Teixeira Duarte Real Estate - an analysis of environmental sustainability

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Abstract (English)

In industrialized economies, issues about the sustainability in the delivery of real estate projects have risen to the fore. The real estate industry has a big impact on the environment. It accounts for over 40% of energy consumption and 36% of the carbon dioxide emissions in the European Union. In this scenario, new regulations have been issued from the European Commission to force companies to disclose the percentage of their business that it can be label as environmentally sustainable. This research is dedicated to understanding where the real estate department of Teixeira Duarte stands from an environmental point of view. An archival analysis is performed to understand which will be the effort that Teixeira Duarte will need to make in to comply with the new European regulations. Furthermore. a competitor benchmark analysis is performed to understand which are the best practices that real estate companies adopt to communicate their policy to the relevant stakeholders through their sustainability reports. Lastly the data from two online surveys are analyzed and presented. One survey is directed to Teixeira Duarte real estate's employees, while the other is targeted to the Portuguese general population. This research presents a set of recommendations to Teixeira Duarte to help understand which are the best concrete actions that the company should make in order to become more environmentally sustainable.

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Abstrato (Português)

Nas economias industrializadas, as questões sobre a sustentabilidade na entrega de projectos imobiliários têm vindo a ganhar destaque. A indústria imobiliária tem um grande impacto no ambiente. É responsável por mais de 40% do consumo de energia e 36% das emissões de dióxido de carbono na União Europeia. Neste cenário, novos regulamentos foram emitidos pela Comissão Europeia para forçar as empresas a revelar a percentagem do seu negócio que pode ser rotulada como ambientalmente sustentável. Esta investigação é dedicada a compreender onde se situa o departamento imobiliário da Teixeira Duarte de um ponto de vista ambiental. É realizada uma análise de arquivo para compreender qual será o esforço que a Teixeira Duarte terá de fazer a fim de cumprir a nova regulamentação europeia. Além disso, é realizada uma análise de referência concorrente para compreender quais são as melhores práticas que as empresas imobiliárias adoptam para comunicar a sua política aos interessados relevantes através dos seus relatórios de sustentabilidade. Finalmente, são analisados e apresentados os dados de dois inquéritos em linha. Um inquérito é dirigido aos empregados da imobiliária Teixeira Duarte, enquanto que o outro é dirigido à população portuguesa em geral. Esta pesquisa apresenta um conjunto de recomendações à Teixeira Duarte para ajudar a compreender quais acções concretas que a empresa deve empreender para se tornar mais sustentável.

Palavras-chave: Indústria imobiliária, sustentabilidade ambiental, regulamentos europeus, edifícios sustentáveis, vontade dos consumidores de pagar.

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Sustainable Development Goal	SDG
Nearly Zero Energy Building	NZEB
Triple Bottom Line	TBL
Willingness to Pay	WTP
Energy Performance of Buildings Directive	EPBD

1. Introduction

1.1 Problem statement and research questions

Teixeira Duarte, which was founded in 1921, by Ricardo Esquível Teixeira Duarte, is currently the leader of one of the major Portuguese business groups. Teixeira Duarte operates in 22 countries on 4 continents and employs over 9,600 people (Teixeira Duarte annual report). Its core business is construction, but during the years it also expanded into real estate, hotel services, distribution, concessions and services, automotive, and energy. The company's experience and reputation, along with a diversification and internationalization plan, helped to not only survive but also thrive in the recent bad environment that hit the construction industry and the global economy hard after the pandemic. The company's real estate business is where this thesis is going to be focused. Teixeira Duarte expanded its activity in this industry in the 1970s. Over the years, the Group has created a large project portfolio that until today has a total built area of over 1.000.000 sqm. In addition, the real estate team manages over 500.000 square meters of assets with strong occupancy rates and customer satisfaction, demonstrating the high quality of the services provided (Teixeira Duarte Group Report 2021). Today the real estate business accounts for 17% of the group's operating income and employees 1% of the group's employees (Teixeira Duarte Group Report 2021).

In industrialized economies, issues about the sustainability in the delivery of real estate projects have risen to the fore. The real estate industry has a big impact on the environment, social ties, and economic growth. It accounts for over 40% of energy consumption and 36% of the carbon dioxide emissions in the European Union. Furthermore, this industry accounts for roughly 9% of Europe's GDP (Dobrovolskienė et al., 2021). As a result, including sustainability in real estate is unavoidable if a good environmental impact is to be achieved. Projects are frequently chosen solely based on financial indicators, and there are only a few indexes and methodologies for determining a project's long-term impact on the environment. As a result, there is a lack of understanding and expertise in the methods that are presently available to assess the sustainability of a real estate project (Dobrovolskienė et al., 2021).

Moreover, in the last years, the European Commission is putting member states and real estate companies under pressure to achieve what are defined as Nearly Zero-Energy Buildings (NZEB). From 2021 onwards, all new buildings (public buildings from 2019 onwards) should be almost zero-energy structures. According to the Energy Performance of Buildings Directive "a NZEB refers to a very high energy performance structure. The almost zero or extremely low

energy requirements should be met to a large extent by renewable sources, including those generated on-site or locally" (D'Agostino & Livio, 2019). Because the EPBD does not define concrete numeric thresholds or ranges, these requirements leave a lot of room for personal interpretation, allowing the Member States to create their nearly zero-energy buildings definition in a very flexible manner, taking into account their primary energy factors, country's climate conditions, and building traditions. Furthermore, from 2022 on companies will have to disclose in their report the percentage of their business that can be considered sustainable according to the criteria contained in the REGULATION (EU) 2021/2139 that will be analyzed later in detail.

In this scenario, Teixeira Duarte is facing a relevant problem. Normally sustainability issued only occupied a marginal spot in Teixeira Duarte real estate strategy. In the past, almost nothing has been done to either assess how sustainable the operations of the group are or how to leverage their environmental impact. The first sustainability report published by the company is dated 2021. The content of this report does not give any valuable information regarding the policy that Teixeira intends to use to face environmental problems. Most of the content of the report is occupied by an extensive description of the employees of the group, including information and statistics on every relevant topic related to them. But there is almost no mention of CO_2 emission, energy consumption, water usage, waste, recycling policy, and in general how Teixeira Duarte intends to reduce its environmental impact. The main goal of this dissertation is to understand where Teixeira Duarte's Real Estate department stands from an environmental sustainability point of view and to come up with a set of recommendations to help the company to comply with the new European regulations and improve the sustainability of its operations. To achieve this goal, four main research questions have been formulated and will be investigated through this research:

1. What is the European Commission demanding from real estate companies in order to be considered sustainable? What kind of information should the real estate company disclose?
2. What kind of pieces of information are the competitors, that are considered the most sustainable in the industry, are disclosing in their report? Which are the best practices in the real estate industry to assess sustainability?
3. What is the Teixeira Duarte employee's awareness about the sustainability of the company and its operations?

4. What is the general population awareness towards the sustainability of the real estate industry in Portugal? And how well known is Teixeira Duarte among Portuguese population?

1.2 Dissertation outline

This dissertation is structured as follows: Chapter 2 presents an academic literature review of the sustainability theory of the Triple Bottom line, in general and applied to the real estate industry. In Chapter 3 the applied methodologies for qualitative and quantitative research and the findings are presented. The analysis is then split into three chapters. Chapter 4 will show the result of the archival analysis of the new European Regulations. Chapter 5 will show the main findings obtained with the competitors benchmark analysis within the real estate industry and chapter 6 is further split in three sections. The first one is dedicated to the analysis of the survey data obtained from Teixeira Duarte employees, the second is dedicated to the analysis of the survey data obtained from Portuguese General population, the third section is dedicated to a quantitative analysis of the willingness to pay for sustainable house by the Portuguese general population. In Chapters 7, 8, and 9 the implications, conclusion, limitations, and future research are presented.

2. Literature review

2.1 Sustainability

With regards to a firm's activity giving a specific definition of sustainability is not an easy matter. At its broad sustainability can be defined as "any action that pushes a firm's decision-making process to address current demands while not jeopardizing future generations' ability to meet their own needs" (Johnston et al., 2007). One of the first and most popular theories on sustainability it is the triple bottom line theory (TBL) created by J. Elkington. This concept was first introduced as an accounting framework in the mid 90' and entails that a business is sustainable when it lives up to the "triple bottom line" which stands for social justice, economic prosperity, and environmental quality (Elkington, 1997). According to this theory, sustainability not only foresees environmental protection and the prosperity of society but also includes economic development. This concept appears to imply that sustainability assessment allows decision-makers to make well-informed judgments while also recognizing the influence of their actions on the environment and society, culminating in the selection of the best options for long-term sustainable growth. As a result, sustainability assessment ensures "good" decisions by providing actionable instructions (Bond et al., 2012). The TBL has made a significant contribution to the integration of sustainability into the corporate agenda, pushing companies to disclose non-financial information in their reports to take into consideration their impact on the three dimensions (Milne & Gray, 2013). The TBL theory stands up two main hypotheses: the win-win hypothesis and the firm-level sustainability hypothesis. The first one asserts that an organization's financial (economic dimension) and non-financial (environment and society dimension) performance are mutually enhancing and that the overarching goal of sustainable economic development is to maximize the synergies across these two-dimension (Isil & Hernke, 2017). Social and environmental issues can enhance a company's financial performance by creating new opportunity for growth. The second hypothesis claims that sustainability can be reduced to the firm level. This implies that planetary sustainability can be achieved if every individual firm is sustainable (Isil & Hernke, 2017). The TBL theory has not been free from criticism. One critique has been directed at its usage as an accounting framework, such as the difficulty of measuring and aggregating non-financial impacts in reports, or the fact that companies can arbitrarily choose which pieces of information to disclose undermining the credibility of the firm itself. Such issues can reduce sustainability reports to illusions, a strategy to boost legitimacy in response to government regulation and public

pressure (Milne & Gray, 2013), in which companies reveal only the most basic information about each dimension without integrating it.

Another criticism upon which authors agree is that this classic definition of TBL should be enlarged by including new dimensions into the framework. The technology aspect of sustainability is one feature that is gaining more relevance in the literature. The importance of incorporating technology into sustainability can be justified in part by the fact that technology can help optimize production. Furthermore, because the efficient use of limited resources is dependent on significant technology innovation, sustainability goals should be integrated into technological development (Vogt & Weber, 2019).

