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How the sustainability characteristics of the real estate properties affect their prices?

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School of Architecture, Engineering, Land & Environmental Sciences

Department of Real Estate

How the sustainability characteristics of the real estate properties affect their prices?

Master Thesis of

Valentina Kontakki

MSc in Real Estate

Pafos, October 2020

School of Architecture, Engineering, Land & Environmental Sciences

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Valentina Kontakki

Submitted to the School of Architecture, Engineering, Land & Environmental Sciences in part of the requirements for obtaining my Master degree in Real Estate

Pafos, October 2020

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MSc in Real Estate

Master Thesis

How the sustainability characteristics of the real estate properties affect their prices?

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Tutor: Dr. Martha Katafygiotou

Abstract

The cities in the past used to be created and developed by slow and smooth rate, while today are created and developed in very short time, they expand become one of the most important sources of many environmental problems. Investment in environmental technologies can ensure that over time many environmental impact will decrease.

We have the technology to survive, but we also need the ecological consciousness of all of us that will help in the timely implementation of the changes to ensure a guaranteed future.

We must urgently reduce greenhouse gas emissions, adapt our buildings so that we can survive in them during intense weather and increase the adaptability of our societies to ensure their survival through the upcoming changes.

Today we have buildings with sustainability characteristics and the governments are trying to implement this through legislation and to apply that characteristics for all new buildings. The scope is in the next 10 years to have buildings with zero energy consumption.

In this paper I try to study how those evolutionary sustainable characteristics are affecting the property prices globally. The study aims at an in-depth review of the literature related to the values of sustainable properties and the description of the evidence that affects them.

In this paper I try to examine the link between property prices and sustainability characteristics and how these characteristics make significant changes on property prices. More specifically I examine the market prices and the rental prices, if there are some changes noticed because of the sustainable characteristics a building may have, and if there is any which are those characteristics which affect more those prices. Generally, the role of the sustainable design in the real estate price.

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Thanking

I would like to thank my supervisors, Prof. Martha Katafygiotou and Prof. Theodora Ioannou, for the patient guidance, encouragement and advice they both provided throughout my time as their student. And also I want to express my deepest gratitude to Prof. Petros Sivitanides, Head of the Department of Real Estate and Coordinator of Master in Real Estate, for the extensive knowledge he provided to me, I was extremely lucky to meet him because he cared so much about my work, and he responded to my questions and queries so promptly.

Finally I have to thank my parents and my husband for their love and support throughout these difficult period. Thank you for giving me strength to chase my dreams.

Introduction

According to the authors of the book "Ecohouse" the last years some facts shake up the world:

- The Europe's heatwave during the summer of 2003 which killed more than 35,000 people.
- The USA's heatwave also during the summer of 2003 which cause power outage in NY with millions of people working in high rise building without ventilation and temperature control.
- The flood caused by Hurricane Katrina in September 2005.

The book refers to the concerns about the climate change and the depletion of fossil fuels. Furthermore, buildings use more than half of the total energy consumed globally and account for over half the emissions that cause climate change.[1]

The cities in the past used to be created and developed by slow and smooth rate, while today are created and developed in very short time, they expand become one of the most important sources of many environmental problems. Investment in environmental technologies can ensure that over time many environmental impact will decrease.[2] This is a challenge for the business world of the European Union, so it will further develop its leading role for effective, in terms of ecology, use of natural resources.

What is clear is that we have the technology to survive, and what we need now is the ecological consciousness of all of us that will help in the timely implementation of the changes to ensure a guaranteed future. We must urgently reduce greenhouse gas emissions, adapt our buildings so that we can survive in them during intense weather and increase the adaptability of our societies to ensure their survival through the upcoming changes.

Today 10 years after the book, sustainability becomes part of our lives. Is a really slow procedure but today we have buildings with sustainability characteristics and the governments are trying to implement this through legislation and to apply that characteristics for all new buildings. The scope is in the next 10 years to have buildings with zero energy consumption.

The aim of this paper is to study how those evolutionary sustainable characteristics are affecting the property prices globally. The study aims at an in-depth review of the literature related to the values of sustainable properties and the description of the evidence that affects them.

In this paper we will try to examine the link between property prices and sustainability characteristics and how these characteristics make significant changes on property prices. More specifically we examine the market prices and the rental prices, if there are some changes noticed because of the sustainable characteristics a building may have, and if there is any which are those characteristics which affect more those prices. Generally, the role of the sustainable design in the real estate price.

[1] Roaf, S., Fuentes, M. and Thomas, S. (2009). EcoHouse. Elsevier Ltd.

[2] Lecture 4–Environmental and Sustainability Issues in Real Estate Development–Dr Theodora Ioannou

Basic Principles and Current Market Trends

Bioclimatic Design

The term "bioclimatic design" means design that aims to protect the environment and natural resources. The goal of bioclimatic architecture is to create urban areas and buildings that are designed to fully meet their energy needs without causing environmental damage.[3] Bioclimatic design refers to the design of buildings and facilities according to the climatic conditions of the location in which the building will be located. It aims to use, where possible, renewable energy sources and the microclimate, with main purpose to ensure the physical conditions of heating, cooling, natural ventilation and visual comfort.

Key elements of bioclimatic building design are passive systems, which are the components of a building. Passive systems operate without mechanical components or additional power supply and of course warm and cool buildings.

The Bioclimatic design can manage to minimize the development's energy needs, either in urban scale or in building scale, by incorporating energy saving techniques and appropriate passive solar systems, systems for natural lighting and shading, natural ventilation and passive cooling. The bioclimatic design refers to the optimal use of environmental and energy parameters during summer and winter seasons.[4]

During the summer, it is necessary to ensure the protection of buildings and open spaces from the sun, using shading and appropriate vegetation, ventilation of buildings and outdoor areas, such as relationship building barriers and open spaces, proper siting of buildings and the location of green spaces, the natural cooling and thermal comfort, with surface waters or by ensuring unobstructed view of the exterior surfaces to the sky.

During the winter season it is necessary to ensure adequate solar insulation of the building units through proper orientation, height and distance of buildings, planting and through the orientation and direction of roads and other paths, protection of buildings and of open spaces from the air, with proper organization of space in relation with the direction of strong winds, the density of urban areas and urban spatial planning features, providing protected areas with dense plantation and using of appropriate vegetation within the building blocks.

Bioclimatic design in urban scale requires specific orientation and location of the buildings and blocks, as well as layout and width of roads at the neighborhoods and building blocks. It also requires suitable landscaping and vegetation selection (based on the season, the required or desired levels of insolation and shading) and exposure to wind or wind protection, with the aim of improving the microclimate of the area.[5]

The modern construction industry is increasingly dependent on the economic conditions of the time as well as on the climatic conditions of each region, as no one can reject reasonable solutions that can drastically reduce the environmental impact as well as the operating

[3] https://landco.gr/en/services-2/environmental-applications/24-services/perivallontikes-efarmoges/95-bioclimatic-architecture-in-association-with-landscaping#:~:text=The%20term%20%22bioclimatic%20design%22%20implies,requirements%20without%20induce%20environmental%20damage.

[4] Lecture 4–Environmental and Sustainability Issues in Real Estate Development–Dr Theodora Ioannou

[5] Lecture 4–Environmental and Sustainability Issues in Real Estate Development–Dr Theodora Ioannou

costs. Taking care of the environment will result in the environment taking care of you and providing a comfortable, sustainable and energy-efficient living environment.[6]

Bioclimatic architecture is not a new concept, since we find it in many traditional architectural styles that operate according to the principles of bioclimatic design. Examples of traditional architectural solutions that work in this way are often vertical archetypes, such as south-facing windows and insulating blind north walls. As a random example, many Greek and Cypriot villages are located on south-facing slopes, using materials with thermal mass (such as adobe) on the walls, creating a stable internal microclimate and comfort conditions for the user of the space. Depending on the actual climatic conditions of each region, these practices differ but operate on the same principle: a design process that requires more time, but also understands the need to monitor the design and utilization of the construction site, offering simple cheap local solutions to problems with aim for a healthy, energy efficient life.

The shift towards tradition and the research on of architectural solutions given through traditional techniques which created wonderful villages can still provide genuine projects capable to correspond to the many environmental and other challenges of modern cities.

Consequently, bioclimatic architecture is associated with Nature, since building designs take into account the climate and environmental conditions to achieve optimal thermal comfort inside. It deals with design and architectural elements, avoiding complete dependence on mechanical systems, which are considered as supportive. Good examples of this practice are the use of natural ventilation, the utilization of the energy supply potential of the sun, the earth and the wind.[7]

Environmental Planning

Buildings should not only implement the principles of bioclimatic design but the principles of environmental design too, in order to achieve satisfactory levels of users' satisfaction and environmental performance. Today, there are commercially available new technologies and materials that can be applied and adapted according to the buildings' and users' needs within the principles of bioclimatic and environmental design.[8]

Environmental design is the process of addressing surrounding environmental parameters when devising plans, programs, policies, buildings, or products. It seeks to create spaces that will enhance the natural, social, cultural and physical environment of particular areas.[9] Environmental design is the design that meet human needs and also includes all the provisions for the protection of the environment. It aims to harmonize the built environment with the natural environment.

[6] Tundrea, H. and Budescu, M. (2013). Bioclimatic Architecture, a sensible and logical approach towards the future of Building Development.
[7] Tundrea, H. and Budescu, M. (2013). Bioclimatic Architecture, a sensible and logical approach towards the future of Building Development.
[8] Lecture 6–Environmental and Sustainability Issues in Real Estate Development–Dr Theodora Ioannou
[9] Caves, R. W. (2004). *Encyclopedia of the City*. Routledge. P. 225.

The developments' planning should have two axes, the design at house level and the planning at the neighborhood level and thus the developments. It is clear that the stage which plays a vital role for the interception and prediction of impacts is that of the study.[10]

Therefore, the most effective method of improving the behavior of developments and minimization of future resources' input is the rational - environmental planning, which applies a holistic approach at all levels and has as its primary objective the optimum management and utilization of natural resources.

There are many possibilities and technologies for energy saving and renewable sources exploitation, as well as many construction methods and materials. In order to achieve significant environmental contribution, careful study and commitment from the initial phase of the project design is required.[11] Many cases and locations may require resourceful methods of financing until the investment becomes more effective. All measures for environmental and energy upgrades cost money and there is always the subject for the investment value.

Environmental design is interrelated with the architecture of buildings. Environmental architecture as we could characterize it aims to create buildings that complete a healthy environment in terms of psychological, social and physiological approach and the less possible impact on the environment.[12]

Practices that can be applied by designers and developers should be considered for the characteristic features of their buildings and the objectives they have as part of an environmental approach. The current trend of the construction industry to use materials for which the production requires huge amounts of energy therefore causing several environmental problems, even when they are at the functioning stage, could be mitigated by substitution or even replacement of these materials with other more friendly to the environment, human health and economy.[13]

Sustainable Design

Sustainability is an alternative lifestyle that seeks the harmonic reintegration of human in the environment and its positive contribution to the evolution of nature.[14] In ecology, sustainability is the ability of biological systems to remain diverse and productive indefinitely. Generally, sustainability is the endurance of systems and processes.[15] In Greek language the word for sustainability defines the relationship between man and the

[10] Lecture 4–Environmental and Sustainability Issues in Real Estate Development–Dr Theodora Ioannou
[11] Lecture 6–Environmental and Sustainability Issues in Real Estate Development–Dr Theodora Ioannou
[12] Lecture 1–Environmental and Sustainability Issues in Real Estate Development–Dr Theodora Ioannou
[13] Lecture 4–Environmental and Sustainability Issues in Real Estate Development–Dr Theodora Ioannou
[14] Lecture 1–Environmental and Sustainability Issues in Real Estate Development–Dr Theodora Ioannou
[15] https://en.wikipedia.org/wiki/Sustainability

environment, based to the human activities which do not destroy, interfere and cause desertification of nature.[16]

The term sustainable development was introduced in 1987 by the report Our Common Future prepared by the World Commission on Environment and Development (WCED). This is Bruntland Report which proposes as the solution of the environmental and development impasses the selection of the self-maintained of Sustainable Development.[17]

The Bruntland report defines sustainable development as "…. A process of change in which the exploitation of resources, the direction of investments, technical and institutional changes are in harmony and enhance current and future potential to meet the needs of the people"[18]

Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs. It contains within it two key concepts: the concept of needs in particular the essential needs of the world's poor, to which overriding priority should be given, and the idea of limitations imposed by the state of technology and social organization on the environment's ability to meet present and future needs.[19]

Sustainable development is the organizing principle for meeting human development goals while at the same time sustaining the ability of natural systems to provide the natural resources and ecosystem services upon which the economy and society depend. The desired result is a state of society where living and conditions and resource use continue to meet human needs without undermining the intergrity and stability of the natural systems.[20]

While the modern concept of sustainable development is derived mostly from the 1987 Brundtland Report, it is also rooted in earlier ideas about sustainable forest management and twentieth century environmental concerns. As the concept developed, it has shifted to focus more on economic development, social development and environmental protection for future generations. It has been suggested that "the term "sustainability" should be viewed as humanity's target goal of human-ecosystem equilibrium (homeostasis), while "sustainable development" refers to the holistic approach and temporal processes that lead us to the end point of sustainability".[21]

Built Environment is the space in which infrastructure and buildings are developed to meet the needs of residence, work and leisure of people. It is characterized as urban, suburban or rural. The variations of the parameters that characterize each of these three groups are the subject of related disciplines, such as urban planning, construction and materials science.[22] The built environment should be treated as an integrated system, which affects and is

[16] Lecture 1–Environmental and Sustainability Issues in Real Estate Development–Dr Theodora Ioannou
[17] Lecture 1–Environmental and Sustainability Issues in Real Estate Development–Dr Theodora Ioannou
[18] Lecture 1–Environmental and Sustainability Issues in Real Estate Development–Dr Theodora Ioannou
[19] World Commission on Environment and Development, Our Common Future (1987)
[20] https://en.wikipedia.org/wiki/Sustainable_development
[21] Shaker, R.R. (2015). The spatial distribution of development in Europe and its underlying sustainability correlations. *Applied Geography*, 63, 304-314
[22] Lecture 1–Environmental and Sustainability Issues in Real Estate Development–Dr Theodora Ioannou

affected by external conditions. The solutions to be provided for individual problems should take into account this holistic approach.

