UNIVERSITAT POLITÈCNICA DE VALÈNCIA

Faculty of Business Administration and Management

DEVELOPMENT OF A CIRCULAR ECONOMY ANALYSIS TOOL FOR THE HOTEL INDUSTRY

Master's Thesis

Master's Degree in Business, Product and Service Management

AUTHOR: Cardenas Paico, Alisson Solansh

Tutor: Peiró Signes, Ángel

ACADEMIC YEAR: 2022/2023

"DEVELOPMENT OF A CIRCULAR ECONOMY ANALYSIS TOOL FOR THE HOTEL INDUSTRY"

Cardenas Paico, Alisson Solansh

Master thesis

Master's Degree in Business, Product and Service Management

Academic Year 2022-2023

Universidad Politécnica de Valencia

Advisor: Prof. Ángel Peiró Signes

Abstract

The current linear economic activity is a concerning topic in regards of the environment as it is constantly affecting it through the large extraction of natural resources, carbon emissions, or products that after consumption and utilization culminate as waste in landfills. Thus, the definition of Circular Economy as a new economic model that is restorative and regenerative by strategy and design, brings a new perspective for businesses. In this circular system, the goods and materials circulate as much as possible, reducing the negative effects to the atmosphere. This economic model can be applied to different sectors including the hotel industry. For that reason, an analysis of this specific industry is conducted highlighting the reasons that encourage them for a transition. It is, therefore, that with the aim of helping the hotel sector switching towards a circular business model, a Circular Economy assessment tool will be established. A deep analysis of the concept to extract the most relevant information will be carried out, to then be able to create the tool that will evaluate their circular rate in regards of their performance and operations. The results will be given in an overall way but also in every area to have feedback and a general acknowledgement of the sections in which an enhancement towards circularity can be implemented.

Key Words: Circular Economy; Circular Economy Business Model; circular assessment; hospitality sector; sustainability

Table of Context

Index of Figures

Index of Tables

Index of Abbreviations

BN	Billions
BY	Business Year
CE	Circular Economy
CEM	Circular Economy Model
CEBM	Circular Economy Business Model
COP	Conference of the Parties
CO_2	Carbon Dioxide
CHSB	Cornell Hotel Sustainability Benchmarking index
EEA	European Environmental Agency
EU	European Union
FY	Fiscal Year
GDP	Gross Domestic Product
HWMI	Hotel Water Measurement Initiative
IISD	International Institute for Sustainable Development
ITP	International Tourism Partnership
KPI	Key Performance Indicator
kWh	Kilowatts per hour
LCA	Life Cycle Assessment
LCT	Life Cycle Thinking
Lt	Litters
MN	Millions
OECD	Organization of Economic Cooperation and Development
SDG	Sustainable Development Goals
UN	United Nations
UNWTO	United Nations World Tourism Organization
UNFCCC	United Nations Framework Convention on Climate Change
UN	United Nations
USD	United States Dollars
WTTC	World Travel and Tourism Council

Index of Annexes

1. Introduction to Circular Economy and the Circular Assessment Tool

In recent years, the current model of economic activity has created an atmosphere with extreme natural resource extraction, generating capital depletion through excessive consumption for business purposes. With this method, products or goods are fabricated that will only have a single lifecycle, since after being processed and used, they will eventually end up as garbage (Rodriguez, Florido, & Jacob, 2020). This unsustainable linear method does not take into account the ecosystem and the damage it yields (Esposito, Tse, & Soufani, 2018). But the environment is not the only one affected, as it is also creating problems in relation to the society and geopolitics (Sillanpää & Ncibi, 2019).

The solution for this growing problem is the transition towards a Circular Economy (CE), an economic model that proposes that the goods manufactured nowadays, will be those resources used in the future by ensuring the extended lifecycle of goods through specific activities including maintaining, reusing, repairing, refurbishing, recycling of some parts or the whole product itself (European Comission, 2022). This model focuses on the circular lifecycle of products or their extension after utilization, while reducing the resource consumption, waste generation and contributing to the environmental regeneration that are part of their main principles.

After the deep analysis of the theoretical background, a Circular Economy assessment tool will be developed as a final outcome to provide the hotel sector a rate system to identify how circular they are performing and in which areas there is still room for improvement.

In furtherance of creating this CE assessment tool to help the hotel industry in their change for a more sustainable economic model, the master thesis will be structure as followed: First, the literature review and theoretical background in regards of the topic englobed in Chapter 2. Afterwards, a deep analysis of the tourism and hospitality sector together with the reasoning for changing into a CE model in Chapter 3 will be presented. In Chapter 4 the methodology that will be followed to create the assessment tool is covered, and the tool itself with its

elements and classification method are to be found in Chapter 5. Finally, Chapter 6 will conclude the research and the master thesis by giving a brief summary of the project.

1.1. Main Objectives

The master thesis will have two secondary objectives focused on literature review and research, and a main objective focused on a practical aspect that will contribute to the hotel industry.

Main objective:

- Development of a Circular Economy analysis tool that can assess the circularity rate in the European hotel industry.

Secondary objectives:

- Literature review analysis to understand the Circular Economy, as well as the identification of how this model can be applied.
- Examination of current tools and indicators that are applied to measure the circularity of a business and extract the ones that are more relevant, viable and useful in the hotel industry.

1.2. Methodology

The methodology of this project consists of three parts that will be explained on a later stage in this project. Overall, the first part will introduce the theoretical background through the literature review deep analysis complying the secondary objectives. Then, by following the example and references of circular indicators and other methodologies already applied in businesses, a tool that can measure the circular rate in hotel companies, which will be the main outcome and objective of this master thesis will be created.

Chapter 4 will describe the method that was used step by step, to build this CE tool in more detail.

2. Literature Review and Theoretical Background: Circular Economy

The outcome of this master thesis relies on the development of a Circular Economy Assessment tool for hotels; subsequently, the theoretical context through the literature review analysis of Circular Economy is of vast importance to understand the implications that should be considered. Thus, Chapter 2.1 will focus on the relevance of transitioning from a Linear Economy to a circular one, Chapter 2.2 will profound on the topic itself, while Chapter 2.3 will cover the Circular Economy applied as a business model.

2.1. Limits of the Linear Economy model

Since many decades, the Linear Economy (LE) has been a unidirectional model of mass consumption and production, designed to obtain natural resources, process them into items, place them in the market for their commercialization and discard them after use. This so called "take, make and dispose" scheme is an unsustainable economic method as it does not consider the limits of the environment and its capital (Esposito, Tse, & Soufani, 2018).

This applied model engenders resources loss in diverse areas of its implementation, being some examples the destruction of ecosystems through the extreme acquisition of natural capital, the supply and production chain by waste generation, the excessive energy consumption through manufacturing and transportation, etc. (Michelini, Moraes, Cunha, Costa, & Ometto, 2017) Furthermore, it does not merely affect the environment, but also the society and the geopolitics (Sillanpää & Ncibi, 2019):

- **Environmental issues:** Going deeper into this topic, the current Linear Economy model creates a scenario where the global industrial sector depends mainly on the use of fossil commodities; for instance, coal, petroleum, and gas, as an energy source. These elements are then converted into electricity, transportation fuels, chemicals, and other components for the production process. However, their extraction and refining procedure, bring alarming repercussions for the environment,

such as water contamination, air pollution, and soil degradation. As stated by scientists, these processes lead to a series of long-term consequences for the affected ecosystems, that in some cases, they are irreversibly damaged. All of the mention above, contribute to steps closer into the phenomena of global warming and climate change.

- **Society and geopolitics issues:** These two topics are related to the exploitation of fossil resources applied by this market-based economy. According to Sillanpää and Ncibi (2019) unnamed studies have identified that the mining activity for extraction purposes affects negatively those involved in the process as well as those outside from it, since it creates a big reliance on the mining as sole economic activity for local employment and income, undermines communities` institutional power, minimizes the opportunities of skilled labour in other sectors, and can damage the physical integrity of its workers and nearby societies with respiratory difficulties as a result of released toxic emissions or accidents from the site.

  Additionally, in other fossil fuels markets like in the petroleum, there is a constant lack of transparency and there is present corruption, this major problem affects the way countries with a high diversity of resources are managed, that are at most, emerging countries. Differing to the belief that being rich in natural assets could boost their economies, enhance the performance on human development indicators, and create both social and economic stability for the population, their conditions are, respectively, slower, lower, and worse than the ones in developed countries with limited raw materials. Most of these topics often leading to aggressive and armed conflicts.

  Another disadvantage of the use of fossil fuels is the mass manufacturing from affordable and low-price items e.g., baskets, brushes, clocks, clothes, or petrochemical products like plastics, adhesives, paints, cosmetics, etc., that through market and advertising strategies accustom clients to a behaviour of mass consumption, that results into the loss of resources, waste generation, and pollution.

And although very successful since the industrial revolution, this economy model is facing additional global issues and the need for switching to a more sustainable economic method is not only rising, but also is being forecasted for the near future. Together with the continuous and high demand of the marketplace, comes the price increase for raw materials and production, the limited availability of raw materials, the volatility of the markets and the strong competition; all of these, resulting into a profit decrease for companies and the value reduction of their economic output. Likewise, the demographics play an important role in this matter; as the population is fast growing and centralizing especially in emerging markets, unlike in past years, those belonging to the middle social economical class are also increasing in number within them, causing an upsurge in consumption reaching an estimate of three billion dollars per year, from which companies will have to invest approximately another three trillion dollars in infrastructure per year to cope with this situation (Sariatli, 2017).

We are reaching a point in which the natural resources are becoming scarce, and where industries are facing problems trying to supply the market with the growing population and demand. For this reason, many projects have resulted into our best chance at addressing this global problem, where natural capital can continue a closed cycle without generating waste, and thus, diminishing or eliminating the need of extracting and using raw materials. These initiatives are part of the Circular Economy model (Nikolaou, Jones, & Stefanakis, 2021).

2.2. Circular Economy

Circular Economy is a term with a wide variety of definitions throughout several scientific and business literature (Kirchherr, Reike, & Hekkert, 2017). However, most of them agree when referring to an economical model that allows the users to extend the lifecycle of a good by reducing the need of resources and waste, and at the same time generating an additional value.

Unlike the Linear Economy seen in the previous point, whose foundation consists of the "take, make, use, and dispose" method and relies on the inexpensive and accessible supplies and energy, the Circular Economy model

proposes that those same goods produced today, will be the assets used in the future. In this sense, it ensures that a product can extend its lifecycle as much as possible, avoiding the use of new resources, through the maintaining, reusing, repairing, refurbishing, recycling, etc. of its parts, and by the low generation of waste and emissions during the process (European Comission, 2022).

The Ellen MacArthur Foundation, one of the organizations that highly contributes with the definition of CE models and its appliance in the industrial sector, (Esposito, Tse, & Soufani, 2018) describes it as a restorative and regenerative technique by intention and design, considering not only the activities of production and consumption of goods and services, but also the optimization of the systems that connects each of the elements of the flow (Figure 1). Therefore, it pursues waste reduction, the use of renewable resources for its processes, and the minimization of the negative impact on the environment. Hence, its implementation is based on three main principles that interconnect between each other (Ellen MacArthur Foundation, 2014):

- **Eliminate waste:** This initial principle denotes the elimination of waste and pollution that is generated from linear economies as they typically take natural resources, transform them while releasing greenhouse gases and dangerous substances, and finally dispose them. Thus, this principle pursues to design out the waste, which leads to the conscious manufacturing of products. If these materials are planned into a production design according to their biological or technical properties (this topic will be developed in Figure 1), they could fit a proper circular cycle, and either be composted or reused/repaired/refurbished again to be part of a new invention, without creating waste in the process.
- **Circulate products and materials:** Similar to the previous point, this principle focuses on all the commodities and products that are retained into circulation while keeping them in use with a high value in the process. For this reason, it is important to take into account the type of material they are, and if they will be used as the product they were originally fabricated for, or if instead they will become a component or a raw

material for a different one. In this way, all goods keep circulating and waste is not produced in the system.