2.2 The TBL in the real estate industry

The triple bottom line literature has been well-investigated across many different sectors, but the situation in the real estate industry is different. Here, the adoption of the TBL principles is rather slow and vague, due to "its decentralized nature, insufficient collaboration among contractors and suppliers, difficulties in hiring a skilled workforce, and inadequate knowledge transfer between projects, the industry is known for being slow to develop and adopt technological innovation compared to many other sectors" (Goh et al., 2020). The triple bottom line principles are realistic and connect nicely with the real estate industry's common goals of sustainability. However, the relationship between TBL and sustainable construction has yet to be thoroughly examined. Sustainable buildings have to integrate environmental, social, and economic sustainability, with no one pillar dominating the others. The environmental pillar in sustainable construction strives to restore and maintain the balance between the natural and the built environments for the duration of a structure's existence. It aims to the optimal use of natural resources in order to limit the construction impacts on the environment. The social pillar refers to community engagement, diversity, equality, health, and safety of the people involved in the project. The economic pillar refers to the financial profit generated from individual projects (Goh et al., 2020).

2.3 Sustainability assessment in real estate

Sustainability evaluation in the real estate industry is a relatively recent subject of study. In consequence, sustainability evaluation methods vary widely, and there is no single definition

or comprehensive knowledge of sustainability assessment. Sustainability evaluation approaches can be divided into four different categories:

(1) indicators;
(2) product-level sustainability assessment tools;
(3) project-level sustainability assessment tools;
(4) sectoral and national sustainability assessment tools (Dobrovolskienė et al., 2019).

With regards to real estate firms, the third and fourth categories are the most relevant due to the nature of their business. Many authors focused their study on the development of an appropriate index to assess the sustainability of the construction of a real estate project. By using this kind of index in a methodical way, real estate firms can compare projects, make optimal financial resource allocation decisions, and analyze the long-term viability and impacts of future real estate projects (Dobrovolskienė et al., 2019). For example, the index RESI (real estate sustainability index) is a multi-criteria decision-making index that takes into consideration 18 different variables, within the TBL framework, (5 technological, 3 social, 5 economic, and 5 environmental). To each of these variables, a specific weight is assigned according to their relevance to the overall sustainability of the real estate project. The weights are fixed and do not change for different projects, and they have been established thanks to the consultation with several experts in the industry. According to this index, the most important dimensions to keep under control while realizing a real estate project are CO_2 emission, health and well-being of workers, employment of innovative technologies, waste management, and use of renewable energy (Dobrovolskienė et al., 2021). The CSIP (composite sustainability index of a project) is another index formulated using multiple criteria decision-making methods. It aggregates 21 variables into a composite index. According to the CSIP, the most relevant variables are the safety and health of workers, energy consumption, water consumption, greenhouse gas emission, use of materials with low health risk, and use of renewable energy (Dobrovolskienė et al., 2019). The development of an appropriate index to evaluate project sustainability is not enough to ensure sustainability, that's why the fourth category is important. Governments and institutions should contribute to the realization of a legal and harmonized framework to facilitate the achievement of sustainability in real estate (Goh et al., 2020).

2.4 How sustainability can create value for companies

In recent decades, a significant trend in corporate sustainability has emerged as a result of both social expectations and governmental pressure (Xie et al., 2019). Nowadays company's sustainability reports follow the ESG framework. E stands for environmental, S stands for social and G stands for governance. The principles of the triple bottom line are contained and reflected in the ESG framework that is used as an accountant reference point. Disclosing a sustainability report can help firms to create values in five different ways.

2.4.1 Topline Grower

A solid ESG proposition helps firms to penetrate into new markets and strengthen their position in the existing ones. When governments have trust in companies, they are more inclined to grant them access, permissions, and licenses that open up new growth opportunities (Henisz et al., 2019). ESG can also drive consumer preference, studies demonstrate that 70% of consumers in industries like automotive, real estate, electronics, and packaging categories are willing to pay up to 5% more for a sustainable product if it has the same performance as a non-sustainable alternative (Henisz et al., 2019). Another research conducted in Milan shows that consumers are willing to pay significantly higher prices for buildings that are sustainable certified (Mangialardo et al., 2019).

2.4.2 Cost Reduction

ESG practices can help firms to reduce operational costs, due to the fact that those practices should aim to increase the efficiency of a company operations for example promoting best practices with the aim of reducing energy consumption, water consumption, and waste management (Henisz et al., 2019).

2.4.3 Reduced Regulatory and Legal Interventions

The goal of ESG disclosure is to acquire legitimacy from society and governments for the company's environmental and social impacts (Xie et al., 2019). Companies with a stronger external-value offer can attain greater strategic independence while also reducing regulatory pressure. ESG practice has been found to help companies lower their risk of negative government action (Heniszet al., 2019).

2.4.4 Employee Productivity Uplift

A solid ESG proposition may help businesses to attract and retain top talent, to increase employee motivation by fostering a sense of purpose and boost overall productivity. Shareholder returns are favorably connected with employee happiness. The positive social effect has also been linked to increased job satisfaction in recent studies (Henisz et al., 2019).

2.4.5 Investment And Innovation

By allocating money to more attractive and sustainable alternatives, a strong ESG offer can boost investment returns. It can also assist businesses in avoiding investments that may not be profitable due to long-term environmental concerns (Henisz et al., 2019). Sustainable activities, especially those directed towards the reduction of a firm environmental impact, are a source of innovation that generates revenue and in consequence improve the financial performance of a company (Xie et al., 2019).

3. Methodologies

As stated in the problem statement section this thesis is built upon four main research questions. To find an answer to these questions, due to their different nature, the analysis is split into three chapters, each of these following a different approach.

In chapter 4, an archival analysis will be performed, dedicated to the analysis of the regulatory framework that Teixeira Duarte will have to comply with. Two main documents issued by the European Commission are analyzed and presented in this section. The first one is the regulation (EU) 2021/2139 which consists of a guide for investors to understand the general guidelines used to define if a business can be considered sustainable or not. The goal of the European Commission is to incentivize investors to support and invest in companies that are actively committed to limiting and decreasing their negative impact on the environment. The second document is the EU 2058, this directive contains the technical screening criteria that must be respected by a firm in order to be considered sustainable. In the document are listed many activities from different industries, with regards to Teixeira Duarte, only sections 7.1 and 7.7 will be deeply analyzed, these two categories correspond respectively to the "construction of new building" and "acquisition and ownership of a new building". These two are the business in which the real estate department of Teixeira Duarte is operating and consequently where the analysis is focused.

In chapter 5, a benchmark analysis of three selected real estate company will be performed. The three competitors that have been selected are Skanska, Tishman Speyer, and Hines. These three firms are real estate multinationals that have prioritized sustainability as a driver of their strategy. Skanska is based in Sweden, whereas Tishman Speyer and Hines are based in the United States. This section aims to comprehend which are the best practices that are deployed in the real estate industry and which information are disclosed to communicate environmental objective and policy to relevant stakeholders and public.

Chapter 6 is split into three sections, and it is dedicated to the analysis of the result of two different surveys. The first section is dedicated to the survey that targets Teixeira Duarte Real Estate employees, and its main goals are:

1. Understanding the perception of the employees towards the overall Teixeira Duarte's sustainability strategy
2. Understanding if concerns around environmental sustainability influence the normal flow of Teixeira Duarte operations
3. Discover which are the main area of improvement that Teixeira Duarte should start work on to improve the sustainability of its operations.

Since Teixeira Duarte Real Estate department employs only 44 people, even in the best-case scenario where the penetration of the survey reaches 100%, the base size would be still too low to make any quantitative analysis. Furthermore, only a total of 21 complete answers was collected from this online survey. For this particular reason a qualitative approach has been chosen to present the results of this section.

The second section is dedicated to the survey that targets the Portuguese general population. The main goals of the survey are:

1. Understanding how well-known Teixeira Duarte is among the population;
2. Understanding the awareness of the Portuguese population toward the real estate industry sustainability;
3. Understanding how important and relevant is for the general population that a real estate company is committed to decreasing its environmental impact;
4. Understanding how interested Portuguese people are in buying sustainable house/apartments.

Lastly, in the third section the data collected from this second survey are used to analyze the relationship between the willingness to pay for sustainable house and some variable of interest. The main goal is to study which variables have the highest impact on the likelihood of being a person who is willing to pay for a sustainable house.

4. European regulatory framework

In April 2021 the European Union has set a uniform climate law for the first time in history. The goals of this law are to achieve net-zero emission by 2050 and to reduce carbon dioxide emissions by 55% of 1990 levels by 2030. It is in this view that the EU taxonomy (2020/852) and the regulation (EU) 2021/2139 have been issued. In the first document are listed the six environmental objectives that the European Union intends to pursue which are:

1. Climate change mitigation
2. Climate change adaptation
3. The sustainable use and protection of water and marine resources
4. The transition to a circular economy
5. Pollution prevention and control
6. The protection and restoration of biodiversity and ecosystems

Climate change mitigation refers to the process of holding the increase in the global average temperature under 2 degrees limiting it to a maximum of 1,5 degrees, while climate change adaptation refers to the process of adjustment to actual and expected climate change and its impacts.

The regulation establishes that business activity to qualify as environmentally sustainable has at the same time to:

- Contributes to one or more of the environmental objectives listed before
- Do not significantly harm any of the other environmental objectives listed before

The REGULATION (EU) 2021/2139 contains the technical screening criteria for determining the conditions under which an economic activity qualifies as contributing substantially to climate change mitigation or climate change adaptation. The regulation also establishes the criteria for determining whether that economic activity causes no significant harm to any of the other environmental objectives. As stated in the methodologies section the two activities that are analyzed are "Construction of new building" and "Acquisition and ownership of new building" which correspond to the two main businesses of Teixeira Duarte's real estate department.

For each activity the analysis is divided in the following way. First the criteria to contribute substantially to the climate change mitigation/adaptation are presented, followed by the criteria to not significantly harm any of the other environmental objectives.

4.1 Construction of a new building

According to the regulation the definition outlined for identify an activity as construction of a new building is the following: "Development of building projects for residential and non-residential buildings by bringing together financial, technical and physical means to realize the building projects for later sale as well as the construction of complete residential or non-residential buildings, on own account for sale or on a fee or contract basis."

4.1.1 Substantial contribution to climate change mitigation

For the construction of the new building, the most important technical criteria is that the primary energy demand of a new edifice, which is the amount of energy that has to be generated to meet the total energy demand of a building, has to be at least 10% lower than the threshold set for the nearly zero-energy building. Furthermore, the energetic level of the construction must be certified using an energy performance certificate. The main problem with this criterion is that by now Portugal, like many other European countries, still has to formulate its own definition of a nearly zero-energy building. The definition of NZEB varies significantly from country to country according to the specific primary energy factors, country's climate conditions, and building traditions. The indicators that are used to create the definition can be different. Most countries use the maximum primary energy as the main indicator to define NZEB, but there are also several countries like the United Kingdom, Spain, and Norway which use carbon dioxide emissions as the main indicator to indicate the threshold. Even within the same classification, definitions can be different, for example, in Austria the maximum primary energy demand for a residential building is set to 160 kWh/m2y while in Cyprus is only 100 kWh/m2y (D'Agostino & Livio, 2019).

