

2017

The effects of sustainability development in high-rise buildings: A sustainability assessment on þý Limassol s new tower The Ov

Evripidou, Solonas

Real Estate Program, School of Architecture, Land and Environmental Sciences, Neapolis
University Pafos

<http://hdl.handle.net/11728/10493>

Downloaded from HEPHAESTUS Repository, Neapolis University institutional repository

NEAPOLIS UNIVERSITY

Real Estate & Valuations

Thesis: The effects of sustainability development in high-rise buildings: A sustainability assessment on Limassol's new tower "The Oval"

Tutor: Dr. Ioannou Theodora

Student: Evripidou Solonas

2017 - 2018

Contents

1. Acknowledgments	5
2. Introduction	6
3. Summary	8
4. Bibliography Review	9
4.1. Sustainable development.....	9
4.3. Sustainable developments are developed through achieving:.....	9
5. Local and European Law	11
6. The impact of sustainability in building development	14
6.1. Environmental impacts of sustainability development	16
6.2. Energy and Environmental Planning for sustainable buildings.	18
6.3 Social and economic impacts of sustainability development.....	20
7. Tools for measuring sustainability – BREEAM, SWAN, LEED	21
7.1.LEED – Categories, calculations and rating	22
8. BREEAM a tool for sustainability measurement	26
8.1. BREEAM Criteria	28
8.2. The nine environmental categories that distinct the criteria are:	29
8.3. Calculating a buildings sustainability level using BREEAM	31
8.4. Categories and weighting BREEAM 2008 edition	32
8.5. Category Criteria BREEAM 2008 edition:	33
8.6. Categories and weighting BREEAM 2011 New construction edition.....	36
8.7. Category Criteria BREEAM 2011 New construction edition:.....	36
8.8. SCORING AND RATING - BREEAM rating benchmarks	39
9.The Oval – an environmental sustainability assessment	40
a. Building characteristics:.....	41

10. Methodology	43
10.1. Step 1 – Preparing the questionnaire	44
10.2. Step 2 - Interview with the building’s expert officials	45
10.3. Interview questionnaire results	46
11. BREEAM 2008 EDITION QUESTIONNAIRE	47
12. Sustainability Assessment – Category weighting calculations. 2008 EDITION	51
13. Sustainability Assessment – Building scoring and Rating	54
14. BREEAM 2011 New Construction Edition – secondary assessment	55
14.1. BREEAM 2011 New construction Edition assessment table	56
15. Assessment results and conclusions	56
16. List of References	59
17. APPENDIX	61

List of Tables

Table 1. BREEAM environmental section weightings	29
Table 2. BREEAM Rating Benchmarks	32
Table 3. The oval building characteristics	34
Table 4. The questionnaire	38
Table 5. BREEAM assessment 2008 edition	43
Table 6. BREEAM assessment 2011 new construction edition	44

List of Figures

Figure 1. The three pillars of sustainability	16
Figure 2. Benefits of BREEAM	22

Figure 3. BREEAM categories and Rating23

Figure 4. The Oval33

1. Acknowledgments

First of all I would like to thank my thesis advisor Dr. Theodora Ioannou of the Real estate & Valuations faculty at Neapolis University.

The door to Prof. Ioannou's office was always open whenever I run into trouble or had a question about my research or writing.

Dr. Ioannou consistently allowed this paper to be my own work, but steered me in the right the direction whenever she believed I needed it.

I would also like to thank the team of experts who was involved in the validation survey for this research project, Mr. Andreas Michaelides the lead expert and Project Manager of The Oval.

Without his passionate participation and input and assistance, the validation survey could not have been successfully conducted.

Last but not least, I need to express my very profound gratitude to my family, and closed ones for providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this thesis. This accomplishment would not have been possible without them.

Thank you.

Author

Solonas Evripidou

2. Introduction:

Amidst the acknowledgments and steps towards that mankind has made in the last century, of mechanical and technological advantages, it is safe to say that since the industrial revolution and on we have only been exhausting our resources whilst contaminating the land we exploit. Since the late 1980's though we have seen that this limitless exploitation pattern is changing.

In 1987 it was the first time that the world heard about sustainability and the need for sustainable development from the WCED and the Bruntland report.

The report suggests that the exploitation of resources, the direction of investments and the technical and institutional changes need to be in harmony and empower today's and future's generations of people ability to satisfy their needs. It is the need to develop and improve the means of develop in order to protect the environment, the community and the economy.

Sustainability affects the buildings in various positive ways, meaning that by applying the rules, principles and indexes of sustainable development correctly the buildings will be more energy efficient, require less energy to be built to operate and to be maintained and will be much easier to handle (refurbish, re use, demolish) in the future.

There has also been a lot of implementation in European and national legislation in order to persuade and gear manufacturing companies to design and build in a more sustainable approach.

Companies nowadays tend to move towards the norms of sustainable development due to the various positive aspects it induces to the building and the area in general.

With this development it has become essential for large developing companies to procure sustainability assessments and reports for their buildings.

Similarly to the ones that are already built but also to the one's under development since it can prove valuable in minimizing the pollution, maintenance costs, waste management and recycling (both in the building phase and throughout the building's life-cycle cost's).

There are a lot of useful tools that can be used in order to assess a building's sustainability performance such as the rating systems of BREEAM, SWAN, LEED, GSBG and many more.

These tools may differ in the data collection methods or the overall methodology but the common purpose of all is to assess the level of sustainability performance of a building and the impacts of it on the environment and the area in general. Whether that is a house, a small two-story building, a multi-residence building or a skyscraper.

The purpose of this study is to use the tool we deemed most efficient for our assessment, in this situation the tool used is the BRE tool of building sustainability assessment and conduct an assessment on one of Limassol's new high-rise towers "The Oval".

This will be done in order to inspect the sustainability of the building and result in a degree of sustainability performance for it.

By the examination for presence or absence of specific sustainability indicators that are provided by the BREEAM tool of assessment and will be answered by credible sources, in our case experts of the developing company's.

This high-rise building is one of Limassol city's latest architectural gems and it was just recently constructed.

It is considered useful to conduct an assessment on such a new and upcoming building and see if the developing companies in Cyprus are in the path of sustainable development goals that were set by various multinational agreements such as the Habitat Agenda for urban sustainability, which was prepared for the 2001 United Nations General Assembly and the United Nations Rio 20 summit in Brazil in 2012.

3. Summary

The study summarizes the need for sustainable environment and sustainable development benefits for developers and the general public.

European and national laws and amendments demonstrate the path that the governments wish the developers to follow, which is towards sustainable development and creation of environmental friendly and energy efficient buildings. The study emphasizes on the principles of sustainability, energy and environmental planning.

Sustainable development seeks ways of making buildings energy sufficient, limiting maintenance costs, extending a buildings life cycle, suggests re-uses and restorations of buildings rather than demolishing them.

Even at the demolition phase, a sustainable building can provide raw recyclable material and demolishing a building would happen only if the building is beyond restoration phase or to improve the already existing territory.

Aim of the present study is to browse through various tools that measure sustainability for buildings such as BREEAM, LEED, SWAN, GSBC and distinct the proper one in order to produce an -accurate as possible- assessment for one of Limassol's recent high rise buildings.

For the purpose of this study the building selected is the "Oval" which is a recently constructed building, it is considered one of the city's highest investments and one of the best and most expected high-rise office buildings in Limassol's rental market.

Therefore it will be an excellent candidate to assess and inspect if the developers in Limassol and Cyprus in general, aim towards the path of sustainable development for their new buildings which is also one of the general aims of this study.

With the help of experts on the field a sufficient amount of data was collected that allowed the study to procure a non-professional sustainability assessment.

It is essential to note that a professional assessment with credible results can only be performed by a professional assessor therefore the assessment created and the assumptions made can only be used for the present study's purposes that will allow the study to assess the knowledge and expertise of developers in sustainability development.

4. Bibliography Review

4.1. Sustainable development

According to the Brundtland Report of 1987 *sustainable development* is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland Report, 1987).

The 3 pillars of sustainability:

- Environmental sustainability refers to the ability to maintain rates of renewable resource harvest, pollution decrease, and non-renewable resource depletion so that it can be continued indefinitely.
- Economic sustainability is the ability to support a defined level of economic production indefinitely.
- Social sustainability is the ability of a social system, such as a country, to function at a defined level of social wellbeing indefinitely (Gibbert, 2008).

