Lisbon School of Economics & Management
Universidade de Lisboa

MASTERS IN MANAGEMENT (MIM)

MASTERS FINAL WORK

PROJECT

PROVIDING A LIFE-CYCLE ASSESSMENT OF SUSTAINABLE MATERIALS FOR ETICS IN PLANBELAS: A CONSULTING PROJECT

MARIANA DE MASCARENHAS FALCÃO QUINTAS

MARCH - 2022

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RESUMO

Numa sociedade em evolução, as tecnologias e novos materiais lutam para combater as alterações climáticas e impor novos hábitos à população e às empresas. O sector da construção não pioneiro nestas iniciativas, é no entanto aquele cuja influência pode parar o tempo contra a degradação do planeta. Esta indústria é responsável por 40% das emissões de gases com efeito de estufa só no continente europeu e por 36% do consumo total de energia. As políticas e legislações apareceram para combater os danos causados pelo consumo não consciente. Um exemplo de uma contribuição de Green Buildings é o ETICS - External Thermal Insulation Composite System. Um produto no mercado de isolamento, que visa a poupança de energia através da redução de pontes térmicas, levando à economização na habitação, conforto térmico, e a questão central, a utilização sustentável de materiais. Este estudo apresenta uma análise comparativa em materiais de isolamento a serem utilizados num ETICS como EPS, XPS, Cortiça, Fibra de Linho, e Lã de Rocha. A metodologia é composta por uma Avaliação do Ciclo de Vida (ACV) cujo principal objetivo é concluir que material tem um impacto mais sustentável, ao mesmo tempo que se tenta atingir um equilíbrio entre características económicas e de performance.

Com este estudo, espera-se que a pergunta "Pode a Planbelas ser rentável nos novos fogos?" seja respondida, garantindo uma oportunidade de negócio para o cliente e de investimento para novos clientes.

Palavras-chave: Mercado-Imobiliário Sustentável, SDGs, Best Practices, ETICS, AVC

ABSTRACT

As an evolving society, technologies and new materials urge to fight climate change and impose new habits to the population and businesses. The construction sector is not a pioneer imposing these changes; however, it is the one whose influence can stop time against the planet's degradation. This industry accounts for 40% of greenhouse gas emissions in the European Continent alone and 36% of total energy usage. Policies and legislations appeared to fight damages caused by non-environmentally conscious consumption. An example of a Green Building contribution is the ETICS - External Thermal Insulation Composite System. An insulation market product, that targets energy saving by reducing thermal bridges, leading to housing economization, thermal comfort, and the core issue, sustainable materials use. This study presents a comparative analysis on insulation materials to be used on an ETICS like EPS, XPS, Cork, Hemp, and Mineral Wool. The methodology is composed by a Life-Cycle Assessment (LCA) whose main goal is to conclude which material has a more sustainable impact, at the same time a balance between economic and performance characteristics is achieved.

With this study, hopefully the question "Can Planbelas be profitable in the new dwellings?" is answered, guaranteeing a business opportunity for the client and an investing opening for new clients.

Keywords: Sustainable Real Estate, SDGs, Best Practices, ETICS, LCA

ABBREVIATIONS

SDGs- Sustainable Development Goals

BCC - Belas Clube de Campo

R&D - Research and Development

MAL - Metropolitan Area of Lisbon

SWOT - Strengths, Weaknesses, Opportunities and Threats

PESTLE - Political, Economic, Social, Technological, Legal, Environmental

ETICS - External Thermal Insulation Composite System

CE - Circular Economy

ETA - European Technical Assessment

APCOR- *Associação Portuguesa da Cortiça*

EPS- Expanded Polystyrene

XPS- Extruded Polystyrene

MW - Mineral Wool

OECD - *The Organisation for Economic Co-operation and Development*

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1. INTRODUCTION

1.1. Contextualisation

Belas Clube de Campo is a resort envisioned by André Jordan Group[1] in 1990. Located between 3 Portuguese mountains (Carregueira, Sintra and Monsanto), the 1.000ha property is known as one of the most sustainable estate in Portugal, offering a high quality of life and ultimately on the way to becoming a world reference. Occupied by more than 2700 residents - 800 families with an average of 2/3 children, BCC is a nationally wide complex with 30 owners' nationalities, in which Angolans, Brazilians and Chinese protrude (Belas Clube de Campo, 2020). Brazilians and Angolans have a weight of 6% and 5% respectively in Belas residents (Belas Clube de Campo, 2020).This resort inhabitants are entrepreneurs, executives, and workers on the superior boards of the working companies.

Planbelas, BCC's real estate corporation, is the entity responsible for the promotion, management, and selling of units. Its main goal is to properly manage the enterprise according to its sustainable vision while ensuring high quality on construction, infrastructure, and design. Besides highly sustainable residences - apartments and townhouses - BCC offers the possibility for clients to construct their own houses by selling the land. Moreover, BCC provides a Club, responsible for the services and amenities offered inside the complex that end up by differentiating Belas from competitors, like a wellness & sports centre, a school, and several other facilities like pharmacy, beauty salon, postal services, and grocery store. Additionally, it has an 18-hole golf course, and golf club, that allows the community to be connected to a natural landscape without negatively impact the ecosystem.

Sustainability

Internally and sustainability wise, Belas Clube Campo has a pivotal role in keeping a balance between the environment and the community, doing so in accordance with the Sustainable Development Goals (SDGs). The residential complex is a pioneer of Best Practices in Europe and was the first company in the sector to have both ISO 9001 and ISO 14001 certifications (Belas Clube de Campo, 2022). These norms ensure that Planbelas provides management focused on the customers' needs and an efficient resources management that protects the environment. With an emphasis on detail from every stage of the construction process, Belas Clube de Campo has been awarded several times with the "Sustainable and Energetic Efficiency Construction" and "Innovation in Construction" awards (Belas Clube de Campo, 2022). The resort endeavors the first solar neighborhood and the most sustainable houses in Portugal, with a Nearly Zero Energy Building certification (Belas Clube de Campo, 2022). Regarding the subject of the individual thesis theme, on a field trip to BCC, it was acknowledged that Belas residences use an ETICS

[1] Andre Jordan Group' Mission, Vision and Values to be found on Appendix 1

(External Thermal Insulation Composite System) with EPS as an insulator from the supplier Neuce. This is a sustainable and effective method to provide thermic insulation.

1.2.Problem Definition

As an ambitioned and promising resort, BCC aims to expand its land and construct 1500 new dwellings, and the main goal of this project is to ensure that this one is successful, being "Is Planbelas capable to be profitable in the new plots of land?" the overriding question. This Consulting Project was designed to answer the mentioned empirical question, albeit being a first-time consultant opportunity, the group made a tremendous effort to ensure BCC's profitability and sustainable continuance on provided suggestions.

1.3.Thesis Structure & Stages of Collaboration

Initiated in September and with an expected duration of 13 weeks, this consulting project was possible due to a collaboration between five masters' students, Inês Santos, Mariana Quintas, Milton Nakhare, Jorge Gaspar, and Rui Gonçalves - supervised by Professor José Veríssimo and co-coordinated by Professor Constança Casquinho - and the client. The project initiated on October 11th, 2021, date of the first steering meeting, and additional meetings were carried out in December and January. The final steering, on March 7th, 2022, aimed to present the final recommendations to the client.

The project was guided under a Diagnosis-Analysis-Recommendation structure, that latter was divided into 6 chapters. The first two chapters, consist of a simple client presentation, conveying findings on the company's research, and on a literature review that concerns the introduction of the most relevant topics discussed in the paper by laying out facts and article reviews. Chapter Three, the issue tree analysis presents a deductive reasoning of the overriding question, worked in collaboration with the other team members, followed by the inductive reasoning, worked individually. Chapter Four illustrates the group's approach to the methodology, that support the hypothesis creation, while Chapter Five, centres on the methodology data breakdown and the analysis of the results achieved. The Sixth Chapter presents the individual recommendation, its implications, limitations to the project, and further studies.

The scope of this project was underpinned on three pillars: the real estate business, the golf course, and services and amenities supplied. In the initial phase of this work, to glean market insights and have a clearer knowledge of the real estate market, several interviews were made to professionals on the industry, such as Dr. José Cardoso Botelho from Vanguard, Patrícia Barão from JLL, Jonas Döhler from Döhler Homes and Ricardo Guimarães from Confidencial, allowing the group to segment the demand and supply of the residential real estate business.

2. LITERATURE REVIEW

2.1.The Pyramid Principle and the Issue Tree Analysis

In an entrepreneurial matter, organizing and structuring thoughts can be quite a challenge. As an approach to lever an effective and simple structuring method, the Pyramid Principle was developed. A consulting methodology commonly used by Mckinsey's consultants, this pyramid-shaped framework, encourages business strategies to be ordered on a top-down approach and thought on a bottom-up style - starting from the overriding question and its answers, followed by the facts and data that sustain it (Minto, 2003). Barbara Minto, the author, defends three rules that must be followed in any consultancy project - 1) the levels of the pyramid must be a summarized-though of line from the next level, 2) each group of ideas must be related, 3) each group of ideas must be logically ordered (Minto, 2003). While creating a structure, it is essential to follow the MECE classification - Mutually exclusive and collectively exhaustive, which means that no thoughts are overlapped (mutually exclusive) and all set of ideas are inclusive (collectively exhaustive) (Paul, s.d.). At the time of exposing the hypothesis of problem-solving, these must be done in the sense that "yes/no" could be answered, helping to see the root of the problem more clearly, and consequently, the solution. This scheme is called the Issue Analysis. After imposing the ultimate question, whether the answer is yes or no, two approaches follow the latter - deductive and inductive reasoning. The deductive reasoning or the "why" tree show us what caused the problem, while the inductive reasoning, also known as the "how" tree, tackles what could be done to solve.

2.1.1. Porter's 5 Forces, SWOT, and PESTLE Analysis

The succeeding frameworks are used to investigate what competitive advantages and main weaknesses of a company exist. The Five Competitive Forces model was presented by Michael Porter who reflects his opinion on competitive advantage as "the heart of a firm's performance in competitive markets" (Porter, 1980). The model that analyses the threat of new entrants, bargaining power of buyers, bargaining power of suppliers, threat of substitute products and industry rivalry (Porter, 1980) - allowed the group to have a deep understanding of the company's environment and how its strengths can be sustained and enhanced in the market. Furthermore, the author claims one of the following competitive advantages: low cost on mainstream products, or premium prices for differentiated products, are a must to thrive.

Concerning a mix of external and internal analysis, a SWOT framework denoted for Strengths, Weaknesses, Opportunities, and Threats - provides internal and external insights on elements influencing the business position on the market (Kotler & Armstrong, 2017), while a PESTLE

analysis, developed by Francis Aguilar, aims to identify opportunities and threats of the external environment of a firm. The latter one focuses on six categories. The government actions and legislations, like tariffs, focus on the Political influence of a business, while unemployment rate and inflation concern the Economic factor. Characteristics like cultural influence, age and profession relate to the Social impact, and R&D investment and product innovation leverage the Technological position of a certain enterprise (Pestle Analysis, 2022). Environmental factors that may influence the firm's performance are climate change, pollution, and temperature. In addition, Legal aspects analysed in this framework include licenses and permits (Pestle Analysis, 2022) (CFI Education Inc., 2022). These models all relate to each other, as competitive advantage was based on the foundation of a strategy, described by Henry Mintzberg as a plan, that must have a simple understanding concept behind like the SWOT analysis (Hill & Westbrook , 1997).

2.1.2. Qualitative and Quantitative Research

As mentioned in the Marketing Management book, the 3rd phase of the marketing research - collecting information - can be proceeded by conducting qualitative and quantitative research methods (Keller & Kotler, 2016). The use of qualitative and quantitative research methods in a study is considered by a few a mixed method, while others think these two are similar, and therefore, not considered one (Tashakkor & Creswell, 2007). The same authors portray mixed methods as study in which the investigator draws answers based on quantitative and qualitative findings analysis (Tashakkor & Creswell, 2007), which may allow for a more complete analysis and collection of information to studies that the single use of a research method may not provide.

The first approach made by the group, in-depth interviews, is a qualitative research method whose purpose is to understand the needs, behaviours, and motivations of the target regarding the main subject. The qualitative method allows interviewees to express themselves regarding a topic while elaborating their opinion, instead of answering straightforward. Interviewees to this kind of research can be found online on group chats, by approaching people in the streets, or by asking familiar faces. This approach can be proceeded via email, telephone or face-to-face, each with its advantages and disadvantages. Moreover, in-depth interviews are used to create Personas, that according to Adela Revella, are hypothesis of buyers that allow professionals to strategically position their products and services (Revella, 2020). Online surveys are an effective quantitative research method that allows anonymous responses to be unbiased, and consequently make certain affirmations to the hypothesis studied. This method generally gleans many responses and symbolizes a zero-spend method.

2.2.Real Estate Market in Portugal

Juridically saying, an estate (immobile in Latin) is characterized as something that cannot be moved. In the Portuguese Civil Code, where the definition of "estate" is inexistent, according to the Article 204º, a rustic building - "a delimited part of the land and the existing construction that does not have economic autonomy"- and an urban building - "any building built into the ground, with the land that serves as a public place" are considered immobile things (DRE, s.d.). The real estate sector, which deals with the commercialization and construction of estates, are often segmented into several types, such as residential, commercial, hotels, industry and logistics, and retail (CBRE, 2021).

In 2020, the residential sector sold 167 thousand residential units, translating into over 25.58 million euros in sales (JLL, 2021). Avenida da Liberdade is the most expensive residential area in Lisbon, valued at 10,500€/m^2, following Chiado/Príncipe Real worth 8,500€/m^2 and the areas of Estoril/Cascais worth 8,000 and 10,000€/m^2 respectively (JLL, 2021). Sales within the Metropolitan Area of Lisbon faced a proliferation from 2013-2019, however, its contractions were marked by the appearance of the COVID-19 pandemic (JLL, 2021). This market segment was still very eventful in 2021, when sales healed from the pandemic effects and additionally motivated by the end of the Golden Visa program, happening in January 2022 - news that forced buyers to anticipate real estate investments.