4.1.1.1 Do not significantly harm

To be consider as substantially contributing to the climate change mitigation the activity must respect also the following criteria, that are those listed to help judging whether the construction of a new building causes no harm to the 5 other environmental objectives.

4.1.1.1.1 Climate Change Adaptation

The European Commission requires companies to make a climate risk and vulnerability assessment according to the specific procedure explained in detail in *appendix I*. The goal is to evaluate and prevent deterioration or damage to the new building coming from one or more of the climate risks listed in *appendix I*. The required analysis is qualitative and there is no indication of any index or threshold to respect. This kind of analysis is not explicitly included in the standard practice of Teixeira Duarte. However, the effort to include such analysis within each project should not increase cost or complexity of the operations.

4.1.1.1.2 Transition to Circular Economy

In order to push companies to adopt a more circular business model is required that at least 70% (by weight) of the non-hazardous waste generated on the construction site has to be reused, recycled, or recovered. For Teixeira Duarte, this represents one of the biggest challenges to face, because by now Teixeira Duarte is not keeping track of the percentage of waste that is generated at the construction site, however from an estimation provided by the company the percentage should be by far lower than 70% (Teixeira Duarte internal information).

4.1.1.1.3 Pollution Prevention and Control

Building components and materials used in the construction that may come into contact with tenants have to emit less than 0,06 mg of formaldehyde per m3 of material or component and less than 0,001 mg of other categories 1A and 1B carcinogenic volatile organic compounds per m3 of material or component. As none of these materials are used by Teixeira Duarte during their operations, the company is already fully complying with this criterion (Teixeira Duarte internal information).

4.1.1.1.4 The Protection and Restoration Of Biodiversity And Ecosystems

To not harm the biodiversity and ecosystem the new building does not have to be built on the following kind of land:

 (a) arable land and cropland with a medium to a high level of soil fertility and below-ground biodiversity;

 (b) greenfield land of recognized high biodiversity value and land that serves as the habitat of endangered species;

(c) land matching the definition of forest as set out in national law.

All the land Teixeira Duarte owns do not match the characteristics listed in this paragraph. The company is fully complying also with this criterion (Teixeira Duarte Internal Information).

Tab. 1 *Substantial Contribution to Climate Change Mitigation, Construction of new building*

Criteria	Is Teixeira complying?	Effort to comply
Substantial contribution to Climate change mitigation	No	Depends on NZEB
Climate Change Adaptation	No	Low
Transition To Circular Economy	No	None
Pollution Prevention And Control	Yes	Medium
The Protection And Restoration Of Biodiversity And Ecosystems	Yes	None

4.1.2 Substantial contribution to climate change adaptation

To contribute substantially to the climate change adaptation, the construction of every new building has to respect only one technical screening criterion that corresponds to the same climate risk vulnerability assessment established in the do not harm the climate adaptation section described in the previous paragraph.

4.1.2.1 Do not significantly harm

The criteria established for evaluating if the construction of a new building does not harm the other five environmental objectives are the same as the ones listed in the previous section, the only difference is that here the criteria for do not harm the climate change adaptation is substituted with the criteria for do not harm climate change mitigation.

4.1.2.1.1 Climate Change Mitigation

There are two criteria that the construction of a new building must respect. The first is that the building does not have to be dedicated to the extraction, storage, transport, or manufacture of fossil fuels, and secondly, the primary energy demand of the new building does not have to exceed the threshold set for nearly zero energy building.

Criteria	Is Teixeira complying?	Effort to comply
Substantial contribution to Climate change adaptation	No	Low
Climate Change mitigation	No	Depends on NZEB

4.2 Acquisition and ownership of new buildings

According to the regulation the definition outlined for identify an activity as acquisition and ownership of new buildings is the following "Buying real estate and exercising ownership of that real estate".

4.2.1 Substantial contribution to climate change mitigation

The technical screening criteria are different for buildings built before 2020 and after. For those who are built before, the building has to have at least an energy performance certificate class A. For those built after 2020 instead, the criteria are the same applied for the construction of a new building.

4.2.1.1 Do not significantly harm

4.2.1.1.1 Climate Change Adaptation

The criteria set to not harm the environmental objective of climate change adaptation are the same as the ones for constructing new buildings and correspond to the risk and vulnerability analysis.

For the other four environmental objectives, no criteria are set because they are all relevant in the phase of construction which does not occur in the case of acquisition and ownership of new building.

Tab. 3 Substantial Contribution to Climate Change Mitigation, Acquisition & Ownership of new building

Criteria	Is Teixeira complying?	Effort to comply
Substantial contribution to Climate change mitigation	No	Low
Climate Change mitigation	No	Depends on NZEB

4.2.2 Substantial contribution to climate change adaptation

To contribute substantially to the climate change adaptation, the acquisition of a new building has to respect only one technical screening criterion that corresponds to the same climate risk vulnerability assessment established in the previous section.

4.2.2.1 Do not significantly harm

4.2.2.1.1 Climate Change Mitigation

As for the construction of the new building, the edifice does not have to be dedicated to the extraction, storage, transport, or manufacture of fossil fuels.

For buildings built before 31 December 2020, the building needs to have at least an Energy Performance Certificate class C. As an alternative, the building is within the top 30 % of the national or regional in terms of operational Primary Energy Demand. For buildings built after 31 December 2020, the Primary Energy Demand of the building resulting from the construction does not exceed the threshold set for the nearly zero-energy building (NZEB) requirements in national regulation.

Tab. 4 *Substantial Contribution to Climate Change Adaptation, Acquisition & Ownership of new building*

Criteria	Is Teixeira complying?	Effort to comply
Substantial contribution to Climate change adaptation	No	Low
Climate Change mitigation	No	Depends on NZEB

5. Competitors' benchmark analysis

The three companies for which the analysis in this section is presented are Skanska, Hines, and Tishman Speyer. Skanska is a Swedish based company which operates mainly in Nordic European countries and US. Its three main businesses are commercial/residential development, investment property, and construction. Hines and Tishman Speyer are American based companies whose operations are expanded worldwide, in America, Europe, and Asia. The two companies' main businesses are property management and residential/commercial development. The particular reason behind why these three companies have been chosen is that they all are seen as examples in the real estate industry of how sustainability practice can be embedded into the day-to-day firm's operations. These firms are looking at sustainability issue not as extra cost but as extra opportunity, they are creating value for themselves and for the environment. For Teixeira Duarte which is a relatively new player in terms of environment sustainability, it is important to understand what these companies are doing and especially how they are presenting them self to the public through their sustainability reports. The focus of this analysis is on the environmental sustainability. The results of this analysis are summarized in four criteria:

- Data Annex,
- Building certification,
- ESG framework,
- CO2 emission target.

Table 5 shows a summary of the main findings of this section.

Tab. 5 Sustainability Report summary of content

Legend: ✔ = example of best practice, 〰 = topic mentioned but require some improvment, ✘ = topic not mentioned drastic improvement required

	HINES	TISHMAN SPEYER	SKANSKA	TEIXEIRA DUARTE
GRI INDEX	✔	✘	✔	✘
CO2 emission	〰	✔	✔	✔
Energy consumption	〰	✔	✔	✘
Water consumption	〰	✔	✔	✘
Recycling practice	〰	✔	✔	✘
Building's certification	✔	✔	✔	✘
Office Certification	✔	〰	〰	✘
SDG/ESG framework	〰	✔	〰	〰
Data Annex	〰	✔	✔	✘
Employees Satisfaction	✔	✔	✔	✘
Employees Diversity	✔	✔	✔	✔
Volunteering/charity initiatives	〰	✔	〰	✔

5.1 Data Annex

All three companies included in their last sustainability report a certain degree of data related to their operations useful to evaluate their impact on the environment. Skanska and Tishman Speyer are the two firm which have the most complete and transparent data annex. Their data annex includes precise information related to CO_2 emission (scope 1, scope 2, and scope 3), energy consumption, source of energy, water consumption, and percentage of self- generated waste. The data are presented and compared at least to the past years and in most of the cases to the past 3 or 5 years. Hines, instead, decided to only disclosed information regarding the building energy intensity, building water intensity, and landfill waste diversion. This information are disclosed in the section dedicated to the building certifications and are not located in a separated data annex.

In Teixeira Duarte sustainability report instead, there is no disclosure at all about any kind of data regarding the environmental impact of the company. Topics like CO2 emission, energy

consumption, source of energy, water consumption, and percentage of self- generated waste are mentioned but to each of one it is dedicated only few descriptive lines that do not give to the reader any sort of concrete information. For each topic is written that Teixeira Duarte is committed reduce consumption or emission but there is no mention of how they intend to do it or any data that actually shows the company's progress. For example, is the paragraph dedicated to the emission of CO2 is mentioned that the company is collecting data on CO2 emissions in Portugal, Brazil, and Angola but these data are not showed in anyway anywhere.

5.2 Building Certification

Obtaining building certification to attest the sustainability performance of a certain edifice is a simple way for real estate company to prove the sustainability of their operations and their outcome. "The Green building certification systems consist in a set of rating systems and tools that are used to assess a building or a construction project's performance from a sustainability and environmental perspective" (Wei et al., 2015). In order to obtain a certification, buildings are assessed by an independent company to verify if they meet a certain level of performance and quality. Different companies use different approaches and criterion to evaluate the performance of a building, but the outcome is similar. All three companies decided to disclose both the number and which kind of certification they received in the past and in the last year. Skanska increased the number of building certification from 2019 to 2020 by 8 units. Its buildings are certified with WELL, LEED (platinum or gold) or BREEM (excellent). Furthermore, other 130 ongoing projects and completed projects are involved in the process of being certified. Hines from 2006 is committed to pursue LEED certification on all new projects. At the present day the company obtained 171 LEED certifications, 148 ENERGY STAR certifications, 52 BREEM certifications, 17 DGNB certifications, and 6 HQE certifications. In 2020 Hines won for the thirteenth consecutive year the EnergyStar Partner of The Year: Sustained Excellence Award. This award is given to companies that have consistently earned Partner of the year for several years in a row, and consequently have demonstrated the adoption of best practice across industry and commitment to reduce energy consumptions within their operations. Tishman Speyer has the 75% of its portfolio sustainable certified with LEED, DNGB, and HQE. Like Hines, the company is also committed to pursue at least LEED silver certification on all new constructions. In 2019 Tishman Speyer won for the sixth consecutive year the EnergyStar Partner Of The Year: Sustained Excellence Award.

In Teixeira Duarte sustainability report, there is no mention of building certifications because the firm never applied for any external independent certification. Certifying its construction does not represent a priority for the company because in order to obtain this certification there is a price to pay which can vary from few thousand of euro to even 20.000 euros or more, according on the specificity of each project (Nord & Sjøthun, 2014). This extra expense would reflect in higher operational expense which in turn would force Teixeira to increase price of their building.