4.2. Sustainable developments

Sustainable developments ensure the public's health and safety whilst improving their quality of life. These developments adapt to the natural landscape and habitat and interfere only to improve a territory that does not meet the standards of sustainable development.

Sustainable developments are developed through achieving:

- Increase of biodiversity in urban areas.
- Viable public transport networks.
- Waste recycle.
- Local energy production.
- Health protection.
- Increase in energy efficient buildings.

- Crime reduction.
- Reduction of social blocking.
- Variety of business opportunities.
- Preserving the environment and landscape.
- Creation of common areas.
- Creation of mixed use areas.
- Accessibility for people with disabilities.
- Permeability.
- Smart technology usage.
- Green areas.
- Minimization of liquid waste amounts (Ioannou, 2016).

Sustainability assessment tool:

In this case the term tool is used to describe a technique that predicts estimates and/or calculates one or more sustainable performance characteristics of a building.

For example: operating energy use, gas emissions, low compound energy materials etc. There are over 180 different sustainability development assessment tools currently in the world.

These tools differ in methodology and data collection approaches. Some rest entirely on life-cycle approach and some are consensus based.

Sustainability tools that rely one way or another on life-cycle approach are considered active tools while tools that do not take into account life cycle approach are considered passive tools (Munch, 2009).

Sustainability assessment method:

Sustainability assessment methods make use of or include references to sustainability tools as decision-making aids. Assessment methods result in a label or a certificate. Labels provide information to potential investors and can be used as an instrument of marketing and promotion for the building as a commitment to sustainability development and high user satisfaction building (Munch, 2009).

5. Local and European Law

Cyprus law is generally in accordance with the European Directives on many levels, mainly due to the fact that Cyprus is a member state of the European Union.

Laws regarding public safety, environmental protection and improvement have been under amendments, as well as legislations that were created in order to improve the sustainability development for countries in Europe.

The European Union has issued various legislations and amendments to its Countries – States in order to attain higher levels of sustainability compliance from the various nations.

The Lisbon treaty – Article 191 stated that in order to provide a more sustainable environment, the European Union member states should work towards attaining various objectives such as:

- *Preserving, protecting and improving the quality of the environment,*
- *Protecting human health,*
- *Prudent and rational utilization of natural resources,*
- *Promoting measures at international level to deal with regional or worldwide environmental problems, and in particular combating climate change.*

All members of the European Union aim in keeping these objectives on high status in order to ensure a better environment and better quality of life for their citizens.

Climate change and the prudent and rational utilization of natural resources are two objectives that interconnect in the way that the one ensures the other and vice versa.

Climate change is nature's way of showing the dramatic effects of resource exploitation throughout mankind's history and especially from the industrial revolution era until recent years.

The exploitation of resources should only secure the present needs while guaranteeing the future generation's availability and access to resources (*habitat agenda*).

The European Union had also introduced Article 192 which was mainly provisions inducted in order to aid countries but also to provide assistance, financial or otherwise, in fields such as town and country planning, quantitative management of water resources or affecting, directly or

indirectly, the availability of those resources and land use with the exception of waste management.

Another important aspect of the two articles is the fact that all countries are able in selecting their own energy resources and ways of harvesting energy according to each country's needs.

Yet another aspect is shown in Article 193 which states that regardless of the existing European laws a member state can prompt harsher regulations if deemed necessary.

The above-mentioned European legislation is already inducted in local legislation, Cyprus has also introduced some legislation mainly in an effort to direct developers towards sustainable development.

For instance "The Energy Efficiency Regulation of Buildings Act of 2006" is a legislation that basically states that all buildings that are over 1000 square meters and are active in the market, either finished or in construction phase should have an energy performance certificate issued.

The energy performance certificate ensures a building's energy consumption is at the acceptable levels and the certification is feasible for ten years.

Another example of how local legislation affects the developers in building on a sustainable development path is the law that obliges any owner of a land property bought that is going to be used for building either a private residence or a multi-store building to devote 15% of the land for green area.

That could be a park, trees, area of green in general, of course it depends on the area of the plot where if the plot is less than 800 meters there is no need for green area creation

Aim of these national and European laws is to provide a healthy, safe and sustainable environment for present and future generations.

In order to ensure a building permit and eventually a title deed for a development these high standards must be met by the developers and real estate companies in Cyprus.

The European Union has funded a lot of projects in the recent years that aimed in improving the sustainability degree of several of its member's cities.

Companies that are in renewable energy and waste disposal are funded in order to orient and inform the public of the benefits from sustainable development and environmental sustainability.

Cyprus has also made several amendments on pre-existing laws as well as imported new ones, either from local legislative means either directly from Europe in order to be in accordance with the abovementioned laws.

It is the aim of the government to invest in creating more sustainable areas in our cities thus giving public contracts for improvement works throughout the main cities of the island.

Cyprus has also shown strong determination in the restoration of villages throughout the island in an effort to preserve the cultural character of the villages.

The last few years there have been many restorative and improvement works in Limassol, which aimed in keeping the town's identity and cultural heritage whilst creating a more sustainable environment for its civilians.

Examples of the above-mentioned comment could be the restoration of the old town in Limassol as well as the old harbor.

The city has also seen a lot of local and foreign investments such the creation of the new Marina and the new skyscrapers that were built as well as the ones being built at the moment.

All of these projects have one common thing and that is they were build, designed, redesigned or restored in order to better adapt to the city's sustainability network.

Some of the projects improved the original landscape, the presence of green area, the public transportations and gave life to parts of the city that were slowly fading due to the lack of interest from the public.

6. The impact of sustainability in building development

Sustainability offers different positive impacts on all aspects of life such as social, environmental, economic, it is therefore essential to refer these positive outcomes in order to better understand the necessity for sustainable lifestyle and sustainability development.

As mentioned before sustainability is a term that has a very wide spectrum of definitions. Still sustainability aims to ensure that all the communities, all the businesses, the public services, the economy, the natural resources will have the capacity and be able to continue in the future (Ioannou, 2016).

Building development has always been in accordance with technological advantages that will improve performance, cost less, provide more safety and speed up the procedure.

In recent years technological means are being developed with sustainability in mind, that means new equipment, machinery, procedures or even materials are created and used while being in accordance with the principles of sustainability.

A sustainable building is a building that was created with low embodied energy materials such as wood, stone, other recycled materials, to the point of course that the building is in accordance with local city planning rules.

Depending for example on how seismic is an area the materials may vary depending the specific needs, sustainable buildings are very well thought and designed in the way that they have very low life cycle costs, that is assured due to the fact that these buildings are designed to be energy efficient.

An additional example would be the use of solar and photovoltaic panels that would ensure a building's electricity and warm water needs, minimizing the building's electricity expenses as well.

Correctly oriented in order to maximize the benefits from the sun and the wind to the building.

One more important aspect of sustainable development is the low maintenance costs that occur in sustainable buildings.

Due to the initial investments (for example the use of photovoltaic panels which is an investment that usually pays back the original sum in the first five years of the investment) and by correctly

designing and applying the natural resources to the buildings needs, sustainable developments are able to minimize their running costs (Ioannou, 2016).

Sustainability aims to bring people closer to the environment by subjecting the building itself into the local culture without negatively affecting the landscape or the local flora and fauna.

The building adapts to the natural landscape without negatively affecting it. Alteration of the existing landscape could happen only to better improve an area that might needs improvement.

For example if an area was contaminated by wastes or other chemicals sustainable development would ensure the areas improvement by disposing of the waste and chemicals and restoring or rebuilding the area according to the city's and sustainable development's needs.

On that note sustainability improves the environment where it needs to be improved and aims in making the buildings self-efficient by having very low life cycle and maintenance costs.

The demolition phase is considered as a last resort solution as refurbishing and reuse of old buildings is what the sustainability design aims for.

Demolishing a sustainable development would mean that a lot of materials could be re-used or recycled for different purposes, as stated before sustainability aims in ensuring a safe community, environment and access to resources for the future generations.

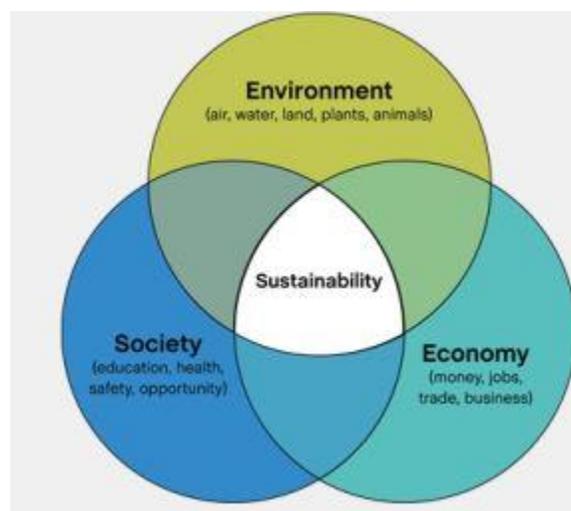


Figure.1

6.1. Environmental impacts of sustainability development

It is the nature of sustainability and one of its key cores to better adapt to the environment and the local climate rather than trying to create unusual habitats and spent money, time and energy in retaining them.

