 below.

*Figure 13 Salt & Sill Hotel in Sweden*

## 3.3 Social dimension in floating buildings

The concept of social sustainability includes issues such as social justice, viability, equality in health, community development, social capital, social support, human rights, labor rights, place-building, social responsibility, social justice, cultural competence, community resilience, and human adaptation, and some of these factors can be applied to floating architecture.

In a floating-house community, residents enjoy a quiet, relaxed atmosphere on water in a natural environment. They believe that the best view is to see only natural elements like sky, mountains, trees, grain fields, and water without any industrial intervention. Some floating-house communities have magnificent views of the river or lake, distant mountains, tides, and habitats of migratory birds, besides, bonding with nature promotes a sense of well-being and health.

When residents were asked why they wanted to live there, the common answer was their love of a quiet environment and good neighbors. They enjoy watching the sunrise and sunset with a water and mountain background. There has to be psychological sustainability between the population and the neighbors.

Residents have a strong interest in preserving the natural environment such as wild birds and plants surrounding bodies of water, collaborate in managing natural disasters such as floods and hurricanes, face the challenges of fires and escape, negotiate laws with city officials and receive administrative and financial support from the local government. Strong social sustainability is necessary and easy to achieve in a floating-home society.

Floating-house communities are usually safer than crime when compared with landlocked residences. Because residents know each other and the access is controlled, and the community is surrounded by water, unwanted guests are not easily accessible. This type of housing environment can promote social sustainability.

## 3.4 Key points from the French book (L'urbanisme durable. Concevoir un écoquartier)

### 3.4.1 The Livable city from Vancouver and the environmental problems

In Vancouver, the sustainable city (defined as livable) is seen as a single system that integrates social, culture, economic and ecological dimensions, it must respect following three objectives:

- **Livability**, which includes equitable access to green spaces, basic services and amenities, mobility and participatory process, participation and the compact to city being the means to achieve this livability.
- **Sustainability**, which integrates into factors relating to employment, affordable housing, crime and poverty.
- **Resilience**, which requires incorporating adaptive management as a learning and feedback model.

The gateway to sustainable development in Europe is often the environment; planning has taken into account environmental concerns for many years. New fields of investigation are thus opened by developers who clearly take into account certain environmental issues such as:

- Green construction sites in other words the integration of the environment and waste management as well as the information of local residents.
- Roads promoting innovative techniques (choice of materials available locally or nearby).
- Control of energy choices with the use of renewable energies.
- Alternative rainwater management techniques.
- The environmental management system.

### 3.4.2 The Environment Quality of Buildings

**‘’**A sustainable neighborhood project must be based on a diagnosis that makes it possible to identify and spatialize the internal riches and weakness of social cohesion, landscapes, environmental resources, nuisance, human resources, economic and demographic potential**”**

**Eco-design** is the integration of environmental concerns into product design. It is a multi-criteria approach (energy, water, soil, air, noise, waste, etc.) and multi-stage (life cycle of the product). The objective of eco-design is to reduce negative environmental impacts throughout the life cycle by maintaining the quality of use of the product, or even improving it.

- **The seven goals for sustainable urban planning are:**

1. The fight against climate change and the protection of climate change.
2. The preservation of natural resources.
3. Improving the quality of the local environment (pollution of soil, air, water, noise, waste management, etc).
4. Social equity, which translates into access for all to employment, housing, community services and facilities.
5. Diversity and diversity of territories and populations.
6. Solidarity between territories.
7. The economic attractiveness of the territory is linked to the development of sustainable production and consumption methods.

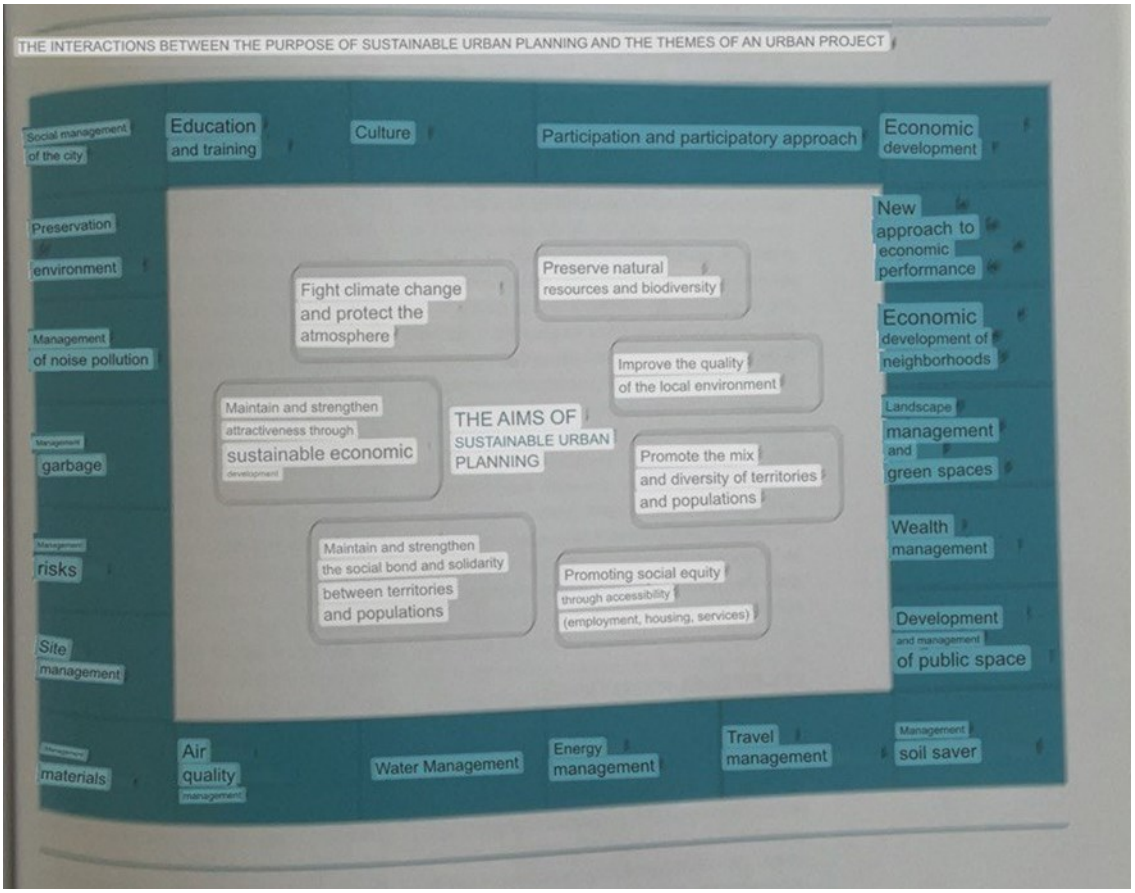



*Figure 14 The Interaction between the Purpose of Sustainable Urban Planning and the Themes of Urban project*

## 3.5 The Principle of Floating and Mooring system

Each floating structure requires a mooring system that is rigid and strong enough to restrict the structure's movement toward external forces such as wind, currents, waves or even the movement of ice in winter. Mooring systems can vary from temporary to permanent and can be done indoors or outdoors. There are several types of Mooring systems:

1. One mooring system with truss (Attached mooring system)
   In this system, the mooring is done by attaching a specific portion of the mooring cord to the floating structure. Additions can include towers that are placed inside (installed at the interior end) or outside (installed with a structure added at the end). This system is affected by waves, using a bridge attached to one side of the building, besides, this system is better suited for large floating buildings.

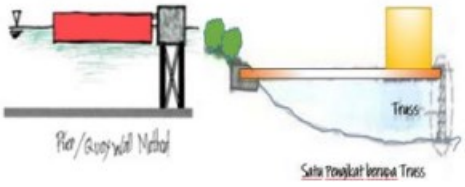



*Figure 15 Attached Mooring System*

2. The mooring system with piles
   This mooring system uses piles to keep the building in position. This system uses the principle of stake. Whereas to maintain the position of the building, the configuration of the supporting pole is also a consideration in this mooring system.

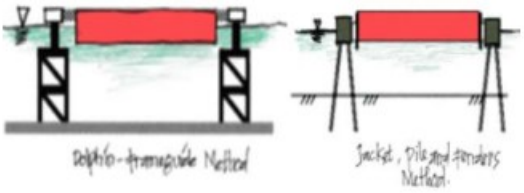


*Figure 16 Pile Mooring System*

3. The mooring system with a cable (Spread Mooring System)
   This type anchors the floating structure with a fixed heading direction. In this configuration a swivel component is not needed, this configuration is only suitable for a location that is relatively quiet and has a change in the direction of loading that tends to be constant / not large. In general, locations such as the Malaka Strait or the Java Sea Coast may be suitable for this configuration. There are two types of cable configurations in this mooring system, including crosses and crosses. A configuration a is more suitable for use in environments with calm water conditions because the cable only functions to maintain the position of the building.

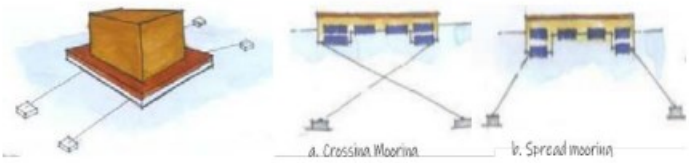


*Figure 17 Spread Mooring System and Type of Cable Configuration*

## 3.6 Materials

In the selection of this material, materials that are environmentally friendly are sought so as not to cause damage to the environment and surrounding habitats.