2.2.1. Foreign Investors in Portugal

Literature hardly confirms when Portuguese real estate trades initiated, yet it is possible to mention when it became perceptible to the world. According to experts, the Portuguese residential market attractiveness to foreigners started around 2012 (Vasconcelos, 2021). The introduction of the Golden Visa program allowed the Portuguese market to become more attractive to investors from foreign nationalities such as Brazilians and Chinese (get golden visa, 2022). The Residence Permit for Investment Activity (ARI in Portuguese), also known as Golden Visa, is an immigrant investor program that allows foreigners to gain residence permit or even citizenship without living in the country. To have access to a Golden Visa, it is necessary to make one of the following investments: 1) €500k min. real estate acquisition, 2) €1 million capital transfer, 3) €500k subscription in a qualifying Portuguese fund, 4) donation of €250k in preserving national heritage in Portugal or €350k in R&D activity in Portugal, 5) job creation in Portuguese business owned by the applicant (get golden visa, 2022). A Golden Visa allows the applicant, and family, to have Portuguese residency, a free-travel card to the Schengen Area (an area encompassing most European Union countries) and to have citizenship within 5years of renewal. In addition, the

introduction of the Urban Lease Law (NRAU – Novo Regime do Arrendamento Urbano) was an extra motivation to embrace the Portuguese real estate sector development (CBRE, 2021). The new Urban Lease Law made life easier for landlords as rental contracts were, for decades, priced under the normal value, not reasonable for house owners and didn't provide the right living conditions for tenants (Montezuma & McGarrigle, 2018). By providing fewer taxes for landlords to pay and more rights for tenants, communication and negotiations became easier between the two parties. As rent was more accessible, urban life increased and the city became more attractive to foreign investment (Montezuma & McGarrigle, 2018).

In 2012 foreign buyers represented only 8% of housing sales, albeit the Golden Visa only contributed 1% (CBRE, 2020). This percentage proliferated after the Portuguese financial crisis in 2010-2014, and in 2014, 16% of housing sales were from foreigners. In 2018 and 2019 these percentages kept the stable at 13% (CBRE, 2020).

Concerning the residential investors in Lisbon, the Chinese are characterized as the "Safe Haven investors", as their motivation is to look for a safe environment to invest in and acquire a visa-free travel (Montezuma & McGarrigle, 2018). Chinese immigration to Portugal was a move of manifest with the State-owned enterprise (SEO) reform, social inequalities, and the search of higher education (Wu & Latham, 2014). Brazilians, also known as the "Safe Haven lifestyle", were mainly influenced by political instability, poor economic growth, and inflation (Montezuma & McGarrigle, 2018). The Brazilian community, the biggest in Portugal, represents 27.8% of total foreigners, the highest value ever seen since 2012 (Reis, Sousa, & Machado, 2021).

2.3.Sustainability and the importance of a Circular Economy

The German term for sustainability, Nachhaltigkeit, was introduced in 1713 as "never harvesting more than what the forest yields in new growth", a concept regarding forest management (Kuhlman & Farrington, 2010) (Scoones, 2010). The concept of sustainability became legally known in the World Commission on Environment and Development's (WCED) "Brundtland Report", in 1987 (Kuhlman & Farrington, 2010) (Wilkinson, Hill, & Gollan, 2001). In this report, the main issues about the environment and development were discussed, among the principal actions to tackle. Nowadays, Sustainability is expressed as maintaining long-term well-being by involving three dimensions: People, Planet, and Profit (Kuhlman & Farrington, 2010). Adopting this concept is aiming to diminish the negative effect of the production of goods and additionally increase efficiency on the use of resources (Vanags & Butane, 2013).

Following the integration of the word Sustainability, in 2015, the United Nations (UN) introduced in the General Assembly in New York the Agenda 2030, an action plan with targets to be achieved by 2030 by the 193 member states of the United Nations and that inserts the SDGs - Sustainable Development Goals (Hák, Janoušková, & Moldan, 2015) (Bexell & Jönsson, 2016).

This action plan recognizes that improving poverty, education, healthcare systems, and other issues, must be a cooperative action as these are divided into a set of 17 goals, 169 targets and 231 indicators that measure its efficiency. The SDGs appeared as an expansion on what was previously called the MDGs - Millennium Development Goals, a set of 8 goals to help the poorest in the most known world's problems (Hák, Janoušková, & Moldan, 2015) (Bexell & Jönsson, 2016), and in addition, as a way to achieve what wasn´t by the MDGs.

A Circular Economy (CE) impacts directly and indirectly on what we call sustainability. The term Circular Economy has been used to describe the "Eco-design, repair, reuse, refurbishment, remanufacture, product sharing, waste prevention and waste recycling" (European Environment Agency, 2016). The adoption of sustainable measures that contribute to a Circular Economy is mainly derived from political pressure and the new generation of consumers (Gen. Z) - a generation that is more environmentally conscious concerning what impacts the Planet and People (de Castro, et al., 2020). Due to the high emphasis that sustainability started to develop, the European Commission created in 2019 the European Green Deal - a pact in which Europe sets to be the first climate-neutral continent by 2050 (European Commission, s.d.) (de Castro, et al., 2020), aspiring to reduce 55% of carbon emissions from vehicles by 2030 and have zero emissions from new cars by 2035. Prior to the creation of the European Green Deal was in 2015 the establishment of the Paris Climate Agreement by the United Nations that ambitions to limit global warming by controlling annual temperature increases - a consequence of CO_2 emissions. Findings on a certain study found that a Circular Economy directly impacts on 21 targets of the SDGs and indirectly on 28 targets, being the most affected: SDGs 6 (Clean Water and Sanitation), 7 (Affordable and Clean Energy), 8 (Decent Work and Economic Growth), 12 (Responsible Consumption and Production), and 15 (Life on Land) (Schroeder, Anggraen, & Weber, 2018).

2.3.1. SDG 9 and Green Buildings

In this project, it is intended to provide a recommendation that tackles Goal 9 - Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation- more specifically target 9.4 that focuses on infrastructure improvements by adopting resource-use efficiency.

Throughout the gross value-added methodology[2], it was estimated that the construction sector contributes between 5% and 6% to the GDP in the European Union, while investment in housing had a 5.4% share in 2020 (Eurostat, 2020). In Portugal, the construction sector plays a major role in employment as it employed 431 thousand people in 2019, as companies in this sector

[2] GVA is "a measure of the contribution to GDP made by an individual producer, industry or sector" (OECD, 2001)

represented 10.6% of the non-financial sector (Instituto Nacional de Estatística, 2021). However, this sector is amongst the most pollutant in the European Union, being responsible for 40% of EU energy consumption and for 36% of greenhouse emissions (European Commission, 2020). Furthermore, it has a high impact on economic growth due to the role it plays in providing infrastructures like hospitals and schools, therefore, it is important to use new technologies and methods in construction.

Acknowledging the influence of the construction industry on the environment, society, and the national economy, the adoption of Green Buildings is an approach to eliminate negative outcomes on these pillars (Zuo & Zhao, 2013). The economic and societal benefits of Green Buildings are interlinked as these not only offer a higher quality of life, or better working conditions due to advantages on materials and technologies used - low maintenance costs, air quality, reduced waste, and water pollution (Zuo & Zhao, 2013) (Kats, 2003), as it offers a long-term saving that sustains the individual's needs. On an environmental level, the adoption of Green Buildings campaigns to reduce waste and water pollution, noise influence, and traffic (Zuo & Zhao, 2013) as studies confirm that sustainable constructions can reduce energy usage from 24% to 50%, CO_2 emission from 33% to 39%, water use around 40% and solid waste around 70% (Hussin, Rahman, & Memon, 2013). To ensure that new and existing constructions play a relevant part in the shift for more environmentally friendly cities, several associations were created to evaluate infrastructures' quality and sustainable practices. BREEAM - The Building Research Establishment Environmental Assessment Method - provides a rating and certification method for sustainable practices in the World and it is given to buildings that ensure a good relationship/balance with the environment. BREEAM was the first environmental building assessment method and remains the most acknowledged and used (Ding, 2008). Additional green building assessment tools exist, most of them created by the Green Building council of each country, all controlled by The World Green Building Council (Zuo & Zhao, 2013).

Looking at BCC as a best practice and bearing in mind the impact that the real estate and construction sphere play in the development of sustainable cities, it was decided to tackle what concerns the construction materials used in BCC houses.

2.4.External Thermal Insulation Composite System (ETICS)

ETICS is a sustainable energy-saving option for insulation in buildings. This system is normally composed by the following layers: EPS/XPS/Cork/MW, plaster, insulating board, fibreglass net, primary, and final touch (Sistema webertherm classic, 2021) (European Association for ETICS, 2021). ETICS is installed under ETA instructions after achieving ETAG 004 certification - performance and durability assessment test to ensure material's quality. The European Assessment Document not only evaluates the ETICS overall performance, as it provides

performance insights on the insulation material used, alone. Materials must follow European safety standards (EN), and international quality and safety standards (ISO). The insulation market is responsible for energy saving in buildings. In Europe, this market is predominant by mineral materials or organic materials like EPS (expanded polystyrene) - which owns 70% of ETICS' European market share (Michalak, 2021) - XPS (extruded polystyrene) and MW (mineral wool) (Sierra-Perez, Boschmonart-Rives, Dias, & Gabarrell , 2016).

The first ETICS system was used in a German building in 1957, but it was in the '70s that its use boosted because of the proliferated increase of energy prices (Michalak, 2021) and the latter introduction of "sustainability" in the construction sector. This system is popular among Europeans due to its several advantages, such as thermic bridges reduction, resulting in less energy consumption; less condensation inside the walls, improving habitants' health; easiness to apply and flexibility of materials used (Barreira & de Freitas, 2014). Besides contributing to energy efficiency, ETICS is associated with long-term durability due to the product's life cycle, and the use of recycled materials (Michalak, 2021). In 2020, almost more than 100 million square meters of external walls were covered in comparison to 2017 (Michalak, 2021). ETICS thermal performance relies on the insulator used and its thickness, in addition, if the system is applied in a high-temperature country building, the resistance to impact also plays a big role (Malanho, Veiga, & Farinha, 2021). Besides bad application consequences like cracks, studies have shown that this system can be low impact resistance and weather conditions can lead to exterior walls disfigurement (Barreira & de Freitas, 2014).

2.4.1. Cork

Cork is the suberose parenchyma originated from the Cork Oak (Quercus Suber L.) (Gil, 2013). The Cork Oak can be found in the Western Mediterranean (Gil, 2013) (Pereira & Santos, 2019) where certain growing conditions allow their production such as temperature from -5ºC to 40ºC; altitude of 100-300m; a rainfall from 400-800mm per year; and a sandy soil with low nitrogen and phosphorus, high potassium, and a pH from 4.8 to 7.0 (Amorim, 2021-2022).

The physic and thermal properties of cork allow this material to protect itself from meteorological conditions such as fires, strong winds, high temperatures and rain. Overall, cork is a material impermeable to liquids and gases, acts as a thermal and acoustic insulator, and on the more detailed side, it is composed of a cell layer full of gas like air, giving a high level of waterproofing (Gil, 2013) (APCOR, 2018).

The main application, and the most known of cork, is for wine stoppers, however, in the construction industry, cork can be used for thermal and acoustic insulation, floor and wall covering and false ceilings (Gil, 2013). According to APCOR, 73% of products from cork have as the main destination the winery industry, as 40M wine stoppers were produced in average per

day in the Portuguese territory in the year of 2018 (APCOR, 2018). Cork has a special taste in the Portuguese economy, as it is the only product in which Portugal is the main exporter, producer, and transformer (Carvalho Mendes, 2002). Portugal's exports on goods and services represented in 2020, 37% of the national GDP (The World Bank, 2020), and products with a cork base weighted 8.6% on total goods exports, being this the biggest product from forestry origin to be exported in 2020 with a total profit of 892M€ (Instituto Nacional de Estatísticas, 2021). According to the Observatory of Economic Complexity (OEC), Portugal was in 2019, the main cork exporter of natural cork and wine stoppers in the World, with a 77.6% (494M€) market share. Its biggest export destinations were France (21.9%), followed by the U.S. (21.1%) (OEC - Observatory of Economic Complexity, 2020).

Cork has a relevant role in a Circular Economy since it's a 100% natural, renewable, and recyclable product (APCOR, 2018) whose production contributes to CO_2 emissions control (de Castro, et al., 2020). However, 100 years is how long it takes for the first cork oak harvesting after being seeded. The cork oak forest contributes highly to the maintenance of animal life, as these are the habitat for several species (Bugalho, Caldeira, Pereira, Aronson, & Pausas, 2011).

2.4.2. MW

Mineral wool (MW) is a term used to refer to rock wool, slag wool or glass wool (Bullen, Sirok, & Blagojevic, 2008). The final product can be achieved by several process options that mix different raw materials, for instance, sand and recycled materials, at high temperatures until it melts (MIMA, 2022). Mineral wool is a bad thermal conductor, which means that keeps interior temperatures stable without being influenced by the exterior ones, and is in addition, fire-resistant.

The use of MW in Europe varies from the region as central Europe's average is 12% while in the rest of the continent goes from 9%-25% (Michalak, Czernik, Marcinek, & Michałowski, 2020). Known as an economic insulator to ETICS, mineral wool contributes to global warming potential (GWP) due to the CO_2 emitted during its production (Michalak, Czernik, Marcinek, & Michałowski, 2020).

Regarding MW's contribution to a Circular Economy, supplier ROCKWOOL ensures recyclability of stone and confirms zero greenhouse gas (CFCs and HCFCs) on stone wool's composition, injuring to the ozone layer, so as no flame retardants are added. In addition, ROCKWOOL's stone wool can be manufactured by a mix of recyclable materials (ROCKWOOL International A/S, 2020).