To better understand the environmental improvements and benefits from sustainable development it would be best to divide it into two categories.

The first category will be the environmental impact of sustainable development for a single establishment whether that is a single house or building.

The second category will be an effort to examine this impact on a bigger scale such as a local neighborhood/area.

According to sustainability the optimum area capacity that can excel as a community is a population of 30,000. Limassol is a city of 235, 000 according to the latest demo graphs (cy stats, 2016).

Single Building scale:

There are many environmental benefits from sustainable developments. For instance the thermal insulation of houses.

The high thermal mass and the airtightness of a building can save running and maintenance expenses to a significant degree, it also ensures lower amounts of energy needed due to the self-efficiency of the building.

This works in favor of the environment both from the low usage of energy but also from the low CO2 emissions created by the energy produced (Ioannou, 2016).

Sustainable buildings use the natural flora ,whether that may be a local forest or just local plantation, in order to lower the wind speed impacts on the house or even amplify sound proofing from outdoor noise.

Local plantation is also essential in reducing the city's CO₂ emissions or any other pollutants in the atmosphere.

Sustainable developments also use low embodied energy materials as well as recycled materials at the building or rebuilding phase.

When the building phase is over the building will be self-efficient on the collection of rainwater and the production of electricity and heat, high-rise or generally large buildings also have the ability to recycle or compost their own waste.

According to the University of Florida *“Composting is the biological decomposition of organic waste such as food or plant material with the use of worms, fungus and bacteria in a controlled environment in order to produce useful soil enricher and reduce waste quantities at the same time”*.

Sustainable buildings are also self – preserving buildings as they need lower amounts of energy to run thus making the building's life cycle much cheaper.

Similarly by reducing the amounts of energy needed a sustainable development reduces the negative impact on the environment.

Local neighborhood /area:

The impact of sustainable developments are much more obvious and imminent if the development happens on a larger scale.

This sustainable development could be something entirely new that was created due to the needs of the local community or it could be a refurbished or restored area that happened in order to preserve the cultural heritage and bring life to areas that were not attracting for the local communities anymore.

The sustainability design leads the developments into keeping the original landscape so that the buildings and the city itself can adapt to the natural landscape and not the other way around.

The only exception to this rule is if the original landscape does not meet the requirements of sustainable development, for example the land could be contaminated and the buildings are not suited for re-use or restoration.

The preservation of the natural habitat is a key requirement for a sustainable development to flourish, local forests and plantations aid in lowering CO₂ emissions as mentioned before, absorbing the sound, lowering the wind speed and reduces draught levels.

Another positive impact both environmental and economical is that sustainable development promotes the use of local materials. By using local materials the construction companies aid the local economy simultaneously minimizing the travel costs and the costs of their own companies.

Furthermore with the use of recycled materials the developing companies aid in preserving and protecting the environment, limiting the future maintenance costs and lowering the buildings thermal losses.

6.2. Energy and Environmental Planning for sustainable buildings.

- 1) Bioclimatic and energy design: The bioclimatic design is created by exploiting the natural resources of outdoor fields in order to acquire for example natural heating or lighting through an area.

Whereas the energy design focuses more on improving the energy efficiency of buildings through various tools of simulation and analysis with the utter purpose of improving the development methods and energy efficiency levels of developments.

- 2) Materials: The materials used in a building are responsible for the building's energy usage but also for the levels of environmental pollution both in construction phase but also through the buildings life cycle.

Sustainable developments prefer low embodied energy materials to work with while using renewable energy technologies and waste disposal technologies in order to have as minimum a negative effect on the environment as possible.

Renewable energy technologies can be applied on a development to make it self-efficient and minimize its running costs.

Recycled materials are preferred since in many demolition situations recycled materials can be recycled again and re-used in future developments or other uses.

3) An ecological orientated and environmentally friendly design must follow some set principles of sustainability.

These principles aren't always met fully by sustainable developments mainly due to the initial cost expenditure that some of these innovations might require. The following principles are considered essential in order to ensure a sustainable environment:

- Building smaller developments.
- The use of recycled and renewable materials.
- The use of low compound energy materials.
- The use of wood.
- Water collection systems.
- Low maintenance cost.
- Re use of buildings.
- Reduction of chemicals affecting the ozone layer.
- Preserving the natural habitat.
- Development of energy efficient buildings.
- Proper sun and wind building orientation.
- Ease of access to transport (Ioannou, 2017).

6.3 Social and economic impacts of sustainability development

The degree of an acceptable sustainability design will be the difference between successful and viable societies and non-viable and socially rejected communities.

There are many aspects of the sustainability design and development that aid a community, an area or a whole city both socially and financially.

As technology progresses so does the need for quality of life, and as this quality of life improves so does our human need to socialize to be more easily accepted and understood.

Permeability in civil designing refers to the ease at which people can transport in an area from one place to another, it is all about keeping the city or the area selected interconnected with no dead end streets, with centers of interest throughout the city.

Ease in approaching all sorts of amenities in the desired area, the ease of use of public transportation in the desired area, these are city design ways which will improve and enhance the socialization of individuals residing in the area (Ioannou, 2016).

As mentioned before, the protection of the cultural heritage is a huge chapter of sustainable development, in keeping this cultural heritage intact it is essential in protecting the local natural habitat as well.

The sustainability design aims in bringing people closer together, in an effort to do that the original landscape can be redesigned if needed in order to create green areas as well as water accessed areas such as small forests, small lakes, or large parks.

Usually landscapes that have lost attraction are picked for restoration in an effort to bring back life to those territories.

Sustainable development creates huge economic benefits, especially in larger scales of developments and extended periods of prosperity. Sustainable buildings are built in such a way that are self-preserving and energy efficient.

The investment on photovoltaic panels for example can prove to be a huge economy saving on electricity expenses. The buildings are also self-sufficient on thermal heat as well as heated water therefore limiting the expenses even more.

On city scale the economic impacts can be huge since the public transportation can provide a huge income for the city authorities that can reinvest the money into city investments.

The use of recycled materials and the recycling policy in general can create new jobs and boost the local economy. Sustainable cities provide the public with a safer and healthier environment.

Sustainable developments don't interfere with the natural landscape but only improve the pre-existing area if needed, creating cities that are improved and better organized but without losing its historic heritage and uniqueness.

Each building's orientation and design provide wind and sun benefits for the owners whilst allowing fumes and emissions to exit the city's atmosphere faster limiting the air pollution.

It also allows the buildings to be thermally efficient, meaning keeping the sustainable development warm in the winter and cool in the summer.

7. Tools for measuring sustainability – BREEAM, SWAN, LEED

Our generation has seen many technological advantages in all the fields of science, as we evolved our knowledge and understanding about our planet and the environment grew exponentially.

The harm done on our planet during the last couple of centuries was so dire that people sought the necessity to implant the need for protection of the environment, the society, for the economic and welfare of people for the present and for the future to come.

Sustainable programs, laws promoting and encouraging sustainability, sustainability in building design and development were inducted in our way of life.

As the years pass by and the need for sustainable adaptation in our developments grows, so does the knowledge and the expertise.

There are many companies that specialize in sustainability analysis and management. These companies have tools that help in accessing the degree of sustainability a building has, the more indicators a building has the better grade it will receive on the sustainability assessment.

The term “tool” is used to describe a specific technique that calculates, estimates or predicts one or more sustainable performance characteristics of a building (e.g. energy use, emissions/waste, compound energy materials used).

There are many tools that assess all sorts of different buildings like LEED, SWAN (which is mostly used for home residences) DGMB, BREEAM and so on.

All of the tools have more or less similar indicators that need to be checked, the differences are spotted usually when a tool has a specific type of building to assess thus having special indicators to inspect, or are designed for specific countries facing special weather conditions (e.g. Dubai).

There are tools like SWAN which are specifically designed to assess small residences and single homes using comparative analysis and criteria metering but this kind of tool is not preferred for large high rise buildings or bigger projects since its missing key sustainability indicators and criteria in order to provide a complete assessment.