- **Regenerate nature:** Opposite to the LE in which the focus is the extraction of natural supplies, manufacturing and creating waste in the process and the use of fossil fuels as an energy source, this foundation has the purpose to use renewable resources, and build natural systems and capital by returning all the biological elements from the manufacturing procedure and reinventing them, having as an outcome the restorage of the environment and the creation of a sustainable circuit.

2.2.1. The Butterfly Diagram

The Circular Economy diagram, also known as the Butterfly Diagram in Figure 1, is the visual representation of how a CE system works. It considers products, materials, and components, looking to circulate them as much as possible in a system, at their highest value, to create economic growth and development. In pursuance of these tasks, the diagram is divided in two sub-cycles that are directly correlated to the characteristics and properties of their elements.

The graphical representation of all the elements involved in the flow and their interrelationship based on the principles for Circular Economy are shown in Figure 1.

The biological cycle, as seen on the left side of the diagram, is a renewable circuit that seeks for the regeneration of the biosphere, one of the three principles from Circular Economy. It contains biological nutrients (or components), which have the capacity to reintegrate into the environment without harming it and at the same time improve it by creating natural capital, in other words, these components are renewable by nature; some examples of this type include biodegradable, compostable products, food, wood-based objects, or sewage.

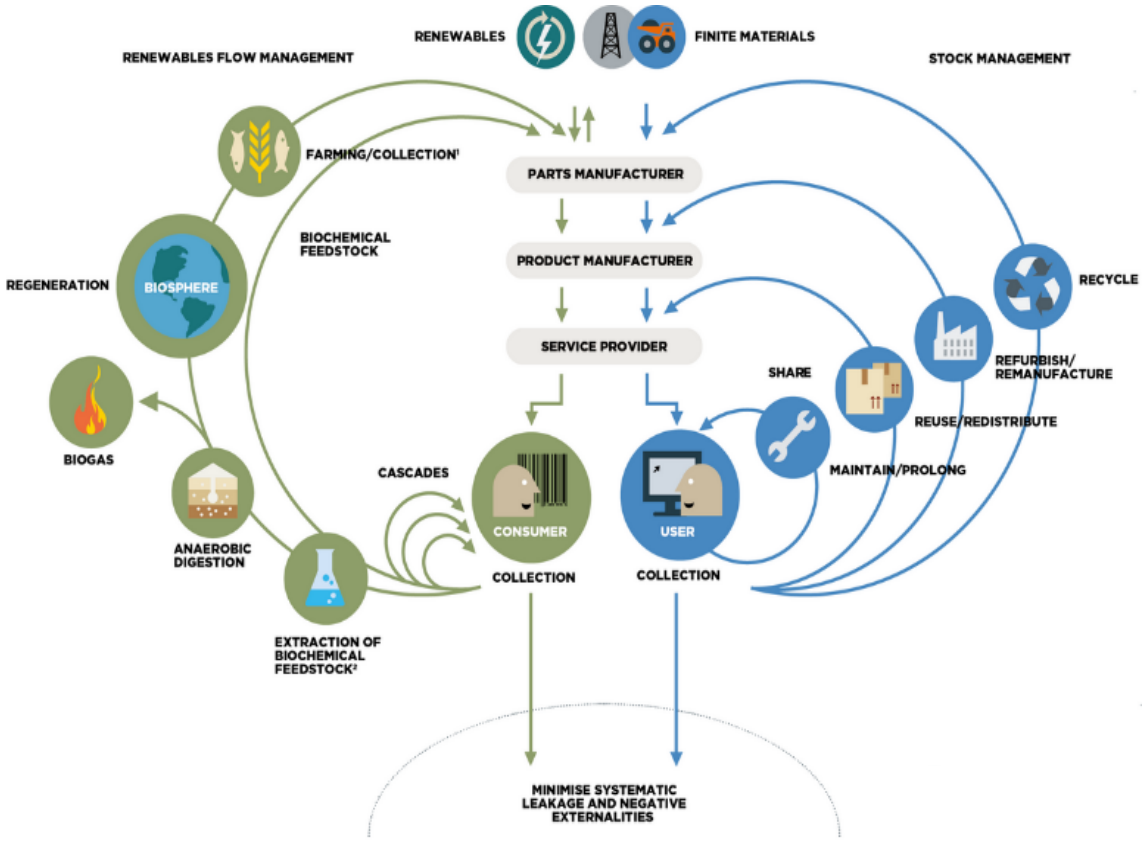


Figure 1 The Butterfly Diagram (Ellen MacArthur Foundation, 2019)

There are few practices inside the cycle that need to be followed to reach maximum effectiveness. One of these includes cascading, which acknowledges to the application that a material can have in diverse valuable streams; for instance, using food products as fruits or vegetables peels for packaging, or applying typical food waste as other final products. Another procedure is the extraction of biochemical feedstock that through conversion methods in biorefineries can create high valuable chemicals. The additional mean occurs when the biological nutrients cannot longer be in the flow; thereupon, food and

other biodegradable components can be composted to outcome with micronutrients acting like bio fertilizers to enhance the lands; whereas with anaerobic digestion, biogas is produced as an energy source and the "digestate", that is the solid residual from the process containing nitrogen, potassium and phosphorus can nourish the soil. The last one implies farming and collection, where organic waste can be collected and return through composting and anaerobic digestion to feed the soil, and the conservation of local biodiversity, air, and water conditions (Ellen MacArthur Foundation, 2019).

The technological cycle, drawn on the right side of the Butterfly Diagram from Figure 1, is the stock management from the industrial sector that is interconnected to the CE principles. Unlike the renewable cycle, the elements flowing in this loop are technical components (nutrients), denoting that they are non-biodegradable namely plastics, and metals, and that they should consequently be preserved as much as possible at a high-quality value without entering the biosphere.

In furtherance of achieving an adequate circularity, there are four steps to follow. The innermost loop seeing in Figure 1 is also the most important, as the product´s lifecycle is maintained and prolonged as much as possible with its entire value, decreasing the demand on raw materials to produce new goods. Sharing is also inside the first inner circle as the product usage gets intensified. The second inner loop contains reusing and redistributing, from which the first one is a common business model, where industrial products are reused many times for similar or equal purposes; whilst the second one refers to the diversification of their intended users as they reach other target markets, keeping its original value. The third loop consists of retaining the most of value and it is done through refurbishing products when they stop functioning or are losing their value, by which either a part of their elements is repaired, replaced, or their appearance is improved, and their value is reinstated. Remanufacturing is, as well, part of this loop, and it requires a higher degree of investment and involves an intensive work, forasmuch as products experience re-engineering steps to remain in circulation. The outer loop is that belonging to the recycling process, in which products that could not be elected for the previous practices, undergo

to this transforming step to maintain their materials in use for other products, retaining their value. From this technique, the value of the product as an entire piece is lost as the energy, the time and manufacturing process are wasted, yet its parts keep circling in the technical cycle to be pieces of new goods and do not become waste that harms the environment (Ellen MacArthur Foundation, 2019).

The Butterfly Diagram displays an overview of the cycling techniques for a CE system where both biological and technological elements can continue in the system by prolonging their life cycle or renewing them, when needed, as part of new products.

2.2.2. The 9R Framework

The 9R framework proposes strategies according to the principles of Circular Economy, that companies can implement within their processes. It considers different business models, infrastructures, relationships between stakeholder and policies (CE Grow Circular, 2021).

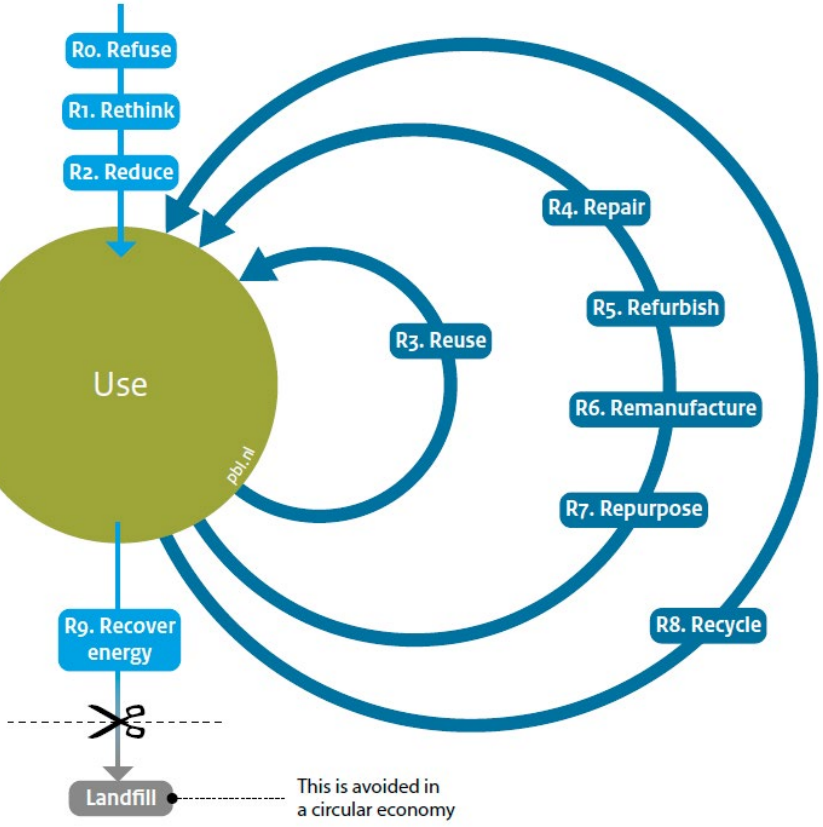


Figure 2 The 9R Framework (Potting, Hanemaaijer, Delahaye, & Ganzevles, 2018)

As shown in Figure 2, this framework consists of ten practices, where the closest ones to the Circular Economy arrow, are the most important to achieve a greater level of circularity and that have a higher impact (Potting, Hekkert, Worrell, & Hanemaaijer, 2017).

These actions can be carried out by both users and businesses, and are divided in three sections: (CE Grow Circular, 2021) (UN Environment Programme, 2022)

Smarter product use and manufacture:

- R0 Refuse: It can be seen from a user perspective as they can reject to receive services or consume products that are not eco-friendly or that are unnecessary. It can also be applied to companies in the way of refusing to utilize raw materials or hazardous chemicals for the manufacturing process.
- R1 Rethink: It includes four actions (products seen as a service, sharing of assets, industrial symbiosis, and performance-based input sharing) that lead to the intensification of product usage or the multi-functionality of the same. And so forth, enterprises can comply with the designing and rethinking about their product functionality while diminishing their environmental footprint.
- R2 Reduce: From a user point of view, it refers to the more conscious thinking about how to best satisfy the needs, by not producing a negative impact on the nature, and by buying less recurrently. From an industry perspective, it is linked to the efficiency on the products manufacturing process and the change in operations to use less but more renewable resources (energy, water, raw materials).

Strategies that extend the lifecycle of products and their parts:

- R3 Reuse: The repeated usage of goods for their same purpose as they were produced. This R also involves reselling or redistributing a product while retaining its value, as it can be commercialized in other market as a second-hand good; in this way, it supports the materials flow and prolongs the lifecycle keeping a high value in the market.