2.4.3. EPS and XPS

Expanded Polystyrene (EPS) is a thermoplastic, meaning that origins from a synthetic polymer, ensuring a feature resistant to high temperatures without losing its chemical characteristics over time (Tsao & DeVoe, 2008). EPS is a widely known foam for thermal insulation due to its lightweight, durability, low thermal conductivity, and low water absorbance (Chen, et al., 2015) (Sulong, Mustapa, & Rashid, 2019). EPS foam is a cellular plastic containing 98% of air, ensuring the same waterproofing ability as cork (Sulong, Mustapa, & Rashid, 2019). While on an ETICS system, EPS has fire retardant (less than 1%) albeit producing fewer toxic fumes as cork for instance (Sulong, Mustapa, & Rashid, 2019).

Like EPS, Extruded Polystyrene (XPS) is a thermoplastic from a synthetic polymer. XPS is a material with high durability, high thermal properties, good water resistance (Geofoam international, 2020), however, it can be a flammable material enhancing the risk of provoking fires (Jiao & Sun, 2014). Literature findings agree that XPS represents EPS expensive version (Braulio-Gonzalo & Bovea, 2017).

The process of manufacture of EPS is called polymerisation. EPS is made out of three stages: 1) expansion, in which solid polystyrene beads at a low boiling temperature expand in size, 2) conditioning or maturing, where beads reach a normal temperature, and 3) moulding, where beads are put into a mould and reheated until EPS reaches a point in which is composed by ~98% air (Expanded Polystyrene Australia Inc., 2014). XPS manufacturing process is called extrusion, also made from polystyrene beads, but instead of melting, these are extruded together with plastic resins that latter cools off and expands to its size (Kingspan Group, 2017).

To what regards these materials impact on a CE, until 2018, there were more than 150 million tonnes of plastic in the ocean. Generally, plastic represents 82% of marine litter as this was segmented as the following: 27% fishing gear plastics, 49% from single-use plastics, 6% other plastics and 18% non-plastic waste (European Commission, 2021). All badly managed transport and fishing activities, and human actions have led to the threat of ocean life, and EPS and XPS have a big influence on this matter (Black, Kopke, & O'Mahony, 2019). Among the several plastic polymers, polystyrene (PS) - EPS and XPS - seen as an economically viable option, has high production and consumption rates, contributing therefore to the annually waste laid up in the ocean (Avio, Gorbi, & Regoli, 2016) (Black, Kopke, & O'Mahony, 2019). To what regards a Circular Economy, these are materials that have not been widely adopted in a waste management system to control end-of-life deposits. The European continent alone is responsible for 200 million tons of EPS production per year, in which 40% of waste does not result in recycling (European Commission, 2021). In addition, until 2015, EPS and XPS production was associated with Hexabromocyclododecane (HBCD) - a flame retardant dangerous for healthcare. Since then,

HBCD use has been globally banned as it is PSLoop Project's goal to remove this from polymers (European Commission, 2021). Albeit being materials that contribute to energy saving in buildings, these have not been, yet, effectively controlled to contribute to a circular economy. In addition, and similar to MW, EPS is associated with high rates of CO_2 emitted during its production (Michalak, Czernik, Marcinek, & Michałowski, 2020).

2.4.4. Hemp Fibre

Hemp fibre (cannabis sativa L.), from industrial hemp, like cork is an environmentally friendly material whose adoption contributes to the concept of Green Buildings (Schumacher, Pequito, & Pazour, 2020). This organic matter is composed of 92% hemp and 8% polyester fibre and by its end life can be reused (Greenfield, 2021). Russia accounts for 33% of hemp production, albeit other countries like France, Italy, Germany, and China also have high production rates (Manaia, Manaia, & Rodriges, 2019). Hemp fibre is a material derived from the cannabis plant and resembling to marijuana (Kymäläinen, Koivula, & Kuisma, 2002). The production of hemp starts in April, considering its fast-growing ability (Schumacher, Pequito, & Pazour, 2020) and growing conditions do not differ from cork as it can survive different temperatures, however, rainy conditions can negatively affect its development.

Hemp places insignificantly in the insulation market, however, due to changes that may arise regarding the impact of the construction sector on sustainability, this material has high chances to succeed (Gaujena, Agapovs, Borodinecs, & Strelets, 2020). France is the largest European hemp producer, accounting for 70% of the market. The diversifying use of hemp goes beyond the construction sphere, acting in the textile and food industry (European Commission, s.d.). The little literature on the eco-friendly material's performance ensures its effectiveness as an insulator, while its harvesting and production manufacture positively impact a circular economy due to low use of water and the fact that it is a 100% biodegradable product.

3. ISSUE TREE ANALYSIS

This problem-solving framework intends to solve the overriding question "Can Planbelas be profitable in the new dwellings?" through an ongoing hypothesis-testing methodology with the available data.

3.1.Deductive Reasoning - The Why of the Question

In this section, the external analysis is presented to support the possibility of the hypothesis. The end goal of this section is to prove that YES, Planbelas can be profitable in the new dwellings due to the demand in the Portuguese market, and little or non-existing direct competition.

3.1.1. External Analysis

3.1.1.1. Demand

According to JLL's report, Portugal is Europe's leading destination, and is placing significantly high in the sustainability sector, as Lisbon was awarded the most sustainable capital in Europe (Barão & Fonseca, 2021). Portugal law enforcers appointed mandatory sustainable measures in the sector of housing, consequently energy efficiency, quality constructions and environmentally friendly designs are rapidly becoming requirements to ensure the promotion of this kind of business. It is relevant to mention that the pandemic not only increased the dynamics of this reality, but it also gave greater expansion in terms of people's personal awareness regarding the subject. The following projects must take more into consideration regarding sustainability and constructions practices, to ensure the quality of lives people expect. Diminished and reduced carbon footprint has become more relevant when thinking about construction as residential, commercial, and industrial real estate ripe for development.

According to JLL, diversity of nationalities is a growing trend, as France, from 2012-2019, increased 3% on total share of houses bought from 15%-18%, placing second, behind UK with a 23% share in 2012 (Barão & Fonseca, 2021).

To what regards demand, Portugal has faced a steep increase in the past decade, causing a shortage of supply, hence an increase in prices. Part of the reason for this, is due to the long process that is required for the licensing and construction, as data from JLL indicates that the number of housing units in Portugal grew by a marginal 1% in 10 years period (2011-2021), a consequence of economic and financial crises, and the licensing process which was previously mentioned. In terms of indicative residential areas, in 2012 the French occupied the most residential buildings in Lisbon, with a share of 20% out of 249 houses, followed by citizens from Angola and Brazil, with shares of 16% and 11% respectively, during a period of a financial crises,

that made its comeback by 2017-2018. During 2019, as consequence of the golden visa, the Asian market also decided to invest and buy residential homes in Lisbon as China occupies the biggest percentage with 18%, out of 1538 international purchases, followed by Brazil and France with 17% and 8% respectively, signaling the effectiveness and of the new advantage applied, that is, golden visa. The North American market has remained stagnant in terms of shares of residential homes during that period, as in 2012, it had a share of 5%, and has remained the same until 2019, with that said, it's ever so important to mention that the weight of the shares is different and that the American market has indeed made a greater impact in terms of weight of housing purchases (Barão & Fonseca, 2021).

Foreign Investment

Articles indicate that foreign buyers are increasingly searching for Portugal as a place for investment, especially on the luxury real estate sector. A Idealista research analysed foreign buyers and investors of luxury properties, done in approximately 422 boroughs and came to the following results. The study was conducted for luxury properties over 1 million the data indicates the searches for luxury property that is priced over the price-tag mentioned. The Spanish and the UK occupy the first and second places respectively, both with percentages over 11.5%, next in line is North America, representing a strong growing market, occupying a share of approximately 10%, finally comes France and Germany with 10% and 9% respectively. Furthermore, the study indicates that the Spanish invests more in Lisbon while UK invests more in Algarve (Sampson, 2021).

As previously mentioned, the Spaniards are the ones leading the race in terms of international investment of property over 1 million, and as so, data indicates that Lisbon is the preferred destination for international investors, occupying approximately 40% of foreign searches for premium property in Portugal. The data indicates the Spaniards are still the main runners, as they occupy a share of approximately 13%, next in line come the North Americans and the British respectively, occupying shares of approximately 11.1% and 10.7%, finally followed by the Brazilian and French markets with shares of 10.4% and 7% (Sampson, 2021).

The most popular countries in terms of international investment for the luxury property are the UK, Germany, and France, weighting 13%, 11,5% and 10,5% respectively of market share (Sampson, 2021).

3.1.1.2. Competitors

The analysis of BCC competitors needs to consider 1) the overall environment of the real estate market and 2) Planbelas business model and strengths, to depict the direct competitors.

The Portuguese real estate sector is going through a phase where there is a disproportion between supply and demand, with the latter far outnumbering the former. This has been

exacerbated with the pandemic, where there was a slowing down in the issuance of new building permits, elongating the licensing processes, as well as an increase in the construction costs that may have impacted development decisions (CBRE, 2020). Therefore, there is also a lack of housing with substantial sustainable measures, though an increasing interest in this area is being observed and expected to rise, as the implementation of such procedures is perceived as value added (CBRE, 2020). Furthermore, the sector of development of building projects is predominantly constituted by microenterprises, which by Banco de Portugal's definition means companies that have less than 10 employees and an annual balance that does not exceed 2 million euros (Banco de Portugal, 2019).

Belas Clube de Campo, being a residential resort, is also committed to align its business model to sustainability and puts great emphasis on this. Moreover, as mentioned before, its prime location and the diversity of services offered to its residents are strengths of this business. Remote working became a consequence of the pandemic, and it seems to be here to stay, so people are no longer so strongly concerned about living in the city, closer to their workplace, and are now seeking more peaceful locations. BCC is offering a place to live that is surrounded by calmness and nature, while still being close to the capital and busier cities (Sintra, Oeiras, Cascais). The wide range of services offered is in addition a great asset, as trends such as "hotelification" and a greater sense of community are emerging (CBRE, 2020).

Having all these factors in mind, the search for BCC competitors was made difficult and it is possible to say that Planbelas stands out in the market. Nevertheless, and considering the strengths previously laid out, a few potential direct competitors can be pointed out. Firstly, having the location factor in mind, meaning Sintra, and the type of housing that is like BCC, such as a private condominium, Condomínio Privado Fonte do Pinhal is a candidate to consider. As stated previously, it is in Sintra and, like BCC, provides the possibility of quickly commuting to other larger cities (Cascais, Oeiras, Lisboa). The amenities that the complex offers can also be compared to Belas Clube de Campo, as it accommodates services and infrastructures that resemble it a health club, tennis court, and kids' park. However, in terms of sustainability, BCC differentiates itself, as there are houses in Fonte do Pinhal that are classified as C in terms of energy efficiency in real estate agencies websites[3]. Secondly, and looking closer at housing options that are putting greater emphasis on sustainability, the project of Grupo Libertas -Tagus Bay - is an example that represents another potential competitor. Grupo Libertas states that it is committed to sustainability and aims to make its projects self-sustainable, by using mainly renewable energies, having already acquired certifications and awards[4]. Tagus Bay is in Alcochete, one of the emerging councils in

[3] Moradia T4 de luxo à venda em Algueirão-Mem Martins, Sintra | RE/MAX Collection (remax.pt) The listing was seen on December 20th 2021, in https://www.remax.pt/125811004-12 , however, on January 4th 2022 the page was not found. It is assumed that the listing was taken down.

[4] Sustentabilidade - Grupo Imobiliário Libertas

the Metropolitan Area of Lisbon (CBRE, 2020). Its sustainable measures such as "rainwater recovery, centralized water heating system with thermal solar panels, accumulators of energy produced by photovoltaics panels", promise to deliver an "economy 45% above the average". Several amenities are also to be noted, with spaces dedicated for co-work, gymnasium, kids' club, and a private biological garden with aromatic herbs[5]. Finally, Vanguard properties in Muda Reserve resemble to BCC, in the sense that it visions to create a village from scratch in Comporta. Therefore, a great importance on the services and infrastructures is seen to assist its residents in their everyday life, but also to improve their quality of life, with amenities like grocery stores, restaurants, green spaces, and sports courts. People will be able to create their own houses and the chance of practicing agriculture for private consumption. Its premium location is due to beaches and golf courses closeness and the commute to Lisbon that takes approximately 1 hour[6].

3.1.1.3. Porter's 5 Forces Model

In a constant changing world, firms need to adapt to different circumstances to ensure competitive advantage comparing to those that participate in the same market. The firm's environment is conditioned by its industry or industries of competitiveness (Porter, 1980). The intensity of competition and potential profit underlies on the so known Five Competitive Forces:

Power of negotiation from Suppliers: LOW/**MEDIUM/HIGH**

Suppliers represent a threat once they realize they have a higher share of the market, insisting on increasing prices or lowering goods/services' quality. To keep up with high standards promised to residents, BCC has several agreements with firms that ensure the supply for the services required, such as: post office, pharmacy, and restaurant. In addition, more than 75% of the materials used on site are extracted or produced less than 100km of distance. Therefore, being these entities the needed ones for BCC to thrive and operate daily, they have in their hands a significant power of negotiation.

Threat of New Entry: **LOW**/MEDIUM/HIGH

The threat of new entry depends on the number of barriers and the reaction from competitors to their entry. Among the six popular barriers to entry - economies of scale, product differentiation, switching costs, access to distribution channels, cost disadvantages independent of scale, and government policy - BCC is considered by the group, an exceptional competitor in product differentiation. In the real estate industry, new entrants must bring innovative technologies, introduce new methods, and pressure investors with lower pricing strategies, cost cutting, and new value propositions for customers. In an initial phase, firms in the real estate and

[5] Tagus Bay (libertas-projects.pt)

[6] Comporta Real Estate: Muda Reserve | Vanguard Properties (vangproperties.com); MUDA RESERVE DIGITAL BROCHURE high by Vanguard Propeties - Flipsnack

construction sector require a significant capital to invest in and to act as threat for others. Additionally, the Portuguese government has proven to be tough on accepting new projects, giving the number of licenced new constructions that were given throughout the years (Instituto Nacional de Estatística, 2021). Planbelas proves to be a harsh company to compete with, however, to guarantee its competitive advantage, new products/services should be developed also by investing more on R&D.