5.3 ESG framework and Sustainable Development Goals

All three companies present in their own way their ESG framework that they use as a reference for their sustainability report structure. These frameworks are also associated to the most important sustainable development goals each company intend to pursue. Tishman Speyer gives the most exhaustive and complete overview. Its ESG framework is divided into 6 macro areas: delivering operational efficiency, managing our impacts, improving the customer experience, engaging with our communities, working with our suppliers, and looking after our people.

To each area are associated:

- The corresponding SDG the company intend to pursue
- Some targets set for each of this objective
- The concrete action and results that during last year brought the company closer to achieve these objectives

Teixeira Duarte is also presenting the Sustainable Development Goal that intend to pursue to promote a more sustainable way of doing business. *Figure 1* shows the six SDG where the company intends to focus their effort.

Figure 1. *Teixeira Duarte Sustainable Development Goal*

For Portugal, the three most important goals are promoting decent work and economic growth, promote responsible consumption, and promote innovation within the Real Estate industry.

Each of these goals is then presented with some action the company intends to activate in order to pursue them. Overall, this is the point where Teixeira practice is closer to the other three selected competitors. However, there is still a lot of room for improvement since all the action and objective listed in this section are not concrete and do not contain any specific threshold.

5.4 CO2 Emission Target

Skanska and Tishman Speyer have both declared in their sustainability report that they intend to achieve net zero emission respectively by 2045 and 2050. Furthermore, Skanska also stated to have decreased the CO2 emissions from its own operation by 34% since 2015, with a goal of 50% by 2030, the company also reduced the carbon intensity of its own operation by 36% since 2015. Even tough Hines made clear its intention to reduce CO2 emissions there is not a concrete numeric target the company intend to achieve. In the report are mentioned collaboration that Hines is making to help reduce its environmental impacts and especially the CO2 emission. For example, in 2019 Hines partnered with Ziggytech, a doubly based proptech company, to help monitor energy level and carbon emission of its European portfolio.

In Teixeira Duarte sustainability report the intention to reduce its CO2 emission is mentioned. However, this commitment is not supported by any concrete proof, action or data.

5.5 Overall Comparison

Just by reading a sustainability report one can understand to which degree a company is taking the sustainability issued to the hearth. In the case of the three selected competitors, it is clear that the decision of disclosing the information reported in the previous paragraphs is spontaneous, the way this information are presented give the reader the impression that the company really believes in what is communicated and that behind this words there is a real effort to respect the environment and the communities.

 In Teixeira Duarte most of the topics treated seem to have been written down just because they had to. In some of the most relevant environmental issues almost no information is given to the reader, giving more the impression that these sections have been added because imposed by some regulation or law rather than for a personal commitment of the company. Of course, when reading a sustainability report, one has always to be careful. Companies can create the most beautiful and rich sustainability report but still not being sustainable at all. Even if it is true that form this instrument is possible to have glimpse of a company commitment to sustainability it is also true that a report alone is not enough to assess the sustainability of a company. The

concrete actions and the achievement of concrete goals by a company, for example should also be considered. The creation of an appropriate sustainability report should only be the end goal for a firm who is interested in act in a sustainable way. The first step it is to start doing business in a sustainable way.

6. Survey results

6.1 Teixeira Duarte employees survey analysis

The first survey is targeted to Teixeira Duarte Real Estate's employees. It was launched on Qualtrics on the 25th of July of 2022, and it was active for almost one month until the 23th of August 2022. 21 complete answers were collected during the time frame the survey was active. The sample is composed by 6 analyst manager, 6 senior manager, 1 director, and 8 other employees who preferred not to indicate their role within the company. 60% of the respondents are working in Teixeira Duarte for at least 4 years. Even though the base size is low the Real Estate department employs only 44 persons. The penetration of the survey within that department is 47%. For this reason, the sample can be considered representative. The summary of the most important and relevant findings is presented in the next paragraph.

All interpretations are based on the assumption that the survey was completed by the respondents to the best knowledge, honesty, and belief.

As it is stated in research methodologies section, this survey aims to investigate three main issues, which are the following:

1. Understanding the perception of the employees towards the overall Teixeira Duarte's sustainability strategy.

> Overall, the answers collected confirm the fact that Teixeira Duarte is a relatively new player in the field of environmental sustainability. *Figure 2* shows that only 57% of the respondents indicate that Teixeira Duarte's overall sustainability strategy does not cover its whole business and supply chain. Moreover, 49% of them respondents that at the moment a proper sustainability strategy to address environmental issue is under development.

Figure 2. *In your opinion, does Teixeira Duarte's Real Estate department have an environmental strategy that covers its entire business and supply chain? (Source: survey data 1)*
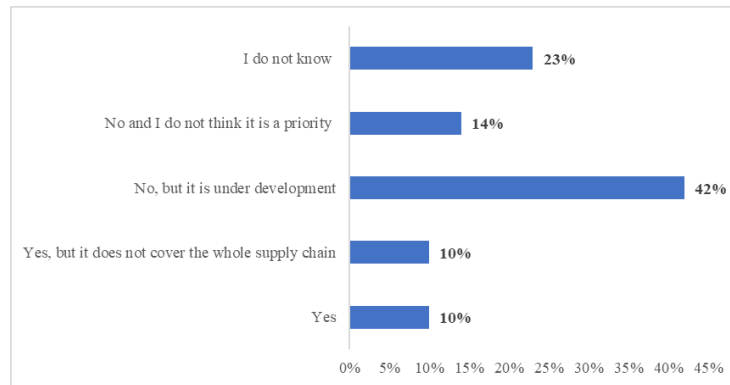
Nevertheless, most of the employees are not aware that Teixeira Duarte is reporting according to the ESG framework some non-financial information within the company annual report. *Figure 3* shows that only 33% of the respondents indicated that they are aware that Teixeira Duarte is currently publishing a sustainability report, of this subsample, only 5 employees have actually read the report. All of them confirm the previous section findings, that the most important and relevant topics related to environmental sustainability, like CO_2 emission, energy consumption, and recycling practice are either not mentioned at all, or if they are, not in an exhaustive and complete way.

Figure 3. *Does Teixeira Duarte formally report on its social and environmental impact and performance, additionally to its financial performance (known as Triple Bottom Line Reporting)? (Source: survey data 1)*
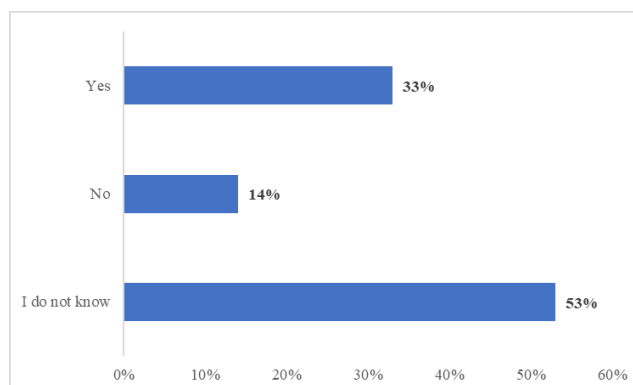
2. Understanding if concerns around environmental sustainability influence the normal course of Teixeira Duarte operations and decisions.

According to the results presented next, it is possible to affirm that concerns around environmental sustainability are not included often in the criteria that are used to evaluate the feasibility of new project. From all the respondents, 85% think that only eventually, rarely, or never the preoccupations around environmental sustainability have an influence in defining the whole Teixeira Duarte strategy, while as *figure 4* shows that 68% think that sometimes or rarely these concerns help to shape the beginning of a new Real Estate project. On the other hand, only 29% of the respondents think this happens frequently.

Figure 4. *In your opinion when starting a new project (e.g., construction of new building) do environmental concerns influence the structure and development of it? (Source: survey data 1)*
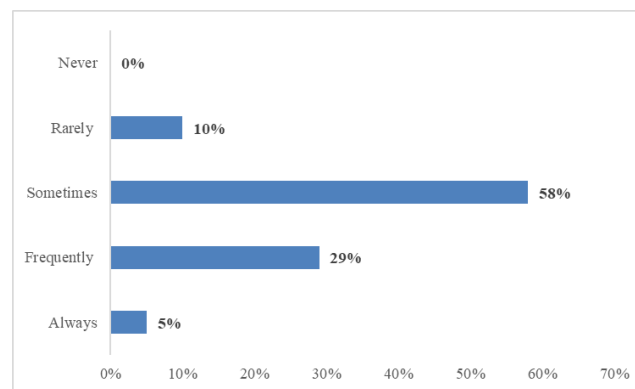
Furthermore, *figure 5*, shows that 57% of them indicated that only sometimes or rarely this kind of concerns influence their day-to-day activity within the company.

Figure 5. *While performing your day-to-day work, how often concerns around environmental sustainability influence your decisions? (Source: survey data 1)*
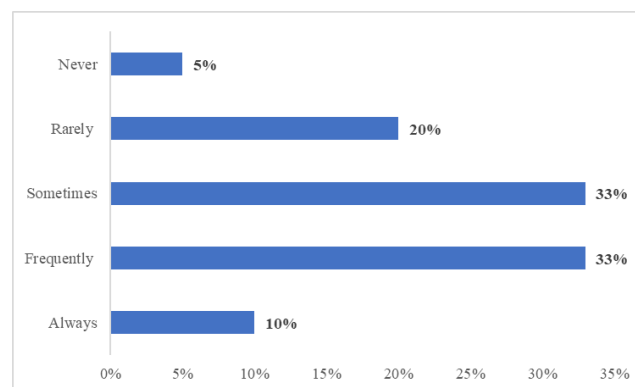
The employees' awareness about how much pollution is generated by the real estate industry is low. Only 33% of the respondents are aware that the Real Estate industry by

itself is responsible for the 40% of the global CO2 emissions. While 50% of employees believe that the percentage of contribution to the CO2 emission is lower than 25.

3. Discover which are the main area of improvement that Teixeira Duarte should start work on to improve the sustainability of its operations.

For Teixeira Duarte employees is a priority that in the next 5 to 10 years the company incorporate in its agenda a plan to reduce its negative impact on the environment. To confirm this finding, 95% of the respondents think that is important or extremely important that the future Teixeira Duarte's strategy contains concrete actions to increase the environmental sustainability of its Real Estate department. When ask which were the most important objectives that this future strategy needs to meet, the most important come out as decreasing the negative impact of Teixeira Duarte operations on the environment and increasing the energy efficiency of them. At the end of the survey, the respondent was given the possibility to write down which are the main area of improvement upon which Teixeira Duarte should work on. Their answers are grouped into three main topics. First, higher investment in innovation to ensure the deployment of new technology to help to mitigate the negative impact of Teixeira Duarte operations on the environment. Second, investment in more sustainable projects and more sustainable materials during the phase of construction, and third, to privilege collaboration with selected supplier which are committed to high standard environmental sustainability.