- R4 Repair: The restoration or maintenance of products or their parts in order to continue having a functional work and extend their lifecycle, without losing its whole value and throwing it to waste.
- R5 Refurbish: Alike repairing, this process has the objective of withholding the most value of the products when they are not in their best status. In the industrial sector, the comprehensive refurbishment grants an almost new service for the lifecycle of the product and brings it up to date enabling a high quality with a low environmental impact.
- R6 Remanufacture: This process requires specific technical conditions to integrate parts of discarded products into new ones. This procedure allows only a part of the value to be maintained.
- R7 Repurpose: The use of products or components that are no longer in use, to adapt them and, consequently, have a new function and getting a completely new lifecycle. It permits users to obtain unique designs, and enterprises, to reduce raw material costs and/or the amount of waste generation from previous goods.

Useful application of materials:

- R8 Recycle: Waste originated from previous goods is treated with the finality to convert it into input and re-access the circular loop. It prevents the use of raw materials and waste generation. Despite the fact that recycling is a valid option, it remains as one of the last strategies on the framework, because it requires collection systems in different points, and a special infrastructure, and technology.
- R9 Recover: The last strategy on the framework refers to a waste treatment procedure where the incineration of materials is conducted, to have as a result, the energy recovery.

2.2.3. CE Indicators

An objective of this master thesis relies on the application of CE indicators into a circular assessment tool to evaluate the circularity rate of the hotel sector.

Hence, the relevance to understand their importance, and how they can be categorized according to the different examined scientific literature.

According to the Organization of Economic Cooperation and Development (OECD), the indicators can be described as "qualitative or quantitative factors or variables that provide a simple and reliable means to measure achievement, reflecting the changes connected to an intervention or helping to appraise its performance. They specify what is to be measured along a scale, determining how expected results are measured and what data are collected" (OECD, 2014). CE indicators are a measurement of circularity´s evolution and Circular Economy progression (De Pascale, Arbolino, & Szopik-Depczynska, 2021). In this manner, they can summarize complex information from a dynamic environment and make it manageable for reporting and decision making, as well as to help defining goals and tracking progress (Saidani, Yannou, Leroy, Cluzel, & Kendall, 2019).

CE indicators have diverse evaluations systems, but overall, they can be categorized in three different levels in regards of their reach even though they can overlap in some cases: micro level, meso level and macro level (Banaite, 2016) (Kristensen & Mosgaard, 2020) (CE Center, 2018).

- **Micro level indicators**: They provide detailed information from an individual product, company, consumer level or city. In order to set indicators withing this level, circumstances such as the company' or product's characteristic, condition and problems should be taken into account. They are, nonetheless, mostly based on the 3R principles and are implemented for products policies, energy, and waste management.
- **Meso level indicators**: They focus on an industry, a product group, or a region with respect to the environment, economic and social factors, seeking industrial symbiosis between companies from the same or akin branches by the creation of resource flows and economy trades. They analyse materials flows inside the economy and can detect their burdens, as well as opportunities to enhance, and can be disaggregated by material category or emission.

- **Macro level indicators:** Indicators at this level focus on the flow and exchange of materials between the economy and the environment. It is the interaction of a country or large region with the rest of the world, which can target one particular element such as material category or emissions. It supports therefore, with action plans related to economics and trade, sustainable development, and policies integration.

In Figure 3, the indicators are classified under three types of measurement scopes considering the Life Cycle Thinking (LCT) approach and their modelling level.

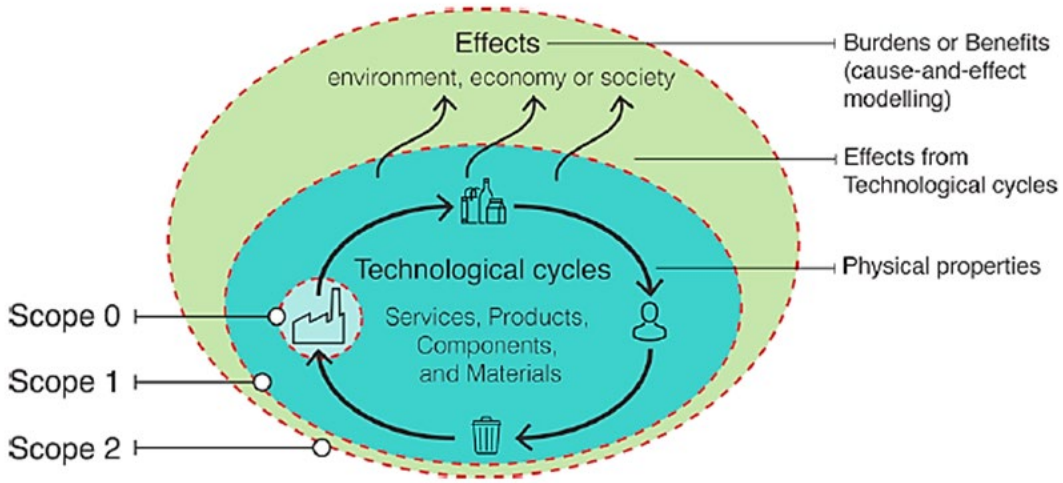


Figure 3 Proposed classification for the three measurement scopes from CE indicators (Moraga, et al., 2019)

On one side, the LCT is a state-of-the-art method that analyses the impact from products or services over their whole life cycle, starting by the design, manufacturing, consumption or use, and disposal. On the other side, the modelling level for the categorization of indicators, refers to the technological cycle of the products including all its elements inside the flow and their effect (see Figure 1 The Butterfly Diagram for additional information).

In Figure 3 the indicators belonging to the *scope 0* would be those measuring physical properties of the technological cycles without taking into account the LCT, such as the Collection Rate (CR), ease of Disassembly Metric (eDiM), End Of Life cycle Recycling Rate (EOL-RR), Old Scrap Ratio (OSR),

Recycling Input Rate (RIR), Recycling process efficiency Rate (RR). In *scope 1*, the indicators also measure physical properties but considering the LCT, for example the Material Circularity Indicator (MCI), Total Restored Products (TRP), Number of Times of Use of a Material (NTUM). *Scope 2* contains the indicators measuring the benefits or consequences from the technological cycle of a good, taking into account the sustainability pillars for the environment, society and economy; for instance, the indicators include the Eco-cost value ratio (EVR), Circular Performance Indicator (CPI), Circular Economy Index (CEI), Sustainable Circular Index (SCI) (Moraga, et al., 2019).

The indicators can be applied to any type of business that is looking towards a Circular Economy model transition by knowing what or which parts of the organization are to be measured and at which scope or level. In this section some indicators were displayed according to their scope, and in the following chapters the application of the most suitable indicators in regards of usability, viability and relevance will be shown inside the CE analysis tool.

2.3. Circular Economy: A Business Model

One of the definitions of business model according to Alex Osterwalder and Yves Pigneur, is that "a business model is the rationale of how an organization creates, delivers and captures value". It is, then, the mean for a company to implement its concepts by different users with a determinate purpose (Lambert, 2008). This system allows an enterprise to connect several elements found both inside and outside of the organization such as customers, suppliers, partners, etc., by conceptualizing and analysing their status in regards of its value proposition, value creation, and value capture. The business model sets the firm strategies and appropriates the economic value as a main goal (Kanda, Geissdoerfer, & Hjelm, 2021).

The Figure 4 represents the business model canvas that involves key elements when developing a business strategy. On the left side of the framework, the value creation implicates all the internal capabilities from a company, including its partners, activities, and resources, with the purpose of converting

the input into offered goods for the customers through different channels, while establishing relationships with them and creating segments, which is where the value delivery will be situated.

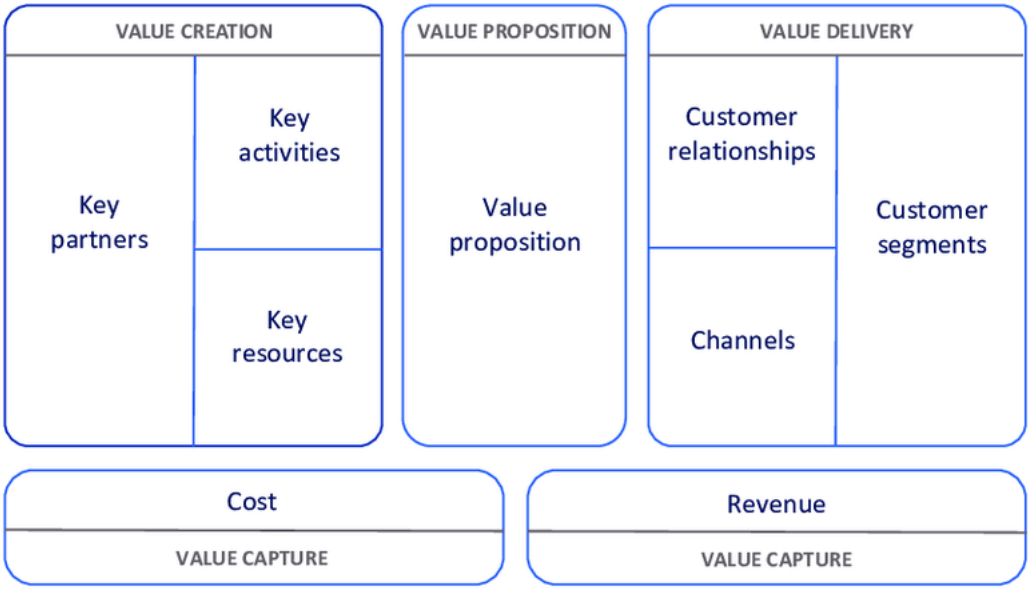


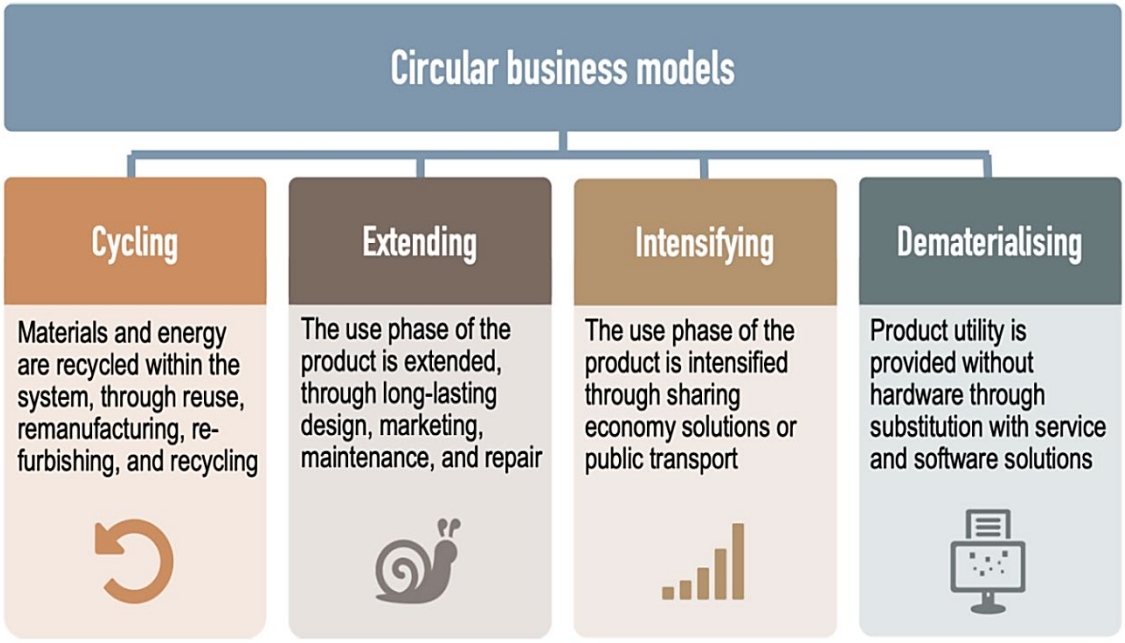
Figure 4 Business model canvas (Guldmann, Circular Business Models - Innovation Journeys Towards a Circular Economy, 2019)

The value proposition is at the centre of the model since it is the product or service itself, which will address to customers' needs and desires. And the value capture, at the bottom of the figure, refers to the financial information from the company, regarding its costs and benefits from all the previous activities (Guldmann, 2019).