The inventiveness does not mean zero impacts, but consent to the Brundtland Convention between present resources use and future requirements. Thus, the definition accepts a responsibility to create natural capital in the form of buildings which represents long-term strength and flexible resources.

In a study conducted by Breheny, Gent and Lock in 1994 for a more sustainable form of development, and taking under consideration economic, social and environmental criteria, they ended up into two possible conclusion for achieving sustainability in real estate development. Either the developments should be of a sufficient size, in order to be able to support services, facilities, public transportations, employment opportunities to meet the needs of the population or as an alternative the developments should be deployed in urban areas.

The basic design principles for an ecologically oriented and environmentally friendly design which aims to create sustainable developments are:

- the construction of smaller buildings,
- the use of recyclable and renewable materials,
- the use of low embodied energy materials
- the use of harvesting timber,
- implementation of water collection systems,
- low maintenance cost,
- reuse of buildings
- the reduction of chemicals that deplete the ozone layer,
- the conservation of the natural environment,
- the construction of energy efficient buildings,
- proper solar orientation and construction
- easy access to public transport
- better quality of life[23]

One could define as a sustainable building "The building that meets the perceived and actual needs of the present with imaginative effective manner, while ensuring attractive, safe and ecologically rich neighborhoods»[24]

Sustainability Parameters and Environmental Design Principles that should be taken into account in the Real Estate Developments

Continuing from where The First United Nations Conference on Human Settlements left off in Vancouver, Canada, twenty years earlier in 1976,[25] the World Summit II held in Istanbul in 1996 recognizes 'cities and towns as the center of civilization, generating economic development, and social, cultural, spiritual, and scientific advancement'.[26] Further, it is

[23] Lecture 1–Environmental and Sustainability Issues in Real Estate Development–Dr Theodora Ioannou
[24] Edwards, B. and Turrent, D. (editors), (2000). Sustainable Housing, Principles and Practice
[25] https://en.wikipedia.org/wiki/Habitat_II
[26] https://documents-dds-ny.un.org/doc/UNDOC/GEN/G96/025/00/PDF/G9602500.pdf?OpenElement

stated that 'Recent United Nations world conferences, including, in particular, the United Nations Conference on Environment and Development, have given us a comprehensive agenda for the equitable attainment of peace, justice and democracy built on economic development, social development and environmental protection as interdependent and mutually reinforcing components of sustainable development'.[27]

Based on the above but also what I mentioned in the previous chapters, sustainability parameters that should be present in any new development are:

- The majority of (new) development should take place within existing developed areas.[28]
- Choice of location for a development/city should also take into consideration the distance from the power stations, to reduce loss of energy over long transport.
- New developments should get sufficient population in order to support services and transport, alternatively, development location must be near to existing public transport services.[29]
- Human activities during construction phase should strive to ensure minimum impact on the natural environment. Construction crews used should originate locally in order to cater with more care for preservation of the natural environment during the construction phase.
- Design and construction of mixed-use development is preferred, ensuring adequate pavement level, in order to facilitate easy and safe access by pedestrians and cyclists, thus maintaining commercial life and preventing crime.[30] Further, mixed use development will consume energy in a more balanced rate, as businesses and commercial infrastructure will use more energy during the day, while households will require more energy in the evening.
- Use should be made of empty houses, empty commercial and industrial buildings.[31] Residency should be offered above shops wherever possible to support the urban economy.
- Ideal density as identified as early as the 1960's by Architects worldwide, without creating sense of crowding, suggests for apartment blocks to be placed preferably in the perimeter of green areas and parks; while apartment buildings should not exceed three-to-four storey height. Further, the more compact is the development, the greater the energy savings since heat losses from one building constitute heat gains for another neighboring building. Finally, compact buildings require less building materials as they share foundations, roofs and walls.
- Excessive unit size in housing is not only unnecessary but also more costly to construct, to service, to make clean, to maintain, to heat and to cool. Optimum covered area indicator, of approximate 25m² per resident, should be used as a guide in housing design stages.

[27] https://documents-dds-ny.un.org/doc/UNDOC/GEN/G96/025/00/PDF/G9602500.pdf?OpenElement
[28] Rudlin, D. and Falk, N. (1999). *Sustainable Urban Neighbourhood.*
[29] Rudlin, D. and Falk, N. (1999). *Sustainable Urban Neighbourhood.*
[30] Rudlin, D. and Falk, N. (1999). *Sustainable Urban Neighbourhood.*
[31] Barlow J., (1994). *The Economy of Ideas.*

- As per the Habitat II agenda, adequate level of housing must be provided for all.[32] The built quality in housing should be high in order to ensure comfortable and healthy living. Housing should be dry and warm internally in the winter, and cool internally in the summer. Thus, the need for materials with high insulation capabilities is essential. During construction phase, less materials requiring high energy consumption during their manufacture stage i.e. steel should be used. Further choice of materials should be made also on the basis of low value of embodied energy. Choice of materials should also take into account their reinstatement back into the natural environment at demolition stage and the end of the building's useful life cycle.
- Housing must be flexible in terms of space adjustment and extension. There must exist design upgrade capacity, and design/provisions for renewable energy sources exploitation. Smart technologies or provisions for such technologies should be used, to ensure energy savings, to enhance the flexibility for future use, and to safeguard the safety of the residents.
- Orientation of housing should be predominantly south facing to maximize passive solar gains, while the glazing to the north and the east should be limited, only to secure light and to release heat in the summer months. The houses should be blind to the west. Buildings must be insulated to prevent thermal loss due to seasonality.
- Quality housing should be offered and should be made obtainable within the same neighborhood to varied budgets, in order to avoid social class separation, thus promoting 'justice between generations and classes of people' instead.[33] Architectural consistency and habitability both promote sustainability.
- Physical separation of activities of housing, employment, education, and leisure facilities should be replaced by social integration[34]. The existence of green areas and leisure areas in the urban area promote such integration and social interaction.
- Landscape design should exist within urban areas to promote social interaction of residents in the urban area, to allow the existence of green views from neighboring residential buildings onto the green area, to prevent crime due to the presence and the frequent use of the landscaped areas and parks by the residents. Trees and lakes provide cooling zones within the cities for the summer by absorbing the heat that cannot permeate road infrastructure. On the contrary in the winter, the presence of trees in the green area limits the impact of strong winds onto the buildings. Green areas and parks serve as landmark for urban areas, and meeting area for residents. Green areas and parks break up the compactness of the construction in the urban area, enhance the presence of biodiversity, thus, making urban areas more resident-friendly.
- Road network in and out of the development should be continuous to allow easier flow of traffic, pedestrians and cyclists, to reduce the need for private vehicle use, and to make the developments more permeable. Personal safety of the pedestrians is a non-negotiable goal.
- Neighborhoods should be easy to recognize by the pedestrians, and enjoyable for pedestrians to browse walking or cycling through them. Emphasis is on landscape

[32] https://documents-dds-ny.un.org/doc/UNDOC/GEN/G96/025/00/PDF/G9602500.pdf?OpenElement
[33] Edwards, B. and Turret, D. (editors), (2000). Sustainable Housing, Principles and Practice.
[34] Edwards, B. and Turret, D. (editors), (2000). Sustainable Housing, Principles and Practice.

diversity and landmark buildings. Car use should be made tame by limiting speed limits, rather than banned. Traffic lights should be made brighter, pedestrians crossing lines more visible, traffic lanes should be identified with clarity, parking on the side of the road should be allowed. All are measures that will ultimately reduce traffic speed. Stricter controls should be placed on heavy vehicle trafficking.

- Commercial activities should be linked with the neighborhoods and must be present at main roads, in order to attract high street business.
- The housing development must enjoy easy and quick access to public services such as schools and hospital, and commercial infrastructure such as supermarkets and other shops, eliminating the need for private vehicle use.
- Architectural design should take into consideration both at the master-plan level as well as at the unit level, the possible use of the development by residents with disabilities. Provisions should also be made for the resident's need to work from home, and for nurses to provide specialized elders care at home.
- Waste separation, waste recycling and waste management strategies should be applied to minimize the resources and energy consumed, and in consequent to minimize also the production of waste at the consumer level. Non-recyclable and non-recycled waste export should also be minimized. Further, the linear system of resource input flow and the subsequent conversion into waste should be become more cyclic in order to return some of the waste back into the production cycle.[35]
- Fresh water should be used rationally (where rational means logical, and in turn logical means 'green'), while the surface and the groundwater should be protected in order to keep clean while infiltrating into underground resources. Contaminated soil surface transfers the contamination to passing water, which ends up in underground water reservoirs, also contaminated. Area of soil sealed should be controlled in order for the rain water to be allowed to permeate, and to reduce the risk of flooding. Drinking water consumption should be limited for drinking purposes, while grey water technologies can suffice household needs in other-than-drinking use of water. Normal soil functions such as food and fiber production, carbon storage, and animal habitat provision should be allowed to continue to occur uninterruptedly.
- Make maximum use of local resources, such as the sun, the wind and rain, while food can be grown in private gardens and fields.

In the previous recent years, since the beginning of the new millennium, in anticipation of the accession of Cyprus in the EU, the island had experienced a remarkable growth and synergies both in the tourism industry and the real estate development sector. The economic, and social benefits were multiple for the population. However, the state of the environment had deteriorated. The residential development has been inconsistent by developing companies with no real interest in the sustainability and the quality of architecture or conceptual design, construction works, the management or the maintenance of their properties.

Since then, a lot of things change and the last years we can notice improvement in the level of sustainability. However, there is still room for improvement and the signs points to the proper direction for property development to become more sustainable, in years to come.

[35] Environmental and Sustainability Issues in Real Estate Development–Dr Theodora Ioannou.

Building Certification Systems

There are many certifications of sustainability for the built environment that we could analyze such as Active House, BREEAM, DGNB, Green Star, HQE, LEED, Living Building Challenge, Miljöbyggnad, Nordic Swan and WELL.

Below is a brief description of some of these certifications of sustainable buildings and especially those that focus on the environmental dimension. Each of these certifications is presented with a description that provides information about the history and scope of the certification.

Certifications are largely based on the environmental dimension, which is largely represented by the resource aspect. The social dimension follows closely after the environment, with an emphasis on the health aspect, where indoor climate and comfort play a major role. The financial dimension is generally underrepresented in all certifications. [36]

BREEAM

BREEAM is an global program that gives autonomous third party certification to survey the viability performance of individual buildings, communities and infrastructure projects. Evaluation and certification can take place at various stages of the built-in environment life cycle, from design and construction to operation and renovation.

Discussing about BREEAM, third party certification involves auditing - by impartial experts - the evaluation of a building or project by a qualified and authorized BREEAM evaluator to ensure that it meets the quality and performance standards of the program. At the center of this process are certification bodies - government-approved bodies (through national accreditation bodies) for the certification of products, systems and services.

BREEAM estimates sustainability in a range of classigications, ranging from energy to ecology. Each of these categories addresses the most important factors, such as low impact design and carbon emissions reduction, design resilience, adaptation to climate change, ecological value of biodiversity and its protection.

BREEAM is the world's leading method for assessing the viability of masterplanning projects, infrastructure and buildings. Recognizes and reflects the value of assets with higher returns in the life cycle of the built environment, from new construction to use and renovation. BREEAM does this through independent certification of the appraisal of the ecological, social and economic performance of an property, using best practice guidelines created by BRE.

The goal of the BREEAM family of programs is to encourage continuous improvement of performance and innovation by setting and evaluating a wide range of scientifically stringent requirements that go beyond regulations and practices. Its purpose is to empower those who own, supply, deliver, manage or use infrastructure buildings or communities to achieve their ambitions for sustainability. It builds trust and value in a project by providing independent certification that demonstrates the broader benefits to individuals, businesses, society and the environment.

[36] https://www.buildup.eu/en/practices/publications/sustainable-building-certifications-comparative-guide

Using BREEAM allows customers to manage and mitigate the life cycle effects of a building and provide them with a reliable environmental label. Achieving a BREEAM rating can lead to smarter, more efficient use of resources and lower maintenance and operating costs. It can also maximize returns through market value and attract tenants with desirable and healthy places to live, work and play.[37]

LEED

LEED (Leadership in Energy and Environmental Design) is a world wide perceived green structure certification system that gives third-party confirmation that a structure or community has been planed and constructed using strategies to improve performance on all major measurements, as energy savings, energy saving, water efficiency, reduction of CO2 emissions, improved internal environment quality, resource management and sensitivity to resources effects.

LEED, which was developed by the U.S. Green Building Council (USGBC), provides building owners and operators with a framework for distinguishing and executing green building plan, construction, operations and maintenance solutions.

LEED is flexible enough to apply to all types of buildings - commercial and residential. Operates throughout the life cycle of the building - design and construction, operations and maintenance, tenant adaptation and major renovation. Also, LEED for Neighborhood Development expands the advantages of LEED beyond the building footprint to the community it serves.

LEED provides a points system for grading green design and construction of buildings. The system is divided into five areas: Sustainable Sites, Water Efficiency, Energy and Atmosphere, Materials and Resources, and Indoor Environmental Quality. Buildings are awarded points based on the extent to which various sustainable strategies are achieved.[38]

Nordic Swan

In 1989, the Scandinavian Council of Ministers established the Nordic Swan eco-label, as a voluntary eco-labeling scheme for the countries Denmark, Finland, Iceland, Norway and Sweden. It is an effective tool that helps companies which want to move forward with sustainable policy, and empower consumers and professional buyers to choose the best goods and services in an environmental way.