6.2 General Population survey analysis

The second survey is targeted to the Portuguese's general population. The survey was first lunched on the 17th of August 2022 and was active for 10 days until the 27th of August 2022. A total of 95 complete answers were collected during the time frame the link was active. The gender split is 47% male and 53% female, the sample's average age is 35 years old. The most relevant findings are reported in the following paragraphs.

All interpretations are based on the assumption that the survey was completed by the respondents to the best knowledge, honesty, and belief.

As it was stated at the research methodologies section, this survey aims to find an answer to three main issues, which are the following:

1. Understanding how well-known Teixeira Duarte is among the population

Figure 6 shows that Teixeira Duarte is the most well-known Real Estate company in Portugal, 76% of the respondents declared to be familiar with the Teixeira Duarte group. The second most well-known firm is Mota-Engil with 59% positive interactions, followed by Alves Ribeiro with only 26% positive interaction.

Figure 6. *Which of the following Real Estate Company are you aware of? (Source: survey data 2)*
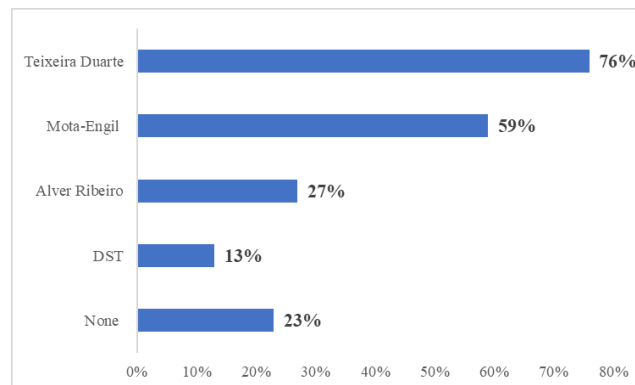
2. Understanding the awareness of the general population toward the Portuguese's Real Estate industry sustainability and evaluate how important is for them that an industry is sustainable.

Portuguese general population care about issues related to the environmental sustainability. However, when sustainability is referred to an industry, their opinions result polarized. Most of the respondents totally agreed on to the following statements: "I am worried about global warming, being able to contribute to the environment makes me feel better, I care about the environment, and I like to feel that with my consumption habits I can contribute to the preservation of the environment (full tables in the appendix)". On the other hand, *figure 7* shows that when asked to express their opinion regarding the sustainability of the Portuguese's real estate industry, 57% of the respondent indicated that they consider this industry not sustainable.

Figure 7. In your opinion how sustainable is the real estate industry in Portugal? (Source: survey data 2)
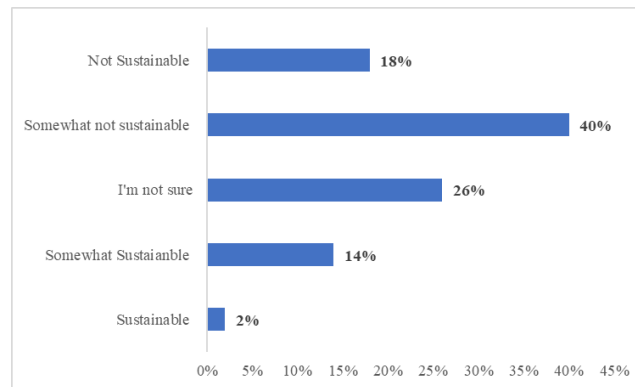
However, *figure 8* shows that when asked to comment the following statement "It makes no difference if the Portuguese real estate industry is sustainable or not" only 15% of the respondents either totally agreed and 38% partially agreed, while only 23% of them disagreed or strongly disagreed.

Figure 8. How much do you agree/disagree with the following statement "It does not make any difference if an industry is sustainable or not? (Source: survey data 2)
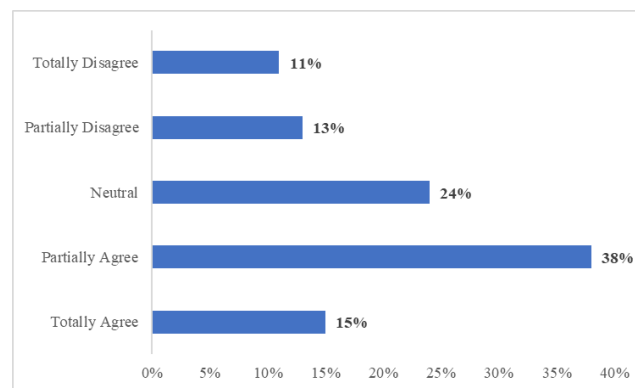
Overall, only 50% of the respondent are aware of the energetic level of the house/apartment where they live. Moreover, 50% of the respondents' buildings have an energetic level equal or lower to C.

3. Understanding how interested are Portuguese people in buying sustainable house/apartments.

Portuguese general population does not add extra value to a sustainable house compared to a normal one. When asked which criteria are the most relevant to take into consideration during the process of buying a new apartment/house, the most important come out as being price and localization of the house/apartment, while the least important are the presence of air conditioning, presence of heating system, the energetic class of the building, and the reputation of the company who build the apartment/house.

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Nevertheless, only one third of the respondent declared that they would be willing to purchase a sustainable apartment/house if it cost more than a normal one. However, 59% of them declared they would be willing to buy the sustainable apartment/house if the price is the same as for a normal one. On average, the consumers who are willing to pay more for a sustainable house/apartment would accept a premium price up to 11%.

6.3 Quantitative analysis of the willingness to pay for sustainable house

The willingness to pay is further investigated to evaluate if it is possible to find a pattern of characteristics that influence the likelihood of being a person people who is willing to pay more for sustainable housing compared to a house that is not. Four main hypotheses related to four specific characteristics of the population were formulated and investigated.

Income

Several studies pointed out a connection between a household income with the willingness to pay for sustainable house. Researchers have demonstrated that people with higher income tend to be willing to pay higher prices for sustainable house (Hu et al., 2014). According to these findings the first hypothesis is formulated as:

H1: People with higher income are more likely to be willing to pay more for sustainable houses

Age

The age of a person can influence the willingness to pay for sustainable house. Past studies have demonstrated that older people have higher willingness to pay for sustainable houses (Khan et al., 2020). According to these findings, the second hypothesis was formulated as:

H2: Older people are more likely to be willing to pay more for sustainable houses

Environmental Attitude

Researchers have demonstrated that people who are more environmentally conscious show higher willingness to pay for sustainable houses (Zalejska-Jonsson, 2014). Environmental Attitude can be described as "a cognitive judgment towards the value of environmental protection"(Yau, n.d.). These people have strong concerns about environmental issues like global warming and pollution. Being more environmental conscious make them more willing

to contribute with their purchase patterns to the environment (Zhang et al., 2018). The third hypothesis was then formulated as:

H3: People who are sensitive towards environmental issues are more likely to be willing to pay more for sustainable houses

Sustainable House

Past studies have demonstrated that people who are already living in a building that is sustainable certified tend to have higher willingness to pay for sustainable housing (Zalejska-Jonsson, 2014). These people are more aware about the benefits, in terms of cost saving, derived from living in a sustainable house, they are consequently willing to pay higher prices for those houses (Nord & Sjøthun, 2014). The fourth hypothesis was formulated as:

H4: People who live in sustainable house are more likely to be willing to pay more for sustainable houses

6.3.1 Data preparation

The output of the survey conducted on Qualtrics in the form of a Microsoft Excel spreadsheet file is analyzed in the statistics and data science software RStudio. The crucial parts of the R script can be found in *appendix IV*.

To investigate the previously formulated hypothesis, some variables were created. First, the dummy variable "wtp" was created, this variable is used as dependent variable in the statistical model of interest, it assumes the value 1 if a person declared to be willing to pay more for a sustainable house than for a normal one, and the value 0 if the respondent declared to not be willing to pay more for a sustainable housing or to not be interested in buying sustainable houses. Furthermore, during the survey the age of each respondent was registered and used consequently to create the categorical variable "age_class", this variable is composed by six categories, which are: "a" from 20 to 27 y.o, class "b" from 28 to 35 y.o., class "c" form 36 to 43 y.o., class "d" from 44 to 52 y.o., class "e" from 52 to 59 y.o., and class "f" from 60 to 67 y.o.. To study the influence of a person income on the dependent variable "wtp" a new categorical variable called "income" was created, this variable assumes the value "low" for people with an annual net income lower than 20.000 euros, "medium" for people with an annual net income between 21.000 and 40.000 euros, and "high" for people with an annual net income higher than 41.000 euros. To investigate the third hypothesis the dummy variable

"env_attitude" was created. It assumes the value "Yes" if the respondent totally agreed or partially agreed to the following statements:

- I care about the environment
- I am worried about global worming
- I like to feel that with my consumption habits I can contribute to the environmental conservation
- Being able to contribute to environmental sustainability I feel a better person

And the value "No" if a respondent did not agree with those statements. Lastly, the dummy variable "certification" was created to investigate the fourth hypothesis. This variable assumes the value "Yes" if the respondent declared that is living in a building with an energy certification higher or equal to B, and the value "No" if the energetic level is lower than B.

6.3.2 Data Analysis

First of all a visual representation of the influence that the four variables of interest have on the percentage of people who are willing to pay for sustainable houses is showed in the following paragraphs.

Figure 7 shows the influence of the variable age on the people who are willing to pay for sustainable houses. The results indicate that the age class with the highest percantage of people who are willing to pay for sustainable house is class "f " (age 60-67 y.o.) with a total of 50%, followed by class "e" (age 52 -59 y.o.) with a toal of 44% and class "a" (age 20 -27 y.o.) with a total of 37%. Due to the low base size of class "e" and "f" was not possible to make a t-test to verify if the difference in mean between older age class is significantly different from younger age class.