Commencing with the most commonly utilized materials, steel and concrete, it should be mentioned that while these materials enable the project to be developed in a modular design, they cannot be regarded as appropriate for sustainable construction due to the significant environmental impact associated with their extraction and production. Furthermore, these materials are extremely heavy, making the project buoyant more difficult than constructive solutions involving adobe, ceramic, or stone elements. Though it is not widely available, bamboo might be considered a material that satisfies the project's specifications, see figure 16.


*Figure 18 Construction with Bamboo*

Also, Wood that has been certified as sustainable by a seal and comes from a sustainable production. Its small weight makes it an easy-to-use material, which gives it additional benefits. This makes loading, transporting, and assembling it easier as well. Its construction allows for the elaboration of lengthy compositions and provides flexibility for both artistic and functional structure. Since it permits shorter workdays, it generates more economy.
When a construction project reaches the end of its useful life, it is easy to demolish it and, if reuse is not possible, use the leftover material as fuel. With the right selection, cutting, drying, and application, wood can last an infinite amount of time with no maintenance.

Say against him that even if it can be attacked by fire, it behaves well in front of him due to the pillar's larger thickness and insulation. Fungi, insects (worms, termites, moths), and chemical agents can also assault it. It is vulnerable to decay and early aging if it sits outside. However, in spite of all, ecological treatments protect the wood from all kinds of damage.

**Wood Gypsium** Generally the walls of wood or plaster are composed of an auxiliary structure of wooden frames and covered with panels of fiber-plaster or wood shavings, among others. Some acoustic and thermal insulation material is provided inside the chamber. Its main advantages are the cleanness of execution and the lightness.

We need to make an effort to stay away from using metallic or plastic materials because of their poor performance as a significant source of heat transmission and their chemical makeup.
As referring to flat roofs, the implementation of a planted roof is thought to be the greatest option from an environmental perspective. The best option for finishing non-passable flat roofs is to use mineral gravel or recycled material. However, because we're going to install solar panels, the project's roof needs to be passable. The most commonly suggested alternative for this is ceramic tile cladding, but it comes with a lot of weight. In order to identify a more practical answer, we shall examine the potential waterproofing material solutions in the section that follows.

- **Flooring**

Flooring materials for houseboats must be moisture resistant and durable. Available options include marine plywood, bamboo and vinyl. Marine plywood is specially treated to resist moisture and prevent warping. Bamboo is a sustainable choice that combines durability and beauty. Vinyl flooring is waterproof, easy to maintain and comes in a variety of designs and finishes.

- **Wall finishes**

Fenestrations on the inside walls must combine durability with beauty. Commonly used materials include gypsum, planks and moisture-resistant gypsum. Gypsum provides a soft, durable surface that can be easily coated or decorated. Wooden panels add warmth and a unique character to the interior. Moisture-resistant gypsum is essential in humid-prone areas to prevent mold and fungus from growing.

- **Plumbing**

Plumbing systems in floating homes require the use of durable, flexible materials. Common options include PVC, PEX and copper. PVC is low cost, easy to install and resistant to corrosion. PEX has high flexibility and the ability to expand without exploding, making it ideal for water supply lines. Copper is solid and has natural antimicrobial properties, ensuring safe drinking water.

- **Water proofing and insulation**

It is undeniable that insulation and waterproofing goods are essential components of any construction since they help to keep the building isolated from the external climate.

Examine the waterproofing materials in the foreground, which are mostly going to be covered. The materials that are most frequently used for waterproofing on flat roofs, like the project, are PVC sheets, figure 19 below, which have a bigger environmental impact, and traditional asphalt sheets, which are used less frequently. We may assert the same thing about insulating materials: natural materials are better than synthetic ones. Since the use of petroleum-based materials contributes to global warming and ozone layer deterioration, we will now list environmentally friendly and sustainable insulators, including cellular glass, glass or rock fiber, and other more sustainable materials that directly come from renewable sources such as cellulose, vermiculite, cork or hemp, flax, wood fiber boards, cotton blankets, expanded clay, perlite (volcanic rock), sheep's wool, and straw.

*Figure 19. PVC Sheets*

## 3.7 Considerations for Material Selection in Padua

One essential aspect of designing mobile cases is material selection, especially when it comes to accommodation for Paduan students. The choice of materials affects the structural integrity and longevity of the buildings as well as their environmental impact, cost-effectiveness ratio, and suitability for the local climate and cultural context. Numerous considerations regarding the selection of materials for the floating apartments in Padova are addressed in this section, with special attention paid to sustainability, functionality, and quality.

- **Climate and Environmental Conditions**

  Padua has a humid subtropical climate, characterized by a hot and humid summer and a moderate and humid winter. The materials used in floating crates must be able to withstand these conditions without deteriorating significantly, key considerations include:

  - **Moisture resistance**: materials should be moisture-resistant to prevent rot, corrosion, and mold growth. Marine plywood treated wood and composite materials are preferred in structural elements exposed to water.
  - **Thermal insulation**: effective thermal insulation is necessary to maintain comfortable temperatures inside the home and reduce energy consumption for heating and cooling. Insulating materials such as expanded polystyrene (EPS) or polyurethane foam can be integrated into the construction process.
  - **UV resistance:** exposure to sunlight deteriorates materials over time. UV-resistant coatings and finishes can help extend the life of materials used on exterior surfaces.

❖ **Sustainability**

Sustainability is a key element of modern building practices, especially in student housing projects that often focus on environmental responsibility. Sustainable material options include:

- **Renewable resources**: Using renewable materials, such as bamboo or sustainably sourced wood, can help reduce environmental impact. For example, bamboo is a renewable and fast-growing resource with high strength ratios to weight.
- **Recyclable and recycled materials**: Integrate materials that are recyclable or made from recycled content that helps reduce waste. Composite materials made of recycled plastic or reclaimed wood can be used in structural and non-structural elements.
- **low-emission volatile organic compounds (VOCs):** The selection of low-emission volatile organic compounds is important to maintain indoor air quality, contributing to a healthier living environment for students.

❖ **Structural Integrity and Durability**

- **Corrosion resistance**: metal components, such as nails and connectors, should be made of corrosion-resistant stainless steel or alloys to protect against degradation resulting from constant exposure to moisture.
- **Buoys:** The materials used in the structure or floats must provide sufficient buoyancy and stability. High-density polyethylene (HDPE) floats are commonly used due to their durability and excellent buoyancy characteristics.
- **Load tolerance:** Materials must be able to support the weight of the structure and its population, including furniture and personal property. Engineered wood products, such as Laminate Cross Wood (CLT), offer high strength and good dimensional stability.

❖ **Economic Considerations**

- **Cost-effectiveness:** It is preferable to use affordable materials that do not affect quality or performance. Prefabricated components can help reduce labor costs and construction life.
- **Maintenance costs:** It is best to choose materials that need little maintenance during the period of use, which helps reduce costs in the long run and ensures that the accommodation remains in good condition with minimal maintenance.

Furthermore, some companies carry out these kinds of projects and have more expertise in choosing the materials; occasionally, they even make the decision on the materials based on their region, for example: ADRIA GROUP, VPFCASE, CRIPPACONCEPT.

# 4. Case studies

## 4.1 Real Case Studies of Floating Homes Around the World

### 4.1.1 Schoonschip

*Figure 20 Top View of Schoonschip*

Location: Johan van Hasseltkanaal, Amsterdam, Netherlands
Year of design: The project began in 2010, and construction began in 2018.
Size and scale: consist of 46 households, approximately 144 residents.

Schoonschip is a sustainable floating residential community designed by Space & Matter, with the intention of building one of Europe's greenest neighborhoods. Encouraging a close-knit community with an emphasis on unique urban living solutions, the project prioritizes the use of eco-friendly materials, smart water management, and renewable energy.

- **Sustainable features:**
  - The residences are not connected to the gas system and are extremely well isolated.
  - Heat pumps are used to provide heat for the homes. The pumps use passive solar energy as much as feasible in addition to extracting warmth from the canal's water (aquathermie).
  - The utilization of photovoltaic solar panels to generate electricity and a smart grid connection connecting every residence.
  - The streams used to separate black water (from the toilets) and grey water (from the shower, washing machine, and other appliances).
  - All houses have a green roof that covers up at least one third of the roof surface.
  - The use of sustainable materials and sustainable installations.

❖ **Problems Solved by Schoonschip**

- Adaptation to rising sea levels.
- Reducing carbon emissions.
- Water resources conservation.
- Promoting social integration.
- Reducing the environmental impact of construction.

### 4.1.2 Four seasons hotel


*Figure 21 Master Plan of Four Seasons Hotel*

Location: Great Barrier Reef area in Queensland, Australia.
Year of completion: 1988.
Size and scale: 5 story, 140 double rooms and 34 luxury suites,

The Four Seasons Floating Hotel is designed by environmentally conscious architects and developers, it seeks to offer a luxurious yet sustainable accommodation experience. By using sustainable practices and innovative design, it minimizes its impact on the environment while providing visitors with breathtaking views of the ocean outside.

❖ **Sustainable features:**

- long term usage by relocation of various areas.
- self-supporting facility with desalination plant, sewage & waste treatment system.
- power plant at almost noiseless levels.