It is possible to obtain certification with the Nordic Swan Ecolabel in 60 different product groups with more than 200 different product types. Small houses, apartment buildings and buildings for preschools and schools can be awarded a Nordic Swan eco-label.

The buildings and construction sector is a major energy user and therefore also has a significant impact on the climate. Raising awareness of how the sector has as little impact on the environment as possible will therefore have a significant effect. Also, in the construction of a house, large quantities of chemicals are used that are both dangerous for health and for

[37] https://www.breeam.com/discover/how-breeam-certification-works/#:~:text=BREEAM%20is%20an%20international%20scheme,buildings%2C%20communities%20and%20infrastructure%20projects.

[38] https://www.bu.edu/sustainability/what-were-doing/green-buildings/leed/#:~:text=LEED%20(Leadership%20in%20Energy%20and,matter%20most%3A%20energy%20savings%2C%20water

the environment. Nordic Swan Ecolabel aims to stop using these chemicals for health and environmental reasons.

The Nordic Swan Ecolabel provides a reliable and efficient tool for both producers and consumers. Manufacturers can, with the help of Nordic Ecolabelling checklists and know-how, build high-quality, energy-efficient homes without the need for chemicals - the kind of home they want to live in. Home buyers can be sure that they move into a resource-saving home with a good interior climate, thanks to the Nordic Swan eco-label.

The Nordic Swan eco-label sets severe environmental requirements at all phases of a product's life cycle, sets exact requirements for chemicals used in ecolabelled products, constantly tightens requirements for goods and services to create sustainable development, and certifies and verifies that all requirements are met before the product is approved.

Nordic Swan Ecolabel tries to decrease the environmental impact of the production and consumption of goods, while at the same time making it easier for consumers and professional buyers to choose the best goods and services ecologically.[39]

Examples of Sustainable Buildings and Developments

The driving force behind the support and promotion of the idea of development within urban areas, is sustainability. As stated in the European Green Paper on the Urban Environment (1990), the city offers density and diversity, time efficiency, and effective combination of social and economic functions. The idea that the city can ensure the preservation of the environment may initially seem contradictory, since so many environmental problems are concentrated in cities. However many of the environmental issues can be confront by the idea of a compact city as the main component for archiving sustainability.

Urban environment regeneration can be the most important factor in the retention of people in cities. Some important and effective movements are the shaping of cities and creation of urban environments that could make people stay in cities, the improvement of their quality of life and the constitute a pole of attraction for the restoration of the people in cities. Important parameter is to avoid the separation social classes and prices increase. Population growth in cities is significant to develop economies of scale and constitute infrastructure and trade viable as Rudlin and Falk said in 2000.[40]

Therefore the new buildings should be constructed within the limits of existing cities, if this is impossible and new developments must be created, then these must be served by public transport.

Neapolis Smart Eco-City

In recent years a major sustainability project is underway in Paphos, the largest in Cyprus, perhaps the largest in the Mediterranean, is the Neapolis Smart Ecocity.

The project is in the design phase and licensing as far as I know. The first phase of the project, the master plan, has already been licensed and then the team that has undertaken it is working on the project in phases. Due to its size and complexity it can neither be

[39] https://www.nordic-ecolabel.org/the-nordic-swan-ecolabel/

[40] Rudlin, D. and Falk, N. (1999). *Sustainable Urban Neighbourhood.*

designed nor implemented at the same time, this should be done in stages. The research team includes many experienced architects, town planners, master planners from around the world who have designed and built other similar projects abroad.

Neapolis ecocity is one of the most important and vital planned mixed use developments given its size, purpose, unique characteristics and eco-smart principles. The development takes place in an area of 1,100,000 sqm with a net buildable area of 777,000 sqm which will combine a wide range of residential product options with a combination of key lifestyle enhancing elements, uch as a leisure and entertainment park, a commercial park, the Neapolis University Campus, a Health Park with a hospital and a wellness center, an Office Park, a Cultural Park and green parks of 200,000 sqm.[41]

Neapolis enjoys a privileged location, as it is next to Paphos town and very close to the sea. The development by itself will include many amenities and facilities but also for those that will not have within the development area will be very close due to the distance relationship it has with the city of Paphos. In addition, it will have a good public transport network, safe and functional cycling routes, pedestrian paths and in general easy accessibility for all the people.

“The Neapolis Project vision is to develop an innovative Smart EcoCity in the Mediterranean that integrates health and wellness, culture, education and life-long learning, as well as the latest technological solutions, with the goal of creating a unique work-live-play experience for its thousands of residents & users.”[42]

The design of buildings is based on environmentally friendly and sustainable principles and incorporates "green" technologies and smart solutions and aims to become the model of an ecologically efficient and smart city on an international scale.[43]

Bosco Verticale

Bosco Verticale translated to Vertical Forest and it’s one of the most intensively green facades we can find anywhere in the world. It is a pair of residential towers in the Porta Nuova district of Milan, Italy. They have a height of 111m. and 76m. and contain more than 900 trees on 8,900s.m. of terraces. The towers were designed by Boeri Studio, Stefano Boeri, Gianandrea Barreca and Giovanni La Varra. It also involved input from horticulturalists and botanists. The building was inaugurated in October 2014. [44]

Architect Stefano Boeri designed these deluxe apartments in the sky with plenty of spaces to accommodate large, full-grown trees, and a variety of ground cover plants and shrubs. The effect is "one of the most intensive living green facades ever realized," according to Skyscrapercenter.com. All this greenery helps improve air quality in Bosco Verticale and the city more broadly, its facades transformed into living, breathing organisms.[45]

The benefits of this architecture go beyond aesthetics. The green area, provides shade in the apartments, psychological benefits for residents and a home for wildlife. But the architect says he is particularly proud because the buildings absorb 30 tonnes of carbon dioxide and

[41] https://www.leptosestates.com/project/neapolis-smart-ecocity
[42] https://www.leptosestates.com/project/neapolis-smart-ecocity
[43] https://www.leptosestates.com/project/neapolis-smart-ecocity
[44] https://en.wikipedia.org/wiki/Bosco_Verticale
[45] CNN Staff. (2020). Green Buildings: 18 examples of sustainable architecture around the world. https://edition.cnn.com/style/article/green-buildings-world-sustainable-design/index.html

produce 19 tonnes of oxygen a year, according to his research, with a volume of trees corresponding to more than 215,000 square feet of forest."The ability to enlarge green surfaces inside and around our city is one of the most efficient ways to try to reverse climate change," he said.[46]

By studying these examples we see that there are solutions to the problems facing our planet, and we can achieve sustainability in smart ways. Sustainable development must become a way of life and thinking and not a necessary evil because it will ensure the survival of the human species in the long run.

[46] Holland, O. (2018). The architect transforming cities into 'vertical forests'. https://edition.cnn.com/style/article/riba-vertical-forest-stefano-boeri/index.html

Legislation

The European Union must be able to provide its citizens with an effective environmentally friendly democratic system, making up for existing ecological shortcomings. Europeans make various protests for environmental protection as we can see. So we can say that the European Union and some organized groups of citizens are seeking to implement legislation on the energy efficiency of buildings under a legal and institutional framework.

After researching environmental policy legislation in the European Union, I found that only recently and more specifically in 1972 was the European Council declaring the political will of its Member States to legally enshrine an environmental policy. The parties involved were actively participated in the formulation and adoption of environmental legislation, but a treaty was first adopted in 1986 with the Single European Act. Today there is a distinct body of many more pieces of EU environmental legislation.[47]

Since environmental legislation was a new development and took time to identify and resolve the problems that arose, it was logical that they were not fully implemented from the beginning. Since the early 1990s, however, it has consistently been one of the main topics of discussion on the European Community agenda. And in addition initiatives were taken to improve implementation and enforcement, like for example dialogue advisory groups were set up to share responsibility between industry, local authorities, trade unions and environmental organizations, proposals for environmental responsibility were studied and the public was given the opportunity to be more involved.[48] Enhancing citizen participation is a benefit not only for the environment, but also for the further European integration and participatory democracy that the EU wants.

Legal action is the central enforcement mechanism for environmental legislation. But to be feasible, each country has adopted European environmental legislation in its own legal system. However, it is also important for the European Community, as an enforcement agency, to monitor whether each country implements this legislation.

The implementation of this legislation depend mainly on the action of the public authorities and the Commission, but it is a pleasant surprise that the private awareness of the citizens on many environmental issues and the actions of the organized groups for the protection of the environment are quite high. Facts that require the implementation of the legislation but also its evolution.

With the accession of Cyprus to the European Union in 2004, a large number of laws have been adopted by the national legislation of Cyprus, creating a strong basis for environmental policy, as well as various environmental instruments and programs, which ensure and improve the state of the environment, where necessary.

The Cyprus Environment Service was established in 1986, but later in 2010 it evolved into the current Department of Environment. The Department of Environment operates as a regulatory authority in Cyprus, plays a key role in the environmental and development institutions of the island. It has a coordinating role for issues in which other competent Services / Departments are involved. In matters of its own competence, it plays a

[47] Syngellakis, A. (1995). Enforcement of European Union Environmental Legislation, *University of Portsmouth, Portsmouth, UK*

[48] Syngellakis, A. (1995). Enforcement of European Union Environmental Legislation, *University of Portsmouth, Portsmouth, UK*

coordinating and executive role, as it implements a series of policies and legislation in a wide range of topics, such as environmental impact assessment, waste management, water and soil pollution control, climate action and nature protection and management.[49]

In addition to the legislation adopted due to the European acquis, the Department is a contact point and implements the provisions of most United Nations Conventions on the environment while also being involved in the implementation of the United Nations Mediterranean Action Plan.[50]

The Green Economy is one of the main pillars of the United Nations World Conference on Sustainable Development Rio + 20 and includes the promotion of economic growth while ensuring the protection of the environment and society. The European Union promotes the pillar of the Green Economy, through the policy of efficient use of resources which is a key component of the Europe 2020 Strategy for Growth and Jobs until 2020. In this context, the initiative for a Europe more resource-efficient, with actions aimed at integrating the objectives of the green economy into all policies.[51]

In Cyprus today, a lot of professional organizations operate in the private sector, which through their actions are involved in local events and raise awareness of citizens as well as contribute with their opinions in a positive way for the best protection of the environment.

Government authorities have also developed a large number and type of actions for the environment. At the same time, they act proactively by conducting impact measurement studies for projects and programs. It seeks through them the optimization of their design as well as the expression of views with those involved in this direction. In this area, Cyprus is on a good path since the system it maintains is one of the most democratic and efficient, although several services are involved in the processes. But there are areas where significant difficulties are encountered, areas where much is still expected to be done.[52]

The Department of Environment of Cyprus aims to protect the environment through the effective management of its resources, and to strengthen public awareness for the benefit of public health, quality of life, and the protection of biodiversity for both current and future generations.

Environmental protection is accomplished through the rational management of resources and waste, the impact assessment, pollution control, tackle actions on environmental change and halting the risk of loss a lot of species and habitats, while contributing to the creation of green economy.

Some of the current objectives of the Department today are the implementation of plans and projects with minimal impact on the environment, the implementation of management plans for protected areas of the NATURA 2000 network aiming at its effective protection, the promotion of licensing of all facilities with liquid waste to protect both the soil and the

[49] http://www.moa.gov.cy/moa/environment/environmentnew.nsf/page03_en/page03_en?OpenDocument
[50] http://www.moa.gov.cy/moa/environment/environmentnew.nsf/page03_en/page03_en?OpenDocument
[51] http://www.moa.gov.cy/moa/environment/environmentnew.nsf/page03_en/page03_en?OpenDocument
[52] http://www.moa.gov.cy/moa/environment/environmentnew.nsf/page03_en/page03_en?OpenDocument

surface waters of Cyprus, the creation of an integrated network of rational waste management facilities, the mitigation of the implementation of actions and adaption to climate change, the strengthening of the institutional capacity and the improvement of its efficiency.[53]

Although the legal framework is systematically comprehensive and clear in its interpretation without leaving room for laxity or illegality, its implementation has made steady progress, as evidenced by the growing number of inspections and fines imposed, as well as the Courts' approach towards environmental matters. In cases where inspections revealed infringements, appropriate measures were imposed, such as warning letters requesting immediate compliance, out-of-court settlement procedures and reporting to the Attorney General on the imposition of criminal sanctions.[54]

At some point, Cyprus faced a deep, unprecedented economic crisis that culminated in 2013. Therefore, it was necessary to focus on the short-term difficulties of the various affected groups and measures to address them, which led to an inevitable focus on economic and social dimensions of policies. Today, however, having managed to recover from the economic crisis, we focus on protecting the environment and strengthening environmental awareness to ensure a sustainable environment for us and our descendants.[55]

[53] http://www.moa.gov.cy/moa/environment/environmentnew.nsf/page03_en/page03_en?OpenDocument
[54] https://iclg.com/practice-areas/environment-and-climate-change-laws-and-regulations/cyprus
[55] http://www.moa.gov.cy/moa/environment/environmentnew.nsf/page58_gr/5A5D5047B1D20558C225818A0039189C/$file/VNR%20Final%20Report.pdf

Literature Review: Market Trends for Sustainable Buildings, Rents & Sales

Whether environmental factors matter: some evidence from UK property companies

I initially studied an article paper named "Whether environmental factors matter: some evidence from UK property companies" by Bod Thompson and Qiulin Ke (2012), which its purpose was to examine whether some property companies had an impact on corporate value as shown by their return on assets (ROA) because of the respect to corporate social responsibility (CSR) and the environment. [56]

The information was taken from the annual report for a sample of UK-listed companies which compares how real estate companies present themselves with their actual performance. They use word frequency analysis (WFA) to extract the information needed, and they create two indices, the general CSR index based on the existence of a CSR vocabulary and a green index based on the environmental vocabulary. After that these indices were modelled against the ROA for each company.