However, typical business models and their different applications, tools or frameworks are measured in financial outcomes and do not necessarily acknowledge the value creation in environmental, or social aspects (Smith-Gillespie, 2020). Therefore, the switch to a model in which the principles of Circular Economy are taken into account is becoming increasing attention (European Environment Agency, 2021) by diverse interested parties in particular businesses, researchers, and both private and public entities (Kanda, Geissdoerfer, & Hjelm, 2021).

The purpose of a Circular Economy Business Model (CEBM) is to apply tactics that can sustainably contribute to the creation of value, and at the same

time bring environmental, economic, and social benefits (Reim, Sjödin, & Parida, 2021). The principles of the CE as previously mentioned in section 2.2 are to eliminate waste, circulate products and materials, and regenerate nature. Hence, the establishment of generic strategies that can cycle, extend, intensify and/or dematerialize in pursuance of reaching the accomplishment of these principles in



a business context (Geissdoerfer, Pieroni, Pigosso, & Soufani, 2020). In Figure 5, the Circular Business Model (CBM) and its different strategies are further developed.

Figure 5 Circular business model strategies (Geissdoerfer, Pieroni, Pigosso, & Soufani, 2020)

The CBM strategies developed by Geissdoerfer et al.,2015 in Figure 5 proposes the integration into a framework of these four approaches with the value creation and delivery, value proposition, and value capture from the business model canvas in Figure 4.

The first strategy is cycling, this is the tactic by which products or energies will keep within the cycle through its consecutive use and reintegration into the system. Not before applying the strategies of extending or prolonging the life cycle of a good and intensifying its use through a share economy. Lastly, the strategy of dematerialization has the purpose of replacing or reducing the manufacturing of unnecessary goods, by the utilization of services or software

while enriching the customer experience (Geissdoerfer, Pieroni, Pigosso, & Soufani, 2020).

These four strategies can all be related with the business model canvas as followed (Geissdoerfer, Pieroni, Pigosso, & Soufani, 2020):

- **Value proposition:** It is the offering of sustainably designed products to existing or new customer segments through the purchase or the leasing of them. Therefrom, customers can have a high degree of reliance on the functionality of the goods.
- **Value creation and delivery:** The production of durable products for long lifecycles and the providence of post-sale services to main long relationships with customers. It also includes the collection of products after the end of their life cycle from customers sites to be redistributed, recycled, or refurbished into new ones. It produces industrial symbiosis between customers, suppliers, and partners, and creates consciousness by rationalizing demand.
- **Value capture:** This represents the costs savings for not using raw material as input and for utilizing products for longer inside of a cycle. It provides additional revenue from its high-quality products, services, and long-term customer relationships.

Taking all the concepts and strategies for a CEBM, this can be interpretated as a model that creates value for its varied clientele, builds a long-lasting network, while encouraging the setting up of new markets and the interlink to the Circular Economy principles (Kanda, Geissdoerfer, & Hjelm, 2021).

2.3.1. Transition towards a Circular Business Model

Moving towards a CEBM considers different aspects that are correlated to sustainability transitions and strategies. For instance, they involve the modifications of energy supply, transportation, production, and distribution as part of societal or basic services; and the adjustments of legislations, policies, manufacturing practices, customer behaviour, and others, as part of socio-

institutional elements. Sustainability transitions are often called technological transitions, as they are triggered by the introduction of radical technologies. They have, however, a complex situation with the socio-institutional elements, that are the ones willing or not, to change the legislation in agreement with their normative framework to allow these type of transitions (Potting, Hekkert, Worrell, & Hanemaaijer, 2017).

There are three transitions when switching towards a circular business model in regards of the use of technology in product chains (Potting, Hekkert, Worrell, & Hanemaaijer, 2017):

- **Type 1:** This first type has its core in the development of radically new technologies that will lead to the introduction of new products and operating systems. Even though they face a disadvantaged position as they often require a great investment, are just entering the market and thus, do not have an established place, have a smaller scale production, and do not necessarily follow current socio-institutional principles as the existing technologies do, they have a great impact in the environment and cause sustainable transitions including innovative products and systems that add value. An example of this application is the bioplastics industry.
- **Type 2:** In this transition, the socio-institutional change is the main focus. And unlike the type 1, technologies play either a minor or not important role, having more relevance the incremental technology, where they rely on the current technological innovation that allows to modify existing products under determinate existing circumstances. For example, the zero packaging on some products for their commercialization.
- **Type 3:** This transition has the socio-institutional change at the core of its definition and considers technologies that are generic, available now and that can adapt according to its activities, e.g., the technologies required to manufacture a mobile phone that is more durable, easy to repair and resistant than common ones. The change might not be notably seen by users, but the good will have been performed under a new knowledge and innovation system.

These three transition trends towards a CBM allow the creation of innovation systems and technologies that lead from a linear to a circular application of materials. Regardless of the transition that is chosen, all of them address the efficient management of resources and commodities. Though, still the biggest challenge are the socio-institutional objections, that build a complex situation for the development of producing and conducting businesses. Thereupon, the continuous demand of the market, together with innovations with enabling technology, can outcome into facilitators for a socio-institutional change (Potting, Hekkert, Worrell, & Hanemaaijer, 2017).

There are, nevertheless, six strategies that companies can also approach in the pursuance of a CEBM and can be divided in accordance with the action of preserving in this case the first five or measuring in the case of the last one (Moraga, et al., 2019). These tactics are associated to the Butterfly Diagram and the 9R Framework from Section 2.2.

- **Strategy 1:** It is linked to the preservation of the product or service core functions to promote their multifunctionality, redundancy and multi usage.
- **Strategy 2:** Product´s lifetime extension through durable designing, reuse, refurbishment, and remanufacturing processes.
- **Strategy 3:** In this strategy, the products or services' components are the ones to be preserved through diverse methods such as the reuse, recovery, and repurposing.
- **Strategy 4:** Preserve the materials of the products by recycling and downcycling when they cannot be conserved as a whole.
- **Strategy 5:** Energy recovery activities to maintain the embodied energy from the goods.
- **Strategy 6:** This last strategy is the one related to measuring the LE that serves as a reference point to inform the users of the current status, progress, or regress towards a CEBM.

Indicators can be classified into measurement types and can help in the transition to a CEBM, as some types already seen in the section 2.2.3. They are interconnected to the above-mentioned strategies: direct CE with specific

strategies (focus on one or more recognizable approaches, for example the recycling rate); direct CE with non-specific strategies (the indicator concentrates into a topic, from which strategies are not possible to clearly identify, e.g., water withdrawal); and indirect CE (the indicators can provide relevant information to Circular Economy but it has no correlation to CE definitions) (Moraga, et al., 2019).

2.3.2. Tools for a CEBM progression

In this section, two methodologies will be introduced as they have been largely applied and are proved to be able to guide organizations into a transition towards a sustainably path, that can serve as a basis for a CEBM. They both help analyse, assess, and understand the companies' current situation, atmosphere, and operation that can lead to setting strategies and goals according to their results. They are, however, limited in capacity and their application cannot assure a complete transition towards CEBM, but rather a starting action.

2.3.2.1. Life Cycle Assessment

The Life Cycle Assessment (LCA) is a methodology supported by the LCT (Azapagic, 2004), that can guide organizations in measuring the ecological impacts that several products can have throughout their life cycle. The outcomes contribute to certain advantages such as promoting the understanding of the environmental effects from the CE strategies (Peña, Civit, Gallego-Schmid, Druckman, & Caldeira- Pires, 2021) and advising the users of possible circular solutions that they can execute in their procedures (Szita, 2017). The assessment can include the resources and how they are processed, the manufacturing activity, the distribution of the products, their use, and finally, how their end of the life is managed (Teuffel Engineering Consultants, 2020).

This tool can be applied for companies when moving towards a Circular Economy model. For that, there are three levels of LCA according to the technological aspects of the products (Farjana, Mahmud, & Huda, 2021):

- **Conceptual LCA:** This type of LCA is a basic examination limited to only some stages of the life cycle of the products and few environmental aspects. It is, nonetheless, useful for producers to obtain qualitative feedback of their operations and evaluate areas where ecological characteristics from their products can be improved.
- **Simplified LCA:** Also called streamlined LCA, it is a more complete analysis compared to the conceptual type, though still a slight version of the complete Life Cycle Assessment methodology. In this level, all the stages from the life cycle of the goods and systems inside the company are measured, but without spending so many resources like money or time. Companies rely on the simplified results of the tool for future implementations and/or improvements inside their life cycle management of products.
- **Detailed LCA:** This level includes a deep evaluation and investment in the use of resources, contrarily from the simplified LCA, as it considers all the phases of the life cycle of the goods from the company, resulting into detailed examined information that firms can then use to improve their processes.

There are different ways of switching into a Circular Economy system, and the use of any level of LCA can give a step onward into that direction (Farjana, Mahmud, & Huda, 2021).

Besides the levels for implementation, there are some tasks that are recommended to take into account when aiming to an efficient appraisement of the product life cycle. The first one is *highlighting the areas for improvement*, referring to the identification of phases of the product life cycle that are critical to change, analyse them, and then, consider alternatives for solutions and assess which ones are the most adequate from an environmental standpoint. The second one is *testing against the changing external factors* by introducing external parameters as data, this is suggested due to the fact that certain circumstances can have an impact in the life cycle of a product. They depend on the time or location when or where they are, and these can be key influencers in the performance and measurements by the LCA. For example, the energy supply with

renewable energies or the recycling processes can be dissimilar from one decade to another or from one country to the other, which will result into different LCA outcomes if there is a change. The third one concerns *comparing similar solutions* inside of a same system, where diverse options are proposed, and they are individually tested based on their ecological impact. For instance, the greenhouse emissions of different choices of components for the same product are contrasted. The last one is *using LCA in later phases of innovation* when there is an established procedure which has accurate and reliable data. In the beginning of an innovation process when the system will be improved, not all information is clear and well defined; therefore, the LCA should be conducted at the latest stages as it requires precise input (The Ellen MacArthur Foundation, 2022).

Even though most of the literature review presented in this section discusses the LCA from an environmental perspective, this tool can be applied to other areas of sustainability namely the social and economic aspects. Since the decisions made by companies from the results of the LCA, can support the Circular Economy strategies and initiatives related to the environment, the production, and the society´s consumption patterns from their products (Peña, Civit, Gallego-Schmid, Druckman, & Caldeira- Pires, 2021).

The LCA has, nonetheless, boundaries with respect to its outcomes, as it examines exclusively the input given by the company, and the results can vary according to the authors, the assumptions made, and the real data used; and can have more benefits in the short term than in the long period. Also, some metrics cannot be studied if they are not quantified, making it difficult for the LCA to assess the future effects of a process; for example, the ecological positive impact from using recycled plastic in the system, rather than their disposal in the landfill, where the emissions can be seen as zero by the methodology, as it is a carbon storage, and not carbon release place (The Ellen MacArthur Foundation, 2022). All of the previously mentioned facts, create a limitation atmosphere in terms of quality, reliability, input data, and temporal factors, that can lead to inaccuracies in the benchmarking of CE strategies from a firm (Lei, Li, Yang, Bian, & Li, 2021).

2.3.2.2. DSPIR Framework

The DPSIR model short for Drivers (D), State (S), Pressure (P), Impact (I) and Response (R) is a systems analysis view, created by the OECD and the European Environmental Agency (EEA) (Majorošová, 2016) in order to understand the human interactions with the nature (Khajuria, 2020) by interconnecting the socio-economic and ecological systems and helping to monitor, assess and achieve the development of environmental projects (Zhou, et al., 2015).