Even though there are many sustainability assessment tools in the market only two of them really stand out due to the vast usage of them on a global scale.

These tools are the American LEED and the British BREEM, the study will thoroughly analyze the market’s top two sustainability assessment tools and suggest the most appropriate tool to use for the study’s sustainability assessment.

7.1. LEED – Categories, calculations and rating

The LEED is a globally established tool with over 92,000 registered and certified projects across 165 countries. Originally the LEED was designed for domestic usage in the United States and preferably for buildings that were in the design phase.

Later on the LEED became worldwide releasing different guides and manuals such as the LEED Italy, LEED India but also guides that were created for buildings passed the design phase such as the LEED – NC (New Construction and Major Renovations) manual.

The LEED sustainability assessment method is based on points, which are being given to individual credits. There are 43 different criteria in LEED. The credits are divided to seven main categories.

The seven main LEED categories are the following

Energy and Atmosphere (EA)
Water Efficiency (WE)
Sustainable Sites (SS)
Materials and Resources (MR)
Indoor Environment Quality (IEQ)
Innovation & Design (ID)
Regional Priority (RP)

Calculating the points for LEED is done through checklists, which gives the design team a wide variety of devices and technologies to consider using.

LEED is most frequently used on buildings that are on the designing phase since the criteria are heavily depended on market values. Originally on the American market but in recent years more manuals have been released aiming in global usage.

The assessment is based on points and all LEED criteria are worth a minimum of 1 point. All LEED rating systems have 100 base points.

There are different topic areas included in the LEED assessment method and each of the topics has a unique goal.

LEED inspects the levels of sustainable practice through mandatory measures in different credit categories and there are no points for meeting the mandatory minimum requirements.

All categories and criteria are listed with the number of available points. In LEED rating system is not possible to meet only a proportion of a criteria requirements, the requirements are either met or not.

For each criteria, the building will either meet the LEED demands and gets a point on the selected criteria or it will not meet the LEED demands and will not receive the point.

The only exception from the above rule is met in the following three criteria which are water use reduction, optimize energy performance and on – site renewable energy.

The number of credit awarded to these three criteria depends on the degree of fulfillment.

In the case of LEED, there is no multiplying system similar to the one we meet in BREEAM and points are awarded directly.

The sum of all the points from all the categories is represented as the assessed building's total LEED score.

The four performance tiers according to the number of points earned indicate the level of sustainability performance of the building.

The LEED certifications Levels are shown below (LEED – NC 2009)

LEED Rating Points

Certified	40 – 49
Silver	50 – 59
Gold	60 – 79
Platinum	≥ 80

Due to the fact that both LEED and BREAM are sustainability assessment tools, they share a lot of similarities and differences as well, they also seem to adapt to each other's innovations in order to present a better completed assessment.

For instance both of the tools require accredited assessing before issuing a certificate of sustainability. BREAM assessment is done by accredited assessors in order to receive a BREAM certificate.

Whereas the LEED assessment can be done by anyone but in order to get an LEED certificate it needs to be submitted to the LEED council and assessed by LEED professionals.

Another alteration is found in the calculation system where in LEED there is a metric system where the sum of all the categories sums the result of the building rating.

Whereas BREAM works with percentages and summing the percentages of each category. BREAM thoroughly explained further below.

Tools such as LEED and BREAM are frequently requested by developing and real estate companies to assess their buildings due to the fact that sustainability accredited buildings gain bonuses from the assessment.

A sustainability certificate can be used as an instrument for marketing and communication of commitment to sustainability from the company/owner to the public. It can also be used as a communication tool for the owners and users of a building and boost PR.

The study will focus specifically on the BRE tool of assessment since it is deemed as the most appropriate one for the building specified in the study. BREEAM was selected due to various reasons such as:

- BREEAM is one of the leading tools in sustainability assessments.
- BREEAM provides specific assessment for newly constructed buildings – which is the case for the building this study will assess.
- Accessible data from BRE that allowed the study to procure an accurate as possible assessment.
- Leading experts for the building which data were taken from were familiar with the tool therefore making the data more credible and easier to collect (BREEAM, 2017).

Detailed explanation of BREEAM tool of sustainability assessment, criteria and criteria weighting, assessing, calculating and rating the sustainability of a building, is provided below.

8. BREEAM a tool for sustainability measurement

BREEAM is the British Building Research Establishment (BRE) Environmental Assessment Method and it was originally created back in 1990, it was the base for many tools that were created more recently. BREEAM is one of the most well-known and acknowledged sustainability assessment tools throughout the world with over 562,000 buildings certified and over 2,200,000 registered buildings (BREEAM, 2017).

BREEAM is thought to be one of the leading tools alongside with LEED in the world at the moment. The tool relies on assessing and metering many different criteria which could be environmental, economic, healthcare, and managerial.

BREEAM was created as a cost-effective mean of bringing sustainable value to development. It helps investors, developers, design and construction teams and occupiers to use natural resources more efficiently.

There may be a capital cost to building to the enhanced standards promoted by BREEM, but this cost needs to be seen in the context of the overall value of sustainable development. Growing evidence is demonstrating that sustainable developments, like those delivered through BREEAM, offer value in many ways, including:

Reduced operational costs

Research carried out by construction consultants and BRE found that office developers typically invest up to 2% more when targeting higher BREEAM ratings, and recover that additional investment in two to five years through savings in their energy and water bills.

The same research found that achieving lower BREEAM ratings can incur little or no additional cost (BREEAM, 2017).

Helping to limit investor and developer risk

Climate change and evolving regulation are posing increasing challenges for existing buildings and their owners and investors. Buildings that are not equipped for the future may face the risk of devaluation and could eventually become stranded assets.

This notes that properties falling below the standard may potentially be subject to, “a negative impact on collateral value and a consequent increase in the loan to value ratio” (bream, 2011).

Making a building more attractive to let, sell or retain

There is growing evidence to show that sustainable buildings offer increased rates of return for investors, and increased rental rates and sales premiums for developers and owners. Various studies conducted shared data from transactions from 2000 to 2009 for a sample of BREEAM office buildings in London. The resulting report found that these buildings achieved a:

- 21% premium on transaction prices
- 18% premium on rents.



Source : BSRIA field research⁽¹⁾ (client respondents only)

Figure 2. Benefits of Breeam

Creating a more productive and healthy workplace

“Sustainable buildings can have a host of benefits for the people who work in them. Standards like BREEAM help to create workplaces with good indoor air quality, good lighting and daylighting levels and higher perceptions of comfort than average offices.

As an example of the impact such factors can have, research by the World Green Building Council says better indoor air quality can help improve staff productivity levels by as much as 8-11%” (BREEAM, 2011).

Note: As most assessment tools are carried out by accredited assessors the study aims in providing an approximation of the actual calculations due to lack of expertise and experience.

Another fact that has to be stated is that this assessment is done with the 2008 and 2011 BREEAM New construction manual since only accredited assessors have access to the latest and most recent updates of this tool.

8.1. BREEAM Criteria

The tool uses various criteria in order to assess a building. BRE defines criteria as “individual assessment issues panning the nine environmental categories.

Each issue addresses a specific building related environmental impact or issue and has a number of ‘credits’ assigned to it.

‘BREEAM credits’ are awarded where a building demonstrates that it meets the best practice performance levels defined for that issue i.e. it has mitigated an impact or, in the case of the health and wellbeing section, addressed a specific building occupant-related issue e.g. good thermal comfort, daylight or acoustics.” (BREEAM, 2017).

8.2. The nine environmental categories

There are nine main environmental categories that the above-mentioned criteria are concluded to. Detailed explanation of the categories listed below

- Management
- Pollution
- Water
- Health and Wellbeing
- Energy
- Transport
- Materials
- Waste
- Land Use and Ecology

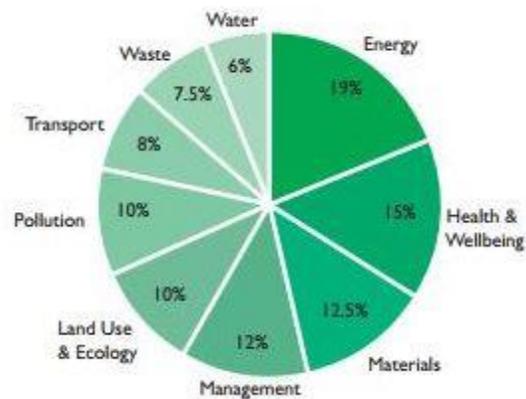


Figure 3. Categories & Weighting

Each of these categories are consisted with a set number of criteria and each category has a percentage of weighting in the overall assessment. For example the Water category consists of four criteria which are:

- Water meter,
- Major leak detectors,

- Water consumption,
- Sanitary supply shut-off.