The final outcome shows that ROA (return on assets) is related with both indices in a positive way and is statistically significant in the GREEN equation. That means that firms with good performance are likely to invest more in environmental friendly buildings. The size of firms is also related with both indices in a positive way, showing that bigger firms have better CSR (corporate social responsibility). Finally return has a significant positive coefficient with both indices, suggesting that the greener companies surpass the others in the stock market.[57]

"…there is one and only one social responsibility of business – to use its resources and engage in activities designed to increase its profits." Milton Friedman 1970

Friedman's opinion is known as the shareholder model. This says that companies should either direct all funds to companies that maximize profits or return extra funds to shareholders.

On the other hand, Drucker (1984) support that a shareholder model should include philanthropic contributions, because in order for a business to prosper, the society in which the business operates must also prosper.

These two views describe the opposite ends of the social responsibility spectrum. The one support that companies make more profits by operating with a social perspective, while others support that CSR distracts from the economic role of business. Many business first incorporate environmental or social responsibility into their business activities to protect or refresh their reputation according to the article. But once implemented, business realized that CSR method actually helped them find and manage risks and also archive to approach new customers. Two supporters of CSR, Porter and Kramer use it as a competitive advantage at a strategic level and they support that the implementation of socially responsible

[56] Thompson, B. and Qiulin, K. (2012). *Whether environmental factors matter: some evidence from UK property companies.* Journal of Corporate Real Estate, Vol. 14 Issue: 1, pp.7-20.
[57] Thompson, B. and Qiulin, K. (2012). *Whether environmental factors matter: some evidence from UK property companies.* Journal of Corporate Real Estate, Vol. 14 Issue: 1, pp.7-20.

activities into the corporation have a positive impact on corporate value, using their example to support their argument. [58]

CSR includes a wide range of factors. Includes a mixture of environmental, social and economic parameters into business strategies and practices. The Commission for the European Communities defines CSR as "a concept whereby companies integrate social and environmental concerns in the business operations and in their interactions with their stakeholders on a voluntary basis". This is distinguished more into an internal and an external approach to each company. The internal approach concern socially responsible practices within the company and the external approach continue further than that to the local community and more. Environmental sustainability is just the one of more other aspects which influenced the increasing business focus on CSR.

The Global Reporting Initiative (GRI) is a network-based organization, established in 1998 and a partner of the United Nations Environment Programme. GRI developed a structure for sustainability reporting and encourage the use of this structure across companies and industries. In spite of the fact that GRI is the most known standard for sustainability, its advices were applied less than the half of all reports published globally in 2008.[59]

In 2008 GRI published the results of a study which shows that the construction and real estate sector is less established in the reporting of sustainability practices than other companies. Since then UK and Australian real estate property companies are following the suggestions for CSR reporting, and some of them were identified as global best practices according to the assessment of published CSR reports and the organizations listed in Global indexes about sustainability. Sustainability is able to increase shareholder value and help the companies to make the difference in-between many others.[60]

Property companies are pressured by stakeholders to apply sustainable strategies and to show off that they reduce their affects to the environment. According to reports in 2010, the construction and real estate industry has in Europe a 42% impact of the final energy consumption and a 35% of greenhouse gas emissions. The property companies are important participants in the international development and implementation of sustainable policies and should play an important role. Furthermore a concern about the social and environmental problems from people worldwide and the fact that the buildings can offer a better quality of environment and so on a better quality of life has led to a range of policies and programs from CSR.[61]

The method used in the article I study is to identify a specific vocabulary that represents environmental issues and the sample is information taken by 20 listed property companies in UK. In the beginning they identify the words and phrases they want to examine, then they examine the frequency of these variables used in the reports so they can relate it with the strength of CSR (corporate social responsibility) in a property company and then develop a

[58] Thompson, B. and Qiulin, K. (2012). *Whether environmental factors matter: some evidence from UK property companies.* Journal of Corporate Real Estate, Vol. 14 Issue: 1, pp.7-20.
[59] Thompson, B. and Qiulin, K. (2012). *Whether environmental factors matter: some evidence from UK property companies.* Journal of Corporate Real Estate, Vol. 14 Issue: 1, pp.7-20.
[60] Thompson, B. and Qiulin, K. (2012). *Whether environmental factors matter: some evidence from UK property companies.* Journal of Corporate Real Estate, Vol. 14 Issue: 1, pp.7-20.
[61] Thompson, B. and Qiulin, K. (2012). *Whether environmental factors matter: some evidence from UK property companies.* Journal of Corporate Real Estate, Vol. 14 Issue: 1, pp.7-20.

CSR index. After that they relate that CSR index with the economic performance of a property company and trying to find a link between them. They support that investment in environmental friendly building could have a positive impact on company value and this is an important fact that property companies should take into account. However each company has to adjust these findings in their needs.

Recently, thing have changed and from now on CSR (corporate social responsibility) is consider as an investment. Companies realized that for their survival they have to be better. They recognized that the long-term value to the company acting in a socially responsible way is much bigger than the short-term cost. The idea of social responsibility itself it wasn't a natural evolution, an important strict legislation in key areas tend to force companies to apply social responsibility. [62]

Few research exist into the relationship between CSR and the financial performance of property companies. Most of the studies of CSR in the property industry focus on finding the link between sustainable buildings and their rental value. These studies shows that there is a difference in rental value for sustainable buildings in contrast with those which are not sustainable.

CSR (corporate social responsibility) reporting is a simple way to inform the investors for some possible risks, which may come over from company's operations. This is now becoming an integral part of the investment analysis process that the Socially Responsible Investors use. Afterwards they examine the environmental dimension of CSR in the main UK-listed property companies, and look for the link between environmental friendly activities, firm performance and firm level characteristics. [63]

In the UK the production of an annual report is a statutory obligation for some companies, and there are penalties so the company's first interest is to get the annual report as factual as possible. The annual report must contain a business review and specifically information about environmental matters, the company's employees and social and community issues. The last few years property investors have given a significant priority to environmental, social and governance issues in their property investment decision making.[64]

The discussion is about how real estate companies present themselves in environmental aspect and if there is a link with their real performance. The method they use for that information is Word Frequency Analysis (WFA) on the contents of the annual reports of property companies. From this study were identified and evaluated the important indicators, and then they search for the frequency of each of them in the annual reports of the property companies. Based on that information they create two indices, a general CSR index based on the appearance of a general CSR vocabulary in the reports and a green index based on the environmental vocabulary.[65]

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[62] Thompson, B. and Qiulin, K. (2012). *Whether environmental factors matter: some evidence from UK property companies.* Journal of Corporate Real Estate, Vol. 14 Issue: 1, pp.7-20.
[63] Thompson, B. and Qiulin, K. (2012). *Whether environmental factors matter: some evidence from UK property companies.* Journal of Corporate Real Estate, Vol. 14 Issue: 1, pp.7-20.
[64] Thompson, B. and Qiulin, K. (2012). *Whether environmental factors matter: some evidence from UK property companies.* Journal of Corporate Real Estate, Vol. 14 Issue: 1, pp.7-20.
[65] Thompson, B. and Qiulin, K. (2012). *Whether environmental factors matter: some evidence from UK property companies.* Journal of Corporate Real Estate, Vol. 14 Issue: 1, pp.7-20.

Through empirical modelling in bibliography the outcome is that the better a firm's social reputation, the lower its total market risk. Also the greener companies outperform others in the stock market.[66]

Concluding in the article the authors have established a vocabulary of environmental terms, and that vocabulary has become much more widespread in the formal reporting of UK real estate companies. This research shows that the larger firms with better defined CSR policies perform better. Is unlikely that this is the exact reason but it is important that CSR is part of this. Also real estate companies respond to the clients needs and the interest that institutional investors show for companies with strong CSR is the evidence that they see the long term value of environmental policies. Finally, while all the parties involved declare their intention to pay more for sustainability, the actual data are showing that is not a fact yet.[67]

Environmental Variables and Real Estate Prices

Then, while doing a bibliographic review, I came across this article that seems to be trying to answer questions close to what I am trying to answer in my dissertation. The scope of this article is to compare different property valuation models about the way that they evaluate the environmental factors during a valuation. A reference model is used, which is a standard model for linear regression and it's include normal variables which are counting the environment quality. At first this model is compared to linear models which includes environmental quality data extracted from a database which has been developed for Switzerland's urban environment. Additionally, that data is used to set up a new parameter, the geo-index. Furthermore the writer find out that the artificial neural network which are non linear models present generally a similar shape of the price indices, but the analytical price behaviors of different models show considerable differences depending on the input information of the environmental variables.[68]

People start studying about pricing of real estate the last 35 to 40 years, using plenty of methods. The research we are talking about has concentrated on real estate valuation and creating real estate indices using at most hedonic pricing models.[69] Hedonic regression is a method based on presenting preferences for estimating demand of value. It analyze the item being researched into its components and calculate the estimated value of each component.[70]

According to the article there is proof showing that both internal and external environmental characteristics affect real estate prices. The most usual physical features are how many rooms they have, how many bathrooms, the quality of the construction, the state of the building and the available parking spaces. While the environmental parameters consider about the quality of the neighborhood and the exact position in it and are measured by regular variables (for example separating the quality measurements by level).

Research has been carried out in order to replace the qualitative evaluation methods by quantitative decision support systems. In the field of real estate pricing, geographic

[66] Thompson, B. and Qiulin, K. (2012). *Whether environmental factors matter: some evidence from UK property companies.* Journal of Corporate Real Estate, Vol. 14 Issue: 1, pp.7-20.
[67] Thompson, B. and Qiulin, K. (2012). *Whether environmental factors matter: some evidence from UK property companies.* Journal of Corporate Real Estate, Vol. 14 Issue: 1, pp.7-20.
[68] Din, A., Hoesli, M. and Bender, A. (2001). *Environmental Variables and Real Estate Prices.*
[69] Din, A., Hoesli, M. and Bender, A. (2001). *Environmental Variables and Real Estate Prices.*
[70] https://en.wikipedia.org/wiki/Hedonic_regression

information systems (GIS) create the possibility to develop databases which can be used to measure qualitative and environmental characteristics of properties. In a context like that, some qualitative variables can be replaced by some quantitative variables.[71]

In Switzerland many studies about environmental parameters, which can be measured in a GIS database, about residential and commercial real estate in specific cities, end up with an important objective. The goal was to create the basis for evaluating the known as geo-index, which is a weighted average of environmental quality of the property extracted from a GIS database. The Analytical Hierarchy Process (AHP) provide a simple and effective methodology for determining the suitable weighting of different environmental qualities. The AHP methodology has been applied to real estate in other contexts than environmental quality but seems to be specifically well suited in a GIS framework.[72]

The scope of this article is to test the power and the resistance of hedonic models when GIS measures of the environment are replaced by qualitative variables. The sample used is a database with transactions on apartment buildings. The fact that we have a rather comprehensive set of exact input parameters from GIS is a motivation for further examination on modelling approaches beyond the simple linear regression type of most hedonic models. There is the possibility that there are more complicated relationships between the input parameters and because of that a reliable price model should consider for sure non-linear effects. Non-linear models can be developed using parametric linear statistical techniques, but because of the fact that they usually include some conjecture, we prefer to use a non-parametric technique. Artificial Neural Networks (ANN) is a new approach to non-parametric and non-linear statistical modelling which has already been implemented in several financial application, notably involving time series.[73] It is the piece of a computing system designed to simulate the way the human brain analyzes and processes information.[74] Models like this have also been used to real estate valuation to appraise the impact of age on housing values, but have not been move forward to use them also to construct the real estate price index.

It's mostly accepted that location is the most significant parameter for real estate valuation and it can only be fully taken into account by using the descriptive context of GIS. The bigger benefit from GIS is that it positioning the properties in a map using their addresses and that way it has their geographical data. Using a sample with transactions in apartment buildings and identifying that sample in the map through GIS, we can see approximately the density of the apartment building in a geographical area such as a city.

In a GIS, it's really important that the locations will be determined with accuracy in order to compose the database of all parameters which may have an impact on real estate quality and price estimation. If all the levels of information were available and transformed into significant data points, a GIS could export a comprehensive quantitative description of the quality in urban areas. In real life, the information are not always available for the area under consideration. Nevertheless, even if the GIS is deficient, it could give us some

[71] Din, A., Hoesli, M. and Bender, A. (2001). *Environmental Variables and Real Estate Prices.*
[72] Din, A., Hoesli, M. and Bender, A. (2001). *Environmental Variables and Real Estate Prices.*
[73] Din, A., Hoesli, M. and Bender, A. (2001). *Environmental Variables and Real Estate Prices.*
[74] https://www.investopedia.com/terms/a/artificial-neural-networks-ann.asp#:~:text=An%20artificial%20neural%20network%20(ANN)%20is%20the%20piece%20of%20a,by%20human%20or%20statistical%20standards.

information that will be a lot more than the usual info from other qualitative approaches which are used in real estate pricing models.[75]

In that research, is been used 8 quality criteria, The GIS provides a quantitative value for performing each point in a region of quality notes. The composition of the GIS database in which the quality notes are based is carried out through a procedure which starts with collecting different geographical data. Afterwards, the data are converted with standard operations to categorize areas of the urban environment in a way that suitably reflects the environmental criteria they chose to emphasize. The classification is done in terms of discrete categories, generally more than 3 points for each criterion, which means straight ahead quality notes for each locations of interest.[76]

The eight separate values can be used as input parameters in a real estate valuation model. Otherwise, they propose to use as input parameter the geo-index which is the result of an equation used weighted average of the quality notes using empirical preference weights for each criterion. It's more interesting to use the geo-index in valuation models when the data of historical transactions is small, because it reduce the total number of parameters and that lead to more robust models. Geo-index is a quantitative-empirical characteristic to a real estate location because all the quality notes are the result of a quantitative process using the GIS.[77]

The weights have emerged by processing a lot of questionnaires including comparisons using the methodology of the Analytical Hierarchy Process (AHP). The questionnaire was sent to single-house owners but they believe that the concept as regards the quality of the environment will be almost the same as the owners in apartment buildings.[78]

The typical approach for making real estate price models is based on linear regression. Usually environmental factors are measured using ordinal variables. In that part they are going to compare this approach to one using GIS data, considering four different scenarios.[79]

The first scenario use four standard internal variables and also two qualitative ordinal variables, to measure the quality of the neighbourhood and the quality of the location within the neighbourhood. The second scenario use eight environmental parameters referred above as variables in the regression. Five of them do not show a lot of variability over the examined apartment locations and for this reason the third scenario exams the three variables which show more variability. At the end the fourth scenario uses the geo-index developed with the eight variables and the preference weights for these variables. The fact that five variables show low levels of variability is not a problem for a global pricing model as we used it in this discussion, it could be a problem for a more detailed explanatory incremental model. All four models use the same internal physical variables, consequently the four scenarios differ only in the way they measure the environmental parameters.