Buyer Power: **LOW**/MEDIUM/HIGH

Buyer Power excel in the industry as an acting weight on prices. The smaller the number of buyers, the higher their bargaining power. Due to Planbelas' high-quality properties, the range of customers is characterized by their financial ability to afford these estates, representing a small percentage of the foreign/national population. Additionally, these buyers are expected to be more demanding, as they want to ensure their money is well-spent and their needs fulfilled. However, since BCC is an awarded and a mark on Best Practices, prices are not negotiable, as these are the business' value representation.

Substitutes: LOW/**MEDIUM**/HIGH

The power of substitutes, influenced by what other firms offer in terms of price & services, limit the range of profits the enterprise has. Firms tend to be successful if they provide products with a lower price and an average performance, or if they stand out in the industry. Regardless the existence of competitors, whether these are in the MAL, in Alentejo or by the coast, BCC surpasses its rivals due to the set of characteristics provided. After research to find competitors that match BCC's level, luxury resorts and well-known buildings were indeed found, however none of these offer a private and gated community, awarded with sustainable recognitions, with several amenities onsite.

Industry Rivalry: LOW/**MEDIUM**/HIGH

"Rivalry occurs because one or more competitors either feels the pressure or sees the opportunity to improve position" cites Michael Porter (Porter, 1980).

When rivalry in the industry is high, it depresses prices and reduces the overall profitability of the industry. Although the Real Estate market is highly competitive, this can affect the overall long-term profitability of Planbelas. However, the attention for detail that Planbelas offers, puts it with a high market share and on the loop for customers. In addition, the balance between Demand and Supply also plays a huge role on the overall profitability. In this case, due to the low supply, like BCC, seen in Sintra or any major cities surrounding, the demand side can increase prices due to the uniqueness of the product in the market.

3.1.1.4. SWOT Analysis

As a mix of internal (Strengths and Weaknesses) and external (Threats and Opportunities) analysis, the SWOT framework is characterized by a gathering of perceptual data suggesting the causes for the results being achieved, alternative means to accomplish desired goals and instances that may threaten the future of the organization (Leigh, 2009).

1. Strengths

Edge on sustainability

Planbelas incorporates sustainable practices in their culture, the importance given to this critical subject is referred in the firm's mission, vision and values and highly promoted through its communication channels by holding an evenly position alongside three main operational activities, real estate, country club and golf. The warranty for competitive advantage is visible through the range of certifications achieved in the last decades in which we highlight the 2011 Sustain Worldwide Award for "Most sustainable south Europe private residential community".

Sense of community

BCC is characterized prominently for being very community friendly, a rare characteristic, only made possible with a broad range of services, careful planning, and special "know-how", in this case, from its founder André Jordan. Services range from school, grocery store, medical home help and several more. These allow groups of people to grow into communities, it guarantees an increase of well-being and the satisfaction of the proposed business model, a high-quality residential area. One of many benefits of communities we can highlight is the inspiration for continuous success as in strong communities there is always someone doing something amazing (Kelly, 2015).

Strategic location

Located equally between Lisbon's centre, Cascais and Sintra, Belas Clube de Campo highly benefits from its centrality, a unique feature considering the size of the resort, besides satisfying different types of customers it's one of the main reasons why competition lacks similarities with Planbelas. It's a definite competitive advantage.

2. Weaknesses

Limitations of the golf course

Although the golf course is one of the main projects of Planbelas, its full potential is held back by two main factors. The first, being in the city centre rules out the possibility of another nearby course to increase diversity of plays, which is something common within Pestana's Golf & Resort enterprise. Secondly, feedback from maintenance workers suggested that financial breakeven has not been achieved and it would only be possible with an increase of 50% on club members from the current 391 hold by October 2021.

Weak mass touristic positioning

Although there is a diversity of nationalities present at BCC, part represented by residential tourism and the rest by daily golf course users, mass tourism accommodation is not yet being satisfied in any form. The growth of this industry in Portugal has been clear despite a pandemic impact and a McKinsey article suggests it will have fully recovered to 2019 levels by 2024 (Espírito Santo, Caballero, Constantin, Köpke, & Binggeli, 2021).

3. Opportunities

Emerging market for sustained solutions

Sustainability and social responsibility are an increasing trending topic in the corporate world, very recently acknowledged at COP-26[7], it is expected that compliance towards ESG factors will continuously grow in importance for the future as well as incentives for change, such as tax and legal incentives. The current progress in BCC is very positive, especially in infrastructure, and even though current market demand is yet to fully comprehend the premium that innovation requires, these steps should keep being taken as prospects are pointing towards their critical need in the future.

Website development

Belas Clube de Campo has a website developed to be one of the main entrance doors to the residential club. It is characterized for its simplistic design and colour scheme, a very informative space and great storytelling. A story is told by scrolling down on the main page, initiating with a description of main club areas and exposing the main business purpose, building a certain interest, that foments excitement from the latter video presentation, hence this is followed by a more in-depth informative text section of every aspect previously approached, and finally a section with latest news and articles and a contact area. It acts as a true experience to visitors and for this reason it can be a useful tool for future projects.

Ability to attract foreign investment

Despite the pandemic, an article posted by Santadertrade states that Portugal has entered the top 10 investment destinations in Europe (Santander, 2020), the country is now one of the main destinations for FDI. Apart from this, research also shows that Portugal is above the European average when it comes to quality of life, which is one of the main factors considered by foreigners when acquiring housing in another country (Caon, 2021). Considering the product offered by BCC, high-quality housing, this is evidence that demand is expected to at least maintain present values, hence an opportunity to secure newcomers to the enterprise.

4. Threats

The uncertainty of the pandemic and the housing market instability

Businesses are impacted by two major types of risk, systemic and specific, the first is common to every industry, a very recent example of this was the Covid-19 pandemic, while the second is

[7] Global Climate Summit, denoted Conference of the Parties, Glasgow

related to a specific sector, and in this case we can highlight the 2008 housing bubble. The threats posed by these risks are seemingly perpetual and very recently, articles suggest that low mortgage rates in Portugal, combined with the inflow of foreign capital, and highly populated Lisbon may lead to a new housing bubble in the country (Value of Stocks, 2020). Although economic crisis may have different impacts, they all threaten the financial viability of firms, Planbelas included. It is important that steps are taken towards protecting the organization against such events, this is done by maximizing competitive advantage and working continuously towards capitalizing on new opportunities.

3.1.1.5. PESTLE Analysis

Political and Environmental

Businesses have been increasingly integrating the SDGs into their business models, as its clear that these are drivers for future sustained growth (COUNTRY REPORTS, 2021). Planbelas is no exception for this. In fact, it is the "most sustainable development in Portugal and a world reference" (Belas Clube de Campo, 2019). When it comes to sustainable construction, as it is aligning its strategy with the 17 SDGs and, more precisely: SDG 5(Gender Equality), SDG 6 (Clean Water and Sanitation), SDG 7 (Affordable and Clean Energy), SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation and Infrastructure), SDG 11(Sustainable Cities and Communities), SDG 12(Responsible Consumption and Production), SDG 13(Climate Action), and SDG 15 (Protecting Life on Land).

The areas of sustainable housing and the minimization of the environmental impact of the golf course are subjects that Planbelas could keep on enhancing, given the fact that they are at the core of their business. Indeed, substantial work has already been put into practice, since it is such a vital issue for the company, with resources allocated to water, energy consumption and waste management, renewable energy sources, as well as the care to use adequate materials and chemicals, either for the houses or the management of the golf course. Nevertheless, there are still targets that the company would like to attain, such as "75% of the waste produced in the development is recycled" (Belas Clube de Campo, 2019), green areas, restaurants, mobility inside the club, and exclusive equipment for residents (Belas Clube de Campo, 2019).

Economical and Societal

Regarding social actions that embrace the sense of community, besides all services and amenities provided (mentioned in chapter one), Belas campaigns to support firefighters, organizes social golf tournaments and employs people with disabilities.

To have a better understanding of the economic and societal context that Planbelas is inserted in, an analysis of Portugal's progress in the relevant SDGs, as well as some insights into the Portuguese real estate market and the population's economic situation, will be laid out. Firstly, a

glimpse will be taken into the evolution of the appropriate SDG metrics and indicators in Portugal, so that there can be a better understanding of the situation of the areas that Planbelas is also working towards. Starting with SDG 11 (Sustainable Cities and Communities), in 2019 and the considered period 2010-2019, the indicator for the urban waste collection was advancing in the opposite direction of the desired target, where Portugal is only catching up now to the values of 2011 in absolute terms a downward slope in urban waste collection by GDP unit, while still above the trend for the EU27 (INE, 2021).For the indicator of the evolution of the efficiency of artificial territories by inhabitant, in 2018 and the considered period 2010-2018, the evolution has been positive towards the desired target, but there is still a long way until the desired results can be perceived, where only MAL demonstrated a positive evolution at the regional level, and the continent still had a negative evolution (INE, 2021). Following the thematic of waste, in SDG 12 (Responsible Consumption and Production) there is an indicator regarding the proportion of municipal waste prepared for reuse and recycling, which has been performing positively towards the desired target, where the goal is 55% by 2025 and in 2019 Portugal reached 41% (INE, 2021). A final SDG that is worth noting, given the importance that it has to Planbelas business model, is SDG 7 (Affordable and Clean Energy), more specifically the indicator of the share of renewable energy in gross final energy consumption, which has been advancing in a positive direction towards the desired goals (INE, 2021).

Looking at the Portuguese real estate market, Moody's predicted that in 2020 it would increase 4% in value (Appendix 2), which means that, despite the pandemic, the market was not negatively impacted (ECO News, 2019). In fact, when analysing INE's statistics on the housing price index, it is possible to observe an upward trend (Appendix 3). This can result in a confidence in investors to invest in Portugal and the fact that the pandemic demonstrated a resilience in the Portuguese real estate market, they will feel confident in doing so. Regarding the demand side, meaning people that are looking to buy a house in Belas Clube de Campo, the price of the available housing needs to be considered, as well as their purchasing power. Focusing on the purchasing power at a national and regional level, all regions apart from the MAL, decreased their purchasing power (Appendix 4). Even MAL with an index of 124.68 is still significantly lower than the evolution of the housing prices. This might translate to the fact that not everyone, perhaps only middle to upper class population, will be able to purchase a house of their own. This case may be even more apparent for the people that want to purchase a Belas house, as a brand new T1 apartment is around 445,000 € and an apartment with 2 bedrooms is worth roughly 660,000 € (Belas Clube de Campo, 2022).

Legal

The Portuguese Government Plan "Reativar o turismo | Construir o Futuro" is an action plan for the public, private and tourism sectors, that pretends to stimulate the Portuguese economy and increase revenues coming from the touristic activities by increasing sustainability measures.

Regarding golf courses, it is intended that water efficiency is improved up to 90% until 2027. In addition, the Portuguese Government released the second edition of the "Programa Edifícios Mais Sustentáveis" program with a budget of 30M that aims to make significant changes in the Portuguese territory habitations to reduce at least 30% of primary energy consumption.

Technological

The technological factor not only relieves people from time consuming jobs to keep their focus in more analytical and needed roles as it ends up improving productivity.

As it's known by the public, golf fields maintenance is regularly required to maintain the complex's high standards and quality. To ensure these factors, BCC made a million euros investment on sustainable technology to use in green spaces. In addition to lawn mowers, sprayers, and leaf vacuums, Greentoro was the main attraction. The main objective was to reduce the ecological footprint by reducing environmental noise and using machines with reduced fuel consumption and a greater safety. (Ambiente Magazine, 2020). Furthermore, Belas Clube de Campo was the first residential community to have an electric vehicle from the first nationwide smart changing network - MOBI.E- the Nissan Evalia, with the purpose of driving the Academy's golf players to tournaments. Moreover, it provides an electric vehicle charging location (Publituris, 2019). Additionally, the estates located in Belas Clube de Campo have implemented solutions that intend to save, storage and reuse energy. From the housing design concept to the use of materials like rocks from on-site excavations, these houses produce their own electricity by solar panels, and the energy that is not able to keep in storage, is shared among other necessities. Solar panels are also used to heat the serpentine water under the radiant floors. Heat pumps, electric appliances, double taps on the kitchen sink and an interior laundry room are other examples of outstanding attention to detail. Moreover, BCC' houses are climate change-proof and uses geothermal energy in several buildings within the complex.

"*Planbelas is a pioneer both in investing in solar energy production and selling it to the grid (2009)"* (Belas Clube de Campo, 2019).

Regarding water efficiency, Belas Clube de Campo was the first entity to receive an AQUA+ award, water efficiency index for buildings, by the Portuguese energy agency, ADENE. The technology used to install and use equipment with flow reducers, double flush, the ability to have recycled water supply and an automatic irrigation system, were among the convincing factors. Concerning waste management and control, residents play an active role in trash separation such as batteries, lamps, cooking oils, among others. The company in charge to collect waste uses an equipment that allows to select and collect it properly. Water consumption control uses an effective management in which the complex lakes are connected to the golf course watering - whose quality is measured regularly to improve its optimization.

3.2.Inductive Reasoning - The How of the Question

Since foreigners play a huge role in the Portuguese real estate market, due to sustainable behaviours population has been consciously adapting, and the high quality and green advantages BCC ensures compared to its competitors, it was acknowledged the possibility of profiting in the new dwellings. Having this in mind, and continuing with the issue tree analysis, the hypothesis (Appendix 5) to be tested under the LCA methodology are the following:

H0: Should Planbelas use Cork as an insulation material?