Figure 9. *Age influence on wtp*

(Source: survey data 2)
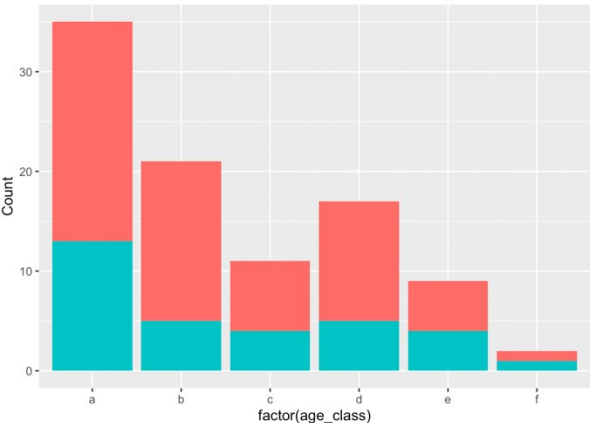
Figure 10. *Environmental attitude influence on wtp*

(Source: survey data 2)
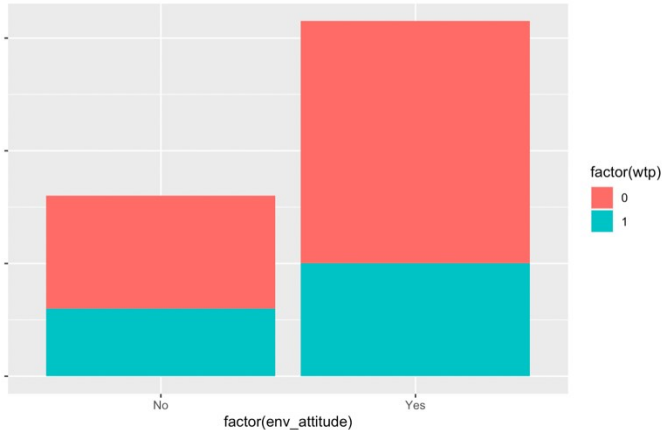
Figure 10 shows the influence of the variable "env_attitude" on the likelyhood to be willing to pay for sustainable houses. Contrary to what it was expected, within the class "env_attitude No" the percentage of people willing to pay for sustainable house is higher by 5% compered to those who are classified "env_attitude Yes". This difference was further investigated through a t-test to understand if the difference in mean between the two group is significative or not. The p-value of this test is equal to 0.58, consequently the null hypothesis that there is no difference in mean between the two group is accepted (full result in *appendix V*).

Figure 11 shows the influence of living in a building sustainable certified on the likelihood to be willing to pay for sustainable houses. Also, here contrary to what it was expected the percentage of people willing to pay more for sustainable house is higher by 3% in the class "certification No" than for those in the class "certification Yes". This difference was further investigated through a t-test to understand if the difference in mean between the two group is significative or not. The p-value of this test is equal to 0.83, consequently the null hypothesis that there is no difference in mean between the two group is accepted (full result in *appendix V*).

Figure 11. Certification influence on wtp *(Source: survey data 2)*   *Figure 12.* Income influence on wtp *(Source: survey data 2)*
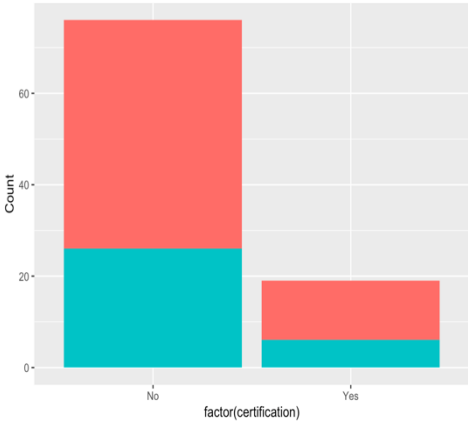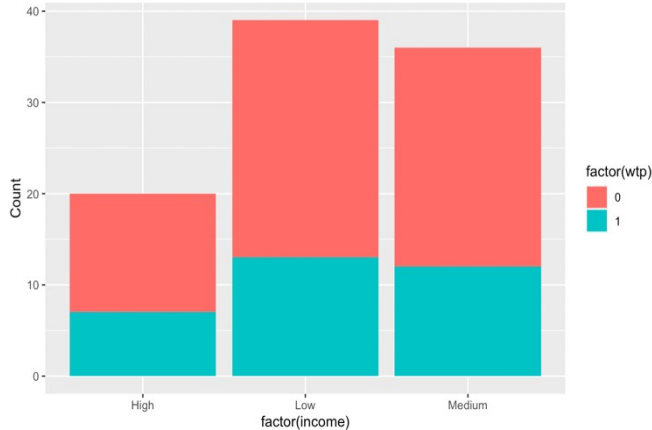
Lastly, *Figure 12* shows the influence of the variable income on the willingness to pay for sustainable houses. Within the class "income High" the percentage of people who are willing to pay for sustainable house is the highest, but the difference is only 2 % higher than for the other two classes. Two t-test were conducted to test if there is any significant difference in average between the proportion of people willing to buy sustainable houses in the class "high" against "medium" and in class "high" against class "low". The p-value for both test is equal to 0.9, therefore the null hypothesis that there is no differenc in mean between the two group is accepted (full result in *appendix V*).

From a first look at the data, it is not possible to confirm any of the hypothesis that were previously formulated. From the data visualization no clear pattern is emerged that can help to understand which variable have an influence in the likelihood of being willing to pay more for sustainable houses. Furthermore, where a difference is spotted it appears not to be statistically significance.

The analysis was further developed to create a statistical model able to predict the likelihood of a people be willing to pay for sustainable house. Since the dependent variable is binary in nature, a linear regression model is not applicable for this study. Therefore, a binary regression as part of binomial regression models is used to analyze the nonlinear relationship between the four variables of interest and the dependent variable "wtp", whereby the most used models are logit and probit. The Logit model assumes that the underlying dependent variable follows a logistic cumulative distribution, i.e., $F(x) = exp(x)$. In the probit model, the underlying $1+$ $exp(x)$ dependent variable is assumed to follow a normal cumulative distribution, i.e., $F(x) = \Phi(x)$, where $\phi(x)$ is the normal density function. Because these models confine the prediction probabilities [0;1] and therefore imply appropriate marginal effects over the full range of independent, explanatory variables these models are preferred by many researchers (Wooldridge, 2012). The betas of the probit and logit models cannot be interpreted directly because of the more complicated and non-linear characteristics of the models. One approach, commonly used in econometric data analysis that estimates probit and logit models replaces each explanatory variable with its sample average. This method is referred to as "partial effect at the average" (PEA) or "marginal effect at the mean" (MEM).

The outcome of the logistic and probit regression between the dependent variable "wtp" and the four independent variables of interest is showed in *figure 13*. Even though as stated previously, the coefficients of a logistic and a probit regression cannot be directly interpreted, it is still possible to assess their significance. Even with a confidence interval of 90% none of independent variables results significant. Continuing with the interpretation of the result through the PEA or MEM methods would not add significative insight to the analysis. According to these findings, with the current sample of observation is not possible to define a group of characteristics that distinguish people who are willing to pay more for sustainable house than for normal one.

Figure 13. *Logistic and probit regressions*

```
================================================
                    Dependent variable:
                  ----------------------------
                              wtp
                    logistic          probit
                      (1)               (2)
------------------------------------------------
age_classb           -0.681           -0.424
                     (0.658)          (0.393)
age_classc           -0.079           -0.055
                     (0.800)          (0.491)
age_classd           -0.366           -0.233
                     (0.779)          (0.472)
age_classe            0.344            0.202
                     (0.847)          (0.525)
age_classf            0.389            0.234
                     (1.617)          (1.006)
incomeLow            -0.113           -0.085
                     (0.759)          (0.461)
incomeMedium         -0.058           -0.030
                     (0.674)          (0.411)
env_attitudeYes      -0.323           -0.200
                     (0.474)          (0.290)
certificationYes     -0.016           -0.004
                     (0.581)          (0.352)
Constant             -0.227           -0.135
                     (0.825)          (0.504)
------------------------------------------------
Observations           95               95
Log Likelihood      -59.445          -59.427
Akaike Inf. Crit.   138.890          138.853
================================================
Note:              *p<0.1; **p<0.05; ***p<0.01
```

7. Implications

According to what have been discussed in the section dedicated to the analysis of the new European regulation, Teixeira Duarte is already complying with most of the listed criteria. However, to fully meet the requirements contained in these regulations and being able to label its activity as environmentally sustainable it needs to improve its performance in two main area.

First, Teixeira Duarte should aim to obtain an energy performance certificate of class A or A+ for every new building they intend to construct. Since the definition of Nearly Zero Energy Building is still under formulation in Portugal, there is not a concrete target that can be used as a threshold. However, since within the criteria for the substantial contribution to climate change mitigation for "the acquisition and ownership of a building" is stated that "For building who are construct before 2020, the building has to have at least an energy performance certificate class A, while for those built after 2020 the total energy demand of a building, has to be at least 10% lower than the threshold set for the nearly zero-energy building" it is reasonable to believe that the criteria for building constructed after 2020 should be stricter than for those built before. The definition of NZEB should be built upon the energy performance of building with an energetic class A or A+.

Second, Teixeira Duarte's recycling policy should have a major area of investment. Within the new regulation, to comply with the criteria for the transition to a circular economy, Real Estate company must recycle, reused, or recover at least 70% (by weight) of the non-hazardous waste generated on the construction site. Currently, Teixeira Duarte was only able to provide an approximation of this indicator as normally during its day-to-day operations it is not something that they keep under control. However, the actual percentage of recycled materials is lower than 70%. It is going to be of fundamental importance not only to start collecting precise data about the current percentage of waste that is generated and recycled but also to implement new mandatory recycling policy to make sure to be able to comply with this criterion in all the new construction site.

Furthermore, at the beginning of every new project Teixeira Duarte should start to implement climate risk vulnerability analysis as required by the European Commission.

According to the findings of the section dedicated to the competitor benchmark there are some immediate actions that Teixeira Duarte can take to present them-self better to the public through their sustainability report. Most of these actions are costless and they are not required by the

European Commission, so do not represent a priority. However, Teixeira Duarte should evaluate the following recommendations if is interested in become more transparent and in communicate in a clear a simple way to stakeholders its new future environmental policy. First, the company should start to collect information regarding its CO2 emission, energy consumption, water consumption, and recycling policy. Once this information is available, it should be incorporated into the annual sustainability report within an appropriate data annex. Teixeira Duarte confirmed that most of these data are either already available to the company or would be easily accessible. Furthermore, it will become fundamental to keep track of this indicator to show over the years how the firm operations are evolving in terms of environmental impact.

Teixeira Duarte should also start to publicly communicate a long-term target in terms of CO2 emission reduction they want to achieve. Companies like Skanska and Tishman Speyer declared that they intend to achieve net zero emission by 2045 or 2050. The target can be very far in time, but by making a public commitment and showing year by year how the company is doing, even if the results are negative, can help Teixeira Duarte not only to actively work to reduce it environmental impact but also to present in a simple a direct way to the public the results obtained over the years.

Another important action the company should take into consideration is to start applying to obtain green building certification. Unfortunately, these certifications are issued by private companies, and they come at a cost which varies according to the specificity of each project. For example, construction-related expenses for one of the most common certifications, the LEED-certified buildings, can increase a project's cost around 10 to 30 percent (Nord & Sjøthun, 2014). Buildings built with energy and environmental goals demand more knowledge, skill, and cooperation from design and construction teams, suggesting that the overall cost of construction for green buildings may be higher than for conventional ones (Nord & Sjøthun, 2014). However, from the results of the survey within the Portuguese General Population, it appears that only 30% of the respondent would be willing to pay more for a sustainable certified house/apartment. Most of the Portuguese population is not willing to pay premium prices for sustainable houses. Obtaining green building certification like LEED or BREEM, would be an easy way to guarantee and show to the relevant stakeholders that every new building in Teixeira Duarte's portfolio is sustainable certified. However, it is necessary to first carry out a cost benefit analysis to understand if the extra cost generated by the process of obtaining the certificate are outbalanced by the benefit of being able to offer to customer sustainable certified

houses. Teixeira Duarte should aim to carefully evaluate the willingness to pay of its clients to better understand the feasibility of this action.