The linear regression models assume that there is a linear relationship between the price and the input parameters. That means that the price determined as a function of the inputs. Analysing and comparing the four scenarios to each other they find out that the price indices

[75] Din, A., Hoesli, M. and Bender, A. (2001). *Environmental Variables and Real Estate Prices.*
[76] Din, A., Hoesli, M. and Bender, A. (2001). *Environmental Variables and Real Estate Prices.*
[77] Din, A., Hoesli, M. and Bender, A. (2001). *Environmental Variables and Real Estate Prices.*
[78] Din, A., Hoesli, M. and Bender, A. (2001). *Environmental Variables and Real Estate Prices.*
[79] Din, A., Hoesli, M. and Bender, A. (2001). *Environmental Variables and Real Estate Prices.*

for all four of them are similar, this suggest that the linear price models are quite robust because is not sensitive to the exact choice of input parameters from a GIS. However, to be more practical it is important to make an appropriate choice of input variables, because it is possible to develop real estate price indices with significant time savings using a GIS if a system like this exist for the specific region.[80]

The index of averages of prices per square metre shows a different pattern. This is a result coming out from the heterogeneity of property, the characteristics of the properties that are sold in any given period will in most instances differ from those of buildings sold in another period.

However, easily we can find non-linear price relationships for which the linear regression models fail both in terms of individual real estate price estimations and the price index. For example, price is not linearly related to age, distance from the city, number of bedrooms etc. It is needed to search for non-linear models, then the research is going to study the possibility of using artificial neural networks to develop real estate pricing models.[81]

For making the comparison easy with the linear regression models, the starting point for the Artificial Neural Network models is also the logarithmic price as a function of the input parameters of the various scenarios. First of all, ANN models are non-linear and non-parametric and consequently do not require any specific assumptions about the functional form of the price relationship. The ANN models use the same input and output parameters as in the linear models, in the ANN framework.[82]

The purpose of the ANN model construction is to develop models which are as simple as possible and show robustness when validated with date which are not included in the sample. Using back propagation techniques for optimising the connection with the target prices, we get models for each of the four scenarios. The back propagation perception model with a sigmoid activation function was implemented using the Neuralware software within Excel. Typically the data-set was divided with 60% of observations for training, 30% for testing and 10% for validation. The ANN models feature a correlation coefficient for all scenarios, which is somewhat higher than for the regression models. This shows that the ANN models have a potential for more realistic pricing of individual properties.[83]

The construction of ANN models is more complicated than in the case with linear regressions. In that model the main idea is that they work as if all objects were undergoing transactions every year and not just during one year. That way, they face the market globally and avoid the shortcoming of a simple average of the transactions during one year. This approach applied to the case of linear regression leads to the same price index.[84]

Furthermore, interpolation using linear regression can only capture some gross average features of this space, that's why there are notable differences in price behaviour between the various scenarios. The linear models give identical results for the different input

[80] Din, A., Hoesli, M. and Bender, A. (2001). *Environmental Variables and Real Estate Prices.*
[81] Din, A., Hoesli, M. and Bender, A. (2001). *Environmental Variables and Real Estate Prices.*
[82] Din, A., Hoesli, M. and Bender, A. (2001). *Environmental Variables and Real Estate Prices.*
[83] Din, A., Hoesli, M. and Bender, A. (2001). *Environmental Variables and Real Estate Prices.*
[84] Din, A., Hoesli, M. and Bender, A. (2001). *Environmental Variables and Real Estate Prices.*

scenarios, and that make them seen so robust, however, they are developed so globally that they are unable to catch more peculiarly market conditions with sufficient accuracy.[85]

The ANN models are seems to be more promising because of their ability, as checked when applied to various classification problems where linear methods fail, to divert spatially different areas of a composite input parameter space.[86]

Finally the conclusion is that the use of GIS data would lead to almost the same real estate price indices in a linear framework. Clearly when GIS data are available, they should be used. Additionally the aim was to design a non-linear procedure for constructing price indices using ANN(Artificial Neural Networks), and while analyzing they released that the general shape of the linear and ANN price indices is similar and the differences across scenarios are more obvious when using ANN models than with Hedonic Linear Models. At this stage the result is that the linear models do not capture specifically the impact of environmental factors on real estate values and also the fact that ANN models are not robust enough, they need larger sample for further research and more outcomes.[87]

Who responds more to environmental amenities and dis-amenities?

Suspecting that external factors are influencing the real estate market, and more specifically factors related to risks arising from natural phenomena, I studied the findings from an article on flood risk and I quote them below.

Different property sub-markets are supposed to react differently to flood risk, flood and environmental factors information. To test this hypothesis, this study uses spatial quantitative regression and quasi-experimental techniques to examine sub-market property behavior in response to the availability of flood risk and also actual flood information. This new addition to the bibliography is based on the use of flood risk mapping in 2009 and the Brisbane flood in Australia in 2011 as a case study. The results show that the impact of flood risk and actual flood on real estate markets varies between different sub-markets. Therefore, they confirm the existence of property sub-markets based on property and environmental characteristics and suggest the need to diversify mitigation policies.[88]

Examining the spatial relationship between environmental health factors and house prices

Much of the literature dealing with these questions addresses specific environmental factors separately and analyzes whether and how they affect property prices. The specific article I chose to mention below analyzes air quality and noise pollution as criteria for assessing quality of life and whether and how they affect property prices.

Air quality, noise and proximity to urban infrastructure can undoubtedly have a significant impact on quality of life. The quality of the environment (the price of good health) has become a central tenet of consumer choice in urban areas when deciding on a residential neighborhood. Unlike the purchase of most material goods, the purchase of environmental quality does not yield a noticeable unit price effect. As there is no explicit price for an environmental quality unit, this document aims to use the housing market to derive its

[85] Din, A., Hoesli, M. and Bender, A. (2001). *Environmental Variables and Real Estate Prices.*
[86] Din, A., Hoesli, M. and Bender, A. (2001). *Environmental Variables and Real Estate Prices.*
[87] Din, A., Hoesli, M. and Bender, A. (2001). *Environmental Variables and Real Estate Prices.*
[88] Rajapaksa, D., Wilson, C., Hoang, V., Lee, B. and Managi, S. (2017). *Who responds more to environmental amenities and disamenities.*

indirect price and check whether these health and well-being components are actually capitalized on real estate prices and are therefore indirectly priced in the market place.[89]

A significant number of studies have used hedonic pricing models by incorporating spatial effects to assess the impact of air quality, noise, and proximity to noise pollutants on real estate pricing. This study presents a spatial analysis of air quality and noise pollution and their relationship to house prices, using a significant number of sales transactions for the period 2013. To estimate the impact of pollutants, three different spatial modeling approaches are used, i.e. standard least squares using spatial mannequins, a geographically weighted regression (GWR) and a spatial lag model (SLM).[90]

The findings show that air quality pollutants have a negative impact on house prices, which fluctuate throughout the urban area. The analysis shows that the noise level matters, although this varies considerably from the urban environment and varies depending on the source.[91]

Air quality and environmental noise pollution are major health and well-being concerns. The impact of noise seems to depend not only on the intensity of the noise to which the dwellings are exposed, but also on the nature of the noise source. This may indicate the presence of other externalities that cause social disgust. This research presents an original study using advanced spatial modeling approaches. The research is valuable for further understanding the market impact of environmental factors and for providing findings to support local air management strategies, noise reduction and management strategies and is relevant to the broader areas of urban planning and public health.[92]

Rental Price and Sustainability Ratings which Sustainability Criteria are Really Paying Back?

As we have seen in market economies the price mechanism has the most important role in resource management, in real estate the outcome of sustainable construction has become an essential matter for all the parts who are active in that sector. The last few years, the economic benefits of "sustainable" or "green" buildings as well as energy efficient buildings have been the subject of increasing research. A study was conducted in Switzerland in which 2500 residential properties were evaluated on how their ecological characteristics affect their rental prices in the market.

According to Levine et al. (2007), global building-related CO2 emissions are expected to increase dramatically. However, with proven and commercially available technologies, it is estimated that energy consumption in both new and existing buildings can be reduced without a significant increase in investment costs. These figures demonstrate both the high impact of the building sector on the environment and the underlying potential for slowing down the growing impact of this sector.

[89] McCord, M. J., MacIntyre, S., Bidanset, P., Lo, D. and Davis, P. (2018). *Examining the spatial relationship between environmental health factors and house prices.*
[90] McCord, M. J., MacIntyre, S., Bidanset, P., Lo, D. and Davis, P. (2018). *Examining the spatial relationship between environmental health factors and house prices.*
[91] McCord, M. J., MacIntyre, S., Bidanset, P., Lo, D. and Davis, P. (2018). *Examining the spatial relationship between environmental health factors and house prices.*
[92] McCord, M. J., MacIntyre, S., Bidanset, P., Lo, D. and Davis, P. (2018). *Examining the spatial relationship between environmental health factors and house prices.*

The real estate industry has come under increasing pressure for higher standards and stricter regulations on energy efficiency and sustainability. In 2003, the European Union introduced the Building Energy Efficiency Directive (EPBD). The directive requires the disclosure of the energy efficiency of buildings. This has led to the application of national energy efficiency certificates for residential buildings as well as commercial buildings.

In real estate research, the price or value of a building or unit was generally analyzed as a function of its physical and economic characteristics, such as size, height, age, location, tax category, etc. In this analysis, in addition to the typical local and physical characteristics, a number of sustainability criteria are included in the model so that their effect on the rental price can be isolated and measured.[93]

In contrast to other studies focusing on how prices were affected by the ecological characteristics of the property, this study investigates the effect of each ecological characteristic of the property separately. They basically find a link between the energy efficiency of buildings and the rental price curve.

They choose the log-linear hedonistic model for the research. The main advantage of a log-linear specification of the hedonistic model is that it mitigates the effect of extreme values and also makes it possible to interpret the rates as an average percentage of premiums. In the model, the result is the physical log of the actual purchase rent per square meter in each respective building unit. They use a variable as a carrier of different explanatory characteristics, such as physical characteristics or sustainability criteria. Two different variables represent the respective parameter vectors to be estimated. And the last variable is a random model error term.[94]

Data obtained from five different portfolio holders in Switzerland (one public institution and four institutional investors) provide the basis for this study. In total, the dataset includes ownership information from more than 10,000 rental units across Switzerland. Different types of real estate are included in the portfolios: offices, retail stores and residential units. With more than 9000 units, residential buildings represent by far the largest share in the entire portfolio. As a result, this type of building has been selected for analysis.

Detailed information about the buildings was obtained from the property owners. In addition, the entire sample has been visited and evaluated by professional real estate consultants according to defined criteria (eg size, flooring, age, etc.). From this set of information, the selected reference year for data analysis is 2009, as it was the year with the highest data availability. Due to the lack of data for some variables, the sample is reduced to 2453 units in the regression analysis. [95]

In addition to the hedonistic features and financial information, the buildings have been evaluated according to a number of sustainability criteria. In total, the list contains 36 criteria which are grouped into 10 groups of indicators and five sustainability sets. As shown below:

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[93] Feige, A., McCallister, P. and Wallbaum, H. (2013). *Rental price and sustainability ratings: which sustainability criteria are really paying back?*

[94] Feige, A., McCallister, P. and Wallbaum, H. (2013). *Rental price and sustainability ratings: which sustainability criteria are really paying back?*

[95] Feige, A., McCallister, P. and Wallbaum, H. (2013). *Rental price and sustainability ratings: which sustainability criteria are really paying back?*

Short list of indicators

First level Sustainability features	Second level Sub-indicators	Third level Indicators
1. Flexibility	1. Flexibility of use	36 indicators
	2. Adaptability to users	
2. Energy and water efficiency	3. Energy	
	4. Water	
3. Accessibility and mobility	5. Public transport	
	6. Non-motorized vehicles	
	7. Accessibility	
4. Safety and security	8. Location regarding natural hazards	
	9. Building safety and security measures	
5. Health and comfort	10. Health and comfort	

Full list of sustainability indicators[96]

Sustainability features	Sub-indicators with indicators
1. Flexibility	1.1 Flexibility of use
	1.1.1 Floor plan
	1.1.2 Storey height
	1.1.3 Accessibility, reserve capacity, and wiring/pipes/building services
	1.2 Adaptability to users
	1.2.1 Wheelchair accessibility
	1.2.2 Flexibility of kitchen layout
	1.2.3 Room for storage of walker/pram
	1.2.4 Balcony
	1.2.5 Usability of outside space
2. Energy and water efficiency	2.1 Energy
	2.1.1 Energy consumption
	2.1.2 Locally produced renewable energy
	2.2 Water
	2.2.1 Water use
	2.2.2 Wastewater disposal
	2.2.3 Rainwater use
3. Accessibility and mobility	3.1 Public transport
	3.1.1 Good connection to public transport
	3.2 Non-motorized vehicles
	3.2.1 Bicycle parking near the building
	3.3 Accessibility
	3.3.1 Distance to local/regional centre
	3.3.2 Distance to shops
	3.3.3 Distance to local recreation area
4. Safety and security	4.1 Location regarding natural hazards
	4.1.1 Location regarding natural hazards (risk of floods, avalanches, landslides, collapse)
	4.2 Building safety and security measures
	4.2.1 Object related safety and security measures
	4.2.2 Safety and security measures related to people
5. Health and comfort	5.1 Health and comfort
	5.1.1 Inside air quality
	5.1.2 Noise exposure
	5.1.3 Sufficient natural light
	5.1.4 Radiation exposure
	5.1.5 Ecological construction materials

[96] Feige, A., McCallister, P. and Wallbaum, H. (2013). *Rental price and sustainability ratings: which sustainability criteria are really paying back?*

Essentially, the research question is based on "Do all other equal, sustainable characteristics affect the price of a building?". The key question for researchers lies in the three words - - everything else is the same.[97]

All buildings in the sample have been evaluated according to 36 different sustainability indicators. The evaluation was done by independent real estate consultants together with a team of researchers from the University of Zurich and the ETH Zurich.