H1: Should Planbelas replace the use of EPS with another material?

Before presenting the individual hypothesis testing, it is essential to recall that Belas Clube de Campo, offers an ETICS with EPS as an insulator from the supplier Neuce.

3.2.1. Life Cycle Assessment of Insulation Materials

Introduction

The proliferation of climate change concerns affected human actions on what regards global energy consumption and the use of sustainable materials. Responsible for 36% of European greenhouse gas (GHG) emissions and 40% of total energy consumption, the construction industry fights daily for best practices purpose, aiming to reduce up to 55% GHG emissions until 2030, through energy and resource efficiency (European Commission, 2020). This target can only be achieved if a holistic approach is taken, considering all aspects of improvement inside and outside buildings, and which materials to adopt. Constant improvements in this sector not only contribute to the stabilization on annual temperatures increase as to better-living conditions. In 2019, 6.9% of the EU population couldn't keep their houses warm, spending almost half of their income on housing expenses (Eurostat, 2021). In the same year, GHG emissions per capita were 669.3 kg/ton, compared to the 921kg /ton in 2016 (Eurostat, 2019), an improvement worth being highlighted.

LCA of insulation materials

A Life-Cycle Assessment is a methodology that aims to evaluate insulation materials' impact on the environment and people's lives from extraction to its installation. Insulation materials can be organic (EPS, XPS, Cork, Hemp), inorganic (MW) or combined, nevertheless, each has a designated range of density and other characteristics to which ensure a low thermal conductivity. Literature findings prove that light-weighted materials like EPS, XPS, and Hemp have an average density range of 15 - 35Kg/m^3, 25 - 45Kg/m^3, and 20 - 68Kg/m^3 ensuring respectively, a thermal conductivity of 0.035-0.04 W/mK, 0.03-0.04 W/mK, and 0.04-0.05 W/mK (Hung Anh & Pásztory, 2021). The same source ensures that denser materials like Cork or Mineral Wool (rock

wool more specifically), weighing 110 -170 Kg/m3 and 30 - 180 Kg/m3, provide a thermal conductivity of 0.037-0.05 W/mK and 0.03-0.045 W/mK respectively.

Goal and Scope of Study

Following ISO 14044 standards, a LCA follows 4 critical steps: scope and goal of the study, Life Cycle Inventory (LCI), environmental assessment impact, and interpretation of results, that will be in this case, presented in chapter six, in discussion. The study's main purpose is to provide a valuable supported decision on which insulation material is more environmentally conscious and economically relevant to apply on an ETICS in BCC. Due to LCA's flexibility, a single methodology procedure does not exist, allowing the study to be subjective and personalized.

The environmental declared unit is $1m^2$, however, Sofalca's ICB values were from a $1m^3$ and therefore, to convert to m^2, it will be achieved through the formula (CEIFA ambiente, Lda, 2015).

$$\text{impact of m3} * (\frac{Thickness\ of\ material\ in\ cm}{100})$$

Equation I - environmental impact of $1m^2$ of ICB

The first step of this assessment was to find suppliers for the materials, that would be either Portuguese or foreigner but with a factory in Portuguese territory, so the distance from BCC wouldn't be far from 100km. Except for Hemp and one of MW's supplier (RockWool) all suppliers are Portuguese or Spanish with a plant in Portugal. In "Physical and Thermal Characteristics" and "Economic" table, the first row underlined in blue, is BCC material's characterization, and information was collected from the technical data sheets from the materials from each supplier. Regarding environmental impact indicators from EN 15804[8], this was gathered from the material's EPD - Environmental Product Document, an international document that communicates transparently the environmental influence of materials during their life cycle.

[8] European standard for the sustainability of construction works and services

Non-Environmental Characteristics

Table I - Physical and Thermal Characteristics

		Physical and Thermal Characteristics				
		Density	Thermal Conductivity	Fire Resistance (EN 13501-1)	Water Absorption (EN 1609)	Resistance to Water Vapour Diffusion (EN 12086)
Material	**Producers**					
EPS	Neuce	21 ± 1	0.036	E	0.04 ± 0.01	39 ± 3
	Weber	19 ± 1	0.036	E	0.07 ± 0.01	
XPS	Fibran	30-33	0.033	E		≥50
	Danosa	32	0.034	E		≥80
Cork	SOFALCA	100-120	0.04	E		7 - 14
	Weber	110	0.04	E	<0.5	
Mineral Wool	RockWool	120	0.035	A1	<1	1
	Weber	110	0.036	A1	<0.5	≤2
Hemp	KOBE-cz	35	0.04	D	1.51	2.294
	HempBuild	35.5	0.04	D		<1.5

Sources: (LNEC, 2017)**,** (LNEC, 2018)**,** (The International EPD System, 2016) (The International EPD System, 2020)**,** (ISOCOR)**,** (DAPHabitat System, 2016)**,** (ROCKWOOL, 2017)**,** (Saint-Gobain Portugal, 2021)**,** (The International EPD® System, 2020)**,** (HempBuild, s.d.)

Insulators contribute to buildings' energy efficiency, control of CO_2 infrastructure emissions, housing comfort, and health issues. The main characteristic of a good insulator is thermal conductivity, equal to or lower to 0.05W/mK. This indicator, defined by k, and expressed by watts-per-meter per kelvin (W/m/K), represents the ability of a material to conduct heat. The lower the thermal conductivity, the less energy is transferred - consequently, and the better is the material. Thermal conductivity is not only reliant on density as factors like outside temperature and materials' age influence the overall performance (Hung Anh & Pásztory, 2021) (Domínguez-Munoz, Anderson, Cejudo-López, & Carrillo-Andrés , 2010). Regardless of that, it is known that the higher the density, the lower is the k. XPS stood out, thermal-performance wise.

The Euroclass system (EN 13501-1) classifies materials regarding their behaviour to fire into 7 classes (A1&A2, B, C, D, E, and F). A classification of A1 and A2 is given to non-combustible materials -that do not contribute to fire development - while others are given to materials that contribute to a fire, and a classification of E is given to those that besides being combustible, only resist to a small flame (AD International, s.d.). Analysing the results, MW presents better fire resistance performance.

Water Absorption (Wp) classification (EN 1609)[9], measured in kg/m^2, is one of the main problems that cause insulators degradation. The higher the water absorption per square meter, the

[9] Thermal insulating products for building applications - Determination of short-term water absorption by partial immersion

higher the material's vulnerability to water infiltration, and therefore, a worse thermal conductivity performance - due to water's heat transfer ability (Nicolella & Landolf, 2022). The four material's values do not differ significantly.

Water Vapour Diffusion Resistance (μ-value) pronounced "mu-value", (EN 12086)[10], measures the resistance level of a material to let water vapour pass through, which means that, the higher the μ-value, the higher the resistance, the better the insulator, a characteristic of XPS.

Table II - Economic Characteristics

		Economic Characteristics		
		Cost	Distance from BCC	Durability
Material	**Producers**			
EPS	Neuce	41,51€/etics	302km	≥25
	Weber	5,16	256km	≥25
XPS	Fibran	10,50	291km	50
	Danosa	9.92	152km	50
CORK	SOFALCA	14,00	163km	50
	Weber	29	256km	
Mineral Wool	RockWool	25,70	928km	≥55
	Weber	13,91	256km	50
Hemp	KOBE-cz		≥2500	50-75
	HempBuild	9,11	≥2500	

Sources: (SAINT-GOBAIN, 2021), (FIBRAN, 2019), (Danosa, 2022), (Sofalca, 2022), (HempBuild, s.d.)

Cost category has a unit of euros per square meter, except for Neuce's that regards ETICS price. As literature stated, XPS is considered EPS expensive version, however, cork is still seen as the premium material, possibility due to its high environmental contributions during its growth stage. Hemp was surprisingly low-priced; however, this material's plants are in Checz-Republic and the United Kingdom, and transport costs would probably not justify the means bearing in mind its performance characteristics.

Regarding suppliers' distance from BCC, Weber (Saint-Gobain), Danosa and Sofalca are the Portuguese (or foreign) suppliers with a production site closer to BCC. Concerning durability factor, these materials ensure at least a 25year performance, however, the average duration of materials is 50years.

[10] Thermal insulating products for building applications - Determination of water vapour transmission properties

Life Cycle Inventory (LCI)

To present the environmental impact of each material, it is necessary to understand which phases of the life cycle are at stake. These are A1-A3 (extraction of raw-material, transport to factory and processing), A4 (transport to client), and A5 (installation) (Appendix 6).

After taking a look to the graphics presented, it will be noticed that phases A4 and A5 are the ones with a lower environmental impact on the mentioned categories.

Environmental Impact Analysis

Table III - Environmental Impact Categories 1

		Environmental impact							
		Global Warming Potential (GWP)				Ozone layer Depletion (ODP)			
Material	**Source**	A1-A3	A4	A5	Total	A1-A3	A4	A5	Total
EPS	EUMEPS	1.69E+00	3.00E-02	3.00E-02	1.75E+00	1.07E-10	1.48E-13	8.17E-14	1.07E-10
XPS	Fibran	3.86E+00	7.61E-02	3.48E-02	3.97E+00	7.15E-08	1.74E-08	1.63E-09	9.05E-08
	Danosa	2.57E+00	2.59E-02	1.30E-01	2.73E+00	8.52E-08	4.96E-09	4.56E-09	9.47E-08
CORK	SOFALCA	1.30E+01			1.30E+01	1.89E-06			1.89E-06
	Weber	(-6.10E-01)	5.74E-02	3.51E+00	3.57E+00	5.52E+07	8.56E-09	1.99E-07	5.52E+07
Mineral Wool	RockWool	1.22E+00	3.24E-01	1.55E-01	1.70E+00	1.43E-09	5.37E-17	1.83E-10	1.61E-09
	Weber	1.30E+00	5.00E-02	7.00E-02	1.42E+00	1.15E-07	3.65E-08	7.50E-09	1.59E-07
Hemp	KOBE-cz	2.18E+00			2.18E+00	8.55E-10			8.55E-10
	HempBuild								

Sources: (DAPHabitat System, 2015)**,** (DAPHabitat System, 2016)**,** (The International EPD System, 2016)**,** (EUMEPS – European Association of EPS, 2017)**,** (Werner, 2019)**,** (Bermejo & Díez, 2015)**,** (The International EPD® System, 2020)**,** (pwc, 2011)

Global Warming Potential (GWP) is an indicator that analysis several gases capacity, comparing to CO_2, to emit in a ton of gas, heat to the atmosphere in a determined space of time (approximately 100years). This means that, the higher the GWP, the more heat per tonne stays in the atmosphere, and faster climate changes (United States Environmental Protection Agency, 2021). On the overall, EPS presented a total GWP lower than any other material, playing a less injuring role on the environment, however, during the growth stage of each product (inserted in A1-A3 phase) it was cork (a plant derived material) that stood out, as this material is known for contributing to CO_2 capture. Due to lack of sources from EPS suppliers, the environmental impact was gleaned from EUMPS - Association of European Manufacturers of Expanded polystyrene. Phase A4 is the less injuring to climate change, showing lower levels of GWP.

Ozone layer Depletion (ODP) is the ratio that denotes the damage a gas produces in the ozone comparing to CFC-11 (trichlorofluoromethane), valued at 1 (Kingspan Group, 2016). A lower value translates in an environment friendlier material. EPS presented less damaging impact to the ozone.

Table IV - Environmental Impact Categories 2

		Environmental impact							
		Acidification of soil and water (AP)				Eutrophication Potential (EP)			
Material	**Source**	A1-A3	A4	A5	Total	A1-A3	A4	A5	Total
EPS	EUMEPS	4.28E-03	8.46E-05	2.60E-06	4.37E-03	3.96E-04	1.98E-05	5.47E-07	4.16E-04
XPS	Fibran	1.54E-02	3.81E-04	5.06E-05	1.58E-02	1.48E-03	1.58E-05	3.16E-06	1.50E-03
	Danosa	1.04E-02	1.04E-04	5.28E-04	1.10E-02	1.34E-03	2.34E-05	6.90E-05	1.43E-03
CORK	SOFALCA	1.84E-01			1.84E-01	4.88E-02			4.88E-02
	Weber	4.78E-02	1.54E-04	2.28E-02	7.08E-02	2.12E-02	3.33E-05	2.00E-03	2.32E-02
Mineral Wool	RockWool	8.46E-03	2.75E-04	2.09E-04	8.94E-03	7.79E-04	6.07E-05	3.10E-05	8.71E-04
	Weber	1.50E-02	3.15E-04	8.00E-04	1.61E-02	1.85E-03	7.50E-05	9.50E-05	2.02E-03
Hemp	KOBE-cz	4.15E-03			4.15E-03	3.90E-03			3.90E-03
	HempBuild								

Sources: (DAPHabitat System, 2015), (DAPHabitat System, 2016), (The International EPD System, 2016), (EUMEPS – European Association of EPS, 2017), (Werner, 2019), (Bermejo & Díez, 2015), (The International EPD® System, 2020), (pwc, 2011)

Acidification of soil and water, and Eutrophication potential are two similar indicators whose impact influences ecosystems, more specifically, the aquatic environment. AP measures the emissions of SO_2 (sulphur dioxide), an air pollutant chemic that can reach the ground as acid rain and be responsible for acidification, while EP analyses potential of aquatic plant growth due to excessed fertilization, measured by phosphate $(PO_4)^{3-}$ (Kim & Chae, 2016). In both indicators EPS distinguishes as the most sustainable material.