❖ **Problems Solved by the Four Seasons Floating Hotel:**

- Reducing the environmental impact of tourism.
- To increase awareness of the importance of marine conservation.
- Support for the local economy and employment creation.
- Presentation of models of sustainable luxury accommodation.

### 4.1.3 Floating hotel "Salt & Sill"

*Figure 22 Floating hotel "Salt & Sill"*

Location: Island of Klädesholmen, near Gothenburg, Sweden
Year of completion: 2008
Size & scale: 2 story, 23 rooms (46 beds)

Architects specializing in environmentally friendly buildings created the Salt & Sill Floating Hotel with the goal of providing a distinctive and sustainable accommodation option. The hotel offers visitors outstanding luxury and easy access to the outdoors, all while emphasizing minimal effects on the environment.

❖ **Sustainable features:**
- protection of the environment.
- use of local raw materials
- geothermal use of sea water.
- habitat creation of marine life by left over stone.

❖ **Problems Solved by floating hotel "Salt & Sill":**
- Reduction of the ecological footprint of tourism.
- Provision of immersive and unique accommodation experience.
- Minimizing the environmental impact of the construction.
- Creating jobs and supporting the local economy.

### 4.1.4 Floating Resort

*Figure 23 The houseboat in Rimini*

Location: Rimini, Italy
Year of completion: 2017 / 2021
Size and scale: In the basic version offers two bedrooms, a kitchen, a living room and a bathroom, accommodating up to 6 people comfortably.

It is a vessel equipped with a 40-horsepower electric motor. Its intended use, however, does not involve movement, but it has a whole series of comforts to spend truly relaxing days: cool air

conditioning for the summer and warm for the winter, refrigerator, relaxation area, kitchen, lounge with armchairs, umbrellas, satellite TV, play area for children, hydromassage pool.

- **Sustainable features:**
  - Energy efficiency
  - Water management.
  - Low impact materials.
  - Marine friendly design.
  - Natural ventilation.

### 4.1.5 Urban Rigger, Copenhagen, Denmark


*Figure 24 Urban Rigger Copenhagen*

Location: Copenhagen, Denmark.
Year of completion: 2019.
Size and scale: 12 apartments across two levels (680 sqm)

This creative housing idea creates small, effective living areas by stacking recycled shipping containers in a circle. It provides an eco-friendly and compact way to live in cities because it is made to float. Its seamless integration of public and private spaces makes it an attractive and sustainable style of house architecture. Both functionality and visual appeal are improved by the use of vibrant colors and contemporary conveniences.

❖ **Sustainable features:**

- Clean and renewable energy is produced by solar panels.
- The energy source for hydro source heating is the nearby sea water.
- Low-energy pumps cut reduced heating and wastewater usage.
- Bike racks, kayak and barbecue areas, and a green courtyard are all present.

❖ **Problems Solved by floating hotel "Salt & Sill":**

- Focuses on the shortage of inexpensive student housing in cities.
- Maximizes land utilization by making use of the available waterfront space.
- Minimizes the influence on the environment by using energy-efficient design.
- Gives other cities a comparable model for housing solutions of a similar nature.

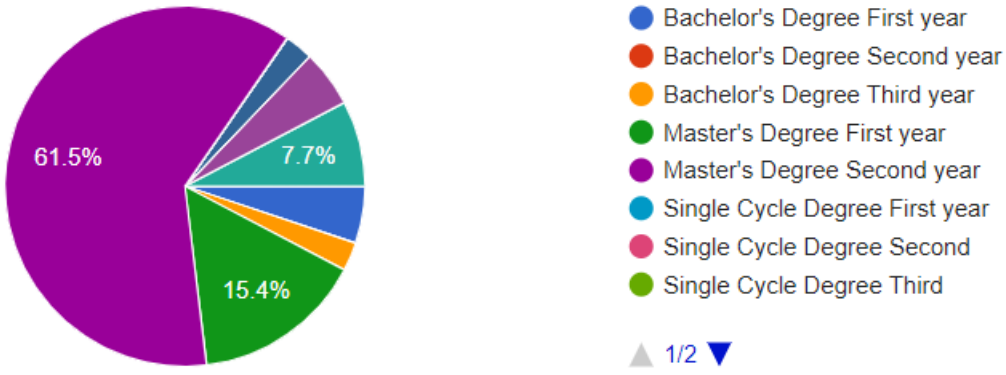
## 4.2 Case study of Padua

Padua is a relatively small city located in northeastern Italy, boasting much evidence of a rich cultural and artistic past, which has made it a destination for tourists from all over the world. Padua is home to a prestigious university founded in 1222, which receives more than 7,000 international students annually. Given this number and the size of the city, a large and obvious problem has arisen among students in terms of housing, which has affected some of them in terms of academic or living standards. In this thesis, we have conducted a survey on more than 180 students at the University of Padua with a google form to see what problems they suffer from and what their opinion is about floating housing and whether it is effective from their point of view or not.

### 4.2.1 The questionnaire

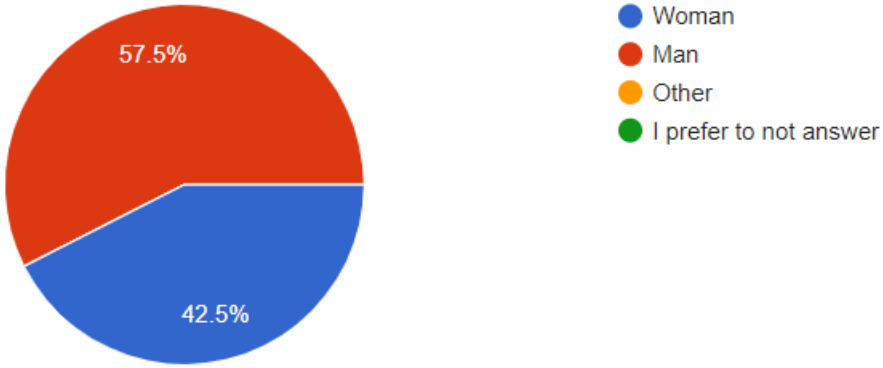
Below are the results of 181 students with different degree courses and different countries:

**1)** What year are you currently attending?



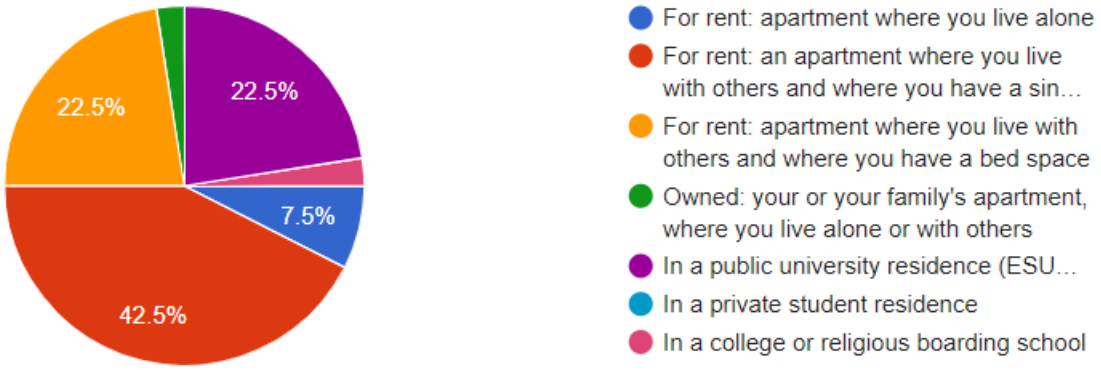
**2)** If you were born abroad, which of the following descriptions applies to you?


**3)** Which of the following gender identities do you identify with?

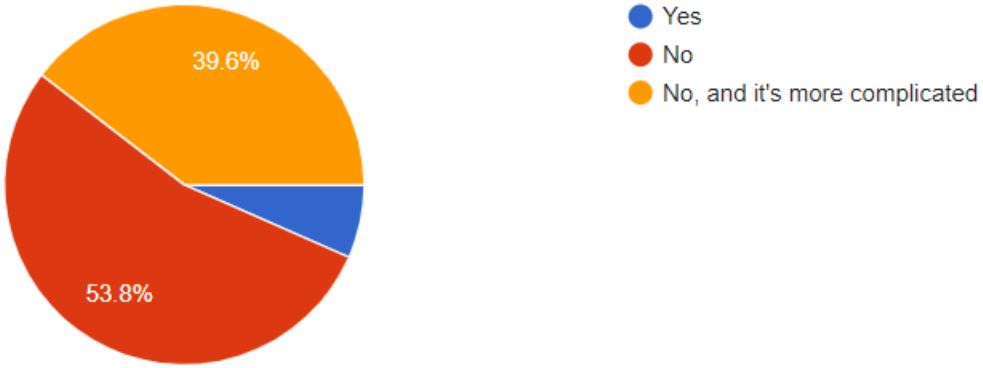



**4)** Thinking about your situation as a university student, with which of the following conditions do you identify yourself?