Lastly, if a good performance in terms of sustainability has to be achieved, also some internal actions have to be taken. It is necessary to change the way Teixeira Duarte is facing at environmental sustainability issue. So far, the approach followed by the company has been passive, meaning that if a change in the way they are doing business is not required by some sort of regulation or law, nothing or very little is done. However, due to the current situation that the Real Estate industry is facing, considering that alone accounts for over 40% of energy consumption and 36% of the CO_2 emissions in the European Union, it is more likely that national and European regulation will become stricter, especially if the goals set by the European Commission are not going to be met. Teixeira Duarte should start to proactively look at the environmental issues not just like cost or obstacle but as new opportunity.

According to the employee's survey, the current concerns around environmental sustainability are not very likely to influence the outcome of a project. So, this way of doing business should change, and accurate environmental analysis should be incorporated into the current criteria used to evaluate a new project. Furthermore, Teixeira Duarte should start to communicate its objectives and goals internally. From the result of the survey, it appears that most of the employees are not aware that Teixeira Duarte is currently publishing a sustainability report. Therefore, they should work on its employees' awareness towards environmental sustainability and make them an active part of the process.

8. Conclusion

This dissertation presents a general overview of what Teixeira Duarte needs to do to comply with the new European regulation and being able to label its activities as environmentally sustainable. The results of this analysis pointed out that the two main area where the company will need to work on are the energetic class of its building and the recycling policy adopted in the construction sites. On the top this, Teixeira Duarte can choose to voluntarily start to disclose many other information related to the impact of its operations on the environment in order to become more transparent. Teixeira Duarte is now facing an important dilemma. It needs to decide with which approach foresee future environmental decisions. The first option is to continue to act like in the past and relegate environmental issue to the border of its strategy, while the second is to start looking at environmental issues as new opportunities of growth. However, given the negative results received from the second survey and since was not possible to extrapolate a significant model to understand the profile of consumers who are willing to pay more for sustainable house Teixeira Duarte need to be careful and further investigate this issue.

9. Limitations & Future Research

Due to a lack of resource and time some of the results obtained in this research must be analyzed carefully and further investigation is recommended.

A first limitation is represented by the methodology chosen to investigate Teixeira Duarte Employees. After reviewing the results, it would have been more useful to substitute this approach with in-person interview. For example, interviewing people in charge of different areas of the Real Estate department would have been more useful to have a better and more exhaustive overview of what people inside the company think about Teixeira Duarte's operations regarding sustainability. Furthermore, the survey was only aimed to the real estate employees working at Teixeira Duarte office at Lagoas Park, no answers were collected from employees working from other departments or at the construction sites. The latter are those employees who are running the physical operation and are the closest to where most of the activity that negatively impact the environment takes place. They, more than anyone else in the company, should be aware about the common practice that are used on the construction site. These employees can provide interesting insights regarding the sustainability of the company's operation of which the management may not be aware.

For the second survey, since Teixeira Duarte resulted the most well-known real estate company, it would have been interesting to add a set of question aimed to evaluate what people think of Teixeira Duarte as a company. Due to a specific request made by Teixeira Duarte was not possible to include any question that had a direct link to the company name. The only approved question that used its name, is the one asking: "Which of the following Real Estate companies are you aware of?". Furthermore, due to the low-base size, the results from the statistical model used to evaluate the likelihood of being a person who is willing to pay for a sustainable house are not significant and should further investigated. Increasing the penetration of the survey and consequently increasing the base size for the analysis could help to have a better understanding of the results and evaluate if it is possible to segment the population.

Lastly, Teixeira Duarte is one of the biggest conglomerates in Portugal, it is operating in six different industries, mainly in Portugal, Brazil, Mozambican, and Angola. Focusing the analysis on only one industry in one country is restrictive. To have a general picture of where Teixeira Duarte stands from an environmental point of view, it is necessary to include in the analysis also the other markets and industries. However, due to the different nature of this business and

the difference in culture, regulation and working standard of the four main countries where Teixeira Duarte operates, this kind of analysis resulted out of the scope of this research.

APPENDIX

I. Classification of climate-related hazard and climate risk vulnerability assessment procedure

<table>
<tr><td></td><td></td><th>Temperature-related</th><th>Wind-related</th><th>Water-related</th><th>Solid mass-related</th></tr>
<tr><td rowspan="6">Chronic</td><td></td><td>Changing temperature (air, freshwater, marine water)</td><td>Changing wind patterns</td><td>Changing precipitation patterns and types (rain, hail, snow/ice)</td><td>Coastal erosion</td></tr>
<tr><td></td><td>Heat stress</td><td></td><td>Precipitation or hydrological variability</td><td>Soil degradation</td></tr>
<tr><td></td><td>Temperature variability</td><td></td><td>Ocean acidification</td><td>Soil erosion</td></tr>
<tr><td></td><td>Permafrost thawing</td><td></td><td>Saline intrusion</td><td>Solifluction</td></tr>
<tr><td></td><td></td><td></td><td>Sea level rise</td><td></td></tr>
<tr><td></td><td></td><td></td><td>Water stress</td><td></td></tr>
<tr><td rowspan="4">Acute</td><td></td><td>Heat wave</td><td>Cyclone, hurricane, typhoon</td><td>Drought</td><td>Avalanche</td></tr>
<tr><td></td><td>Cold wave/frost</td><td>Storm (including blizzards, dust and sandstorms)</td><td>Heavy precipitation (rain, hail, snow/ice)</td><td>Landslide</td></tr>
<tr><td></td><td>Wildfire</td><td>Tornado</td><td>Flood (coastal, fluvial, pluvial, ground water)</td><td>Subsidence</td></tr>
<tr><td></td><td></td><td></td><td>Glacial lake outburst</td><td></td></tr>
</table>

1. Screening of the activity to identify which physical climate risks may affect the performance of the economic activity

2. If at risk a climate risk and vulnerability assessment to assess the materiality of the physical climate risks on the economic activity

3. An assessment of adaptation solutions that can reduce the identified physical climate risk

For new activities and existing activities using newly-built physical assets, the economic operator integrates the adaptation solutions that reduce the most important identified physical climate risks

For existing activities and new activities using existing physical assets, the economic operator implements physical and non-physical solutions ('adaptation solutions'), over a period of time of up to five years, that reduce the most important identified physical climate

II. Teixeira Duarte Employees survey

Variable	Category	Category description	Count response	Percentage response
Age	1	< 25 years old	2	9.5%
	2	25-30 years old	3	14.3%
	3	31-40 years old	12	57.1%
	4	41-50 years old	3	14.3%
	5	> 51 years old	1	4.7%
Role	1	Analyst Manager	6	28.6%
	2	Senior Manager	6	28.6%
	3	Associate Manager	0	0%
	4	Director	1	4.8%
	5	Managing Director	0	0%
	6	I prefer not to say	8	38.1%
Time in the company	1	Less than a yesr	7	33.3%
	2	1 a 3 anos	1	4.8%
	3	4 a 6 anos	5	23.8%
	4	More than 7 years	7	33.3%
	5	I prefer not to say	1	4.8%
Gender	1	Masculino	16	76.2%
	2	Feminino	4	19%
	3	Prefiro não dizer	1	4.8%
	4	Outro	0	0%

Q1) For how much do you think that the real estate/construction industry contributes to the worldwide greenhouse gas emissions?

#	Answer	Count	%
1	Less than 5%	5	23.8%
2	Between 6% and 25%	7	33.3%
3	Between 26% and 50%	7	33.3%
4	Between 51% and 75%	2	9.5%
5	Between 76% and 100%	0	0%

Q2) In your opinion does Teixeira Duarte have a coherent strategy for corporate sustainability that covers the whole real estate business and its supply chain?

#	Answer	Count	%
1	Yes, it covers the whole business including the supply chain	2	9.5%
2	Yes, it covers the business but not the supply chain	2	9.5%
3	No but it is under development	9	41.8%
4	No and it is not a priority	3	14.3%
5	I am not sure	5	23.8%

Q3) Does Teixeira Duarte formally report on its social and environmental impact and performance, additionally to its financial performance (known as Triple Bottom Line Reporting or ESG)?

#	Answer	Count	%
1	Yes	7	33.3%
2	No	3	14.3%
3	I am not sure	11	52.4%

Q4) (If yes to Q3) Have you ever read the annual report of Teixeira Duarte?

#	Answer	Count	%
1	Yes	5	71.4%
2	No	2	28.6%

Q5) (If yes at Q4) What do you think about it? Does the report give an exhausting explanation of how Teixeira Duarte intends to face problems regarding its environmental impact?

#	Answer	Count	%
1	No, there is no mention	3	60.0%
2	No, and I do not think it should mention those themes	0	0%
3	Yes they are mentioned but there is no concrete explanation of how to solve them	1	30.0%
4	Yes, they are mentioned but not in an exhaustive way	1	30.0%
5	Yes they are mentioned in an exhaustive way	0	0%

Q7) In your opinion, how often do concerns about environmental sustainability affect the definition of the Teixeira Duarte's global strategy?

#	Answer	Count	%

1	Always	1	4.7%
2	Frequently	2	9.5%
3	Sometimes	14	66.7%
4	Rarely	2	9.5%
5	Never	2	9.5%

Q8) In your opinion when starting a new project (e.g., construction of new building) do environmental concerns influence the structure and development of it?

#	Answer	Count	%
1	Always	1	4.7%
2	Frequently	6	28.6%
3	Sometimes	12	57.1%
4	Rarely	2	9.5%
5	Never	0	0%

Q9) While performing your day-to-day work, how often concerns around environmental sustainability influence your decisions?

#	Answer	Count	%
1	Always	2	9.5%
2	Frequently	7	33.3%
3	Sometimes	7	33.3%
4	Rarely	4	19.1%
5	Never	1	4.7%

Q10) How important is to you that Teixeira Duarte Real Estate will have a coherent corporate sustainability strategy?

#	Answer	Count	%
1	Very important	2	9.5%
2	Important	7	33.3%
3	neutral	7	33.3%
4	Somewhat not important	4	19.1%
5	Not at all important	1	4.7%

Q11) In your opinion how important is that the future strategy of Teixeira Duarte Real Estate meets the following objectives? ? (1 Very important – 3 neutral - 5 Not at all important)

	Min	Max	Mean	SD	Count
Communicating the commitment to sustainability to investors and stakeholders	1	4	2.10	0.81	21
Increase the use of recycled materials	1	4	2.0	0.82	21
Increasing transparency and quality of the non-financial disclosed information	1	5	2.19	1.05	21
Improving operations' energy efficiency	1	4	1.76	0.81	21
Reducing operations' environmental impact	1	4	1.76	0.81	21
Enhance the impact of the organization on the community	1	3	2.0	0.81	21
Reducing greenhouse gas emissions and/or waste	1	4	2.0	0.76	21
Implementing stronger controls over suppliers on human rights standards	1	4	2.14	0.94	21
Implementing stronger controls over suppliers on environmental standards	1	4	2.29	0.70	21

Q12) In your opinion which are the main area improvement where Teixeira Duarte Real Estate should work on to improve the environmental sustainability of its operations?