Table V - Environmental Impact Categories 3

		Environmental impact			
		Formation potential of tropospheric ozone (POCP)			
Material	**Source**	A1-A3	A4	A5	Total
EPS	EUMEPS	9.00E-03	(-2.49E-05)	2.30E-07	9.42E-03
XPS	Fibran	1.05E-02	4.14E-04	6.81E-05	1.10E-02
	Danosa	6.30E-04	4.35E-06	3.17E-05	6.66E-04
CORK	SOFALCA	4.60E-01			4.60E-01
	Weber	5.42E-03	4.68E-06	1.47E-03	6.89E-03
Mineral Wool	RockWool	5.07E-04	1.07E-06	1.52E-05	5.23E-04
	Weber	7.50E-04	7.00E-06	3.90E-05	7.96E-04
Hemp	KOBE-cz	2.16E-04			2.16E-04
	HempBuild				

Sources: (DAPHabitat System, 2015), (DAPHabitat System, 2016), (The International EPD System, 2016), (EUMEPS – European Association of EPS, 2017), (Werner, 2019), (Bermejo & Díez, 2015), (The International EPD® System, 2020), (pwc, 2011)

Formation potential of tropospheric ozone (POCP) evaluates the ability of materials to create ground level ozone, a layer prior to the ozone layer (Jenkin, Derwent, & Wallington, 2017). Mineral Wool was the material with the best overall performance, however EPS's phase A4 had a negative impact on the potential of tropospheric ozone creation.

4. METHODOLOGY

When developing a study investigation, several variables need to be considered to know which approach to follow, who/what should participate in, and what resources to use. The use of mixed research methods is very much appreciated by investigators, as it allows higher legitimacy on data information while providing answers to subjects that single methods could not answer alone (Doyle, Brady, & Byrne, 2009). In both research methods, the personas that were aimed to be targeted were foreigners with high income.

The income variable was a common factor among BCC habitants since it is a requirement to acquire an estate in Belas. The nationality variable was considered due to the client's desire to diversify BCC's culture. In addition, real estate interviews performed to specialists (Appendix 7) in this sector mentioned on Thesis Structure & Stages of Collaboration, eased on targeting nationalities.

4.1.Qualitative Approach

4.1.1. Sampling and Data Collection Method

Online Interviewees were achieved by the professor, colleagues, friends, and family recommendations. These were previously contacted to have their participation while describing the interview conditions, time expected, and the ambit scope. The time expected for interviews was of 30minutes and these were initially asked to be recorded.

9 interviews (Appendix 8) were performed, in which 3 were Americans (33.3%), 4 were French (44.4%) and 2 were Brazilians (22.2%). These took place during the months of November and December and transcripts were performed during the same months. Afterwards, a data analysis was performed using the MaxQda software. Interviews description like nationality, age and profession can be found on Appendix 8.

In-person interviews were executed in Praça do Comércio and Belém (Appendix 9), in Lisbon, due to their high density of tourists. These were approached by the group members and asked to participate in a brief interview, that in average took around 15minutes. Interviews were not recorded; however, notes were taken by one group-member while the other was interviewing. Interviews were performed during October and a transcript was written afterwards. Only 5% from performed interviews fit in the established persona.

4.1.2. Interview Script Development

The interview follows a semi-structure methodology, which consist of several written questions that are intended to be asked, while others arise as the interview progresses. The goal of the script was to understand interviewees given relevance to certain aspects while searching for an estate. The interview starts with introductory questions to gather personal information - socio-demographic questions - followed by questions on new markets, sustainable measures, new services, and communication channels topics. In the appendix, only socio-demographic and sustainability related questions are presented.

4.2.Quantitative Approach

4.2.1. Sampling and Data Collection Method

On the quantitative approach, a survey- Appendix 10- took place, in where each respondent answered to the questions anonymously. The main goal of the quantitative approach was to prove the hypothesis that the qualitative approach and previous studies allowed to do. The questions presented were of 3 types: multiple choice, rating on a scale from 1 to 5 (Likert scale) and ranking by level of importance.

Before releasing the official survey, this one was requested feedback to a family of BCC, to understand the relevance on the overall questions. A few changes were made in the end, with the professor approval. The survey was firstly shared, on December 9th of 2021, among friends, family, colleagues, friends of friends and after a few answers (about 100), shared on social media platforms like LinkedIn and Facebook group chats. The same was closed on February 3rd of 2022.

4.2.2 Survey Development

The survey structure follows the same as the interviews, so, firstly socio-demographic question, followed by the individual topics of research. Questions like the sex and marital status were not imposed to not discriminate the sample, and in addition, due to the low relevance these had on the final analysis - the income was the main variable to bear in mind.

5. ANALYSIS

In this section, conclusions on methodology's data acquired are presented, by MaxQda and survey analysis, with the end goal of understanding people's interests (wants and needs) in real estate searching, and how sustainability positions in their minds.

5.1.Analysis of the Qualitative Method Results

The 9 online interviews performed, a third was to young adults, 18-34years, another third to the age range 35-44, and the rest to people older than 44 years. From the sample, 5 were women (56%) and 4 were men (44%), existing therefore, a balanced between genders. Only one French was unemployed, and at least three interviewees could be from upper class as these are entitled with high professional positions like CEO, Executive Director, and Owner of a business. 6 documents were analysed, as some have the presence of two interviewees on it (Appendix 11).

5.1.1 Codes & Frequency

MaxQda codes were segmented as the following 14 categories: Socio-Economic, Demographic, Communication Channels, Sustainability, Wants, Housing Requirements, Market Insights, Services, Golf, Needs, Reason to Move to Portugal, Social Media, Sports, and Company. Sustainability was a subject discussed in five out of six documents - 83%. In a total of 257 underlined references, Market Insights was the most discussed topic with a frequency of 41, used as a bridge to connect with other topics, without the interviewer feeling the need to mention those, followed by Wants - frequency of 34.

The sustainability factor, with a frequency of 22, was proven by all ages interviewees to be a growing interest on population, "*agora, se eu procurasse uma casa agora isso era prioridade*" (Interview 6, 37y.). Regarding the willingness to pay, people seemed available, "*Yeah... Like I think, I would pay up to twenty thousand dollars to have things efficient*." (Interview 4, 57y.), however, it's a trend very dependent on people's conciseness and monetary convenience, regardless of efficiency benefits, "*if it is isolated you get efficiency and pay less for instance for your bills, so that's something she considers as well as the materials used to build the house, that are more huh I don't like "eco-friendly" but they respect more the environment*" (Interview 3, 23y.). In addition, continuous improvements on the construction sector are noticeable, "*há muitas coisas que ainda não se pode substituir, tipo o betão, o ferro, o aço, que tem que ser utilizado na construção, mas eu acho que a indústria está a encaminhar para maior sustentabilidade*" (Interview 2, 40y.).

5.2.Analysis of the Quantitative Method Results

In this research, 144 answers were obtained. The age range 18-34 represented 65% of the sampling, and Portuguese was the nationality of most respondents (94%). Working respondents - 72.2% of sampling - are divided in the followed categories: working student (13.8%), employee

(54.1%), and self-employed (4.1%). Through the OECD website, it was possible to assign an economic class to the 102 inquiries that provided salary related data. This was achieved considering the number of people in the household. As a result, data proved that 34% of the 102 are considered upper class, and therefore, are the main target of this project. Regarding housing situation 55.5% (85p.) of interviewees have bought the house they live currently in, while 9% (13p.) live in a rented house.

Concerning Sustainability questions that are of interest to interpret, when initially asked, this one was most voted as the 4th option (in six) regarding services around residential areas. Out of 144 people, 16 showed no interest towards the sustainable factor in housing, while the rest, 128 people, either showed preoccupation (108p.) or indifference on the subject (20p.). Energy saving and environmental benefits were the main stimulus to those that care about sustainability (108p.). Regarding housing conditions, (128) people equally voted on insulation and double glass as the biggest concern while buying a house, elements that are, in fact, linked. Regarding the mystery that is the willingness to pay for sustainability, BCC offers a 30% surplus on the purchasing price, however 57% of the inquires (128) showed openness to pay only a 10% extra on the initial price, 9% would pay any price, while 13% weren't open to pay at all. In a different situation, if a sustainable investment meant a monetary saving on a long-term, 37% of the respondents would be opened to pay regardless of the price asked, while only 6% wouldn't still invest.

It was concluded that what draws attention to sustainability from population are financial motives, as less people close themselves to the idea of investing in such factor.

As mentioned in chapter 2, in Literature Review, Sustainability is a concept that it is quite recent, however, more and more spoken daily. This is due to the importance given to inform younger generations to prosper in the reduction of the ecological footprint, and as these are the planet's future, and consequently, might be the generation with more information access regarding the subject. As so, it was verified that young adults, 18-34 years old, was the age range with the biggest concern to sustainability (59%). As expected, older generations, >55 years old, those harder to convince due to educational habits and scepticisms, did not have such significant weight (13%) on answering yes to the question "Regarding the sustainable characteristics of the house, is this something you plan to take into account when buying a house / when you bought it?".

6. CONCLUSION

6.1.Discussion

Summing up, and as it is mentioned in Goal and Scope of Study from the Life-Cycle Assessment, the analysis to the environmental impact, performance, and economic characteristics, always comparing to the material that BCC uses, will be presented in this chapter, as a response to the hypothesis imposed.

H0: Should Planbelas use Cork as an insulation material?

Concerning Thermal and Physic Characteristics, EPS evidenced literature, being a material with a superior performance, offering individually, a lower thermal conductivity, and a higher resistance to water vapour diffusion. Along with thermal characteristics, Cork is, at least, three times more expensive than EPS, leaving no room to second thoughts on which is economically a better choice. And finally, evaluating the environmental impact, EPS was in most categories presented with lower values, linking to a more sustainable material. However, both presented on the overall similar values, except for one specific, and probably the most important category - GWP. In A1-A3 phase, Cork presented a negative potential on global warming. This is supportable, in phase A1, by cork being a natural organic material, from the cork oak, and therefore, being responsible for CO_2 capture, while EPS is in a cubic meter unit, responsible for emitting 65-94 kg of $C0_2$ equivalent (Malanho, Veiga, & Farinha, 2021). These materials impact on a circular economy depend much on where they end up, by the end of their cycle. While Cork is a 100% recyclable and renewable material, EPS (non-renewable) is a plastic source, responsible for marine litter and ecosystem pollution. In addition, Cork contributes to ecosystems creation, while EPS is associated to its destruction.

Concluding and answering the hypothesis, yes, Planbelas should use cork as an insulation material, grounding this decision on the fact that BCC has in sustainability its differentiation factor. Recognized as a Best Practices in the real estate sector, BCC must grasp the business opportunity of increasing brand-value.

H1: Should Planbelas replace the use of EPS with another material?

Seizing the possibility of replacing EPS with another material for the exception of cork, as this was already studied, this hypothesis was focused on the performance level of materials. As energy-efficiency and comfort depend on the ETICS performance, the material with a better thermal conductivity compared to EPS was chosen, XPS. Economically, literature verify that XPS is EPS's expensive version, which was, as one can see, verified from suppliers' prices. Concerning environmental impacts, EPS was as mentioned before, the material with less injuring aptitude, but once again, never with a significant disparity comparing to others. Even if XPS does not contribute to CO_2 emissions as much as EPS, these materials impact on a CE are similar (Malanho, Veiga, & Farinha, 2021).

Wrapping up, besides presenting a better insulation performance, EPS is already a good insulator, and economic and environmental analysis do not support this change as XPS would be an expensive choice regarding the environmental impact these materials carry. Therefore, the answer to the hypothesis H1 is no, Planbelas should not replace the use of EPS with XPS.

6.2.Practical Contribution

This section of the chapter emphasis on how pursuing H0 will impact the overriding question, supported with a Profit & Loss Statement. As it was perceived from the survey analysis, buyers are more drawn to pay a 10% surplus on the initial price of a sustainable house than the 30% that BCC offers. Therefore, the choice of following this hypothesis will depend on the willingness to pay from customers, and the willingness of the client itself to invest in the sustainability element.

After acknowledging prices of an ETICS with EPS and Cork, from the supplier Weber, the main purpose is to foresee how much Belas will save or spend by adopting an ETICS with Cork. The prices, including installation, obtained (Appendix 12) were the following: ETICS w/ EPS - 37€/m^2 - and ETICS w/Cork - 50€/m^2 (+35%).

Prior to consulting BCC' engineer, it was acknowledged that in a townhouse and an apartment (T3) with a gross area of 265,98m^2 and 171,76m^2 respectively, 27.8m^2 and 38m^2 are filled with ETICS insulation respectively. After computing (Appendix 13) how much would BCC spend on each, it was possible to conclude that by using cork on ETICS, BCC would spend extra 494€ on an apartment, and 361€ on a townhouse, compared to the use of EPS, as this offers a curtailed price. Cork and EPS weight 0.29% and 0.22% of the sale price of an apartment, while on a townhouse these values reduce to 0.10% and 0.07% of the sale price respectively (Appendix 14). Such low impact on the overall sales demonstrates the duty and availability to pursue this hypothesis. However, if it is not the client's wishes to pursue this recommendation, it was noticed that Weber offers a 37€/m^2 for an ETICS insulation with EPS while BCC spends 41.51€/m^2 on townhouses and 44.84€/m^2 in apartments with the current supplier. The use of supplier Weber facing current one would offer a saving of 297.9€ in apartments and 125.3€ in townhouses.

6.3.Theory Contribution

The recommendation offered can be seen as an economic burden, but since its weight on a sales price is so reduced, it must be taken a deeper look into what really matters - the repercussions on the ecological footprint this recommendation tackles. In theory, by adopting cork as an insulation material in ETICS, the only advantage associated cannot be the fact that cork is a 100% recyclable and renewable material and EPS is not. BCC would be directly making a positive change on the real estate sphere and the entangled SDGs. The use of this sustainable material tackles SDG9 "Industry, Innovation and Infrastructure", contributing to Green Buildings development and the reduction of $C0_2$ emissions, furthermore, to the end of material waste in

ecosystems. Green Buildings contribute to economic and social benefits, while working earnestly to fight pollution and waste.