**5)** What is your living arrangement in the city where your degree course is?




**6)** If you are a student in Padua, is it easy to find a room for living?




**7)** What difficulties have you encountered in finding accommodation where your degree course is held?

Some critical answers:

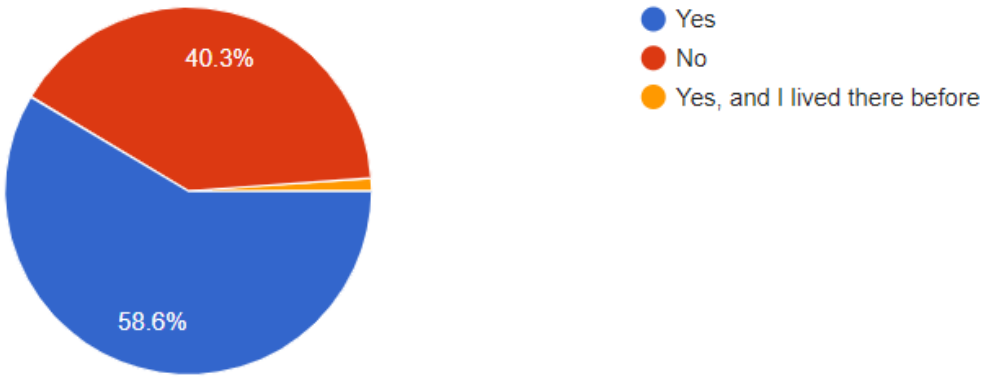
| | |
|---|---|
| High prices and fewer options | No response from a lot of messages that I sent |
| Very high rent and difficult to find | Far from university |
| As a foreigner, it is almost impossible to find a house even if you have a stable job. | I could say, the high rent price was really inconvenient. |
| Find a place to stay due to high request | Difficult to find a good place near university |
| Difficult for foreign students to get accommodation for renting | When you find accommodation the utility bills are extremely high which is considered a disadvantage for the student |
| Living far away from my campus, not having gotten the chance to live in a student residence | The lack of offers compared to the request, I asked in different places, but I was refused because of best alternatives |

**8)** Would you like to change your current living arrangements? (if yes why?)

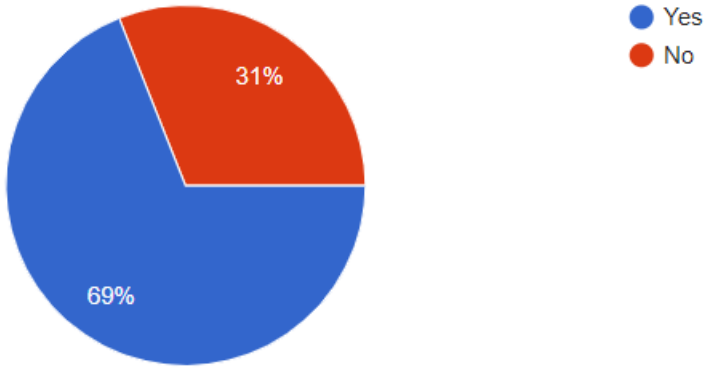
Some critical answers:

| | |
|---|---|
| Because I Hope to find a house with a garden and nice flat mate | Yes, because it is outside Padua and too expensive |
| Yes, I didn't like the experience of living in a residence with lots of students, it's not comfortable | Yes, because I would prefer to live in a small apartment |
| Yes, I would like to live with other students closer to city center rather than with my family. | Yes, because of the bills which is consider extremely high |
| Yes, it's not comfortable | Yes, looking for something more modern |
| Yes, I don't like the experience of living | No, because private room will cost me more |

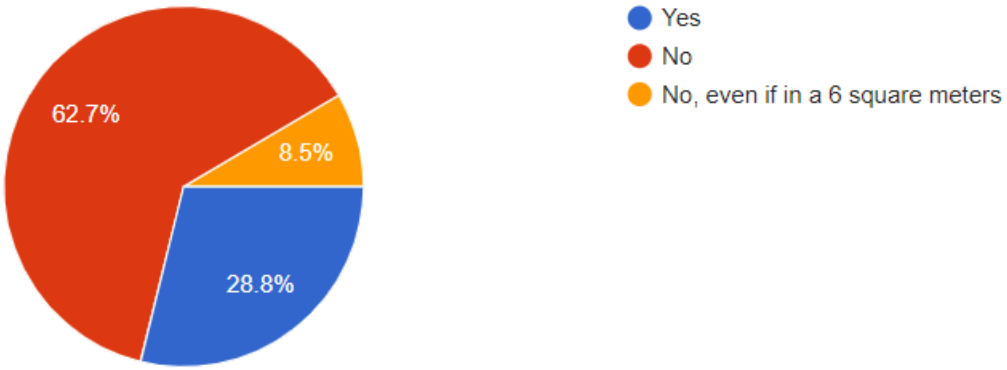
**9)** Have you heard about floating buildings?



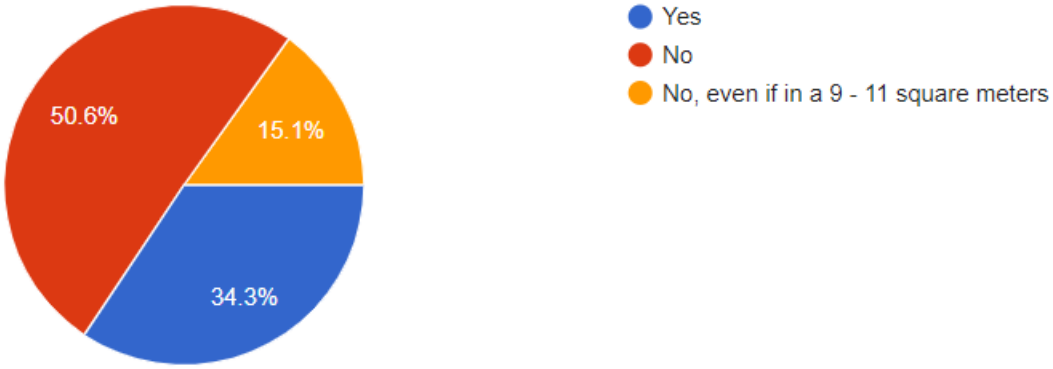

**10)** A floating building is a structure designed to float on water often anchored in place, allowing it to rise and fall with the water level. According to this, would you like to live on a floating house (paying rent less than you pay now)?



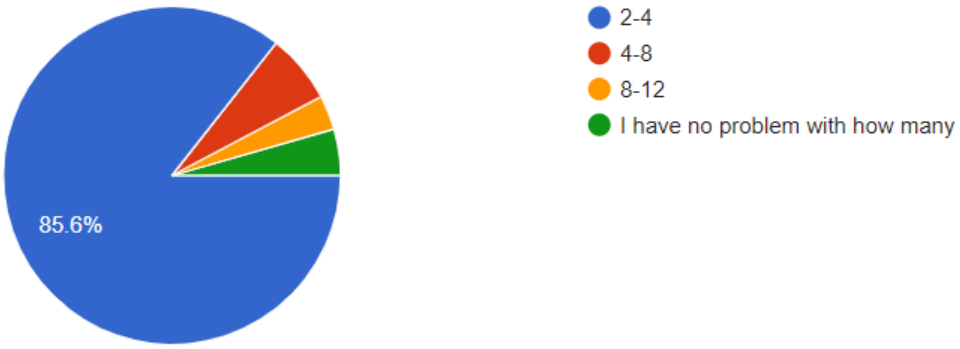
**11)** Do you have a problem staying for (6 months - 1 year) in a floating single room of 7 square meters?



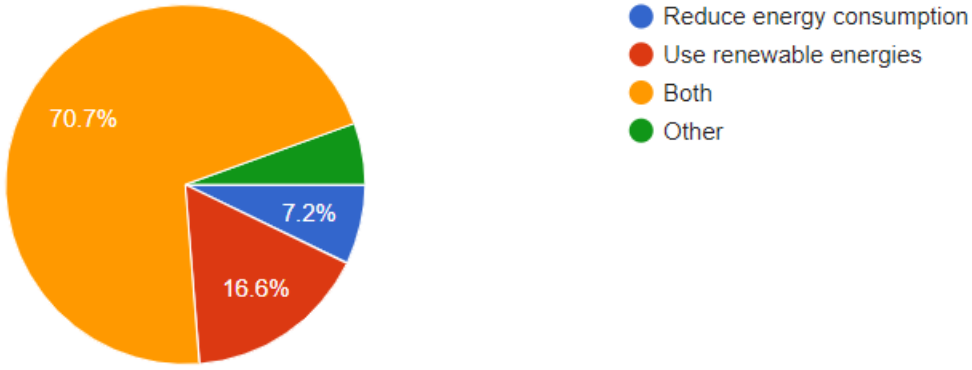

**12)** Do you have a problem staying for (6 months - 1 year) in a floating shared room of 12 square meters?



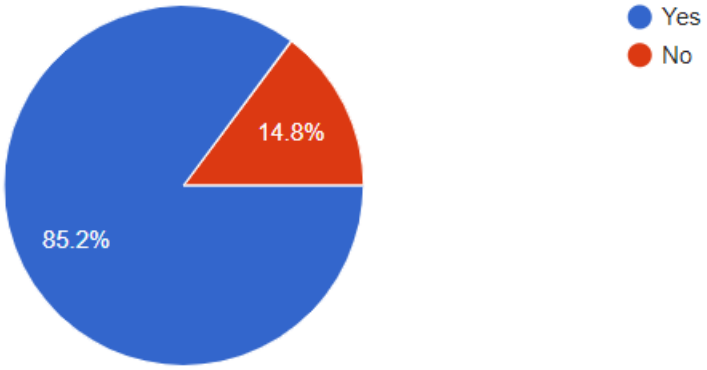

**13)** With how many people would you mind sharing the kitchen?



**14)** What do you consider more important?




**15)** As a student, in your opinion, is the floating residence for students in Padua can be useful?




### 4.2.2 Outcome of the results

The previously mentioned survey clearly demonstrates that a significant number of students experience common issues, such as the high cost and frequent lack of housing. Some students also encounter issues related to their distance from the university campus, which has a detrimental impact on their comfort, performance, and social cohesiveness. It's also evident that the majority of students haven't tried floating housing, but at the same time, they strongly support the concept and believe it may be a component of the solution to most problems.