This framework enables users to identify and attribute indicators by acknowledging the complex links of the three previously described systems and understand how they interact: if their links are weak, strong, qualitative, or quantitative. When a balance between them is reached, then this allows a transition towards the CE (Liviu, Razvan, & Alina, 2021)

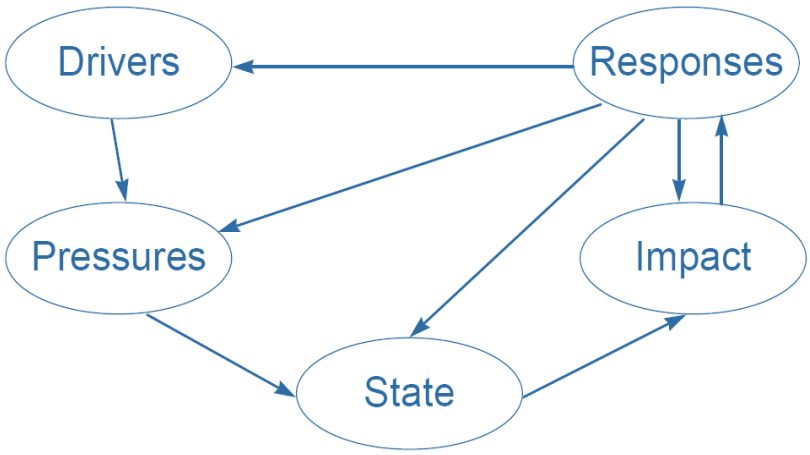


Figure 6 The DPSIR Framework for Reporting on Environmental Issues (Smeets & Weterings, 1999)

According to the literature, with the purpose of establishing proper indicators, there is information that needs to be addressed. In Figure 6, the "drivers, pressures and state" can be contemplated as the causes, while "responses" as solutions and "impacts" as the problems (Majorošová, 2016). The flow normally starts with the *driving forces* referring to the socioeconomic schemes, by which human activities exert *pressure* on the nature, that then changes the *state* of the ecosystems, causing *impacts* on the environment and

available resources, that lead to the creation of policies as a *response* (Khajuria, 2020). The *responses* can flow back to any of its previous elements in the system.

For example, in the case of applying the DPSIR framework for the goal of having low-carbon cities, the indicators concerning the *driving forces* would be those related to the energy consumption in urban areas such as transportation, buildings, industry, etc., the release of greenhouse gasses emissions would be the *environmental pressures*, the low water or air quality as effects of the greenhouse gasses would be within the *state*, while climate change would be considered as an *impact,* and the enactment of Sustainable Development Goals (SDG) to reduce carbon emissions as the *societal response to these changes* (Zhou, et al., 2015). Therefore, ecological indicators should englobe the dynamic relationship from the origin to the consequences and their links, starting by society activities to their environmental impacts and final response (Smeets & Weterings, 1999).

2.3.3. Barriers for a Circular Model

As mentioned in the previous section, the transitions to a CEBM face a set of barriers and challenges regarding technological, economical, regulatory, institutional, and social and cultural issues (de Jesus & Mendonça, 2018), that with the support from the market demand in terms of circular systems, can consequently become a motivation towards the change (Potting, Hekkert, Worrell, & Hanemaaijer, 2017).

Nevertheless, there are other barriers when seeking to an evolution into a CBM. These can be divided into internal or external ones as seen in Figure 7 (Hina, Chauhan, Kaur, Kraus, & Dhir, 2022).

On the top side of Figure 7, the internal barriers represent the obstruction within the company caused by the implementation of a circular model, being the *firm policies and strategies* one of the main problems, as they are settled by different *internal stakeholders* that do not fully understand the circular methods for their *lack of resources* such as time, knowledge, or information, along with

trainings in the topic or communication with other areas. For example, in the case of reverse logistics, it is difficult for managers to evaluate the efficiency or importance of recycled products going back to the initial manufacturing processes.

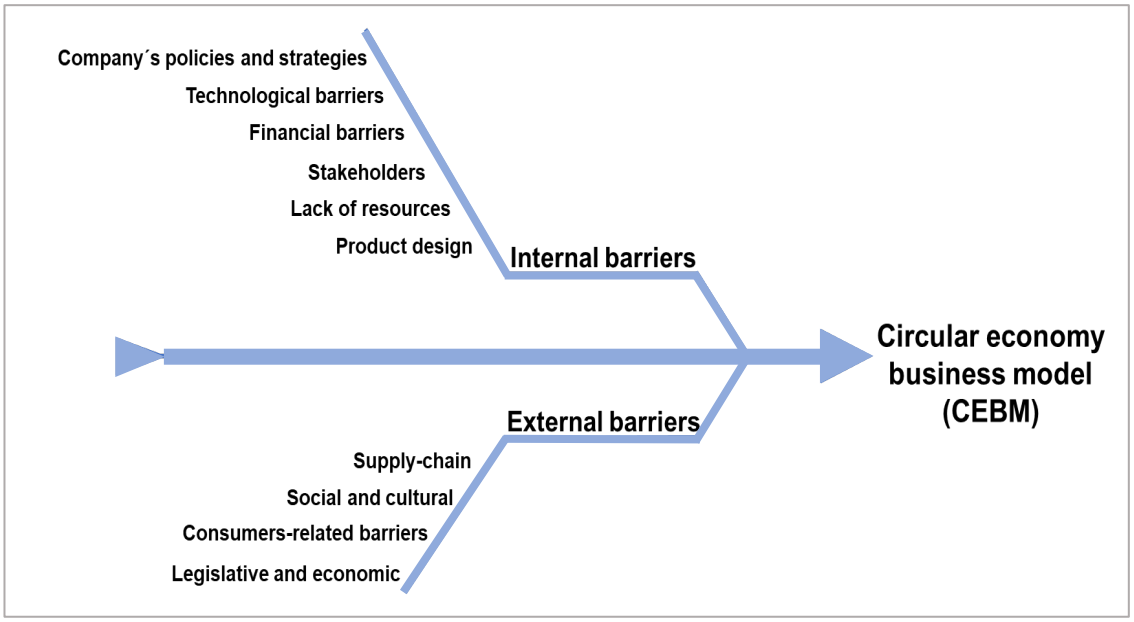


Figure 7 CEBM Barriers adapted from "Drivers and barriers of circular economy business models: Where we are now, and where we are heading" (Hina, Chauhan, Kaur, Kraus, & Dhir, 2022)

Furthermore, the *technological factors* can be challenging with reference to the development of innovative goods as it is necessary to count on special technologies, which often firms do not have in their capacity or merely do not have the ability to access to these special resources (Hina, Chauhan, Kaur, Kraus, & Dhir, 2022); however, if overcoming these obstacles, these efforts will result into a step further into a CE transition (Kirchherr, et al., 2018). They will also require *financial* investments leading to *risks and uncertainty* regarding the new structure of revenue models and profitability from the circular goods (de Jesus & Mendonça, 2018), together with higher costs due to the complexity of circular *product and system designs*, and the intensive employee trainings to help them encounter a whole new business model (Hina, Chauhan, Kaur, Kraus, & Dhir, 2022).

On the bottom side shown on Figure 7, the external barriers include factors outside the company's sphere, being the market one of them, where there is not

always possible to create symbiosis between different players in the industry. This is created from *supply chain issues* by which the involved businesses do not share transparency within each other or there is incompatibility in their processes.

Another problem related to this outer barrier is the reverse logistic management, which depends on the location where all the products are and the process of recovering them and re-manufacturing to keep them in the biological/ technological cycle as much as possible. Additionally to this barrier, the *consumer* is used to one type of business model, and it is not willing to change their usual commodities or behaviour (de Jesus & Mendonça, 2018), because of the absence of awareness related to CE (Kirchherr, et al., 2018), the price increase for more durable products, or the shortage of information and reliance on the products from a circular manufacturing.

Moreover, the *institutional and economic factors* do not support a transition towards a CEBM as there are not enough initiatives or legal parameters (de Jesus & Mendonça, 2018), in addition to the regulatory ambiguity and insufficient sustenance from the government to companies to change from a Linear Economy into a circular one. Notwithstanding there are barriers imposed by the *society*, where there is no involvement or social inclusion from the community to environmental issues and therefore, generates sustainability matters and a scarcity of motivation for both companies and society to switch the system (Hina, Chauhan, Kaur, Kraus, & Dhir, 2022).

As seen in the previous points, there are challenges and barriers in the transition to a CEBM that include diverse individuals from the companies, society, institutional level, and value chain. Only by the support of all these factors to transit into a CE model, and the foundation of tools, policies, and initiatives, the organizational inertia can be dissolved and give way to a sustainable business model (Guldmann, Bocken, & Brezet, 2019).

2.3.4. European Union Policies

Policies are a fundamental component to acknowledge when transitioning into a CEBM, as they set the regulations that an organization should apply and follow for a proper shift. The European Commission, the policy maker organism from the European Union (EU), supports the transition towards a Circular Economy model by the establishment of goals and policies in Europe. In this section, some areas of attention for policies will be displayed.

In order to transit into this model, a new Circular Economy action plan was set in 2020 together with the European Green Deal, whose purpose is to overcome the current sustainable challenges and transform the EU into a resource efficient and competitive economic model with sustainable growth (European Commission, 2023). The action plan includes the adoption of initiatives through the whole life cycle of the products, including the natural resource extraction, circular processes and designs, consumption, waste prevention and maintenance of components inside the economy as long as possible (Eurostat, 2023).

Some of the specific policies apropos this new circular agenda include topics in diverse fields (European Commission, 2023):

- **Critical raw materials:** Even though most of the raw materials are coming from international markets, the EU provides a list of the most endangered ones every three years in relation to production, the market, and technological developments. This publication helps to understand how much Europe relies on external resources and how to address the challenges of their upgrowing concerning supply.
- **Industrial emissions:** Industrial activities are an important part of the world economy; however, they account for a considerable amount of greenhouse gasses release, which negatively affects the atmosphere, water, and soil, as well as a high energy consumption and waste production. Consequently, the European Commission enacted a series of directives to regulate this economic activity.

- **Plastics:** Regardless of their useful contribution to today´s society, plastics account for negative impacts to the environment and human health, generating approximately 26 million tonnes of waste per year only in Europe. It is thus one of the focus from the EU to stop the plastic contamination and transcend into a CEBM by reducing greenhouse gas emissions, the dependence on fossil fuels and the decrease or elimination of maritime waste, from which 80% is composed by plastics.

  The application of the policies belonging to this product depend on the area of focus. For example, for biobased (plastics fully or partially produced from biological sources), biodegradable and compostable (plastics made from either biological resources or fossil fuels), there is not a law that clearly regulates them, but a communication for an EU policy framework named "COM (2022) 682 final" to help understand the society on the conditions to produce and consume them to ensure a positive impact, and their differences. Other application areas include microplastics, plastics packaging ("directive 94/62/EC on packaging and packaging waste"), single-use plastics ("directive (EU) 2019/904" that declares the market restrictions in regards production, consumption reduction, collection and design, labelling, and awareness), and plastic waste shipments.

  Ultimately the main goal of the plastic policies is to transit to a circular life cycle, where the concepts of plastics' production, design, and recyclability, as well as consumption, switch to a more sustainable pattern, bringing innovation, competitiveness and the creation of new jobs and setting an example at a worldwide level.
- **Sustainable products:** A new framework for sustainable design was proposed in 2022 based on the "Eco-design directive", which until now only covered energy-related goods. The framework will set requirements to have more eco-friendly products, by focusing on the 9R´s principle (see section 2.2.2 for more reference), carbon neutrality, energy and resource efficiency, presence of substances that prevent circularity, and information requisites.