As the role of the construction industry was the focus of this study, it is important to highlight the relevance of the use of sustainable materials on every aspect of construction phase, as BCC already does. Surely it is hard to be the pioneers or the first ones to adopt innovative measures, as expensive materials do not justify demand, however, if a deeper look is not being taken, who will make a difference? The more openness to invest in sustainable materials and technology, the bigger the impact on the environment, quality of life, and recipiency to the most sceptics. The sustainable impacts of cork can tremendously prosper in a long-term situation.

6.4.Future Research

Escaping the cork scope, but still focusing on the energy-efficiency sphere, Green Roofs are a trending act in the market. Although its challenge to cope with solar panels in roofs, this would be an interesting study to contribute to higher thermal comfort and use of natural resources. Biotecture is a company that provides green walls, ensuring acoustic and thermal performance, air purification, and fire-resistance infrastructures.

Concerning EPS, it would be interesting to study how and if BCC can play a role on the end of the life cycle of this material, to what regards waste management.

Additionally, a study that can be performed is how the war between Russia and Ukraine, that impacts electricity and gas prices, will impact the construction and real estate sector. Will the Portuguese people adopt sustainable decisions to have a long-term economization? Will the ETICS market increase in Portugal? Will the adoption of this system back up electricity prices? And additionally, will Ukrainians be the new foreigners to invest in the Portuguese real estate market? How is segmented their purchasing power?

6.5.Limitations

One major limitation to this study were the quantitative and qualitative methods. As the personas design was upper class foreigners and being students without access to such diversity, it was hard to reach the number of responses with such description in the survey, which made answers biased. In addition, to glean several people with such characteristics for interviews, whose ideal number was not achieved, was also a long-taking process and of insistence from the group member's part.

Having an academic path focused on management, and without any previous engineering background, it was also a challenge to play a critical role analysing insulation materials. However, this was accepted with an open mind and willingness to learn, always focusing decisions on a pragmatic and analytical approach based on data. Furthermore, the lack of knowledge regarding the real estate market played a significant role during the initial phase of the project.

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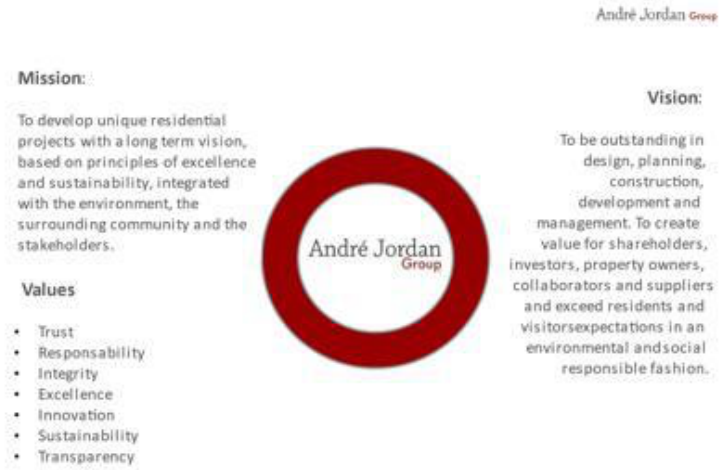
APPENDIX

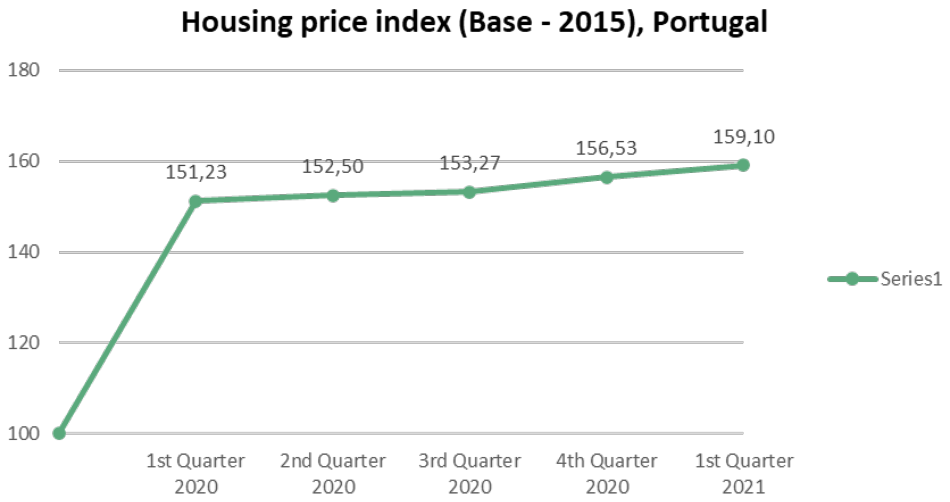
Appendix 1 - André Jordan Group's Mission, Vision and Values[11]



Appendix 2 - Prediction of Real Estate values for 2020

Source: (ECO News, 2019)

Appendix 3 - Housing Prices Index



Source: (Instituto Nacional de Estatística, 2021)

[11] Source: Email from the Client

Appendix 4 - Purchasing Power per Capita

Purchasing Power per Capita (Base – 2015)	
Geographical Location	**Year - 2019**
Portugal	100
Norte	92,09
Centro	88,75
A.M Lisboa	124,68
Alentejo	91,04
Algarve	95,17

Source: (Instituto Nacional de Estatística, 2020)

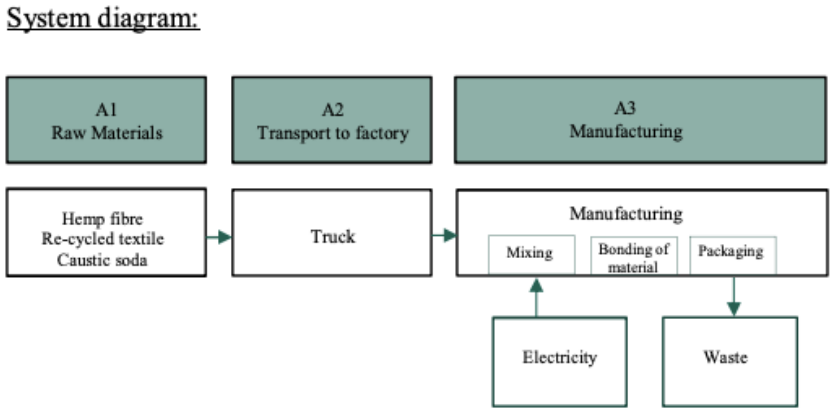
Appendix 5 - Hypothesis and Sub Issue Creation

Table VI - Hypothesis and Sub Issue Creation

ISSUE	SUB ISSUE	HYPOTHESIS	ANALYSIS
Products	Should Planbelas use cork as an insulation material?	Yes. Besides being a 100% natural product cork is one of the most sustainable materials to be used in construction and other applications	- Interviews to experts - Theory research - Life-Cycle Assessment
	Should Planbelas replace EPS with another material?	Yes. Although the European insulation market is controlled by materials like EPS, XPS and Mineral Wool, it is believed that this material can be replaced by some with better characteristics	

Source: The Author

Appendix 6 - Insulation Materials Life Cycle



Source: (The International EPD® System, 2020)

2.1.1. Flow diagram of input and output of the processes

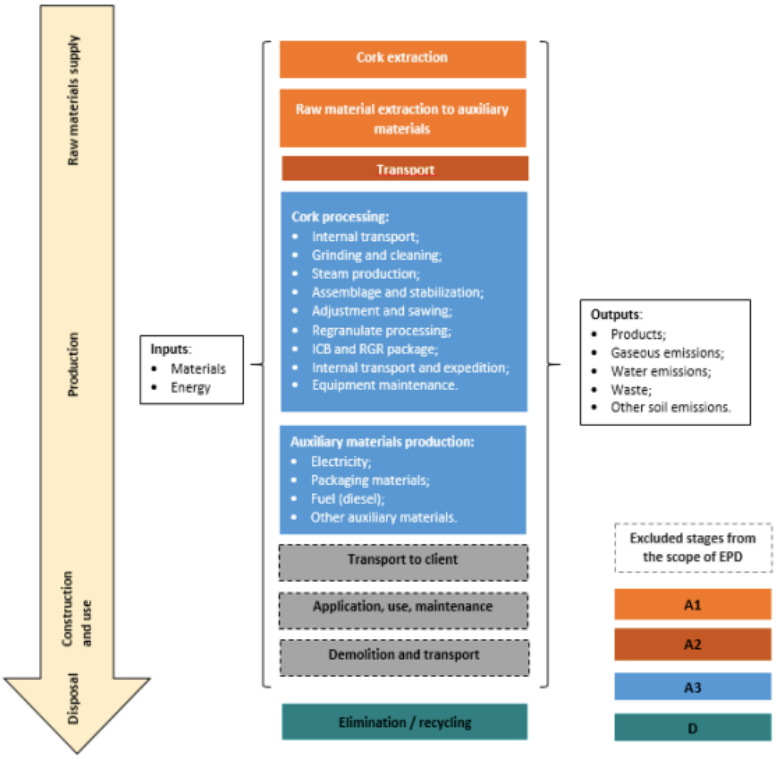


Figure 1. Life cycle stages and unit processes of the product

Source: (DAPHabitat System, 2015)

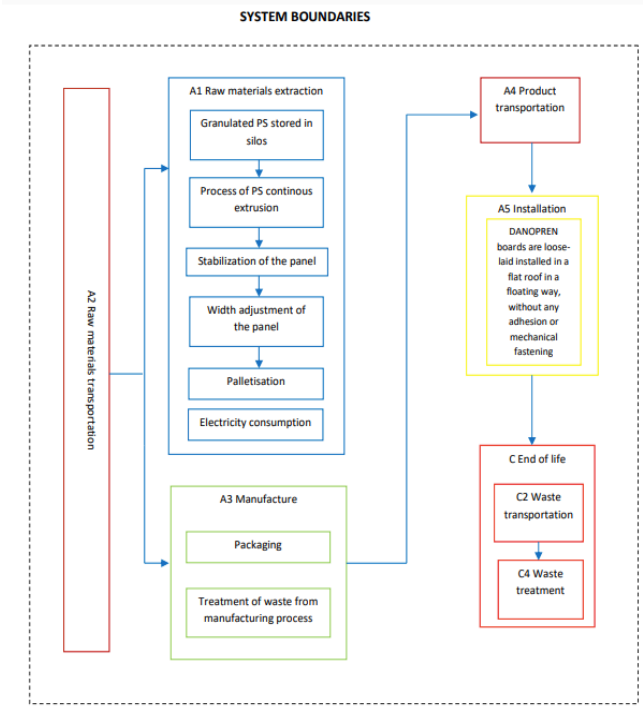


Figure 3 System boundaries and description of the significant processes

Source: (The International EPD System, 2016)

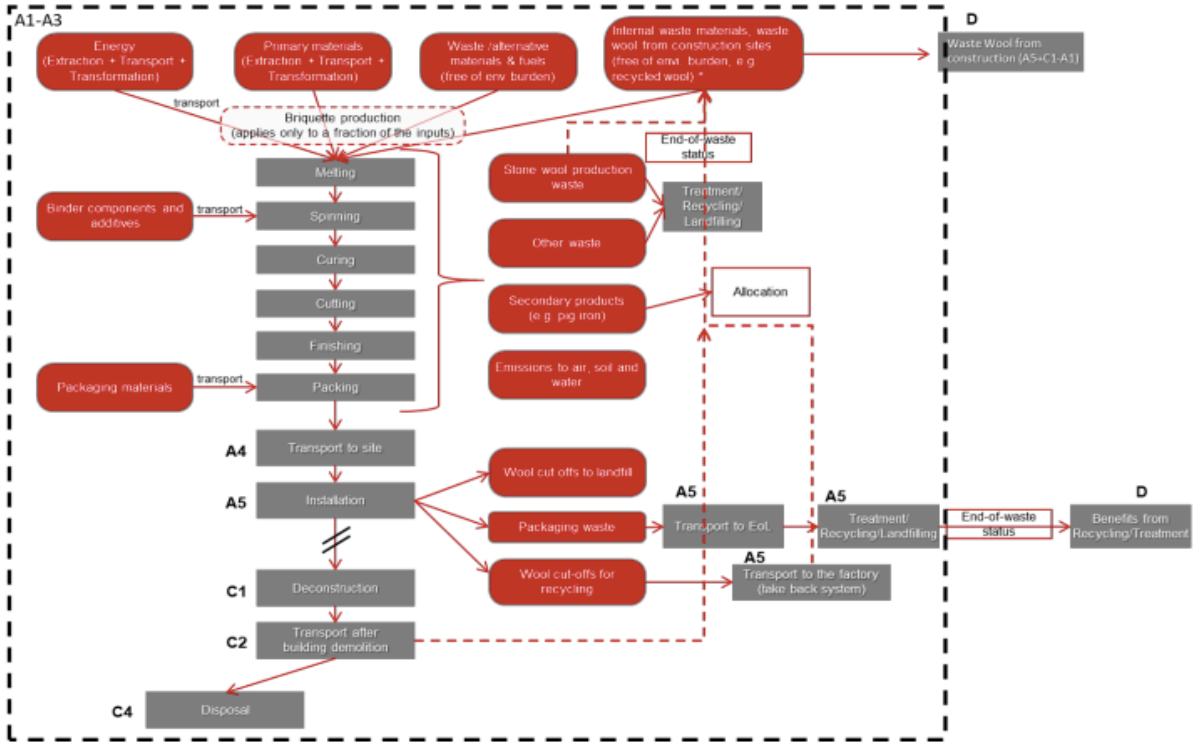
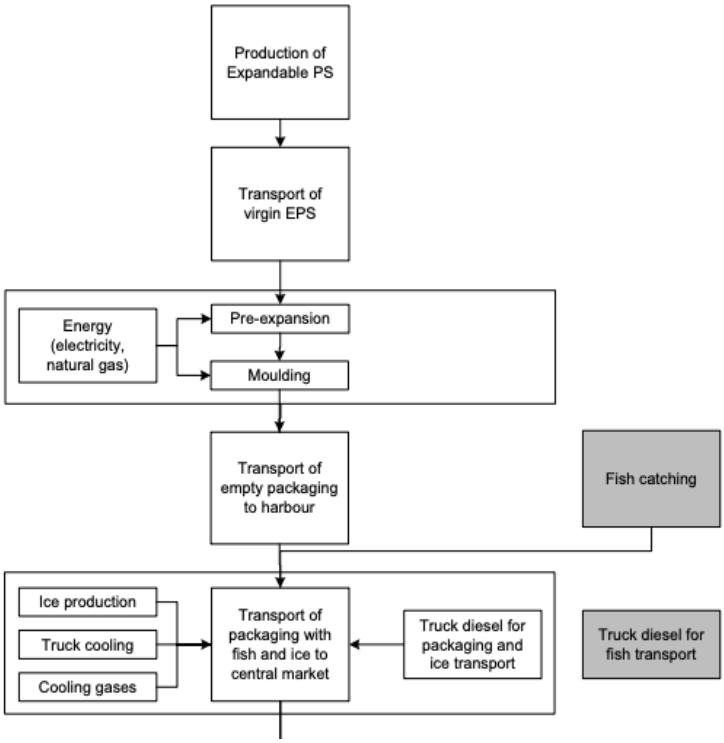


Figure 1: System boundaries for ROCKWOOL production system

Source: (Werner, 2019)



Source: (EUMEPS – European Association of EPS, 2017)

Appendix 7 - Real Estate Research Interview

Somos alunos de mestrado em gestão do ISEG e estamos a realizar um projeto de consultoria com um cliente do setor do imobiliário residencial, com a Professora Constança Casquinho como coordenadora.