1. Waste, Innovation and sustainable and efficient projects (higher investment)
2. More Digital World and less Prints / Search for Environmentally Concerned Suppliers / Search for building solutions with less waste
3. Framing the "Sustainability" in all Projects that develops
4. Implementation of technology in the management and monitoring of operations
5. Implementation of more sustainable materials in construction;
6. Implementation of solutions that provide water saving and recycling
7. Innovation and Education
8. Inclusion of recycled materials in construction; more efficient solutions in projects
9. Improve communication to employees about the company's sustainability policies
10. Definition of concrete goals and action strategy with stipulated timings of action; clearly communicate all actions
11. clearly communicate all actions / initiatives carried out in the area of sustainability, both internally and externally.

12. Tele-work (1Xweek); investment in sustainable materials; incentive to purchase electric vehicles

13. Opt for sustainable construction rather than traditional construction;

14. Choosing better building materials in new projects with less environmental impact;

15. Create a department/team dedicated exclusively to sustainability

16. Supply Chain, greater digital implementation and internal KPI valorization

17. Suppliers, paper recycling and efficient water use

18. Materials use, construction efficiency, short supply chain

19. Projects with lower environmental impact

20. Have a strategy for measuring and monitoring environmental KPIs

21. Communicate better, reduce CO_2 emissions

III. General Population Survey

Descriptive statistics

Variable	Category	Category description	Count response	Percentage response
Age	Open box		95	Average 35, SD 10.88
Income	1	0 to 10.000€	14	14.7%
	2	11.000 to 20.000€	25	26.3%
	3	21.000 to 30.000€	29	30.5%
	4	31.000 to 40.000€	7	7.3%
	5	41.000 to 50.000€	11	11.58%
	6	51.000 to 60.000€	4	4.21%
	7	More than 61.000€	5	5.2%
Family Cycle	1	Single	47	49.4%
	2	In a relationship/married with children	28	29.4%
	3	In a relationship/married without children	16	16.8%
	4	Divorced	4	4.2%
	5	I prefer not to say it	0	0%
Gender	1	Male	45	47.3%
	2	Female	49	52.7%
	3	I prefer not to say	0	0%
	4	Other	0	0%

Q1) For how much do you think that the real estate/construction industry contributes to the worldwide greenhouse gas emissions?

#	Answer	Count	%
1	Less than 5%	15	15.9%
2	Between 6% and 25%	47	49.5%
3	Between 26% and 50%	22	23.1%
4	Between 51% and 75%	11	11.5%
5	Between 76% and 100%	0	0%

Q2) How sustainable you think the Portuguese real estate industry is?

#	Answer	Count	%
1	Sustainable	2	2.1%
2	Somewhat sustainable	13	13.7%
3	I am not sure	25	26.3%
4	Somewhat not sustainable	38	40.0%
5	Not sustainable	17	17.9%

Q3) Qual das seguintes empresas, que atua no ramo da construção cívil e imobiliária, conhecem? (multiple choiche)

#	Answer	Count	%
1	Mota-Engil	56	29.6%
2	DST	13	6.9%
3	Teixeira Duarte	72	38.1%
4	Alves Ribeiro	26	13.8%
5	None	22	11.6%

Q4) Do you know what an energy performance certificate is?

#	Answer	Count	%
1	Yes	72	29.6%
2	No	12	6.9%
3	I am not sure	11	38%

If no to Q4 an explanation of what an energy performance certificate was showed to the respondent:

An energy performance certificate is document that evaluates the energy efficiency of a property on a scale from A+ (very efficient) to F (not very efficient), issued by qualified experts recognized by the Agency for Energy (ADENE) - the managing entity of the energy certification system for buildings (SCE). It contains information about the building's construction characteristics and energy consumption for different uses, such as heating and cooling of the house and production of hot water.

Q5) Do you know if the flat or the house where you leave has an energy performance certificate?

#	Answer	Count	%
1	Yes	51	70.8%
2	No	9	12.5%
3	I am not sure	12	16.7%

Q6) (if yes at Q5) Do you know which energetic level your house or flat has?

#	Answer	Count	%
1	A+	4	7.8%
2	A	5	9.0%
3	B	10	19.6%
4	C	12	23.5%
5	D	4	7.8%
6	E	4	7.8%
7	F	2	3.9%
8	I am not sure	10	19.6%

Q7) Imagine yourself in the position of buying or renting a new apartment, how important would you consider each of the following criteria? (1 totally agree – 3 neutral - 5 do not agree at all)

	Min	Max	Mean	SD	Count
Price	1	3	1.33	0.57	95
Location	1	4	1.45	0.66	95
Energy class of the building	1	5	2.52	0.88	95
The apartment/house is sustainable certified	1	5	2.58	0.96	95
The reputation of the company who built it	1	5	2.59	1.03	95
Presence of AC	1	5	2.81	1.00	95
Presence of heating system	1	5	2.72	1.03	95
Good thermic isolation	1	5	1.92	0.91	95

Q8) Imagine yourself in the position of buying or renting a new apartment, would an apartment that is certified "environmentally sustainable" (high energy performance, usage of recycled materials in the construction…) sway you to purchase that product over the rest?

#	Answer	Count	%
1	Yes, I would prefer the environmentally sustainable if it cost the same as the others	56	58.9%
2	Yes, I would prefer the environmentally sustainable even if it is more expensive	32	33.7%
3	I don't care if a house/apartment is sustainable certificated	7	7.4%

Q9) How much more would you be willing to pay? (open box)

Count	Average	SD
32	11%	

Q10) 7Which of the following statement reflects your housing situation?

#	Answer	Count	%
1	Me or the person I live with own the flat/house where I live	45	47.4%
2	I live in a flat/house and pay monthly rent	47	49.5%
3	other	3	3.2%

Q11) How much do you agree/disagree with the following statements ? (1 totally agree – 3 neutral - 5 do not agree at all)

	Min	Max	Mean	SD	Count
I spend a lot of time thinking how much my daily action can damage the environment	1	5	2.55	1.08	95
I like to feel that with my consumption habits I can contribute to the environmental conservation	1	5	1.74	0.96	95
Being able to contribute to environmental sustainability I feel a better person	1	5	1.59	0.85	95
I care about the environment	1	5	1.66	0.93	95
I am worried about the global warming	1	5	1.68	0.92	95
I try to buy products from sustainable certified companies	1	5	2.7	1.13	95

Q12) How much do you agree/disagree with the following statements regarding the real estate industry in Portugal? (1 totally agree – 3 neutral - 5 do not agree at all)

	Min	Max	Mean	SD	Count
Cares about the environment	1	5	3.33	1.08	95
Cares about the community that surround its activity	1	5	3.27	0.96	95
Actively works to reduce its environmental impact	1	5	3.41	0.85	95
Prioritize financial objectives at the cost of environmental objectives	1	5	2.19	0.93	95
It does not make a difference if is a sustainable industry or not	1	5	2.66	0.92	95

IV. R script

```
#setting working directory

setwd("~/Desktop/RSM")

#loading the data
data <- data.table(read_xlsx("datafile.xlsx"))

#data visualization income and wtp

ggplot(data4, aes(factor(income), fill = factor(wtp))) + geom_bar() + labs
(y= "Count")

#t-test difference average wtp between high income category and low income
category

t.test(incHL$wtp ~ incHL$income_num)

#t-test difference average wtp between high income category and medium inc
ome category

t.test(incHM$wtp ~ incHM$income_num)

#data visualization env_attitude and wtp

ggplot(data4, aes(factor(env_attitude), fill = factor(wtp))) + geom_bar()
+ labs(y= "Count")

#t-test difference average wtp between env_attitude two category

t.test(data4$wtp ~ data4$env_attitude)

#data visualization certification and wtp

ggplot(data4, aes(factor(certification), fill = factor(wtp))) + geom_bar()
+ labs(y= "Count")

#t-test difference average wtp between certification two category

t.test(data4$wtp ~ data4$certification)


#data visualization age_class and wtp

ggplot(data4, aes(factor(age_class), fill = factor(wtp))) + geom_bar() + l
abs(y= "Count")

#probit a logit regressions

probit <- glm(wtp ~ age_class + income + env_attitude  + certification , d
ata = data4, family = binomial(link = 'probit'))
logit <- glm(wtp ~ age_class + income + env_attitude  + certification , da
ta = data4,  family = binomial(link = 'logit'))
stargazer(logit, probit, type = 'text', no.space = TRUE)
```

V. T-test

```
#t-test difference average wtp between high income category and low income
category

##   Welch Two Sample t-test
##
## data:  incHL$wtp by incHL$income_num
## t = 0.12485, df = 37.606, p-value = 0.9013
## alternative hypothesis: true difference in means between group 2 and gr
oup 3 is not equal to 0
## 95 percent confidence interval:
##  -0.2536783  0.2870116
## sample estimates:
## mean in group 2 mean in group 3
##       0.3500000       0.3333333

#t-test difference average wtp between high income category and medium inc
ome category

##
##   Welch Two Sample t-test
##
## data:  incHM$wtp by incHM$income_num
## t = -0.12313, df = 38.6, p-value = 0.9026
## alternative hypothesis: true difference in means between group 1 and gr
oup 2 is not equal to 0
## 95 percent confidence interval:
##  -0.2905529  0.2572196
## sample estimates:
## mean in group 1 mean in group 2
##       0.3333333       0.3500000

#t-test difference average wtp between env_attitude two category

##
##   Welch Two Sample t-test
##
## data:  data4$wtp by data4$env_attitude
## t = 0.54725, df = 59.885, p-value = 0.5862
## alternative hypothesis: true difference in means between group No and g
roup Yes is not equal to 0
## 95 percent confidence interval:
##  -0.1527884  0.2678678
## sample estimates:
##   mean in group No mean in group Yes
##          0.3750000         0.3174603

#t-test difference average wtp between certification two category

t.test(data4$wtp ~ data4$certification)

##
##   Welch Two Sample t-test
##
## data:  data4$wtp by data4$certification
```

```
## t = 0.21483, df = 27.709, p-value = 0.8315
## alternative hypothesis: true difference in means between group No and g
roup Yes is not equal to 0
## 95 percent confidence interval:

##  -0.2247191  0.3174603
## sample estimates:
##  mean in group No mean in group Yes
##         0.3421053         0.3157895
```

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