### 4.2.3 Proposal of Floating Residences in Padua

As previously demonstrated, we were required to present a workable solution to each of these issues in our thesis. With the assistance of my supervisor, I examined the data and, in accordance with the findings, conducted site visits to provide workable recommendations to install floating residences on water in Padua.
I will thus discuss a few of the useful, workable models that could be developed. Technicality, surroundings, accessibility, distance from the university campus, and services that the student could require were taken into consideration when conducting this proposal.

- **First case study**

  It is situated on the Piovego Canal, in about twenty meters wide, and near the majority of the university's departments and services, which we shall go into more depth about, here is google maps details https://maps.app.goo.gl/fftbK8bJ6gfV6Gjz6 .


*Figure 25 Location of the First Case Study*

*Figure 26 Real Image for the First Case Study*

From the technicality point of view, we have showed before all the specification of the materials can used, besides the experience of the companies that have built such as this type of houses, therefore according to its characteristics we could say it can be installed without major difficulties, therefore all this is applicable for all the case we will discuss.

For the environment, the use of sustainable materials clearly will minimize the environmental impact, also using the renewable energy sources, efficient water management and waste management enhance its environmental benefits.

For the distances, firstly there is already an entrance from the main road to the site, as shown in figure 27 below, and it can be easily reached by bike, Moreover, there is a suggestion that, if built as a little flying crossroads, may offer a novel and ideal solution, shortening the distance almost 50%, see figure 28 below.

*Figure 27 The Exist Entrance*


*Figure 28 The Another New Suggestion*

The university campus is the primary critical distance to be mentioned. From its location to the Porta Portello, which is symbolic of the center of most departments, including the study rooms, it could only take six minutes by bike or roughly twenty minutes walking, see figure 29 below, making it an important point for students. In addition to the several stores and supermarkets in the same center (Porta Portello), there is another international store approximately nine minutes' walk away, as shown in figure 30 below, if that is not convenient for the student.


*Figure 29 Distance to Porta Portello*

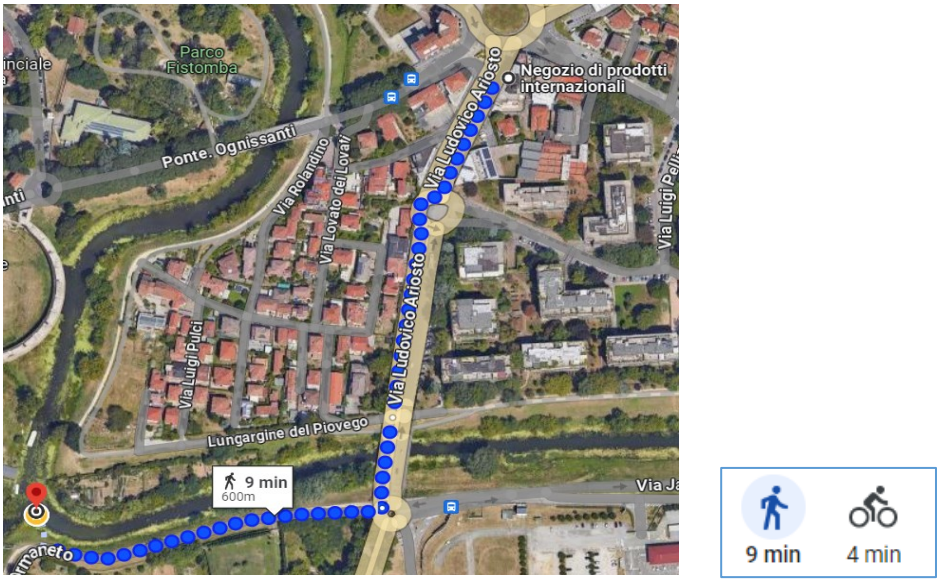



*Figure 30 Distance to an international shop*

If students are looking to exercise, the renowned CUS Padova (Centro Universitario Sportivo Padova) sports center is just a three-minute bike ride away, offering a variety of athletic facilities, see figure 31 below. And for leisure, a popular cinema is also conveniently located about nine minutes by bike, perfect for enjoying a film and unwinding, see figure 32 below.

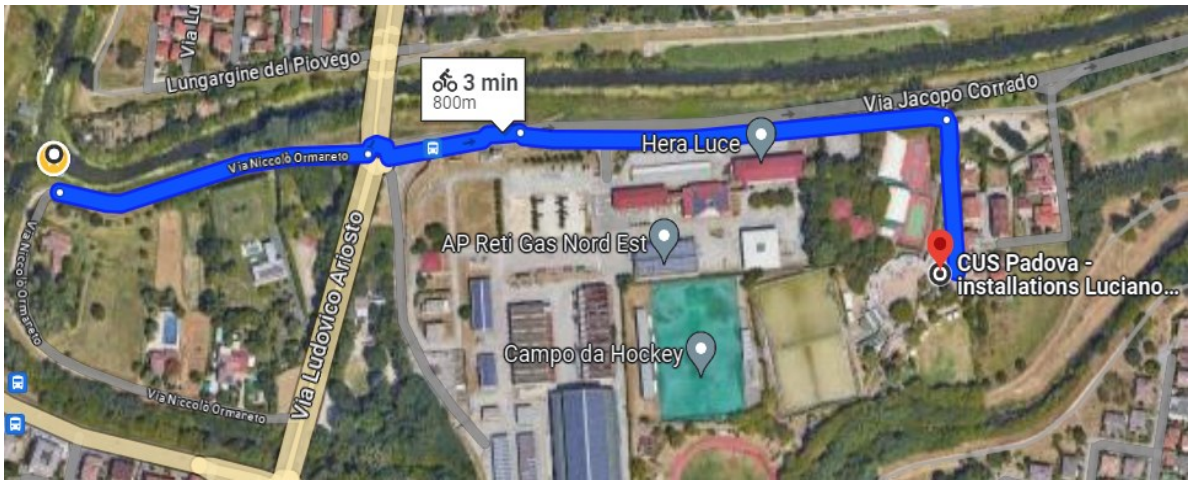



*Figure 31 CUS Padova Distance*


*Figure 32 Distance of Cinema Rex*

Furthermore, although we hope it remains unnecessary, but we have to take it into considerations, a hospital and pharmacy are conveniently located just a three-minute drive away, ensuring prompt access to essential medical services if needed, see figure 33 below.


*Figure 33 Hospital Distance*

➢ **Second case study**

It's located on Bacchiglione River, on section wide approximately 50 meters, near to buildings for the university (chemistry labs) and close to Parco dei Platani, here the google maps details https://maps.app.goo.gl/TTaDCJFQ8Nzffcbm9


*Figure 34 Location of the Second Case*

*Figure 35 Real Image for Second Case*

Building a floating residence on Bacchiglione River has a number of significant environmental advantages. First, with this idea we are contributing to urban development by conserving land by using the water's surface and may this land can then be set aside for parks or other green areas. Also, because floating homes can adapt to varying water levels and minimize their impact on naturally occurring floodplains, they provide a workable option for mitigating flood damage. The biodiversity of the river can also be preserved by designing these residences with as little disturbance to aquatic ecosystems as possible. Sustainable living is further encouraged by the incorporation of renewable energy sources including solar panels and water turbines. Moreover, by use of programs for cleaning and monitoring the river, floating homes can contribute to the improvement of water quality.

The location is ideally situated for students, as it is only a short 13-minute bike ride from Porta Portello, this close proximity guarantees easy access to the university and nearby amenities, enabling students to benefit from the innovative homes' environmental features while also taking advantage of the social opportunities and lively community life, see figure 37 below. Additionally, it's worth noting that the hospital is almost a 7-minute drive away, even in the worst-case scenario, see figure 36 below.