Com esta entrevista à/ao ___ pretendemos adquirir mais conhecimento acerca deste setor, com insights sobre certos mercados estrangeiros em Portugal, o papel e a importância da sustentabilidade, a relevância de serviços/amenities nas áreas residenciais, e canais de promoção. A entrevista tem uma duração esperada de 1h.

Sustentabilidade

- Tendo em conta os mercados mencionados antes, quais os principais fatores que têm em conta na decisão de comprar casa?
- Existe uma preocupação pela sustentabilidade? Ou, em que áreas já se nota uma maior preocupação (energia, água, isolamento, infraestrutura)?
- Estes mercados estão dispostos a pagar pela sustentabilidade? Qual é o premium?
- Qual é a situação da oferta de residências com maior foco na sustentabilidade em Portugal, e mais especificamente Lisboa?

Appendix 8 - In-depth Interviews Script

Semi-structured interview – Temos diversas perguntas para chegar a temas de interesse, mas não é obrigatória a sua utilização

Questões Gerais

- Pode falar-nos um pouco sobre si? Idade? Profissão (quantos anos de experiência na mesma)?
- Onde compra/vende imóveis?
    a. Agências imobiliárias
    b. Vendo online
    c. Através de conhecidos
    d. Outro
- Considera que se encaixa em que classe societária? Média ou alta?
- Tem habitação própria? Com que idade começou a pensar obtê-la?
- Onde reside?
- Tem preferência em viver em locais urbanos ou rurais?

Sustainable Measures

- Quais os principais fatores que tem em conta quando vai comprar casa?
- Tendo em conta a qualidade das casas portuguesas, acha que devia haver melhor revestimento? (vidros duplos, maior espessura das paredes, menos entradas de ar)
- Estaria disposto a pagar mais por uma casa com medidas sustentáveis? Quanto seria esse premium?
- Considera a existência de um dos seguintes espaços importantes? (escritório/jardim/quarto de empregada)
- Qual a área em que sente que as casas precisam de melhorar? (energia, água, isolamento, infraestrutura)
- Há alguma zona no distrito de Lisboa que considere mais Family-friendly em termos sustentáveis? (Green zone)
- Qual a importância dada a sustentabilidade (ex: fatores de conservação e poupança de energia/ responsabilidade social)?

Appendix 9 - Socio-Demographic Characteristics of In-person Interviews

Table VII - Socio-demographic Characterization of in-person interviews sample

Interview Number	Nationality	Age	Profession	Economic Class
1	Dutch	18-34	Student	Low
2	French	45-54	N/A	Medium
3	Dutch	45-54	N/A	Medium
4	Brazilian	35-44	N/A	Medium
5	American	>55	N/A	Medium
6	Dutch	45-54	N/A	Medium
7	Dutch	18-34	N/A	Medium
8	French	45-54	IT Consulting	Medium
9	Romanian	35-44	N/A	Medium
10	British	45-54	N/A	Medium
11	Spanish	35-44	N/A	Medium
12	Spanish	18-34	N/A	Medium
13	Spanish	18-34	N/A	Medium
14	Mexican	45-54	N/A	Medium
15	Brazilian	35-44	Physician & Lawyer	Medium-High / High
16	Brazilian	18-34	N/A	Medium
17	British	18-34	N/A	Medium
18	Brazilian	>55	N/A	Medium
19	Brazilian	>55	N/A	Medium
20	Brazilian	45-54	N/A	Medium

Appendix 10 - Survey

The following study aims to discover points of interest in the real estate market of Portuguese and Foreign individuals.

This questionnaire was carried out as part of a consultancy project as a final Master's work for the Master's Degree in Management in Instituto Superior de Economia e Gestão (ISEG), University of Lisbon.

The data obtained in this study is anonymous and confidential, so we ask for complete honesty in answering the questions. Thank you!

Expected duration: 4min.

(This appendix will only show the English version, as the Portuguese is the same)

Q1. Would you rather answer this form in English or Portuguese/ Prefere responder a este questionário em Inglês ou Português?

- ❍ Portuguese
- ❍ English

Socio-Demographic Questions

Q2. What is your nationality?

- ❍ English
- ❍ French
- ❍ Brazilian
- ❍ American
- ❍ German
- ❍ Spanish
- ❍ Chinese
- ❍ Portuguese
- ❍ Other

Q3. What is your age?

- ❍ <18
- ❍ 18-34
- ❍ 35-44
- ❍ 45-54
- ❍ >54

Q4. Indicate your professional status:

- ❍ Student
- ❍ Working Student
- ❍ Employee
- ❍ Self-employed
- ❍ Retired
- ❍ Other

Q5. In which country(ies) do you have a house(s)?

- ❍ Portugal
- ❍ UK
- ❍ France
- ❍ Brazil
- ❍ USA
- ❍ Germany
- ❍ Spain
- ❍ China
- ❍ Other

Q6. What is your housing situation?

- ❍ Bought
- ❍ Rented
- ❍ Both options
- ❍ I live with family/friends
- ❍ Other

Q7. From 1 to 5, how do you classify Lisbon as a place to live?

o 1	2	3	4	5

Q8. Which factors do you value the most in Lisbon as a place to live?

	1st Option	2nd Option	3rd Option	4th Option	5th Option	6th Option	7th Option
Architecture	❍	❍	❍	❍	❍	❍	❍
Habitations Prices	❍	❍	❍	❍	❍	❍	❍
Transport	❍	❍	❍	❍	❍	❍	❍
Weather	❍	❍	❍	❍	❍	❍	❍
Job opportunities	❍	❍	❍	❍	❍	❍	❍
Educational Institutions	❍	❍	❍	❍	❍	❍	❍
Healthcare System	❍	❍	❍	❍	❍	❍	❍

Q9. How many people do you have in your household?

- ❍ 1, just me
- ❍ 2
- ❍ 3
- ❍ 4
- ❍ >= 5

Q10. What is your household's monthly income after taxes?

- ❍ <1399€
- ❍ 1400€ - 1690€
- ❍ 1691€ - 2390€
- ❍ 2391€ - 2930€
- ❍ 2931€ - 3380€
- ❍ 3381€ - 3780€
- ❍ >=3780€
- ❍ I rather not answer

Sustainability Questions

In this survey, Sustainability is seen as the ability of the construction and real estate sectors to positively impact on a circular economy. With this, we associate sustainable aspects to the use of solar and geothermal energy, solar panels, solar collectors, thermic sheets, preservation of green spaces, collection of waste...

Q19. Regarding the sustainable characteristics of the house, is this something you plan to take into account when buying a house / when you bought it?

- ❍ Yes
- ❍ No
- ❍ Doesn't matter

Q20. If your previous answer was "yes", please justify

- ❍ Energy savings
- ❍ Environmental benefits
- ❍ Increase property value
- ❍ Health reasons
- ❍ Other

Q21. What sustainable aspects do you take into account when thinking about buying a property?

- Isolation
- Solar panels
- Use of thermal energy
- Double glasses
- Use of renewable materials
- None
- Other

Q22. Typically, sustainable homes are more expensive. Would you be willing to pay more for these?

- Yes, if it represented a 10% increase in the purchase price
- Yes, if it represented a 20% increase in the purchase price
- Yes, if it represented a 30% increase in the purchase price
- Yes, if it represented a 40% increase in the purchase price
- Yes, regardless of price
- No

Q23. Typically, sustainable homes are more expensive. Would you be willing to pay more for these if it represented a long-term saving?

- Yes, if it represented, at least, a saving of 500€/year
- Yes, if it represented, a saving of 500€/year max
- Yes, regardless of the saving
- No

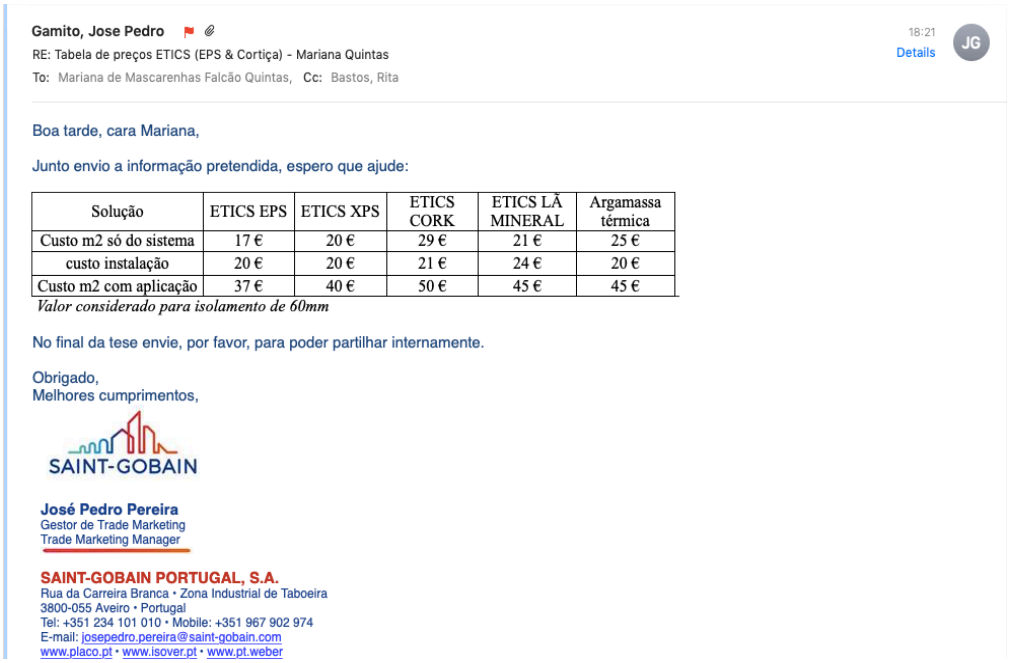
Appendix 11 - Socio-Demographic Characteristics of Online Interviews

Table VIII - Social-demographic characterization of online interviews sample

Interview Number	Nationality	Age	Profession
1	American	~50	Executive Director of IEEE
2	American	35-44	Art Gallery Owner
3	American	55-64	CEO of a Medical Group
4	French	18-34	Masters Student
5	French	45-54	Unemployed
6	French	18-34	Chief Project Manager
7	French	18-34	Logistic Manager
8	Brazilian	35-44	Quantic Biofeedback Therapist
9	Brazilian	35-44	Real Estate Agent

Appendix 12 - ETICS Prices from Weber

Figure I - ETICS Prices from Weber (Saint-Gobain)



Gamito, Jose Pedro 18:21 Details JG

RE: Tabela de preços ETICS (EPS & Cortiça) - Mariana Quintas

To: Mariana de Mascarenhas Falcão Quintas, Cc: Bastos, Rita

Boa tarde, cara Mariana,

Junto envio a informação pretendida, espero que ajude:

Solução	ETICS EPS	ETICS XPS	ETICS CORK	ETICS LÃ MINERAL	Argamassa térmica
Custo m2 só do sistema	17 €	20 €	29 €	21 €	25 €
custo instalação	20 €	20 €	21 €	24 €	20 €
Custo m2 com aplicação	37 €	40 €	50 €	45 €	45 €

Valor considerado para isolamento de 60mm

No final da tese envie, por favor, para poder partilhar internamente.

Obrigado,
Melhores cumprimentos,

SAINT-GOBAIN

José Pedro Pereira
Gestor de Trade Marketing
Trade Marketing Manager

SAINT-GOBAIN PORTUGAL, S.A.
Rua da Carreira Branca • Zona Industrial de Taboeira
3800-055 Aveiro • Portugal
Tel: +351 234 101 010 • Mobile: +351 967 902 974
E-mail: josepedro.pereira@saint-gobain.com
www.placo.pt • www.isover.pt • www.pt.weber

Appendix 13- Comparison between prices of materials in apartment and townhouse

Table IX - Prices for insulation materials for apartment and townhouse

Supplier	ETICS w/ EPS		ETICS w/Cork	
	Apartment	Townhouse	Apartment	Townhouse
Weber	1406€	1028.6€	1900€	1390€
Neuce	1703.92€	1153.98€	N.A.	N.A.

Appendix 14 - Percentage of ETICS on sale price

Table X - Impact of each material on sales prices of apartment and townhouse

Material	**Apartment**	**Townhouse**
	635 000€	1 370 000€
EPS	0.22%	0.07%
Cork	0.29%	0.10%