The weighting of this category is 6% of the total assessment. Detailed criteria and category weighting for all categories will be provided in the assessment section of this study.

- Note: BREEAM states that “The number of ‘credits’ available for an individual assessment issue (criteria) will vary and generally the higher the number there are for a given issue, the more important that issue is in terms of mitigating its impact.

In most cases, where there are multiple ‘credits’ available, the number awarded is based on a sliding scale or benchmark, where progressively higher standards of building performance are rewarded with a higher number of ‘credits’ (BREEAM, 2017).

As stated before, the assessment for the building is done with valid yet limited information, therefore this study acquired valid information on the presence or absence of the criteria’s for the selected building but since the study is done on an academic level and not by an accredited professional deciding the percentage of credits given for each individual criteria would not have been accurate due to lack of expertise and experience.

For example the criteria named “Major leak detectors” could have consisted of 5 different sub-criteria which could be concerning the system used, if the system complies with certain credentials and so on. Only an accredited assessor that is properly trained could provide an accurate assumption as to what sub-criteria are met to each main criteria point.

The study procured valid information from expert officials about all nine categories and all 61 criteria but takes in account only the presence or absence of the specific criteria and not the percentage of the sub-credits achieved by each criteria.

BREEAM 2011 technical manual also states that “*An additional 1% can be added to a building’s overall score for each ‘innovation credit’ achieved. The maximum number of ‘innovation credits’ that can be awarded for any one building is 10 therefore the maximum available additional score for ‘innovation’ is 10%. Innovation credits can be awarded regardless of the building’s final BREEAM rating i.e. they are awardable at any BREEAM rating level*” (BREEAM, 2011).

8.3. Calculating a buildings sustainability level using BREEAM

Whilst the full assessment and calculations for it will be thoroughly listed in the assessment section of this study, outlined below is the process of determining a BREEAM rating for a building and an example calculation included all provided by BREEAM:

For each environmental section the number of ‘credits’ awarded must be determined by the assessor in accordance with the criteria of each assessment issue (as mentioned before for the purpose of this study credits for each criteria will not be awarded, as data were provided only for the presence or absence of each criteria).

An example of BREEAM 2011 technical manual calculations for a building assessment is listed as follows “*The transport section will be calculated as an example of how all the sections will be calculated on the assessment section of this study.*

1. *The Transport section consists of 5 different criteria in our assessment the building scored positively at 4/5*

The percentage of ‘credits’ achieved is then calculated for each section.

2. *Converting a fraction such as 4/5 into a percent is calculated as follows.*

Divide the numerator by the denominator and then multiply that result with 100.

$$(Numerator/Denominator)*100$$

*Transport example: $(4/5)*100 = 80\%$*

3. *The percentage of ‘credits’ achieved in each section is then multiplied by the corresponding section weighting.*

*Example for Transport its 8% -> $80\% * 8\% = 0,064 = 6,4\%$*

This gives the overall environmental section score. In our example out of the 8% that could possibly be attained the building scored a 6, 4%.

4. *The section scores are then added together to give the overall BREEAM score. The overall score is then compared to the BREEAM rating benchmark levels and, provided all minimum standards have been met, the relevant BREEAM rating is achieved.*
5. *An additional 1% can be added to the final BREEAM score for each ‘innovation credit’ achieved (up to a maximum of 10%)” (BREEAM, 2011).*

8.3. Categories and weighting BREEAM 2008 edition

The following bulletins consist the different categories with their allocated weighting according to the BREEM manual 2008 edition.

- **MAN** - Management (management policy, commissioning, site management and procurement) **12%**
- **HEA** – Health & wellbeing (indoor and external issues(noise, light, air quality, etc.) **15%**
- **ENE** – Energy (operational energy and carbon dioxide (CO2)) **19%**
- **TRA** – Transport (transport related CO2 and location related factors) **8%**
- **WAT** – Water (consumption – and loss-related aspects) **6%**
- **MAT** – Materials (embodied impacts of building materials) **12,5%**
- **WST** – Waste (construction resource efficiency and operational waste management and minimization) **7,5%**
- **LE** – Land Use & Ecology (aspects of ecological value of the property) **10%**
- **POL** –Pollution (external air and water pollution) **10%** (Munch, 2009).

8.5. Category Criteria BREEAM 2008 edition:

- Note that as previously mentioned these criteria will be checked only for their presence or absence from the building that will be assessed.
 - Management - (management policy, commissioning, site management and procurement) 12%
 1. Commissioning
 2. Constructors experience
 3. Construction site impacts
 4. Security

 - Health & wellbeing - (indoor and external issues(noise, light, air quality, etc.) 15%
 1. Daylighting
 2. Outside view
 3. Glare control
 4. High frequency lighting
 5. Potential for natural ventilation
 6. Indoor air quality
 7. Lighting zones and control
 8. Volatile organic compounds
 9. Thermal zoning
 10. Thermal comfort
 11. Microbial contamination
 12. Acoustic performance

 - Energy - (operational energy and carbon dioxide (CO2)) 19%
 1. Reduction of CO2 emissions
 2. Sub metering of substantial energy use
 3. Lifts
 4. Escalators & traveling walkways

5. Sub metering of high energy load and tenancy areas
 6. Low to zero carbon technologies
- Transport - (transport related CO2 and location related factors) 8%
 1. Provision of public transport
 2. Proximity to amenities
 3. Cyclist facilities
 4. Pedestrian and cyclist safety
 5. Maximum car parking capacity
 6. Travel plan

 - Water - (consumption – and loss-related aspects) 6%
 1. Water consumption
 2. Water meter
 3. Major leak detectors
 4. Sanitary supply shut –off

 - Materials - (embodied impacts of building materials) 12,5%
 1. Materials specification (major building elements used)
 2. Reuse of building façade
 3. Reuse of building structure
 4. Responsible sourcing materials
 5. Insulation
 6. Hard landscaping and boundary protection
 7. Designing for robustness

 - Waste - (construction resource efficiency and operational waste management and minimization) 7,5%
 1. Construction site waste management
 2. Recycled aggregates
 3. Recyclable waste storage

4. Floor finishes
 5. Low compound energy materials used
 6. Composting of garden waste
- Land Use & Ecology - (aspects of ecological value of the property) 10%
 1. Re use of land
 2. Contaminated land
 3. Ecological Value of site and protection of ecological features
 4. Mitigating ecological impact
 5. Is it enhancing the site ecology?
 - Pollution - (external air and water pollution) 10%
 1. Minimizing watercourse pollution
 2. Reduction of night time light pollution
 3. Noise attenuation
 4. Refrigerant GWP – Building services *
 5. Preventing refrigerant leaks *
 6. Nox emissions from heating source * (Munch,2009)

➤ Note: The criteria displayed here are the 2008 edition criteria and weightings, which were used in the interview in order to collect data about the building assessed.

Criteria 4 – 5 -6 from the Pollution category, were removed and exchanged during the interview.

The reasons were that first and foremost the interviewee did not provide the necessary data concerning the three abovementioned criteria and secondly since BREEAM suggests that it is possible to differentiate criteria in order to deem the Country's needs and legislations.

Thus removed these criteria and added new criteria concerning the use of photovoltaic systems since the weather conditions in Cyprus greatly benefit the investors on economic, social and environmental levels. More details on criteria selection and calculation in the assessment section of this study.

8.6. Categories and weighting BREEAM 2011 New construction edition

Environmental section	Weighting
Management	12%
Health & Wellbeing	15%
Energy	19%
Transport	8%
Water	6%
Materials	12.5%
Waste	7.5%
Land Use & Ecology	10%
Pollution	10%
Total	100%
Innovation (additional)	10%

Table 1.