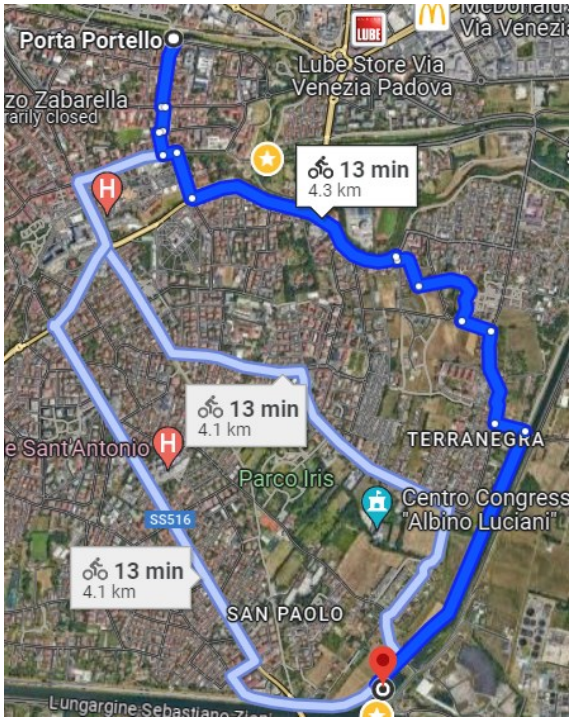



*Figure 37 Distance to P. Portello*

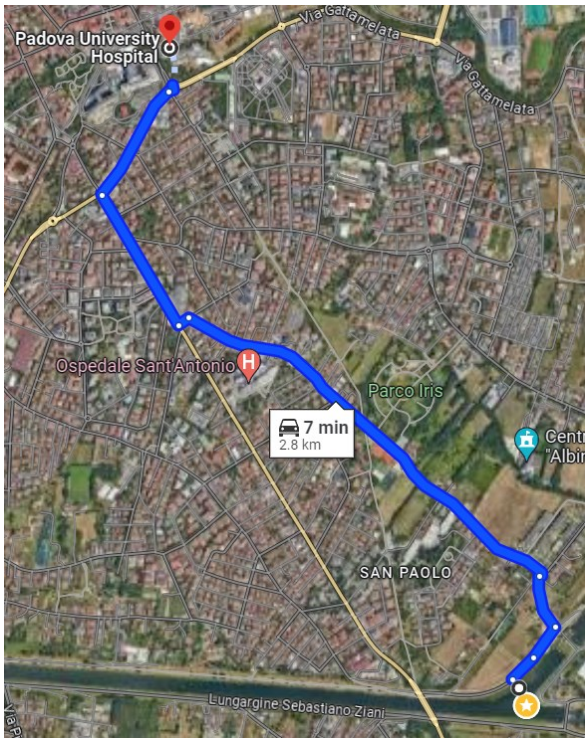



*Figure 36 Distance to Hospital*

In terms of nearby facilities and services, several notable options are available. For instance, the MD S.p.A supermarket is conveniently located just 3 minutes by bicycle or 9 minutes on foot, as depicted in figure 38 below. Additionally, Palestra Vlacovich, a local gym, is about 5 minutes by bicycle, see figure 39 below, also for those looking to relax or unwind, Parco Iris is a pleasant 15-minute walk away, offering a serene environment for leisure and relaxation, see figure 40 below. These amenities contribute significantly to the area's convenience and accessibility.


*Figure 38 Distance to MD S.p.A*


*Figure 39 Distance to Gym*


*Figure 40 Second Case to Parco Iris*

The proposed floating residence on the Bacchiglione River offers a forward-thinking approach to urban development that integrates environmental sustainability with strong social cohesion. By utilizing the river's surface, these homes conserve valuable land for green spaces and reduce impact on floodplains, promoting local biodiversity, besides the use of renewable energy sources underscores a commitment to eco-friendly living. Additionally, its proximity to the university, essential amenities, and recreational areas creates a lively and connected community for students. This setup not only fosters environmental responsibility but also strengthens social ties, providing a supportive and engaging living environment that enhances both personal well-being and community interaction.

➢ **Third case study**

It's located near most of the departments of the University of Padua, which is an advantage for students due to its proximity to the academic buildings with easy access to public transportation, exact location google maps https://maps.app.goo.gl/BoJapAR5FPhgpCfa8

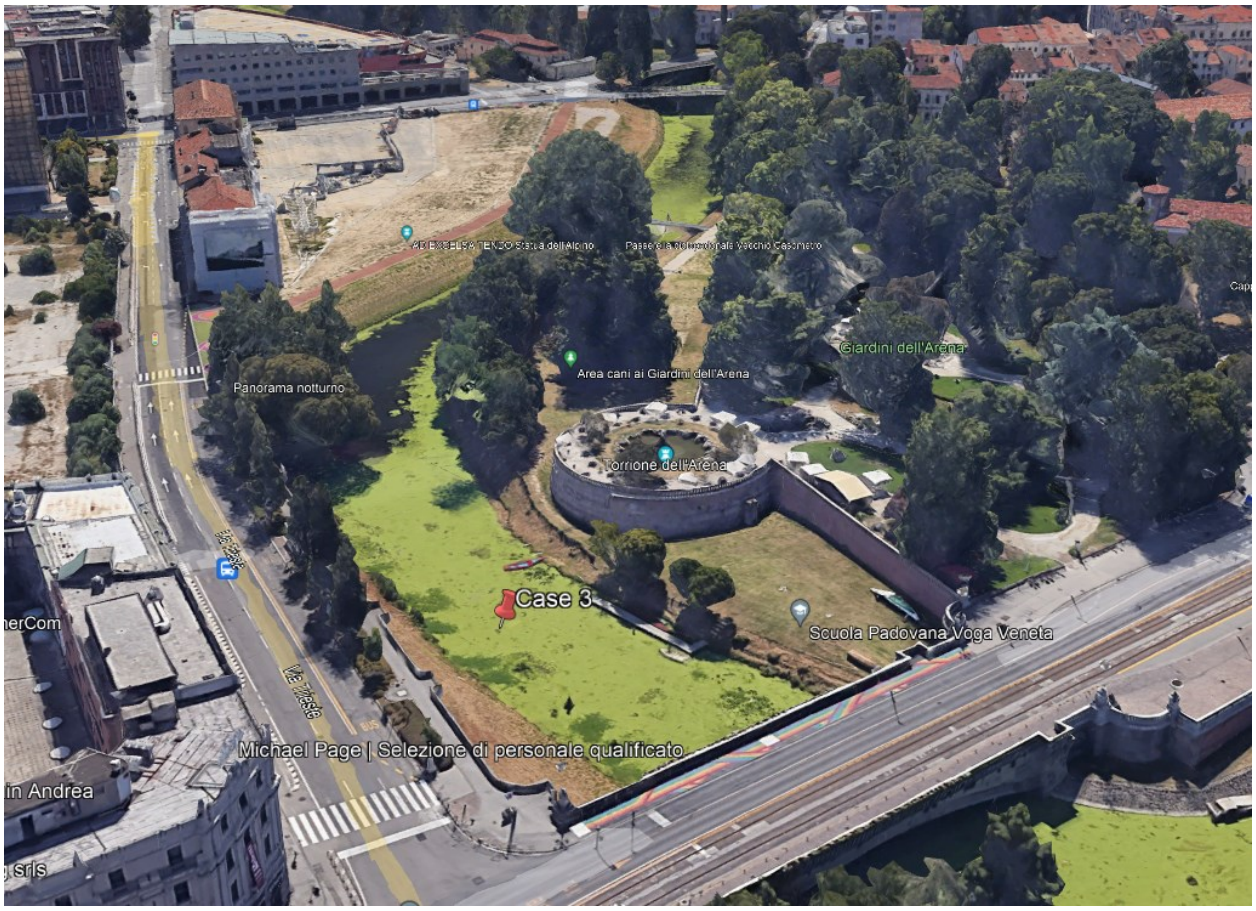



*Figure 41 The Location of The Third Case*

*Figure 42 Real Photo for the Location*

Practical and environmental factors have influenced the installation of floating homes in this particular area of Padua. As we can see in the previous photos this area is bounded by a river that is severely polluted because of the leaves that fall from the nearby trees, these leaves fall into the river, break down, and cause a number of biological issues that damage the aquatic ecology and affect the water quality, including decreased oxygen levels and nutrient overload.
Choosing this location enables us to address these environmental issues head-on. By putting down floating residence and, could be with integrated leaf collection systems, we can both actively improve the quality of the river and offer creative and sustainable dwelling.

Because of its advantageous location and easy access to important amenities, this location is ideal for student living. From Porta Portello, just a five-minute bicycle ride away and the city center is also conveniently located within a short riding distance and is full of stores and other student-friendly attractions. Ensuring safety and prompt response times, emergency services are well-covered, with ambulance access taking only eight minutes.

In addition, the location is only a seven-minute walk from Padua's major train station, making it easy for students to connect and travel. There are many different kinds of stores surrounding the neighborhood that provide daily necessities and lifestyle conveniences.