- **Textiles:** Textiles are the fourth highest sector responsible for climate change and impacts on the environment, right after food, housing, and mobility, it is also the industry with the third highest consumption of water and land usage, and fifth in raw materials consumptions and greenhouse gas emissions. It is therefore, that the EU has incorporated as part of their green global agenda to produce durable, with high recyclability, reparability, and reusability rate textiles, while respecting both social and environment aspects, as well as attentive actions through the whole supply chain to have enough capacities for the 9R framework application in products and not ending up incinerated or in landfills.
- **Waste and recycling:** There are about 5 tonnes of waste produced by each European inhabitant every year. Hence, the EU considers in its action plan for CE, the recovery of high-quality materials or components from their disposal, and mostly important, the establishment of new laws, including the Waste Framework Directive for treating and handling litter in a hierarchy, starting by the prevention being the preferred option, preparing for re-use, recycling, recovery, and disposal as the last resource. Other policies can be found in the topic of batteries and accumulators, biodegradable waste, construction and demolition waste, packaging waste, sewage, waste oil, etc.

3. Importance of a Circular Economy Transition in the Hotel Industry

This master thesis has as a foremost objective the development of an evaluation tool that can assess the circularity rate of hotel enterprises. It is therefore important to know beforehand the background of the tourism sector, from which the hotel industry belongs, to understand the reasons behind the need to shift from a Linear Economy to a circular one.

3.1. The Tourism Sector: A Background

The tourism industry brings many global advantages within its implementation including socio-cultural and economic factors (Sørensen & Bærenholdt, 2020), namely the high amounts of employment rate and revenue contributing to each countries' Gross Domestic Product (GDP) around the world (see Figure 8 and 9), the progress of rural and peripheral regions and their economic growth, and the establishment of new infrastructure for the communal use (Rodriguez, Florido, & Jacob, 2020). It has also shown a constant international growth in the market for the last four decades being a relevant business activity for both developed and developing countries (Koçak, Ulucak, & Ulucak, 2020).

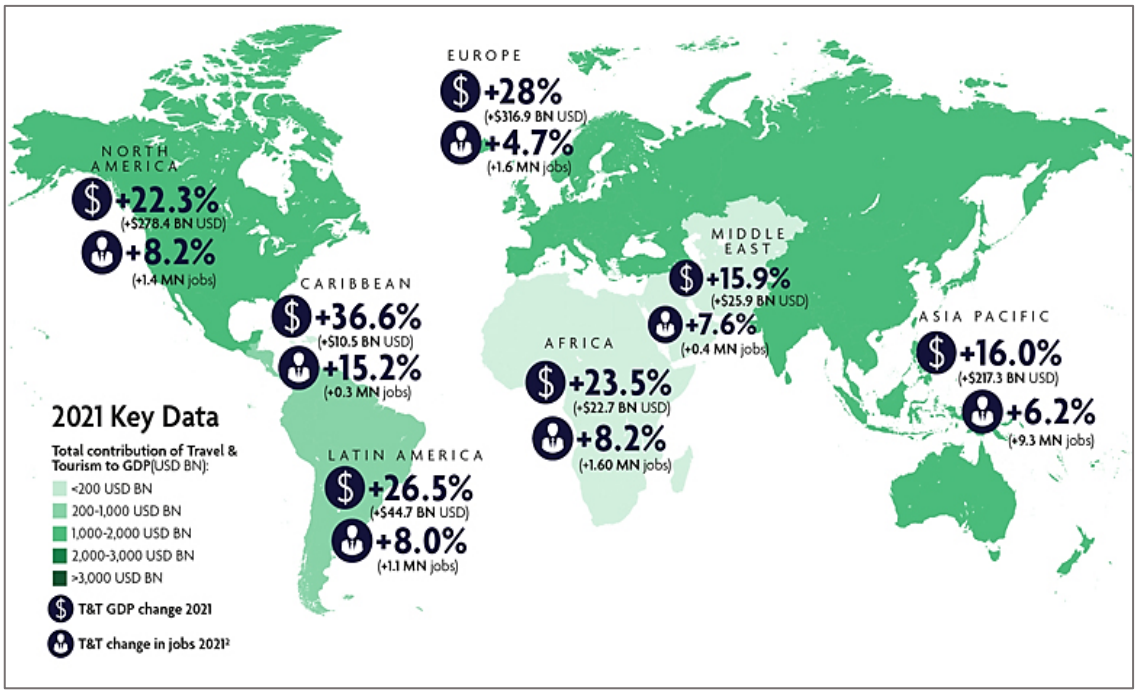


Figure 8 Total contribution of travel and tourism to GDP: Regional overview 2021 (WTTC, 2022)

According to the World Travel and Tourism Council (WTTC, 2022), in 2019 the tourism sector represented an average of 10% of all jobs around the world and 10% of the global GDP, while it only accounted for 6% in 2021.

Figure 8 shows the GDP contribution change according to region in both percentage, and in billions (BN) of United Stated Dollars (USD) compared to 2020, it also displays the development in percentage and numbers in millions (MN) when contrasted to the same year. The map is also categorized in colours according to their economic input, being North America, Europe, and Asia Pacific, the most profited from this industry (WTTC, 2022).

Even though the travel and tourism industry have not yet recovered its 2019 contribution of almost ten trillion dollars of global GDP because of the COVID-19 pandemic, numbers for year 2021 (see Figure 9) showed a 21% growth equivalent to over a trillion dollars more versus its last year. Year 2021 worldwide GDP in this sector accounted for almost six trillion dollars and it is likely to keep growing (Statista Research Department, 2023).

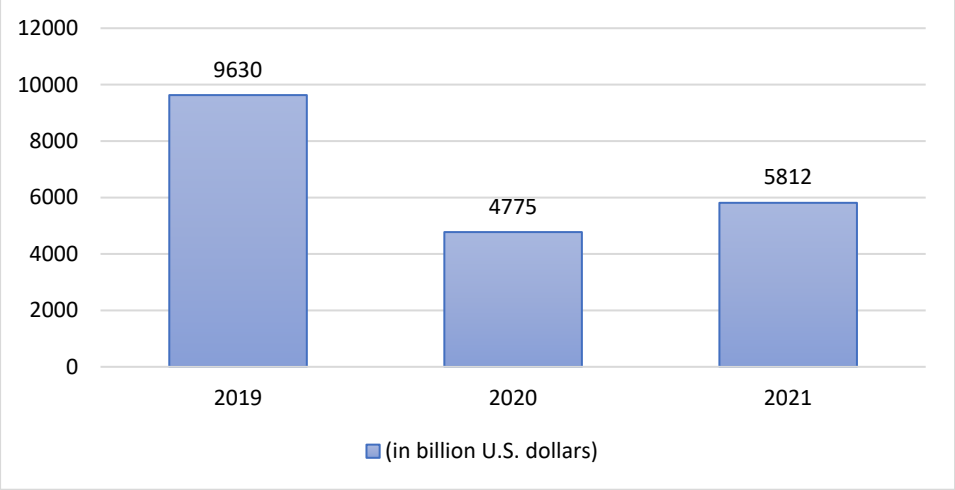


Figure 9 Total contribution of travel and tourism to worldwide GDP from 2019 to 2021 (Statista Research Department, 2023)

However, this economic activity accounts for approximately 8% of the total carbon emissions worldwide (Sustainable Travel International, 2020), requires large amounts of natural resources including water, food, and energy for its application, and generates big quantities of solid waste and sewage at the same

time. All of the previous releasing greenhouse gases such as methane and CO_2, that result into environmental deterioration (Rodriguez, Florido, & Jacob, 2020).

According to the United Nations World Tourism Organization (UNWTO), the tourism sector releases pollutants due to the large rotation of tourists and the correlated activities that they offer, all of them, showing trades of high contamination, high consumption and low utilization interconnected to Linear Economy business model principles, and the pursuit of maintaining market growth (Xu, Wang, Tang, & Ye, 2022).

While transportation accounted for most of the tourism carbon emissions in 2018 (see Figure 10) it currently accounts for 5% of all man-made carbon emissions (UNWTO, 2019).

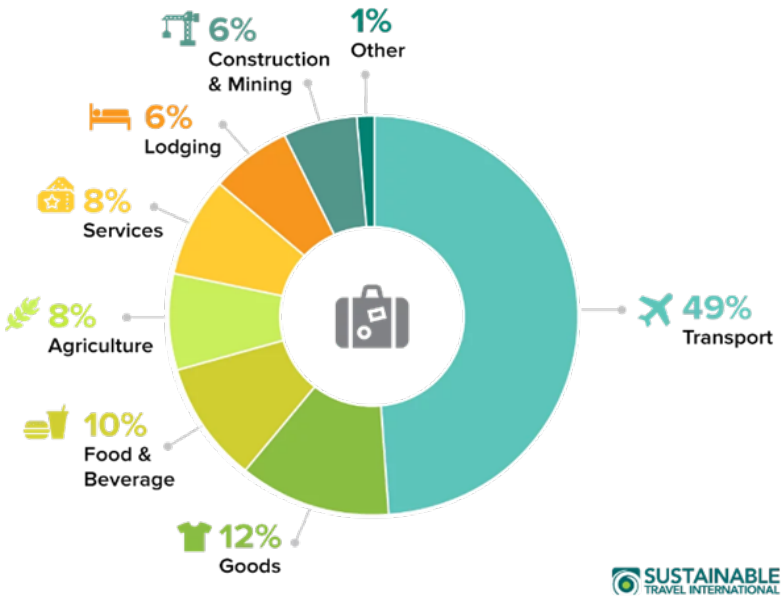


Figure 10 Carbon footprint of global tourism, data from 2018 (Sustainable Travel International, 2020)

As the society will be able to afford travelling by different means, the tourism' environmental footprint is also expected to grow if continuing with the same operating actions (Sustainable Travel International, 2020). Therefore, the World Tourism Organization proposes the approach of the CEBM and its tools to help the tourism sector become innovative, whilst having a sustainable future,

where the natural and social stocks are protected and optimized for a long-term rather than for an immediate one (UNWTO, 2020).

In an effort to raise awareness, the UNWTO declared 2017 as the "International Year of Sustainable Tourism" in order to establish strategies to contribute to the 17 SDGs shown in Figure 11.

Figure 11 Sustainable Development Goals (UN: Department of Economic and Social Affairs, 2023)

The strategies focused on five areas of implementation for the tourism sector (IISD, 2018):

- **Pillar 1:** Inclusive and sustainable economic growth, which links with SDG 8, 9 and 17.
- **Pillar 2:** Social inclusion, employment, and poverty reduction, linked with SDGs 1, 3, 4, 5, 8 and 10.
- **Pillar 3:** Resource efficiency, environmental protection, and fight against climate change, linked with SDGs 8, 12 and 14.
- **Pillar 4:** Cultural values, diversity, and heritage, related to SDGs 8, 11 and 12.
- **Pillar 5:** Mutual understanding, peace, and security, connected to SDG 17.

This report encourages governments to create policy frameworks for a proper sustainable tourism development, encourages companies to create sustainable business models and value chains, and individuals to adopt sustainable practices and behaviours (IISD, 2018).

On a general way, the UNWTO considers the CE strategies as a driving force for a change, which can also lead to an acceleration to reach the 2030 Sustainable Agenda and, believes that the tourism sector can make a great contribution to the SDGs achievement by applying them within its operations (Comunidad Autónoma de las Illes Balears, 2022).

Following the efforts on 2017, some other initiatives have already been taken regarding these issues in more recent years, as in 2021 during the 26th Conference of the Parties (COP26) from the UN, it was established the "Glasgow Declaration for Climate Action in Tourism" which united numerous businesses from the sector under this cause. This pact addressed the reduction of emissions to half by year 2030 and the Net Zero by 2050 (Comunidad Autónoma de las Illes Balears, 2022).