8.7. Category Criteria BREEAM 2011 New construction edition:

- Note: that as previously mentioned these criteria will be checked only for their presence or absence from the building that will be assessed.
 - Management
 1. Sustainable procurement
 2. Responsible construction practices
 3. Construction site impacts

4. Stakeholder participation
 5. Life cycle cost and service life planning
- Health and wellbeing
 1. Visual comfort
 2. Indoor air quality
 3. Thermal comfort
 4. Water quality
 5. Acoustic performance
 6. Safety and Security

 - Energy
 1. Reduction of emissions
 2. Energy monitoring
 3. External lighting
 4. Low and zero carbon technologies
 5. Energy efficient cold storage
 6. Energy efficient transportation systems
 7. Energy efficient laboratory system
 8. Energy efficient equipment
 9. Drying space

 - Transport
 1. Public transport accessibility
 2. Proximity to amenities
 3. Cyclist facilities
 4. Maximum car parking capacity
 5. Travel plan

 - Water

1. Water consumption
 2. Water monitoring
 3. Water leak detection and prevention
 4. Water efficient equipment
- Materials
 1. Life cycle impacts
 2. Hard landscaping and boundary protection
 3. Responsible sourcing of materials
 4. Insulation
 5. Design for robustness
 - Waste
 1. Construction waste management
 2. Recycled aggregates
 3. Operational waste
 4. Speculative floor and ceiling finishes
 - Land Use and Ecology
 1. Site selection
 2. Ecological value of site and protection of ecological features⁴
 3. Mitigating ecological impact
 4. Enhancing site ecology
 5. Long term impact on biodiversity
 - Pollution
 1. Impact of refrigerants
 2. NOX emissions
 3. Surface water run off
 4. Reduction of night time pollution
 5. Noise attenuation (BREEAM, 2011).

- Note: The BREEAM 2011 new construction edition consists of 43 criteria most of which are either exactly the same or a combination of 2008 edition criteria. Therefore an additional assessment will be attempted on the building using the BREEAM 2011 edition but the results of this assessment will be of secondary use and purely to satisfy the interest and not to be taken into account.

8.8. SCORING AND RATING - BREEAM rating benchmarks

OUTSTANDING	>85%
EXCELLENT	>70%
VERY GOOD	>55%
GOOD	>45%
PASS	>30%
UNCLASSIFIED	<30 %

Table 2.

The percentages displayed above would represent the sum of all percentages from all nine categories of a building assessment plus any additional points awarded for innovation schemes or certificates possessed by the assessed building (Breeam, 2011).



Figure 4. The Oval

9. The Oval – an environmental sustainability assessment

The Oval was designed by Atkins architecture a global firm with huge projects all around the world, the owners are one of the biggest investor and developer companies in Cyprus.

The Oval is an ideal high-rise building situated near the Limassol seafront, Limassol is one of the wealthiest and most upcoming cities in Cyprus. It is the tallest building in Limassol for the time being with sixteen floors and two basement floors for parking at a total high of at seventy five meters.

The developer aims to sell luxurious high end offices that are close to city center and offer a unique view of the sea and the island in general. State of the art facilities and services, manned reception and security, camera surveillance and other amenities.

The Oval has already three green certificates that already shows the buildings and the developing companies principles regarding sustainable development and environmental awareness.

The building has just recently finished from construction phase and is expected to be a fast seller since the demand for these type of buildings is on the rise in recent years (The Oval, 2017).

As mentioned aim of this study is to inspect the sustainability of a big investment project preferably a recently finished construction and by doing so inspect the awareness showed by the developing companies towards sustainable development.

a. Building characteristics:

Name	The Oval
City	Limassol
Height(architectural)	75m
Floors (above ground)	16
Floors (below ground)	2
Construction start	2014
Construction end	2016
Building type	High-rise building
Total area	19,000 sqm
Amenities	Exercise room, raised floors

Table 3

The selection of the building is ideal, since the study aims to inspect the sustainability on recently developed buildings and not buildings that were built over a decade ago or so.

The reason is that sustainability, and sustainability development in Cyprus, is such a new science that it is constantly evolving giving us new information about better ways of developing, restoring, reusing buildings.

The building is one of the biggest projects in Limassol right now, it was designed and manufactured from a leading group of experts both foreign and domestic, it will be very useful to inspect if Cypriots and Cyprus established developing companies are in harmony with the environmental sustainability local and European laws of their buildings.

It is obvious from European and Cyprus legislation that the governments are trying to implement an environmental sustainability vibe to developing companies, with many amenities, exclusions or tax reduction in order to be persuaded in following a more sustainable path.

From the early stages of research done to the building, it became clear that it is developed with sustainability principles in mind and very green friendly due to the fact that it had multiple environmental certificates.

Environmental certificates don't always ensure that the building is a sustainable development but rather it is in a path towards sustainability development that was also the reason the study wanted to subject the specific building to an environmental sustainability assessment in order to inspect whether the certificates are accurate.

Also to examine what direction our latest and biggest projects are going to, even if the knowledge of the tools is not 100% accurate and a professional assessment would not be possible to be exempted, the procedure and methodology of the tool and assessment is followed exactly according to the instructions.

Thanks to the developing company's experts all the information needed to proceed with the assessment were provided and will be processed accordingly.

10. Methodology

It is the goal of this case study to examine one of the biggest projects of recent years in Limassol, using the BRE environmental assessment method (BREEAM British edition).

The selected building is a project that demonstrates the intentions of development companies and leading designs in high rise buildings, it will be useful to conduct this sustainability assessment in order to see if the developers are willing to persuade the sustainability development path that is orchestrated and promoted by the European Union and Cyprus.

Of course the grade that this particular building receives does not necessarily mean that it represents a similar responsive grade for all the new buildings or the buildings in construction.

It is rather a case study on one of the biggest and most noticeable projects in the city, designed and developed by esteemed experts and it is a huge investment for the city, making it a perfect assessment scenario, the fact that it is also a recently finished building will allow us to have better accuracy on the report rather than assessing a relevantly older building.

To conduct this assessment a questionnaire was prepared using the 2008 BREEAM manual which consists of 59 criteria.

Note that one of the leading reasons BREEAM is so vastly used on a global scale is that the creators of the tool made it possible to exchange criteria, this was made available for several reasons. For instance in order to satisfy specific country weather conditions or differentiations in country legislations.

Countries like Cyprus or Qatar where the weather is sunny and has clear sky's for 60%-80% of the year we can exchange various criteria enlisted in the Energy category, such as NOX emissions since Cyprus does not have any heavy industry to produce the scale of emissions suggested to be dangerous for public health and replace it with Photovoltaic usage since that way it would make the Energy category enlist factors which are more relevant to the local weather conditions and economy.

This might seem a bit engineered in order to procure a higher rating but the tool suggest to differentiate criteria if needed in order to address local factors and/or conditions in a more accurate manner.

The criteria that changed was differentiated before the interview with the building's experts and their answer on the matter was not orchestrated, the fact that the criteria that was changed by the study received negative responses thus lowering the buildings grade only amplifies the integrity of the study.

The questionnaire was answered by expert officials and with all the credible data that was collected an assessment was procured following the steps provided by the 2008 & 2011 BREEAM technical manual for new constructions.

In the assessment that will follow two separate assessments are prepared, one using the categories and criteria weightings from BREEAM 2008 edition and the second by BREEAM 2011 edition.

The reason behind this is that the data collected was sufficient enough to provide accurate assessments on both editions due to the fact that the criteria of the 2011 edition were similar to the criteria of the BREEAM 2008 or a combination of criteria, as mentioned before due to the fact that only the 2008 edition criteria were answered by expert officials, only the 2008 edition percentage of sustainability will be taken into account.

The 2011 edition will be calculated and produced in order to see if the two percentages are similar since the same procedure will be followed.

10.1. Step 1 – Preparing the questionnaire

As mentioned before the questionnaire was comprised of 59 criteria weightings that was designed following the BREEAM 2008 British edition manual.

The only difference is that because this was designed for the United Kingdom some criteria was not going to be of the same importance due to the fact that the study takes place on a Mediterranean island with warm sunny weather for at least nine to ten months a year instead of the United Kingdom where the weather is much different.

Similarly the UK has one of the biggest industries in the world exporting everything from cereal to automobiles whilst Cyprus exports only consumables therefore has no heavy industry.

Whilst inspecting the several criteria it was decided to differentiate some environmental criteria as NOX emissions with photovoltaic installment or photovoltaic procurement since as stated before Cyprus is a country that can heavily benefit from photovoltaic installations both from an economic and environmental aspect.

Due to the fact that the whole system of rating is percentage based for each criteria removed a criteria that affects the same category was added.

For this building two more criteria were which was photovoltaic energy sufficiency and photovoltaic installation providence which could be inputted if some of the criteria was of no use for our building mainly due to country differences.

Keep in mind that as stated before BREEAM is a flexible tool that can have several inputs or outputs as sustainability criteria and those criteria may change according to the areas needs, that's why there are a lot of different BREEAM editions all over the world.