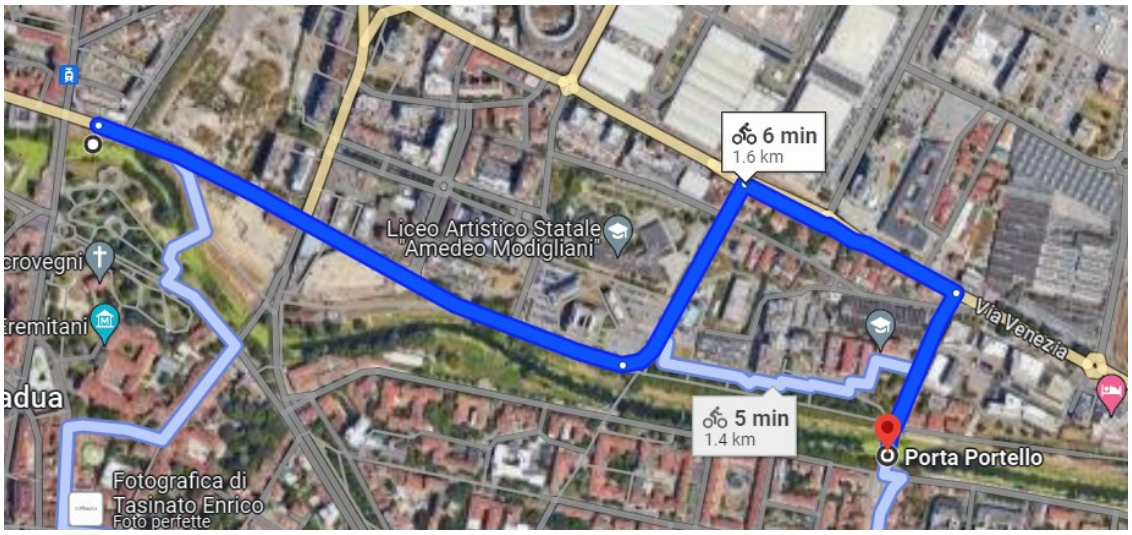



*Figure 43 Distance to Porta Portello*

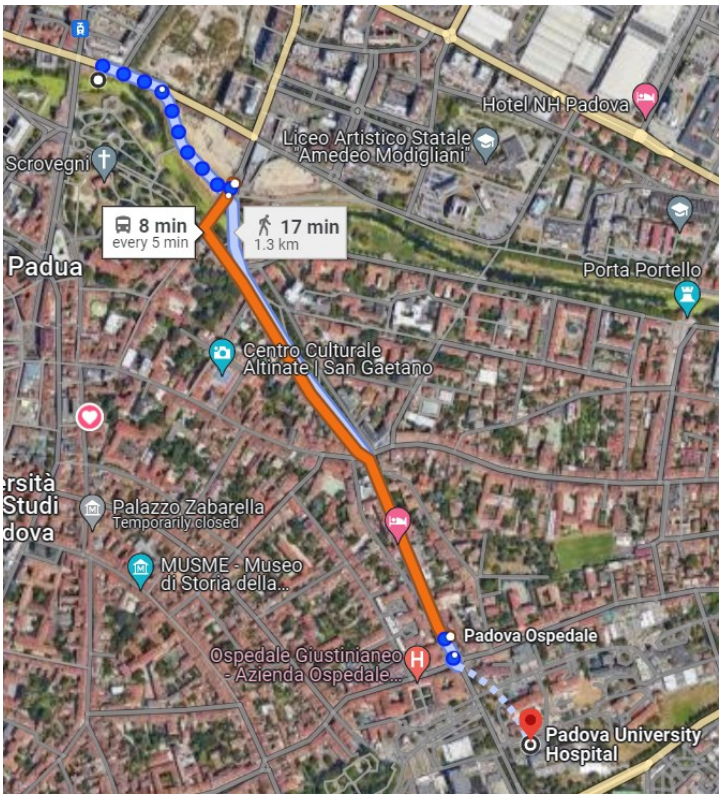



*Figure 45 Dis. to the Hospital*

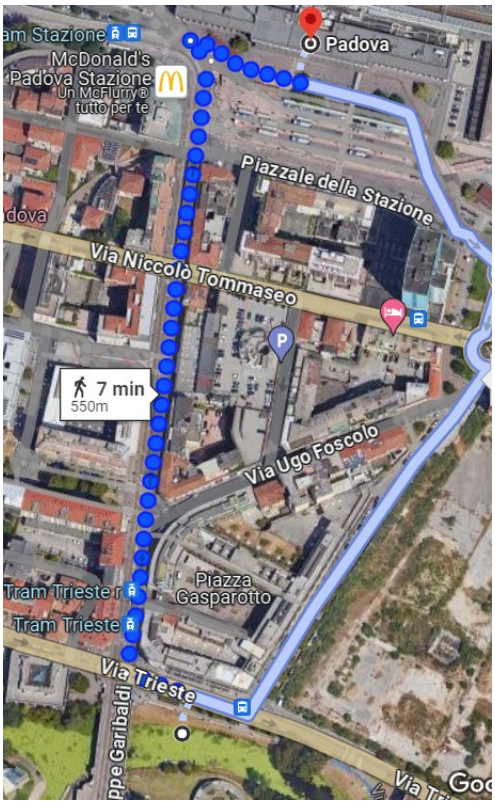



*Figure 44 Dis to Main Station*

### 4.2.4 The analysis and purposes of the three cases of a sustainable floating houses project

Based on previous experiences and also the sustainable development purposes of a territorial project proposed by EU, Territorial Agenda 2030, which aims to achieve sustainable and inclusive development across all European regions, we have done several purposes with their targets to create sustainable urban development.

- **Purpose 1: Fight Against Climate Change**
  One of the global problems today lies on the evolution and instability of the local and global climate, linked to the strengthening of the greenhouse effect, knowing that buildings, transport, and the materials used have an impact on greenhouse gas emissions. The goal is broken into two targets: Reducing greenhouse gas emissions and Saving energy. For saving energy several principles to guide the decision regarding this, the best is that we do not consume; we must therefore above all seek to reduce energy needs (highly efficient insulation and air renewal, reduction of thermal bridges). The energy need remaining to be covered must be studied between the different possible solutions, and their respective economic, social and environmental impacts will define the choices to be made. Moreover, the action does not stop at the technology, but must integrate information and awareness raising for students as well as all users so they can appropriate the technology and adopt an economical mode of consumption. Besides, it is necessary to improve the efficiency of

electricity consumption by using energy class A electrical equipment in residences, and above all to use renewable energies by production sector.

- **Purpose 2: Preserving Resources Natural**

Biodiversity is a major component of the sustainability of ecosystems, on which they directly dependent or indirectly all human societies. The goods and services provided by biodiversity (food, raw materials, active substances, capacity for self-purification, etc.) are in fact innumerable and for the moment irreplaceable. Likewise, the vital character of the environments and resources that make up the planetary environment (water, air, soil, etc.) obviously makes their preservation a fundamental condition for human development.

Target 1: Improve local water management:
The objective is the ecology of the environments, which corresponds to a radically new conception compared to previous objectives (objectives of means with a view to an ability to use (drinking water, bathing water, etc.). After construction the water can be saved and with a simple system of sanitation, we can reuse it again, the separate streams for the disposal of grey water (from the shower, washing machine, etc.) and black water (from the toilets) can be done.

Target 2: Optimize space consumption:
Urban sprawl is an obstacle to economic development in Europe, where space has become an increasingly rare resource, therefore, efficient space utilization is crucial for developing floating buildings in Padua. By optimizing space usage, we lessen the dependence on land, enhancing the functionality and sustainability of these structures. We can support higher population densities while maintaining comfort and accessibility, and effective space management ensures that floating residences blend seamlessly with the urban environment, providing innovative solutions to the challenges posed by limited land. Thus, we may say improve soil quality, in other words take into account soil pollution and the possibility of reversible choices in their use.

Target 3: Optimize consumption materials:
The choice of materials involves a great deal of debate and research, in Europe, which mainly concerns construction activity. The debate focus on the environmental impacts of materials and their impact on human health throughout their life cycle; impact at the time of their production, their transformation, their use then their treatment at the end of their life. In order to optimize the consumption of materials we have to promote the choice of environmentally friendly materials for the development, for example solid wood, products derived from tree processing and composite products constitute a panel of products available for construction and civil engineering.

- **Purpose 3: Improve the Quality of the Local Environment**

  Target 1: Strengthen health-related aspects and security:
  These aspects are essential; indeed, each individual must have the right to a healthy and productivity life in harmony with nature (Rio declaration), therefore each student lives on these floating houses must have food, water, education, and housing in a healthy environment, this also will involve improving the quality of outdoor air and reducing pollutant emissions.

  Target 2: Strengthen the environmental quality of residences:
  Even if sustainable development is an ethic, it should not ignore aesthetics. The aesthetic quality of the home remains an important criterion to reassure students (users) in their desire to live in the proposed environment. In addition, improving as much as possible the quality of interior equipment and finishing work. The quality can be environmental (ecological paints, non-polluting floor coverings, etc.)

  Target 3: Improve the waste management:
  In order to improve the management of household waste an urban plan project will need to encourage their sorting and selective collection. Consideration will be given to collection methods (for example voluntary contribution), and certainly, raising students' awareness may contribute greatly to this, with the presence of separate garbage places according to the classification of materials.

- **Purpose 4: Promote Social Equity**

  Target 1: Ensure access to public services effective:
  It will be necessary to ensure access to public services for any student (education, goods, health, security, sport, etc.)

  Target 2: Guarantee social cohesion of the residence:
  The social bond and solidarity between students partially takes up one of the purposes of sustainable development, and in urban planning project the aim will be to avoid the creation of ecological and social inequalities.

- **Purpose 5: Maintain and Strengthen Attractiveness for Sustainable Economic Development**

  Target 1: Strengthen local economy.
  Target 2: Promote development of production methods and sustainable consumption.
  Target 3: Promote sustainable management of the housing.

### 4.2.5 Towards sustainable buildings

The European Commission proposed a definition of sustainable construction in 2004, which places strong emphasis on environmental aspects, without forgetting economic, financial or social aspects: sustainable construction is a process in which all stakeholders participate (owners, financiers, engineers architects, contractors, material suppliers) and with integrates functional , economic, environmental and qualitative consideration in order to construct and renovate buildings and an environment built that is attractive, accessible, comfortable, easy to live and use, favorable to the well-being of those who are in contact with it,  and economical in its use of resources particularly with regard to energy, materials and water.