3.2. Circular Economy in the Hotel Industry

Similar to the tourism industry, the sub-sector of hotels with the main business of lodging and its complementary non-stop services, as they work around the clock, located in multi-functional buildings (Julião, Gaspar, & Tjahjono, 2018), occupies the third socio-economic activity and employs over 12,5 million workers in Europe (HOTREC, 2020), greatly contributing to the continent GDP. It uses, however, 5% of the water in the planet, and accounts for roughly 1% of worldwide carbon emissions (Sorin & Sivarajah, 2021), meaning 363 million carbon tonnes out of the 36,3 billion released in 2021 (Compton, 2022).

In response to this problem, the United Nations Framework Convention on Climate Change (UNFCCC) together with the International Tourism Partnership (ITP) emphasized and agreed at the past 21st COP in 2015, where urgent

sustainable issues were addressed, to reduce the carbon footprint in 66% by 2030 and 90% by 2050 specifically in the hotel industry. To do so, Sustainable Development Goals came into force. The most important initiative inside the SDGs was to decarbonize the hotel sector, followed by the increase of efficient water usage, and social topics regarding awareness implementation of human rights and creation of more youth employment (UNFCCC, 2018).

Even though the hospitality sector is profitable and occupies a big role in the GDP development in many countries around the globe, all the facts show unsustainable growth and sets pressure from both private and public entities that encourage every time more, the industry to take measurements in order to evaluate their economic, social, and environmental impacts (Sorin & Sivarajah, 2021). Hence, the change towards a CEBM seems to be a solution to handle these difficulties.

And as a clear example for a CEBM transition in the hotel industry with the support of authorities and the willingness of the industry to transit from a LE to a CE, and in an attempt to achieve the sustainable development goals, last year in 2022, the Autonomous Community of the Balearic Islands of the Spanish government implemented the "Decree-Law 3/2022, on urgent measures for the sustainability and circularity of tourism", regarding the changeover in the sector with a strategy based on the circular evaluation and planification (EY Abogados, 2022).

The legislation involved the community of Balearic Island as a start for the law execution, where all companies providing hospitality services i.e., hotels, city hotels, apart hotels, and rural tourism accommodations, must have a circular report whose validity will be of maximum five years, and after that period must be renewed. In furtherance to this report, they have to initially evaluate their circularity, to then be able to compose a circularity plan including all their activities and lodging characteristics, in addition to possible sustainable measures to be adopted in compliance with the "Decree-Law 3/2022". The plan and evaluation include the period from when the establishment first started operating; the percentage of suppliers attaining the principles of CE from the

total of them; the amount of investment made in trainings for workers, infrastructure and equipment linked to the implementation of circular practices in the facility including the last three fiscal years; and a general recompilation of customers communications where the hotel company announced their circular action or suggested them to guests. This information will be then transferred into a report to be presented to the tourism inspectors (Comunidad Autónoma de las Illes Balears, 2022) .

The report must contain the following priority areas (Comunidad Autónoma de las Illes Balears, 2022):

- **Energy:** Within this priority area, the report must include the annual carbon footprint per overnight stay, along with the building(s) energy certifications, the percentage of self-supply energy consumption in proportion to the total amount of energy consumed per year, and installed renewable energies expressed in kilowatts (kW).
- **Food:** Local or zero-kilometre ingredients should be measured out of the whole amount of food and beverage expenditure, this number should be expressed in percentage. In terms of packaging, it should also be shown the percentage of bulk products and/or food with reusable or biodegradable packaging over the total food supply. Any local ingredient offered in the lodging establishments that is commercialized thereby, must have proof of its veracity and be able to be corroborated by local authorities.
- **Water:** Water consumption in litters per year from the public water system, along with the percentage of total captured or purified (recycled) water from the overall annual building consumption. Additional information in regards of numbers of toilets with dual flush buttons versus the total amount.
- **Materials and waste:** In this section must be included the total percentage of recycled construction material considering waste generated during edification or demolition of the last fiscal year, and if not applied, then consider the last finished project. Moreover, disposable items such as room amenities e.g., bathing caps, body lotion, nail files, shampoo,

soap, etc. must not be placed for customers consumption unless they are requested and are able to comply with the principles of the 9R´s (see section 2.2.2). It is therefore mandatory to report the annual volume of waste per overnight stay including paper, cardboard, packaging, and other produced waste by the guests.

With the successful accomplishment of the "Decree-Law 3/2022", the lodging establishment can market and advertise themselves as a circular enterprise, as long as they have first requested and obtained an EU Ecolabel (Comunidad Autónoma de las Illes Balears, 2022).

There are other measurements and actions that hotels can fulfil for transitioning into a CEBM. According to Xu, Wang, Tang & Ye (2022), the DPSIR framework (see section 2.3.2.2 for more reference) can help tourism companies to have a sector ecologization. In Figure 12, this same theory has been applied to generally analyse the hotel business and assess its sustainability for transitioning into a CEBM.

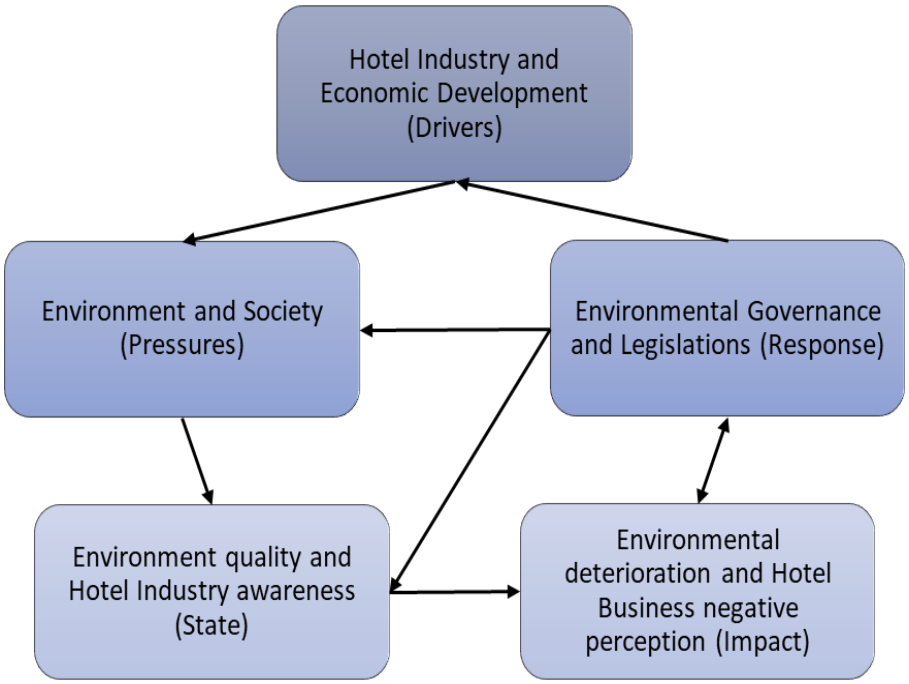


Figure 12 DPSIR framework for a CEBM in the Hotel Industry (own illustration)

The DPSIR framework typically starts with the driving forces, in this case the hotel industry and its economic impact. This one exerts a pressure into the

environment because of its operations, e.g., the raw resource consumption, waste generation, etc. and a burden on the society, as people depend on these natural resources for living.

The aforementioned creates a change on the state of the environment, and on the perception that the community can have regarding the hotel industry. If the cycle keeps moving on, then the sector's economic activities will create a negative impact on both the environment, through its deterioration (release of greenhouse gasses, intensive resource consumption, pollutants, etc.), and on its public image, creating a negative perception of itself. All these consequences will finally lead to a response via the settlement of legislations and an environmental governance to limit or minimize the repercussion produced by the business sector.

The response can have an influence on any phase of the DPSIR framework, for instance, on the drivers by assuring that the industry accomplishes a standard circular plan and operates it correspondingly; it releases the pressures, in this case the environment and the society, by the circular planification from the hotels; and changes the state of the environment by enabling a control over its quality and assures a hotel awareness that follows the CE legislations. Responses affect the impact by reducing the damage caused by the industry and changes the customers perception to positive as sustainable principles are being applied.

4. Methodology

In this chapter, the development of the thesis and how the final outcome was reached will be explained. In the next chapter, the CE assessment tool will be further presented and analysed.

The methodology of this master thesis is divided into three steps: First, the analysis of the literature review and the theoretical background examination of the Circular Economy and Circular Economy Business Model with the purpose of having a deep knowledge about the subject itself and understanding its importance. Second, a sector investigation was conducted from a general standpoint including the tourism industry, to then move towards a more specific area as it is the hotel industry, in here the reasons that urge into a transit from a Linear Economy to Circular Economy were also assessed. And lastly, all of this information was processed and then applied into the main outcome that is a circular assessment tool for hotels, with the purpose of examining the current activities and operations from lodging establishments in order to give them a score based on this corporate behaviour. This last point will be developed to a greater extent in the next chapter.

In the next chapter, as priorly mentioned, the final outcome of the project will be presented in a describing manner, section by section. Hence, it is reasonable to explain that this tool was inspired by the content of the master thesis considering the CE principles, indicators, methodologies, and legislations inside the theoretical background in Chapter 2, and the recommendations and examples to transit into a CEBM in the hotel industry seen in Chapter 3. The information and data taken for the realization of this tool was the most relevant, viable and useful for the industry. This tool can be contemplated as part of the SDG 12 (see Figure 11 for more reference) related to the responsible production and consumption.

Moreover, further analysis of existing assessment initiatives were considered when building the assessment tool including Circulytics (The Ellen MacArthur Foundation, 2021), Hotel circularity and competitiveness: Handbook for the implementation of good practices (Fundación Impulsa Balears, 2020), the

Hotel Water Measurement Initiative (HWMI) (Sustainable Hospitality Alliance, 2016), the Cornell Hotel Sustainability Benchmarking index (CHSB) (Greenview, 2022), the Inventory of Circular Economy Indicators (OECD, 2020), and the "Decree-Law 3/2022" (Comunidad Autónoma de las Illes Balears, 2022). These references were basis for the author inspiration on the creation of the "Circular Economy Assessment Tool for Hotels: Moving Towards a CEBM".

For the development and explanation of the tool, the next chapter will be as explicit as possible and therefore it will be divided in five subchapters. In the beginning the tool will be introduced along with general indications for the participant hotels, the elements that can be found inside the tool and some qualification points. The subchapters 5.1, 5.2, and 5.3 will focus on these elements which will be at the centre of the tool, hence it will be explained what they englobe and its assessments in regards of the CE in the hotel; in subchapter 5.4 the results will be presented as an overview, and in subchapter 5.5, there will be an example created by the author with the purpose of showing how the CEBM assessment tool can be better understood.

5. CE Analysis Tool

The main objective of this master thesis relies on the creation of a tool that can assess the circularity rate of businesses, specifically lodging establishments. Consequently, along this chapter, the development of the "Circular Economy Assessment Tool for Hotels: Moving towards a CEBM" will be presented and described in detail. The analysis tool will be explained step by step, together with its functionality, how it was divided in three sections, what belongs in each category, and how the circularity results system works.

This tool was developed using Excel, because it facilitates the calculation of the CE rate for the hotels, and have an automatic and immediate response, without having to address the author for the results. Hereby, the guest houses can have direct feedback of their performance and understand in which sections they can improve their activities and their corporate behaviour.