The questionnaire was finally drafted with two extra criteria rather than the original 59, as mentioned before and was sent via e-mail to expert officials of the project so that they could study and provide useful Intel.

10.2. Step 2 - Interview with the building's expert officials

An interview was conducted with the expert officials via telephone call, the building official was very helpful and seemed interested in the sustainability assessment of the building. Bare in mind that this report is neither official nor can it be used for any other reasons other than serving as a thesis report for the Real Estate & Valuation department of Neapolis University.

The interview was continued with answering questions about each criteria and the methodology that will later be used and was completed in an orderly fashion with the building official filling and sending a copy of the filled questionnaire that is going to be assessed via the BREEAM methodology and procure a grade for the building.

Even though a table with the answered criteria will be provided below, the original documents sent via email by the buildings officials will be attached with the study as proof of the interview (see APPENDIX).

10.3 Interview questionnaire results

Below is a table of the answered questionnaire for the sustainability assessment of “The Oval” in Limassol, using the BREEAM methodology. Even though the similar case studies that were examined before this study used only YES or NO indicators in order to specify the presence or absence of a sustainability indicator.

The percentage possibility was added in order to extract more accurate results on some indicators and for example if an indicator was in use but not to its full capacity it would be helpful to have knowledge of it rather than just dismissing it, secondly the Notes section was added in order to provide the opportunity to the experts to share some additional knowledge on the building that could also allow the study to proceed with better knowledge about the building therefore creating a better assessment.

10.4. BREEAM 2008 EDITION QUESTIONNAIRE

Sustainability indicators	YES	NO	% when possible	category codes / Engineer notes
1. Provision of public transport	X			Tra1
2. Proximity to amenities	X			Tra2
3. Internal and external lighting levels	X			Hea5
4. External lighting	X			Ene4
5. Cyclist facilities	X			Tra3
6. Pedestrian and cyclist safety	X			Tra4
7. Maximum car parking capacity	X			Tra6 / notes 220 , 107 residents ,13 visitors
8. Hard landscaping and boundary protection	X			Mat 2
9. Designing for robustness	X			Mat7
10. Re use of land		X		LE 1
11. Contaminated land		X		LE2
12. Ecological Value of site and protection of ecological features	X			LE3
13. Mitigating ecological impact	X			LE4
14. Minimizing watercourse pollution	X			Pol 6

15. Reduction of night time light pollution		X		Pol 7
16. Noise attenuation	X			Pol 8
17. Daylighting	X			Hea 1 / Notes: The whole day, correct orientation
18. Outside view	X			Hea 2 / Notes :Mountain, Sea
19. Glare control	X			Hea 3
20. High frequency lighting				Hea 4 / LED lighting everywhere
21. Potential for natural ventilation	X			Hea 6
22. Indoor air quality	X			Hea 7
23. Lighting zones and control	X			Hea 8
24. Volatile organic compounds		X		Hea 9
25. Thermal zoning	X			Hea 10
26. Thermal comfort	X			Hea 11
27. Microbial contamination		X		Hea 12
28. Acoustic performance	X			Hea 13
29. Reduction of CO2 emissions	X			Ene 1
30. Sub metering of substantial energy use				Ene 2 / (exchange with new indicator)
31. Sub metering of high energy load and tenancy areas				Ene 3
32. Lifts	X			Ene 8

33. Escalators & traveling walkways		X		Ene 9
34. Water consumption	X			Wat 1
35. Water meter	X			Wat 2
36. Major leak detectors	X			Wat 3
37. Sanitary supply shut –off		X		Wat 4
38. Materials specification (major building elements used)	X			Mat 1
39. Reuse of building façade		X		Mat 3
40. Reuse of building structure		X		Mat 4
41. Responsible sourcing materials	X		10%	Mat 5
42. Insulation	X			Mat 6
43. Refrigerant GWP – Building services				Pol 1 / Replace with new criteria
44. Preventing refrigerant leaks				Pol 2 / Replace with new criteria
45. Nox emissions from heating source				Pol 4 / Replace with new criteria
46. Recycled aggregates		X		Wst 2
47. Commissioning	X			Man 1
48. Constructors experience	X			Man 2
49. Construction site impacts	X			Man 3
50. Security	X			Man 8
51. Low to zero carbon technologies	X			Ene 5
52. Travel plan		X		Tra 5

53. Construction site waste management	X			Wst 1
54. Double glazed windows	X			Hea 13
55. Recyclable waste storage	X			Wst 3
56. Floor finishes	X			Wst 6
57. Is it enhancing the site ecology	X			Le 5
58. Use of photovoltaics?		X		Ene 6
59. If not is there a provision for installation of photovoltaics?		X		Ene 7
60. Low compound energy materials used	X		60%	Wst 7
61. Composting of garden waste		X		Wst 8
62. Use of original landscape		X		Le 7
63. Improvement of original landscape	X			Le 6

Table 4. Questionnaire

11. Sustainability Assessment – Category weighting calculations. 2008 EDITION

- **Management - (Man) 12% category weighting (Management policy, commissioning, site management and procurement):**

The Management category has four sustainability indicators out of which the building has scored positively on all four of them. Four out of four suggests a 100% rate. The 100% rate of the allocated 12% translates into **12%**.

- **Health and wellbeing – (HEA) 15% category weighting (Indoor and external issues, (noise, light, air quality):**

The Health and wellbeing category has thirteen sustainability indicators out of which the building has scored positively on eleven of them. Eleven out of thirteen indicators suggests 85% rate. The 85% rate of the allocated 15% translates roughly into **12, 75%**.

- **Energy – (ENE) 19% category weighting (Operational energy and Carbon dioxide CO2):**

The energy category has nine different sustainability indicators out of which the building has scored positively on five of them. Five out of nine possible indicators suggests a 55, 5% rate. The 55, 5% rate of the allocated 19% for this category translate roughly into **10, 5%**.

- **Transport – (Tra) 8% category weighting (Transport related CO2, and location related factors):**

The Transport category has six sustainability indicators out of which the buildings has scored positively on five of them. Five out of six indicators suggests an 83, 3% rate. The 83, 3% rate of the allocated 8% for this category translates roughly into **6, 6%**.

- **Water – (WAT) 6% category weighting (Consumption and loss related aspects):**

The water category consists of four sustainability indicators out of which the building has scored positively on three of them. Three out of four indicators suggest a 75% rate. The 75% rate of the allocated 6% for this category translates roughly into **4, 5%**.

- **Materials – (MAT) 12,5% category weighting (embodied impacts of building materials):**

The materials category consists of six sustainability indicators, out of which the building has scored positively on four of them. Four out of six indicators suggests a 66, 6% rate. The 66, 6% rate of the allocated 12, 5% for this category translates roughly into **8, 3%**.

- **Waste – (WST) 7,5% category weighting (Construction resource efficiency and operational waste management and minimization):**

The Waste category consists of six sustainability indicators, out of which the building has scored positively on four of them. Four out of six indicators suggests a 66, 6% rate. The 66% rate of the allocated 7, 5% for this category translates roughly into **4, 9%**.

- **Land Use & Ecology – (LE) 10% category weighting (Aspects of the ecological value of the property):**

The Land use & Ecology category consists of seven sustainability indicators, out of which the building has scored positively on four of them. Four out of seven indicators suggests a 57% rate. The 57% rate of the allocated 10% for this category translates into **5, 7%**.

- **Pollution – (POL) 10% category weighting (External air and water pollution):**

The Pollution category consists of six sustainability indicators, out of which the building has scored positively on four* of them. Four out of six indicators suggests a 66, 6% rate. The 66, 6% rate of the allocated 10% for this category translates into **6, 6%**.

12. Sustainability Assessment – Building scoring and Rating

The Building scoring will be calculated by summing together the percentage rates of each of the categories and according to the following rating system the building will receive its corresponding grade. We have to bear in mind that the BREEAM assessment and the BRE board award with an additional score of 1% to the building's final score for buildings that innovate in the field of sustainable development and already attain other "green certificates". The Oval has energy performance certificate of "A" rating with low CO2 emissions, therefore an additional 1% will be awarded to the overall rating of the building.