After the analysis for public spaces and with a helping of the French book “L’urbanisme Durable”, we have made a reference framework named ‘MIFISTO’ (the key words of which from the seven themes). Each theme has several targets with their sub-targets and sustainable development objectives. By this we can ensure sustainable housing in Padua and the assistance of students from the difficulties that may face in more green aspects.

- The MIFISTO repository

| | |
|---|---|
| M | Mobility management |
| I | Interface between public and private spaces |
| F | Flow management |
| I | Integration of the project into the city |
| S | Site monitoring |
| T | Treatment of public spaces |
| O | Occupancy of space |

Table 1. Themes and Targets for the Sustainable Development of Public Spaces

| No. | Target | Sub-target | Sustainable development goal |
|---|---|---|---|
| 1 | Mobility Management | More pedestrians | Ensure quality pedestrian's paths and organize the location of services to encourage gentle circulation |
| | | More trips by bike | Ensure quality paths and secure parking spaces |
| | | Good Connection to the city | Promote access for all the city public facilities and services |
| 2 | Interface between public and private spaces | The disabled | Create suitable barrier-free paths allowing safe movement of people with reduced mobility |
| | | Reduction of noise | Reduce possible nuisances for occupants' private plots |
| 3 | Flow management | Flood and risk management | Preserve property and people |
| | | Sanitation | Reduce collective sanitation needs |
| | | Collection of waste | Guarantee the cleanliness and promote the selective collection |
| 4 | Integration of the project into the city | Awareness | Education, environmental awareness and citizenship. |
| | | Participation of residents in developments | Improve the relation and conviviality and co-operation of the projects |
| 5 | Site monitoring | Development of the spaces | Maintain the cleanliness of the residence and avoid degrading existing natural spaces |
| 6 | Occupancy of space | More green space | Maximize the surface area of green spaces > promote ecological continuity through green spaces |
| | | Networks | Optimize maintenance, repairability and control networks |

## 5. Conclusion

Living on water provides a unique lifestyle that is compatible with the natural environment and addresses some of the major challenges facing modern cities. Floating homes not only offer beautiful and quiet living spaces, but also offer practical solutions to the problem of population density and land shortages.

- **Resilience: Adapting to Sea Level Rise**

  On the one hand, with their unique ability to adapt to fluctuations in water levels, floating homes offer innovative solutions to sea-level rise. Coastal and riverine cities, such as Padua, are threatened by rising sea levels as a result of the accelerating effects of climate change. With their distinctive design, floating homes give society a sustainable means of maintaining safety and habitability, thanks to their natural ability to resist flooding and constant environmental changes.

- **Innovative Urban Development**

  Floating homes, however, represent a revolution in emerging cities, where they have successfully addressed land consumption issues and their impacts on the environment. Traditional urbanization also often leads to the loss of natural ecosystems and the depletion of priceless land, with floating houses taking advantage of water bodies to reduce the environmental impact of urban growth and maintain terrestrial ecosystems.
  This innovative approach allows housing and infrastructure to expand without the need to consume precious land. Using water surfaces for construction, cities can preserve green spaces and natural habitats that are often lost in traditional expansion. In addition, floating houses enhance the aesthetic and recreational value of coastal areas, thus contributing to the improvement of the overall urban environment.

And we can consider this as two points of view:

1. **Floating Houses as Tourist Attractions**

   In one view, floating houses are an amazing opportunity to promote tourism, as have been proven successful experiences in cities like Rimini and Lignano. These cities have succeeded in integrating floating houses into their tourism strategies, providing visitors with a unique and unforgettable residence experience. Stay in a floating house, whether it's a fascinating lake with a scenic lake or installed in a bio conference, adding a distinct dimension to the travel experience.

*Figure 46 Houseboat in Lignano*

*Figure 47 Houseboat in Rimini*

Tourist cities can make great benefits by adding floating houses to their accommodation options. These houses can be directed to attractive water sites, allowing guests to enjoy great scenes and new experiences in the city. Floating Houses combine luxury, comfort and water connection, giving them an advantage that traditional hotels don't offer, and thus can enhance the attractiveness of the city and attract more visitors.

Moreover, through using the aesthetic and experimental advantages of floating houses, cities may boost the tourism industry, stimulate economic expansion, and create new revenue streams. This creative lodging concept follows the current trends in experimental travel, as travelers seek out immersive and unusual experiences. Thus, floating homes enhance the quality of residency options in tourist destinations, boosting their competitiveness in the world travel industry.

## 2. Floating Houses in University Cities

In university cities such as Padova, which attracts over 7,000 international students a year, the problem of housing shortage is a major challenge. The growing demand for accommodation often goes beyond the availability of appropriate options, leading to crowded and high-cost rent markets, this problem is complicated by the flow of students with each new school year, which is difficult for the city to meet the growing housing needs.

Thus, floating residences are a practical solution to this challenge, offering additional and flexible housing options for students and college staff. These houses can be designed to meet the needs of the academic community, near university facilities, and access to public transport, and the example of Urban trigger Copenhagen, and the floating university Berlin showed a wide range of benefits for the environment and the social.

**But what are the benefits of floating houses for University Cities!**

- Increased housing capacity: Floating housing can quickly contribute to expanding the residential base without the need to use large amounts of land. This is especially useful in cities that lack the lands available for development.
- Flexibility in order and adjustment: These units can be easily adjusted or transferred to meet changing demands, which is appropriate to accommodate changes in student numbers and different housing needs.
- Near the university: By carefully floating houses near the university, students and faculty members can be improved and their travel time can be reduced.
- Improved view of housing: compared to normal college housing or apartment housing, floating housing provides a special and attractive living environment that can positively affect student experiences. As a result, it's an enjoyable and special alternative that is useful for the well-being of the student which result in their performance.

❖ **The Floating University Berlin**: Temporary educational and housing space designed for students and researchers, using a reusable water basin to create a floating campus with classrooms, workshops, and living places. The project focuses on practical learning, sustainability, and innovative design.

*Figure 48 The Floating University Berlin*

## 5.1 Temporary Living and Multifaceted Benefits:

Whether they're used to accommodate students or tourists, floating houses are usually considered temporary solutions. This feature provides great benefits for flexible housing and urban planning. When there are short-term increases in housing demand, especially during summer or school periods, temporary housing options become very useful, knowing that cities are able to better manage housing resources and react swiftly to changing requirements because of this flexibility, and we can mention a several benefits:

- Flexibility: Floating dwellings can be moved or rearranged as needed to allow cities to dynamically adjust to changes in demand.
- Resource efficiency: By reducing the need for long-term building, temporary structures lessen the consumption of resources and the harm they cause to the environment.

- Economic Benefits: Floating homes give that are well-liked by tourists and students new revenue streams. By offering both private lodging that draws tourists and reasonably priced options for student housing, they promote local economies.
- Improving urban planning: floating houses contribute to urban planning and sustainable development by addressing housing shortages without taking away precious land.

## 5.2 Padua context

Integrating floating homes into Padua's housing strategy is an innovative solution to address the housing shortage afflicting the city's large international student population. By providing additional, adaptable living spaces on water, Padua can strengthen its ability to effectively house students and faculty while contributing to the city's sustainability goals.

According to the case studies that I mention in the previous chapter, the benefits of floating houses were assessed based on most important factors, which are:

**1. Technicality:**

- A thorough evaluation of the structural stability and safety of floating homes in Padua's aquatic environment was conducted, including a review of the materials that could be utilized and an examination of potential difficulties arising from variations in weather and water levels.

**2. Convenience to services and the university:**

- The university and essential services were taken into consideration when analyzing the residences' strategic location.
- Also access to the university, public transit, and surrounding facilities like supermarkets, libraries, and leisure centers were taken into consideration when choosing the best sites.

**3. Accessibility and the environment:**

- Access to the floating homes from the streets has been carefully planned to ensure that residents and visitors can easily access and enter these unique homes, and key aspects include Connecting Infrastructure, Proximity to Streets, and the Entry points.
- The environmental impact of placing boats in specific bodies of water has been assessed to ensure minimal disturbance in local ecosystems and to maintain water quality.

According to the above, these case studies demonstrate that floating residences offer substantial benefits in terms of environmental sustainability and accessibility to essential services, in addition to being technically possible. Padua can successfully address housing difficulties and develop a dynamic, sustainable, and inclusive living environment by implementing this innovative approach. This approach not only satisfies the pressing requirements of the community of international students, but it also advances the objectives of environmental preservation and urban development.

Additionally, the utilization of floating houses could result in additional revenues for the city by allowing people to rent them for a temporary period in addition to creating potential for tourism. Finally, this strengthens Padua's position as a premier city dedicated to economic development, enhanced quality of life, and sustainable growth.

## 5.3 The environmental problem and our purposes from sustainable housing in Padua

The gateway to sustainable development in Europe is often the environment; planning has taken into account environmental concerns for many years. However, sustainable development (or rather taking into account the environment and sustainable development) is only timidly beginning to be a selection criterion for development projects. Among these we have to mention the international ISO 14001 standards, which related to the environmental management system. According to all above and the questionnaire we have done with the analysis of case studies, we have reached to five purposes could be useful and innovative for floating residences in Padua:

- Combat Climate Change.
- Conserve Natural Resources.
- Enhance the Quality of the Local Environment.
- Foster Social Equity and Cohesion.
- Maintain and Boost Attractiveness for Sustainable Economic Growth.

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