The list of indicators was created in 2008 by a dedicated group of market participants and academics (containing appraisers, real estate investors, academic real estate and construction in Switzerland).

In order to assess the viability of the building, the 36 indicators have been scored as follows:

-1 = the building is below common standards and rules.

0 = the building meets the common standards and rules of the building.

+1 = the building exceeds common standards and rules

In addition, several physical criteria were considered in the analysis. These often include features included in hedonistic modeling, such as size, age, number of floors, number of rooms, and location factors.[98]

The buildings are located mainly in the city centers. Most of the buildings were built in the 1960s and 1970s and have already undergone renovation. The sample buildings are mostly high-rise houses of medium height with an average of five floors. Descriptive statistics show information on assessing the sustainability of the building in relation to the five sustainability characteristics (flexibility, energy and water consumption, accessibility and mobility, safety and security and health and comfort). Apart from energy and water consumption, the largest share of buildings was below the standard, as shown by the average score -0.5.[99]

One of the main problems is the lack of building quality data. Quality tends to include some complex features, including condition, location, interior specifications, design, age, construction and facilities, among others. An important modeling advantage in this study was that detailed information is available at the unit level. Most of the results are expected and show similar results to previous studies, in particular, rental, unit size and location are important determinants of rental price.[100]

In terms of unit size, the analysis shows that the smaller the apartment, the higher the rental price per square meter. The position indicator shows the expected results. The model estimates that rental prices are steadily declining as the quality of the location decreases.[101]

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[97] Feige, A., McCallister, P. and Wallbaum, H. (2013). *Rental price and sustainability ratings: which sustainability criteria are really paying back?*
[98] Feige, A., McCallister, P. and Wallbaum, H. (2013). *Rental price and sustainability ratings: which sustainability criteria are really paying back?*
[99] Feige, A., McCallister, P. and Wallbaum, H. (2013). *Rental price and sustainability ratings: which sustainability criteria are really paying back?*
[100] Feige, A., McCallister, P. and Wallbaum, H. (2013). *Rental price and sustainability ratings: which sustainability criteria are really paying back?*
[101] Feige, A., McCallister, P. and Wallbaum, H. (2013). *Rental price and sustainability ratings: which sustainability criteria are really paying back?*

Further important factors are the floor level of the respective unit, the total number of floors inside the building, the number of rooms within the unit and the age of the building. The model estimates that the rental price is negatively related to the height of the building. However, rental units on the higher floors show higher prices. The rental price per square meter also increases as the number of rooms increases. Not surprisingly, age is also a major determinant of rent.[102]

Regarding the variables of interest, the results for the possibilities of sustainability vary. Four of the five sustainability characteristics show a significant effect on the rental price. Three of them have a positive effect: energy efficiency and water, safety and security safety and health and comfort. The analysis shows that the higher the score of these sustainability characteristics, the higher the rent. The most important factor is "energy efficiency and water efficiency".[103]

Surprisingly, all the rest, the model estimates that a strong score in terms of accessibility and mobility has a negative effect on the rental price. In addition, flexibility has no statistically significant effect on price. Therefore, in this second model, 10 different sustainability indicators are evaluated.[104]

The secondary indicators of sustainability "accessibility and mobility" are: proximity to public transport, non-motor vehicles and accessibility, which describes the distances from local centers, etc. Of these three indices, only the index for non-motor vehicles has a negative effect on the price. One possible explanation could be the definition of criteria for the non-motor vehicle index - it is essentially a measure of the availability of bicycle parking spaces. As a result, more expensive locations often have poor bike facilities. However, being in the city center has a positive effect on prices - as indicated by the "accessibility" indicator.[105]

For the second sustainability feature "flexibility", two sub-indicators were analyzed. While usage flexibility has a significant positive effect, adaptability to user requirements still has a negative impact on rental prices. Adaptability indicators for user requirements include features such as wheelchair accessibility or outdoor usability. Rental units with these features are often located on the ground floor, where rental rates are usually lower.[106]

An important, but unexpected, result is the estimation of energy efficiency. The model shows that energy efficiency has a significant negative effect on rental prices. This suggests that less energy efficient buildings achieve higher rental rates. The explanation for this amazing result is likely to be found in the typical Swiss lease structure for residential buildings. Building owners in Switzerland usually charge a fixed rent to their tenants (gross rent) which includes energy costs. Building owners are then responsible for paying the

[102] Feige, A., McCallister, P. and Wallbaum, H. (2013). *Rental price and sustainability ratings: which sustainability criteria are really paying back?*
[103] Feige, A., McCallister, P. and Wallbaum, H. (2013). *Rental price and sustainability ratings: which sustainability criteria are really paying back?*
[104] Feige, A., McCallister, P. and Wallbaum, H. (2013). *Rental price and sustainability ratings: which sustainability criteria are really paying back?*
[105] Feige, A., McCallister, P. and Wallbaum, H. (2013). *Rental price and sustainability ratings: which sustainability criteria are really paying back?*
[106] Feige, A., McCallister, P. and Wallbaum, H. (2013). *Rental price and sustainability ratings: which sustainability criteria are really paying back?*

energy costs. The results are consistent with owners of less energy-efficient buildings charging higher rents to incorporate the expected higher energy costs.[107]

Overall, the results for the indicators are mainly in line with expectations and are in line with previous research on price premiums for eco-certified buildings. The analysis shows that not all the criteria included in the building certification measurements seem to have an impact on the price.[108]

When it comes to policy-making, it is important for policymakers to have strong evidence of whether there is adequate pricing incentives or that they are operating as expected. To date, a standard fact from this research body is a positive relationship between rental and sale prices and the presence of an eco-label.[109]

An innovative contribution of this paper is that it provides some initial insights into how different sustainability criteria affect rental rates for residential buildings. In general, we find that the viability of residential buildings positively affects rental prices. The sustainable characteristics of the building, especially those that enhance water efficiency, the level of health and comfort, and the safety and security of the building have significant positive effects. In contrast, some sustainability features do not have a significant effect on the rental price or even have an obvious negative effect.[110]

Concluding, the data are consistent with a positive relationship between a number of sustainable features and (rental rates).

[107] Feige, A., McCallister, P. and Wallbaum, H. (2013). *Rental price and sustainability ratings: which sustainability criteria are really paying back?*
[108] Feige, A., McCallister, P. and Wallbaum, H. (2013). *Rental price and sustainability ratings: which sustainability criteria are really paying back?*
[109] Feige, A., McCallister, P. and Wallbaum, H. (2013). *Rental price and sustainability ratings: which sustainability criteria are really paying back?*
[110] Feige, A., McCallister, P. and Wallbaum, H. (2013). *Rental price and sustainability ratings: which sustainability criteria are really paying back?*

Methodology

From a very young age I had a special sensitivity regarding the protection of our natural environment, flora and fauna, perhaps because I grew up in nature in a small village away from the city and in a very pleasant family environment that taught me to love, to respect and take care of what nature has generously given us.

Later, when I decided to study architecture, this way of thinking greatly influenced my design. And always in everything I do in my life I do it with respect first to everything and everyone around me. Sustainability is a way of thinking and educating and must be cultivated in children from an early age to learn to appreciate and respect nature.

The topic I study in this work has to do with the environmental parameters that affect property prices. In my opinion, everything that is designed and built should be based on bioclimatic architecture and sustainable design. These characteristics should have been taken for granted in our time and not tried to motivate investors to apply them. Nevertheless, the states have done a very good job and we are on a very good path.

On my study at first I try to investigate extensively the bibliography about my subject, books with main topic sustainable buildings, environmental design and bioclimatic architecture, papers that refer to price changing because of sustainable characteristics in Cyprus but also abroad. And beleive me there has been a lot of research on the sustainability and environmental characteristics that affect the prices of a property.

My aim in that research is to specify the environmental factors which affect prices through literature review, analyze those data and then organize my own agenda with the reasons that I believe that they can affect the property prices in Cyprus with ultimate goal to develop my own questionnaire. With that questionnaire I can proceed with my research and find out through different groups of people if these facts actually affect the property prices through their eyes or not. Then I am analyzing the results and find out if those factors actually affect the prices, and if yes in which level is that happening.

Collecting data from the chosen articles I finally ended up which environmental factors I believe I need to examine in my report. I excluded some factors because we are in Cyprus and here we do not have the phenomenon of the big city with many apartment buildings, small living spaces and lack of open public spaces. And then I completed my list with the following 12 factors:

Wheelchair accessibility
Use of locally produced renewable energy
Water efficiency
Wastewater treatment
Good connection to public transport
Good and safe cycling routes
Good and safe pedestrian network
Distance to local centre
Distance to amenities and facilities
Safety and security measures related to people in the neighborhood
Noise exposure
Ecological construction materials

*See Appendix A for Questionnaire

My research addresses mainly to two target groups. The tenants or owners of a house/ apartment, with an age range between 25-40, who are the target group who recently, or at least the last 5 years, bought or rented a house. And the Real Estate Specialist who are people who know the market demands, they have daily contact with interested tenants or buyers and know the requirements of the time, they may even have their own type of questionnaire created empirically to help them understand the client's needs.

Questionnaire method may have some shortcomings because of the fact that it examine randomly people who may not be familiar with that kind of research for finding a house, they may have inherited a property from their family or someone else may have gone through this process to secure that property and not the respondent himself / herself. Furthermore my research focus in a small city like Paphos and its surrounding and that may effect negative my questionnaire outcome if that does not respond to other cities, it may be less accurated.

Results and Discussion

The questionnaire was written in English language. The Likert scale was selected to obtain weight of 12 environmental factors which may affect Real Estate prices. In this type of question, the respondents answer based on the amount of importance where 1 represented “Unlikely”, 2 “Neutral”, 3 “More or Less Likely”, 4 “Likely” and 5 “Extremely Likely”.

In the data analysis that follows I initially analyzed all the data I had collected together. But then I thought I had to group my data into 2 categories. The first category is the tenants or owners of a property who express their personal opinion based on their own data and the second category are the Real Estate Specialists who deal professionally with the topic and express their professional point of view.

Table I:

Factors People Consider in mind while Choosing their House.												
	Wheelchair accessibility	Use of locally produced renewable energy	Water efficiency	Wastewater treatment	Good connection to public transport	Good and safe cycling routes	Good and safe pedestrian network	Distance to local centre	Distance to amenities and facilities	Safety and security measures related to people in the neighborhood	Noise exposure	Ecological construction materials
A1	1	4	5	3	3	2	5	5	5	4	5	2
A2	1	2	5	1	3	1	5	5	5	4	3	1
A3	1	5	5	5	3	1	5	5	5	5	5	5
A4	1	1	5	2	2	2	1	5	5	5	5	2
A5	1	2	5	2	4	1	5	5	5	5	5	3
A6	1	3	5	3	1	1	3	5	5	5	5	3
A7	1	2	5	4	3	2	4	5	5	5	5	3
A8	1	3	4	5	1	1	5	3	4	5	4	3
A9	1	3	5	5	1	1	5	4	4	5	5	2
A10	3	2	5	4	1	1	5	5	5	5	5	3
A11	1	3	5	4	1	2	4	4	5	4	4	1
A12	2	2	5	4	1	2	5	4	5	5	5	1
A13	1	5	2	2	2	3	3	5	5	5	5	2
A14	2	2	4	4	2	2	4	4	4	4	5	4
A15	2	3	3	3	2	3	4	4	4	4	5	2
A16	3	4	4	2	3	2	4	4	4	3	4	3
A17	2	2	4	4	2	3	3	4	4	3	4	3
A18	2	4	4	4	3	4	4	3	3	5	4	5
A19	3	4	4	4	3	4	4	3	5	5	4	2
A20	1	1	3	3	4	2	3	3	4	5	4	2
A21	3	3	2	2	4	4	2	3	2	3	2	4
A22	1	3	3	3	4	4	5	5	5	5	5	4
A23	3	3	5	4	3	3	5	4	4	5	5	4
A24	2	2	3	2	3	4	2	4	4	2	3	3
A25	3	3	3	3	4	3	4	4	4	4	4	3
A26	4	5	5	4	5	5	5	5	5	5	4	5
A27	3	1	4	5	5	3	5	5	5	5	5	3
A28	1	4	1	1	5	2	5	5	5	4	4	3
A29	2	3	3	3	4	4	4	4	5	4	1	3
A30	1	1	1	3	3	3	4	5	5	4	4	1
Average	**1.80**	**2.83**	**3.90**	**3.27**	**2.83**	**2.50**	**4.07**	**4.30**	**4.50**	**4.40**	**4.27**	**2.83**