Breem 2008 edition assessment table:

Breem section	Credits achieved	Credits available	% of credits achieved	Section weighting	Section score
Management	4	4	100%	10%	12%
Health and wellbeing	11	13	85%	15%	13%
Transport	5	6	83,3%	8%	6,6%
Energy	5	9	55,5%	19%	10,5%
Water	3	4	75%	6%	4,5%
Materials	4	6	66%	12,5%	8,3%
Waste	4	6	66%	7,5%	4,9%
Land use and ecology	4	7	57%	10%	5,7%
Pollution	4	6	66%	10%	6,6%
Total Score					72,1%
				Innovation Bonus	1%
Final Breem Score					73,1%
				Breem Rating	Excellent

Table 5. Breem assessment 2008 edition

13. BREEAM 2011 New Construction Edition – secondary assessment

Categories and Criteria weighting:

- Transport 4/5
- Water 4/4
- Materials 4/5 (exchanged life cycle impacts with reuse of buildings from 2008 edition which were still negative hence the 4/5 on the Material category)
- Waste $\frac{3}{4}$ (replaced operational waste with 2008 editions Recycle waste storage criteria)
- Land use and ecology 4/5 (replaced site selection with reuse of land criteria from 2008 edition still negative criteria)
- Pollution 2/6
- Management 4/5
- Health and wellbeing 4/5
- Energy 5/9

13.4. BREEAM 2011 New construction Edition assessment table

Breem section 2011 edition	Credits achieved	Credits available	% of credits achieved	Section weighting	Section score
Management	4	5	80%	12%	9,6%
Health and wellbeing	4	5	80%	15%	12%
Transport	4	5	80%	8%	6,4%
Energy	5	9	55,5%	19%	10,5%
Water	4	4	100%	6%	6%
Materials	4	5	80%	12,5%	10%
Waste	3	4	75%	6%	4,5%
Land use and ecology	4	5	75%	10%	7,5%
Pollution	2	6	33,3%	10%	3,3%
Total Score					69,8%
Innovation Bonus					10%
Final Score					79,8%
Breem Rating					Excellent

Table 6. BREEAM assessment 2011 new construction edition

- Note: that there is a significant difference due to the fact that the innovation points have increased in the BREEAM 2011 edition from an additional 1% for each innovation scheme to 10% for each innovation scheme (Breem, 2011)

14. Assessment results and conclusions

After analyzing the data provided and calculating the overall scores, the study concluded that the developing company's building is a sustainability giant with an overall score of 73,1% on the BREEAM scale of assessment and a rating of excellence. The Oval is a building that should be imitated by all the serious professionals in Cyprus.

The building scored positively on most of the categories with the most impressive category being health and wellbeing, perhaps one that should be considered the most important, got an astonishing score of eleven out of thirteen indicators.

When such a huge investment in Cyprus shows serious professionalism in all aspects of their work and take into serious caution sustainable development, it shows that in order to be competitive other companies will have to move alongside the same path which will benefit the society, the environment, the economy.

The overall mark of the building shows that it corresponded well with almost all the indicators requested, the BREEAM assessment duels with all sustainability areas that affect the world today, the building showed excellent responsiveness in some very important criteria that would be fair to point out in order to emphasize the sustainability principles that were adapted in the project.

Some of the most important criteria attained were:

- Mitigating ecological impact
- Major leak detectors
- Construction site waste management
- Recyclable waste storage
- Improvement of original landscape
- Low compound energy materials used (60%)

The reason that these few indicators were picked is to show the intentions of the company for the future of the city and their projects.

It is easily noticeable that the company was very carefully during and after construction phase with the correct waste management during and post construction, the intention for the improvement of the original landscape by implementing sustainability rules and procedures to the territory.

Another positive fact is that the company used for a very large proportion of the building, materials that were of low compound energy, meaning that the materials didn't require massive amounts of energy to be produced, Leak detectors and security were some indicators that showed responsibility from the company to the owners and the general audience.

The assessment leaves positive feedback as to what are the property developers goals and direction, when projects as big as The Oval is, are designed and constructed within the rules of sustainable development, it shows that the policy and the direction these firms intent to keep is towards sustainable development and sustainable environment that will promote welfare for societies and the environment surrounding them.

15. List of References

BREEAM. (2017). Available at <http://www.breeam.com/> [Accessed 20 Sept 2017].

BREEAM. (2011) BREEAM New Construction Non-domestic buildings Technical Manual SD5073-2.0:2011 Available at http://www.breeam.com/breeamGeneralPrint/breeam_non_dom_manual_3_0.pdf

Carey, K. (2008) Gallatin Hall Renovation Project Profile LEED-NC version 2.2 GOLD [Online] Available at <http://www.energyandfacilities.harvard.edu/sites/energyandfacilities.harvard.edu/files/HBS%20Gallatin%20Case%20Study.pdf>

Cy Law. (2017). [Online]. Available at <http://www.cylaw.org/> [Accessed 09 Aug 2017].

European Law. (2017). Available at https://europa.eu/european-union/law_en [Accessed 11 Aug 2017].

Gibberd, J. (2008) The sustainable building assessment Tool: Integrating sustainability into current design and building processes. [Online]. Available at <http://researchspace.csir.co.za/dspace/handle/10204/2882> [Accessed 19 Aug 2017].

Habitat Agenda. (2003). Available at http://www.un.org/en/events/pastevents/pdfs/habitat_agenda.pdf [Accessed 17 Sept 2017].

Ioannou, T.(2016). Lecture Notes Real 404. Sustainability and environmental issues in Real estate.

Munch, J. (2009) Sustainability Assessment on Buildings. [Online] Available at http://etd.dtu.dk/thesis/268962/Julianes_Comparative_Analysis_of_three_assessment_methods.pdf

The Oval. (2017). [Online]. Available at <http://www.cybarco.com/theoval> [Accessed 10 Sept 2017].

LEED performance and Rating. (2017).[Online]. Available at <https://www.usgbc.org/credits/existing-buildings/v4/> [Accessed 17 Dec 2017].

LEED and BREEM. (2017). [Online]. Available at https://www.researchgate.net/publication/261079555_LEED_and_BREEM_Comparison_between_policies_assessment_criteria_and_calculation_methods [Accessed 15 Dec 2017].

Cy Stat. (2011). Available at <http://www.mof.gov.cy/mof/cystat/statistics.nsf> [Accessed 10 Oct 2017].

16. APPENDIX

Sustainability indicators	YES	NO	% when possible	Notes
1. Provision of public transport	X			
2. Proximity to amenities	X			
3. Internal and external lighting levels	X			
4. External lighting	X			
5. Cyclist facilities	X			
6. Pedestrian and cyclist safety	X			
7. Maximum car parking capacity				203 resident 17 visitor
8. Hard landscaping and boundary protection	X			
9. Designing for robustness	X			
10. Re use of land		X		
11. Contaminated land		X		
12. Ecological Value of site and protection of ecological features	X			
13. Mitigating ecological impact	X			
14. Minimizing watercourse pollution	X			
15. Reduction of night time light pollution		X		
16. Noise attenuation	X			
17. Daylighting	X			THE WHOLE DAY
18. Outside view				SEA & MOUNTAIN
19. Glare control	X			
20. High frequency lighting				LED lights everywhere
21. Potential for natural ventilation	X			

22. Indoor air quality	X			
23. Lighting zones and control	X			
24. Volatile organic compounds		X		
25. Thermal zoning	X			
26. Thermal comfort	X			
27. Microbial contamination		X		
28. Acoustic performance	X			
29. Reduction of CO2 emissions	X			
30. Sub metering of substantial energy use				
31. Lifts	X			
32. Escalators & traveling walkways		X		
33. Water consumption	X			
34. Water meter	X			
35. Major leak detectors	X			
36. Sanitary supply shut-off		X		
37. Materials specification (major building elements used)	X			
38. Reuse of building facade		X		
39. Reuse of building structure		X		
40. Responsible sourcing materials	X		10%	
41. Insulation	X			
42. Refrigerant GWP - Building services				WHAT IS THIS
43. Preventing refrigerant leaks		X		PLUS A YEAR CHECKING OF SYSTEM
44. Nox emissions from heating source		X		
45. Recycled aggregates		X		
46. Commissioning	X			

47. Constructors experience	×		
48. Construction site impacts	×		
49. Security	×		
50. Low to zero carbon technologies	×		
51. Travel plan		×	
52. Construction site waste management	×		
53. Double glazed windows	×		
54. Recyclable waste storage	×		
55. Floor finishes	×		
56. Is it enhancing the site ecology	×		
57. Use of photovoltaics?		×	
58. If not is there a provision for installation of photovoltaics?		×	
59. Low compound energy materials used	×		60%
60. Composting of garden waste		×	
61. Use of original landscape		×	
62. Improvement of original landscape	×		