Table II:

Factors People are willing to Pay More in order to have them applied in their House.												
	Wheelchair accessibility	Use of locally produced renewable energy	Water efficiency	Wastewater treatment	Good connection to public transport	Good and safe cycling routes	Good and safe pedestrian network	Distance to local centre	Distance to amenities and facilities	Safety and security measures related to people in the neighborhood	Noise exposure	Ecological construction materials
A1	1	3	5	3	4	3	5	5	5	5	5	3
A2	1	3	5	4	4	4	5	5	5	5	4	3
A3	1	4	4	4	2	1	5	5	5	5	5	4
A4	1	3	3	3	1	1	5	5	5	5	5	3
A5	1	3	5	3	1	1	5	5	5	5	5	3
A6	2	3	5	3	1	1	3	5	5	5	5	3
A7	1	4	4	4	1	3	5	5	5	5	5	4
A8	1	4	3	3	1	1	5	3	4	5	3	4
A9	1	1	5	4	1	1	5	3	4	5	3	2
A10	2	2	5	4	1	1	5	4	4	5	5	3
A11	1	4	5	4	1	2	5	4	4	5	3	1
A12	2	2	4	3	1	1	4	3	4	4	4	2
A13	2	4	4	4	2	3	3	5	5	5	5	3
A14	2	3	4	4	2	1	4	3	4	5	5	4
A15	2	3	3	3	3	3	4	4	4	4	5	2
A16	3	3	4	2	1	3	4	5	5	4	4	2
A17	1	2	3	3	3	4	4	4	4	5	4	3
A18	2	4	5	4	3	4	4	3	4	5	4	4
A19	2	4	4	4	2	3	3	2	4	4	4	2
A20	4	3	2	2	4	4	4	3	3	2	3	3
A21	3	2	2	2	5	5	3	5	2	4	2	4
A22	1	4	4	4	5	4	5	5	5	5	5	5
A23	2	4	5	5	5	4	5	5	5	5	5	4
A24	2	3	3	3	3	3	3	4	4	2	3	4
A25	2	2	2	2	3	3	3	4	4	4	4	3
A26	3	3	4	4	4	5	5	3	4	5	5	5
A27	2	2	3	2	4	2	3	4	4	4	3	2
A28	1	5	3	2	5	2	5	5	5	5	5	3
A29	2	3	2	3	3	3	3	2	4	4	3	3
A30	1	4	3	5	2	1	3	5	5	5	5	2
Average	**1.73**	**3.13**	**3.77**	**3.33**	**2.60**	**2.57**	**4.17**	**4.10**	**4.33**	**4.53**	**4.20**	**3.10**

Chart I:

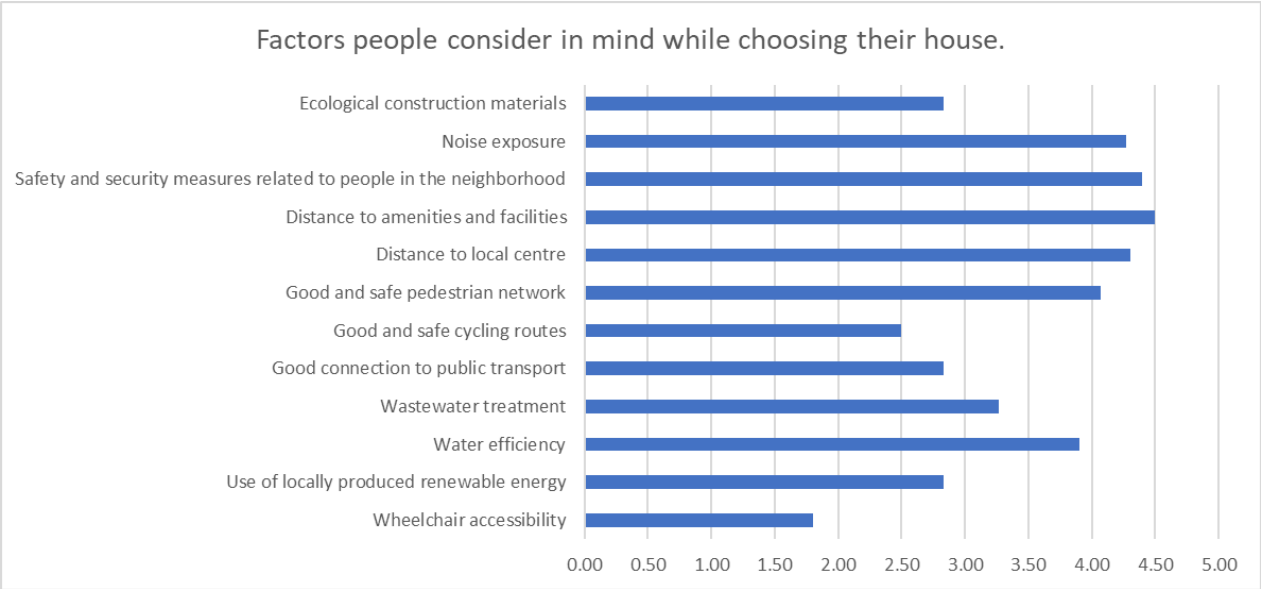
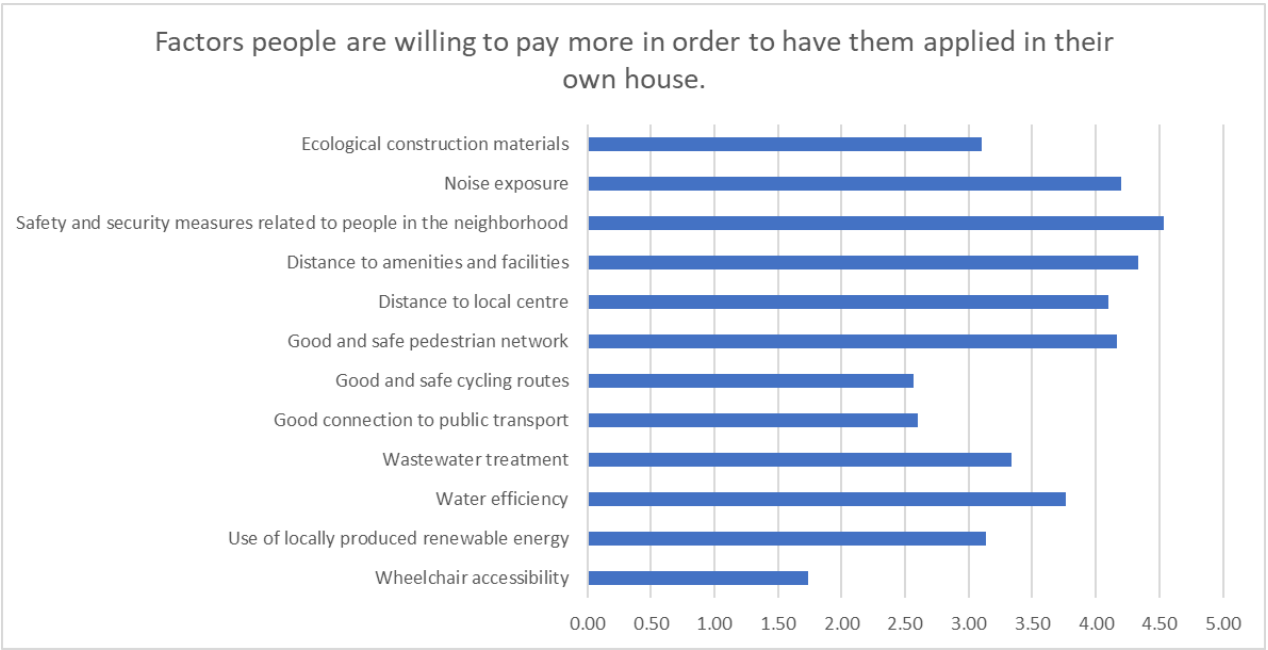


Chart II:



In the charts shown above we can notice that the most important factor people consider in mind while choosing their house is distance from amenities and facilities but the one that they are willing to pay more to have it applied Is safety and security measures related to people in the neighborhood. On the other hand the less important factor while choosing a house is also the one they don't want to pay more to have it applied and it's the wheelchair accessibility. More or less the two charts agree to each other and the factors that the people consider in mind while choosing their house are the ones that they are willing to pay more in order to have them applied in their houses.

Table III:

Factors Tenants and House Owners Consider in mind while Choosing their House.												
	Wheelchair accessibility	Use of locally produced renewable energy	Water efficiency	Wastewater treatment	Good connection to public transport	Good and safe cycling routes	Good and safe pedestrian network	Distance to local centre	Distance to amenities and facilities	Safety and security measures related to people in the neighborhood	Noise exposure	Ecological construction materials
A1	1	4	5	3	3	2	5	5	5	4	5	2
A2	1	2	5	1	3	1	5	5	5	4	3	1
A3	1	5	5	5	3	1	5	5	5	5	5	5
A4	1	1	5	2	2	2	1	5	5	5	5	2
A5	1	2	5	2	4	1	5	5	5	5	5	3
A6	1	3	5	3	1	1	3	5	5	5	5	3
A7	1	2	5	4	3	2	4	5	5	5	5	3
A8	1	3	4	5	1	1	5	3	4	5	4	3
A9	1	3	5	5	1	1	5	4	4	5	5	2
A10	3	2	5	4	1	1	5	5	5	5	5	3
A11	1	3	5	4	1	2	4	4	5	4	4	1
A12	2	2	5	4	1	2	5	4	5	5	5	1
A13	1	5	2	2	2	3	3	5	5	5	5	2
A14	2	2	4	4	2	2	4	4	4	4	5	4
A15	2	3	3	3	2	3	4	4	4	4	5	2
A16	3	4	4	2	3	2	4	4	4	3	4	3
A17	2	2	4	4	2	3	3	4	4	3	4	3
A18	2	4	4	4	3	4	4	3	3	5	4	5
Average	**1.50**	**2.89**	**4.44**	**3.39**	**2.11**	**1.89**	**4.11**	**4.39**	**4.56**	**4.50**	**4.61**	**2.67**

Table IV:

Factors Tenants and House Owners are willing to Pay More in order to have them applied in their House.												
	Wheelchair accessibility	Use of locally produced renewable energy	Water efficiency	Wastewater treatment	Good connection to public transport	Good and safe cycling routes	Good and safe pedestrian network	Distance to local centre	Distance to amenities and facilities	Safety and security measures related to people in the neighborhood	Noise exposure	Ecological construction materials
A1	1	3	5	3	4	3	5	5	5	5	5	3
A2	1	3	5	4	4	4	5	5	5	5	4	3
A3	1	4	4	4	2	1	5	5	5	5	5	4
A4	1	3	3	3	1	1	5	5	5	5	5	3
A5	1	3	5	3	1	1	5	5	5	5	5	3
A6	2	3	5	3	1	1	3	5	5	5	5	3
A7	1	4	4	4	1	3	5	5	5	5	5	4
A8	1	4	3	3	1	1	5	3	4	5	3	4
A9	1	1	5	4	1	1	5	3	4	5	3	2
A10	2	2	5	4	1	1	5	4	4	5	5	3
A11	1	4	5	4	1	2	5	4	4	5	3	1
A12	2	2	4	3	1	1	4	3	4	4	4	2
A13	2	4	4	4	2	3	3	5	5	5	5	3
A14	2	3	4	4	2	1	4	3	4	5	5	4
A15	2	3	3	3	3	3	4	4	4	4	5	2
A16	3	3	4	2	1	3	4	5	5	4	4	2
A17	1	2	3	3	3	4	4	4	4	5	4	3
A18	2	4	5	4	3	4	4	3	4	5	4	4
Average	**1.50**	**3.06**	**4.22**	**3.44**	**1.83**	**2.11**	**4.44**	**4.22**	**4.50**	**4.83**	**4.39**	**2.94**

Chart III:

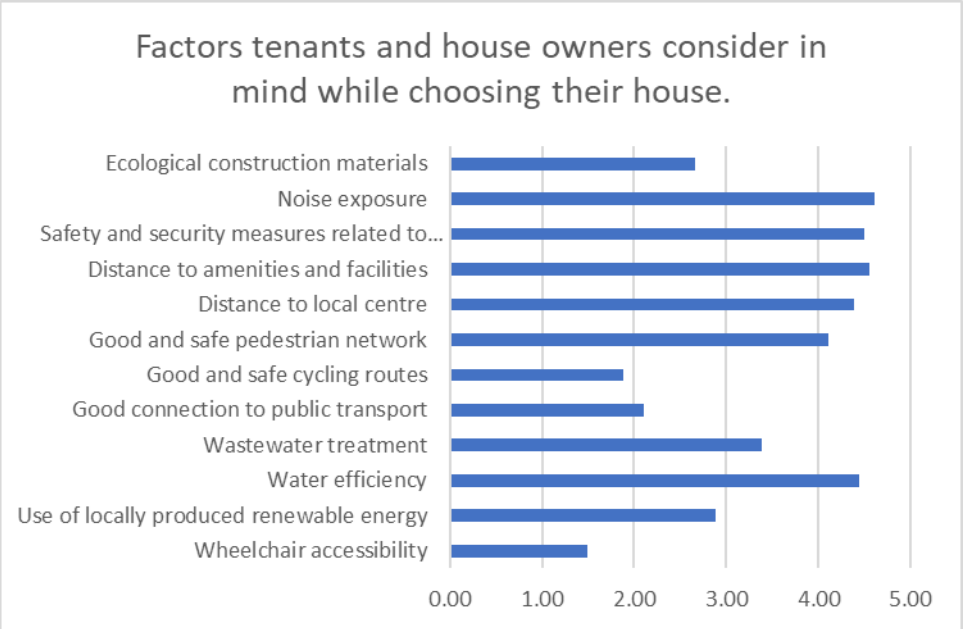
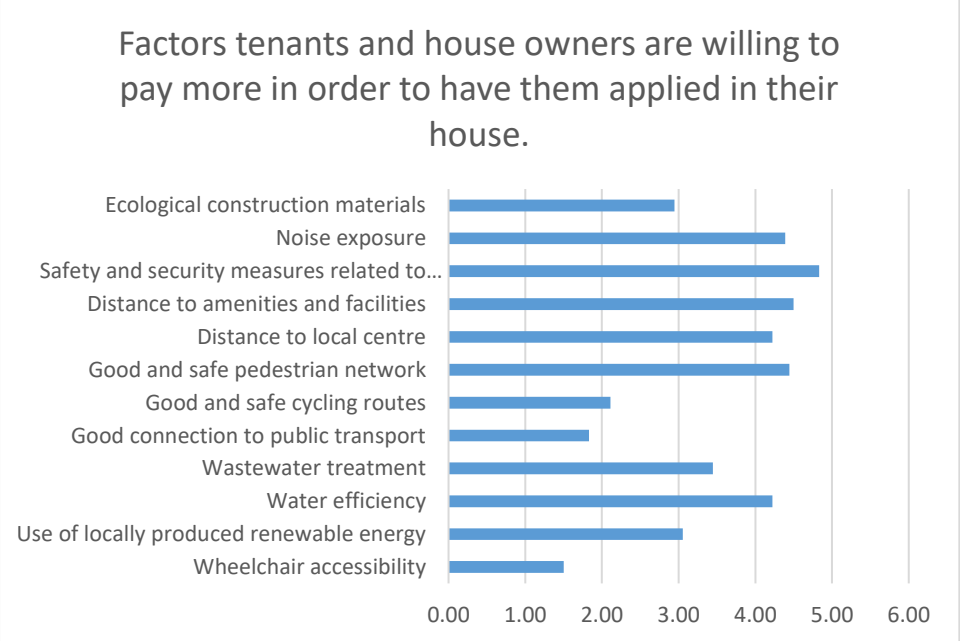


Chart IV:



In the charts III and IV we can notice a similarity between them and the charts I and II that we analyzed earlier. That may happen due to the fact that the tenants and owners are numerically superior than the Real Estate Specialists and that may affect the outcome. Furthermore in those charts the tenants and owners answer that they consider in mind the factor of noise exposure more than others while choosing their house but they are willing to pay more in order to have applied the factor of safety and security measures related to people in the neighborhood. On the other hand the factor of wheelchair accessibility continue to stay at the lower levels of considering and willing to pay more to have it applied from the tenants and the owners compared to other factors.

Table V:

Factors RE Specialists think that their Clients Consider in mind while Choosing their House.												
	Wheelchair accessibility	Use of locally produced renewable energy	Water efficiency	Wastewater treatment	Good connection to public transport	Good and safe cycling routes	Good and safe pedestrian network	Distance to local centre	Distance to amenities and facilities	Safety and security measures related to people in the neighborhood	Noise exposure	Ecological construction materials
A1	3	4	4	4	3	4	4	3	5	5	4	2
A2	1	1	3	3	4	2	3	3	4	5	4	2
A3	3	3	2	2	4	4	2	3	2	3	2	4
A4	1	3	3	3	4	4	5	5	5	5	5	4
A5	3	3	5	4	3	3	5	4	4	5	5	4
A6	2	2	3	2	3	4	2	4	4	2	3	3
A7	3	3	3	3	4	3	4	4	4	4	4	3
A8	4	5	5	4	5	5	5	5	5	5	4	5
A9	3	1	4	5	5	3	5	5	5	5	5	3
A10	1	4	1	1	5	2	5	5	5	4	4	3
A11	2	3	3	3	4	4	4	4	5	4	1	3
A12	1	1	1	3	3	3	4	5	5	4	4	1
Average	**2.25**	**2.75**	**3.08**	**3.08**	**3.92**	**3.42**	**4.00**	**4.17**	**4.42**	**4.25**	**3.75**	**3.08**

Table VI:

Factors RE Specialists think that their Clients are willing to Pay More in order to have them applied in their House.												
	Wheelchair accessibility	Use of locally produced renewable energy	Water efficiency	Wastewater treatment	Good connection to public transport	Good and safe cycling routes	Good and safe pedestrian network	Distance to local centre	Distance to amenities and facilities	Safety and security measures related to people in the neighborhood	Noise exposure	Ecological construction materials
A1	2	4	4	4	2	3	3	2	4	4	4	2
A2	4	3	2	2	4	4	4	3	3	2	3	3
A3	3	2	2	2	5	5	3	5	2	4	2	4
A4	1	4	4	4	5	4	5	5	5	5	5	5
A5	2	4	5	5	5	4	5	5	5	5	5	4
A6	2	3	3	3	3	3	3	4	4	2	3	4
A7	2	2	2	2	3	3	3	4	4	4	4	3
A8	3	3	4	4	4	5	5	3	4	5	5	5
A9	2	2	3	2	4	2	3	4	4	4	3	2
A10	1	5	3	2	5	2	5	5	5	5	5	3
A11	2	3	2	3	3	3	3	2	4	4	3	3
A12	1	4	3	5	2	1	3	5	5	5	5	2
Average	**2.08**	**3.25**	**3.08**	**3.17**	**3.75**	**3.25**	**3.75**	**3.92**	**4.08**	**4.08**	**3.92**	**3.33**

Chart V:

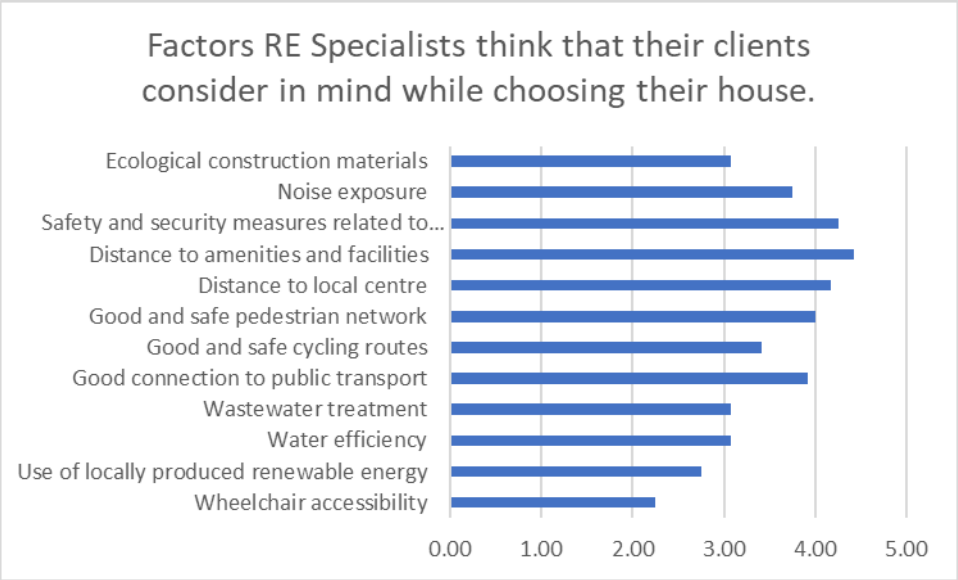
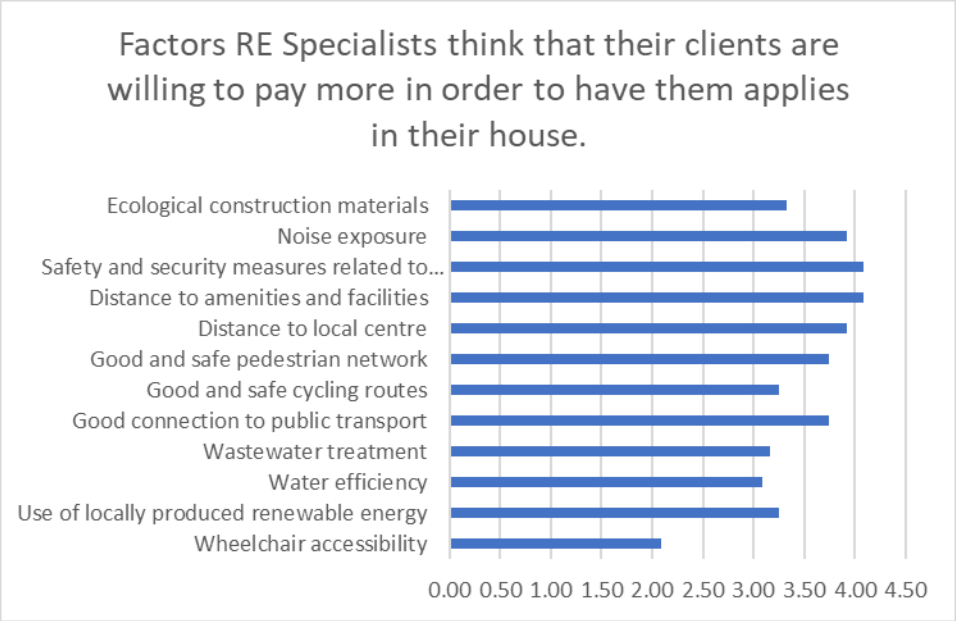


Chart VI:



In the charts V and VI we can notice the difference compared to the previous charts I presented. The data I got from the Real Estate Specialists I think is more reliable and valid because they express their professional opinion based on their many years of experience in the field, in addition these people have academic qualification regarding the subject. The difference we see may arise from the fact that Real Estate Specialists represent a much larger number of people, all the people who were their clients, people at different ages, coming from different population groups, with different needs and requirements. Concerning the above data we can see that in the question which factors the RE Specialists

think that their clients consider in mind while choosing their house the most common answer was distance to amenities and facilities. Comparing those charts with the previous ones the factors of good connection to public transport and good and safe cycling routes were surprisingly high. And the factor of wheelchair accessibility continues at the same level as previously, as the less important factor. After that, in the second question, which factors the RE Specialists think that their clients are willing to pay more in order to have them applied in their house we have two answers with the same higher score, distance to amenities and facilities but also safety and security measures related to people in the neighborhood. And also here comparing those charts with the previous ones the factors of good connection to public transport and good and safe cycling routes were surprisingly high. And finally the factor of wheelchair accessibility continues at the lower level as previously.

Conclusions

As we realised many market participants require price incentives to adopt sustainable policy. So is up to us and our goverment to give those incentives in order to have a more efficient and sustainable living environment. To date there are a lot of studies all over the world researching tthe factors that affect sustainability, how to ensure a complete natural environment in the next generations, where there is room for improvement, the relationship of these factors with economic benefits, etc.

An innovative contribution of this paper is that it investigates some factors that have been discussed in the foreign literature and tries to determine whether they have room to be applied to the Cypriot data. About what sustainability criteria do Cypriot citizens employ in their market search for housing and which of these criteria are so important to them that they intended to pay more money to secure them. Given the range of dimensions of sustainability, not all factors could be studied, but I chose 12 factors that I considered important and applicable for Cyprus.

In general, we found that the viability of buildings affects demand and property prices. The sustainable characteristics of a building and an area, such as distance to amenities and facilities, safety and security measures related to people in the neighborhood, distance to local centre, noise exposure, good and safe pedestrian network and water efficiency are the factors that possible owners or tenants consider more than 75% compare to others while choosing a house. Other factors like wastewater treatment, use of locally produced renewable energy, good connection to public transport, ecological construction materials and good and safe cycling routes are important as well but not critical as the results shown. And the final factor that scored with a grade below average is wheelchair accessibility, it does not seem to be a problem that concerns the people, perhaps because the average age at which the questionnaire was addressed was around 30-35, it would employ more older people I think. More or less we have the same results at the question which factors people are willing to pay more in order to have them applied in their house.

This study, similar to the large majority of previous studies, provides an overview of whether and if yes how much some sustainability factors affect property prices. Like most previous studies, the data are consistent with a positive association between a number of sustainable features and prices. However, it is also important to know whether those sustainability attributes working as expected. Ultimately, all those environmental factors affect the property prices, each one of them with different gravity, but they also depend on a set of supply and demand conditions. Each one of these factors is an object of study and analysis in itself, seperately. A major area of future research is to obtain enough data of the financial and sustainability attributes required to conduct research about those factors seperately and more specificly in specific areas or cities.

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APPENDIX A: QUESTIONNAIRE

Master Thesis

MSc in Real Estate – Neapolis University of Pafos

How the sustainability characteristics of the real estate properties affect their prices?

Questionnaire

Name……

Phone Number ……Date……

Category

☐ **Tenant** ☐ **House/ Apt. Owner** ☐ **Real Estate Specialist**

Which of the following factors consider in mind while choosing your house?

Wheelchair accessibility
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Use of locally produced renewable energy
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Water efficiency
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Wastewater treatment
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Good connection to public transport
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Good and safe cycling routes
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Good and safe pedestrian network
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Distance to local centre
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Distance to amenities and facilities
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Safety and security measures related to people in the neighborhood
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Noise exposure
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Ecological construction materials
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

For which of the following factors you are willing to pay more in order to have them applied in your house?

Wheelchair accessibility
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Use of locally produced renewable energy
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Water efficiency
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Wastewater treatment
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Good connection to public transport
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Good and safe cycling routes
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Good and safe pedestrian network
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Distance to local centre
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Distance to amenities and facilities
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Safety and security measures related to people in the neighborhood
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Noise exposure
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Ecological construction materials
1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐

Where:
5 – Extremely Likely
4 – Likely
3 – More or Less Likely
2 – Neutral
1 – Unlikely