Circular Economy Assessment Tool for Hotels: Moving towards a CEBM Tool designed to measure the degree in which hotels operate in regards of Circular Economy	
Hotel Name: **Location:** **Type of Accomodation:** **Total Square Meters (m²):** **# of Rooms:** **Available room night (total number of rooms*days):**	
We kindly ask you to provide accurate data about your operations. Some of the following sections will require general and/or specific information about the hotel to assess the CE level in which it operates. For this, we ask you to have on hand all necessary documents regarding the below topics, including suppliers information. Please only complete the "hotel data" column. The other results will be automatically filled in. Every statement will have a weight, from 1-10, prefilled by us, being 1 the lowest priority and 10 the highest.	

Table 1 CE Assessment Tool for Hotels: Moving towards a CEBM - Overview n°1 (own illustration)

Table 1 requires some general information regarding the accommodation type (e.g., if they are a hotel, hostel, resort, lodge, etc.), number of rooms, square meters, and available room night (calculated by multiplying the total

number of occupied rooms, with the number of operating days), which is information that hotels manage on their daily basis. It gives the instructions for the successful completion of the tool, the weight system for every statement is also mentioned on the lower side of the table, but this topic will be developed on a later stage inside this same chapter.

This initial details are necessary for hotels to fill in as they can help in further research to examine the circularity rate of lodging according to their type of establishment, occupied rooms, size, and understand their behaviour according to location (specific rules or policies on site, larger fees for unsustainable practices, etc.) towards consumption.

These first questions will help us in creating a benchmarking for future further assessment in the industry: *(optional)*	
Total amount of energy (electricity, heat, gas, etc.) consumed per year (including renewable and no renewable sources). Expressed in kWh	
Energy consumed by occupied room: Total annual energy consumed/ total amount of annual occupied rooms. Expressed in kWh	
Energy consumed by occupied room: Total annual energy consumed/ total amount of annual occupied rooms. Expressed in kWh	
Energy consumed by square meter: Total energy consumed/ total square meters. Expressed in kWh/m²	
Carbon footprint per occupied room: Total annual carbon footprint / total annual rooms. Expressed in kg	
Carbon footprint per square meter: Total annual carbon footprint/ total square meters. Expressed in kg/m²	
Total amount of water consumed per year in litters (inflow water from all sources including the water used for the business purposes even if outsourced such as laundry). Expressed in Lt	
Amount of water consumed by occupied room per overnight stay: Total annual water consumed/ total amount of occupied rooms per year. Expressed in Lt	
Amount of water consumed by square meter per year: Total annual water consumed / total square meters. Expressed in Lt/m²	

Table 2 CE Assessment Tool for Hotels: Moving towards a CEBM - Overview n°2 (own illustration)

Table 2 exhibits additional data that is raised to lodging establishments in regards of their annual consumption on resources such as energy, water, and on their carbon footprint, from a total number to an amount consumed per occupied room or per square meter.

The total amount of occupied rooms can be calculated by knowing the occupancy of rooms per night (hotels know this information everyday) in an accumulated way. After having this data, hotels can see their annual expenditure in these areas through their suppliers, and knowing their annual occupied rooms, or total square meters, they can know this specific consumption.

These questions are meaningful in the interest of creating a benchmarking that can aide in understanding the consumption patterns from hotels in consonance to their operations and have a basis to compare between them and establish standards. These statements were inspired by the CHSB index (Greenview, 2022), and the HWMI (Sustainable Hospitality Alliance, 2016) that currently work benchmarking hotels including different parameters, to assess their utilization in energy and water to set criteria according to what it is sustainable or not. Nonetheless, as these questions will not be graded and they neither account for points on the final results, then they are optional but recommended to complete.

Tables 3, 4, and 5, will present the three sections in which this Circular Economy tool will be divided: *Operations & Services*, *Building Equipment*, and *Building Structure*. As it considers the hotel as a whole and following previous tools and methodologies from various sources and authors (see Chapter 4 for more reference), it was decided to follow this approach.

The section of *Operations & Services* displayed in Table 3 englobes all the hotel operations, the business itself and the services inside the installations. The sum up of 100% that gives this category, will represent a weight of 65% to the final result, as the operations and services are the main business of the establishment. For a better understanding, this area was classified in six sub-categories purely considering the prior mentioned activities: Energy (from all the operation related activities such as the energy consumed for cooking, for

cleaning, for general services, heating, cooling, etc.) with a 23% of weight, food and beverage (all the operations-related to this services including the restaurants, bars, room service, and food for employees) with a 20%, stakeholders (employees, customers, and suppliers) with a 10%, waste (from all the services-related activities) with 22%, water (from all the business related activities such as the water consumed for cooking, for cleaning, for general services, washing, etc.) with 18%, and others (stationary and office supplies, cleaning products, etc.) with 7%. Hence, at the moment of inserting the data, the weight of every section will influence the final results (for more information please see Table 34.

Operations & Services	**65%**
Energy	23%
Food & Beverage	20%
Stakeholders (Employees, Customers & Suppliers)	10%
Waste	22%
Water	18%
Others	7%

Table 3 CE Assessment Tool for Hotels: Moving towards a CEBM - Overview nº3 (own illustration)

The section of *Building Equipment* showed in Table 4, considers all the fixtures that are incorporated into the lodging premises and that are essential for the operations inside the establishments. Within this category we can find the electrical appliances (kitchen, washing machines, refrigerators, minibars, light bulbs, etc.), furniture (equipment such as tables, chairs, desks, beds, sofas, …), textiles (e.g., cloth napkins, sheets, towels, duvet, carpets, etc.) and waste (from all the previously mentioned subcategories in this section). For the corresponding weight, and in agreement with preceding literature and after intensive research, it was determined that this 100% resulting in this section, should weight 15% of the total for the circular assessment.

Regarding the subsections, they will weight 20%, 25%, 25% and 30%, accordingly, which will then be rated with the hotel data to result into a circular score.

Building Equipment	15%
Electrical Appliances	20%
Furniture	25%
Textiles	25%
Waste	30%

Table 4 CE Assessment Tool for Hotels: Moving towards a CEBM - Overview nº4 (own illustration)

The section of *Building Structure* from Table 5, displays the last category of the Circular Economy Assessment tool. It is related to the lodging establishment structure, including the main components that have the purpose of enclosing, supporting, shaping, and protecting the building architecture. They can include a variety of parts such as floors, walls, columns, roofs, etc. And after prior research along the thesis, the 100% that they result in (35% + 65%), will weight 20% at the end for CE assessment. The building structure section is subdivided in construction and building materials (brick, cement, concrete, clay, wood, glass, plastics, etc.) with a 35% of value, and a 65% for the waste (included all the waste generated from its co-subdivision).

Building Structure	20%
Construction and Building Materials	35%
Waste	65%

Table 5 CE Assessment Tool for Hotels: Moving towards a CEBM - Overview nº5 (own illustration)

The range of points exhibited in Table 6 are categorized in four different results: "Very high", if the establishment obtained between 76 to 100 points; it will be "high" if the points gained were between 51 and 75; "medium" if they are in the range of 26 and 50; and "low" when the score is between 0 and 25 points. This table will be shown at the end, but it this introductory phase is used to explain the participants what to expect if they obtain this qualifications.

The list of abbreviations (CE, CEBM, FY, BY) seen in Table 6, will be on the lowest side of every Excel sheet to guide the participants with the meanings of the acronyms. The screenshot from this portion of the page, was only reflected on this table.

Points	CE Performance
76 - 100	Very high
51 - 75	High
26 - 50	Medium
0 - 25	Low

Abbreviations
*CE: Circular Economy
*CEBM: Circular Economy Business Model
*FY: Fiscal Year
*BY: Business Year
*Local: Inside the hotel´s region

Table 6 CE Assessment Tool for Hotels: Moving towards a CEBM - Overview n°6 (own illustration)

From the next section and on, the three divisions of the CEBM tool and the results will be explained. There will be three weighting systems, one for each of the three sections, one for every subcategory inside the sections, and another weight for every statement inside the subcategories.

5.1. CE Assessment Tool: Operations & Services

Table 7 presents the first section that is Operations & Services and explains in the header to consider a whole business year (BY) or fiscal year (FY) for the data that will be inserted by the hotels. It also clarifies the meaning of this area and what is to be internally considered on a short and precise description, and once more, the total weight of this area. Next to this cell, there is another weight which every statement on the subsection will have, these numbers will vary from 1 – 10 (differently from the weight in percentages of the three main sections), being 1 the lowest priority or less important, and 10 the highest priority, or importance. These rates were given by the critical reasoning of the author after a deep analysis of the precedent literature review and theoretical background related to the topic. Next to the weight, is the hotel data that is to be inserted by the lodging enterprises and whose input will be in percentages. The results from the last cell will be automatically filled in after the insertion of the hotel data and will be calculated by multiplying the weight (in numeric form) with the hotel data (in percentages).

Circular Economy Assessment Tool for Hotels: Moving towards a CEBM Please fill in the Excel sheet with the lodging establishment data considering the information from the previous FY (or BY), then just complete the data column. The other results will be automatically filled in.			
Operations & Services (65% weight) This section includes all the operations of the hotel, including lodging, food and beverage service, event and conference rooms, wellness and fitness area; and the resources used for these purposes.	**Weight**	**Hotel Data (%)**	**Result**

Table 7 CE Assessment Tool for Hotels - Operation & Services n°1 (own illustration)

5.1.1. CE Assessment Tool: Operations & Services – Energy

The first subsection from Table 8 is energy, which was established to have a 23% of weight. Four questions belong to this subcategory regarding renewable energies, energy compensation and self-supplied energy for the enterprise operations. As seen on the table below, the question with the lowest priority is the self-generated energy, referring to the energy that those companies are capable of producing with their own resources; for instance, solar panels, wind turbines, biomass processes, etc. and that after production, can self-supply their own functions. The low weight is given as these implementation require investment for the proper infrastructure, which is not the main focus of lodging establishments. Regarding the other topics, the companies can have initiatives by obtaining renewable energy sources and carbon footprint compensation for its operations.

In the same Table 8, at the end of the energy subsection, there is the "sum of points" which will come from the addition of points from every question with the respective weight. Under this result, there is the cell with the "maximum possible score of the section", this one bears on the maximum of points that can

be obtained in the *energy* subcategory, if all the percentages from the hotel data were to be 100%, the ideal hotel data.

Energy			
% of consumed renewable energy (solar, wind, biomass, etc. from both outsourced and self-supply): Total annual renewable energy / Total annual energy consumption	10		0
% of self-generated energy (solar, wind, biomass): Total annual self-supplied energy / total annual energy consumption	4		0
% of heating and cooling from renewable sources (heat pumps, geothermal, solar thermal, bioliquids, etc.) / Total energy for heating and cooling consumption	9		0
% of carbon footprint compensation: Amount of carbon footprint compensation / Total annual carbon footprint	8		0
Sum of points			**0**
Maximum possible score of the section		**100%**	31

Table 8 CE Assessment Tool for Hotels - Operation & Services n°2 (own illustration)

5.1.2. CE Assessment Tool: Operations & Services – Food & Beverage

The *food and beverage* subcategory from Table 9 has a 20% of importance rate from the overall of Operations & Services section. As mentioned earlier, here we can find the restaurants, bars, room service, catering, and those all services in general incorporating food for both guests and employees.

The questions from Table 9 are related to the amount of utilized food referring particularly to the edible food and not including the packaging from them, for the sake of knowing how much food is wasted every year; and if they will regenerate nature as an energy source (see the third principle of CE "regenerate nature" in Chapter 2.2); if the ingredients are local (inside the region of where the hotel stands); to which extent they come from non-related animal meat, excluding ingredients such as milk, yogurt, eggs, cheese, etc.; the eco labels or sustainable practices from the suppliers from which this food and drinks are being provided; if they are purchased with or without packaging; the amount

of packaging in consonance with the 9R framework (see section 2.2.2 for more reference); and the processing of the waste to create a positive impact.

Food & Beverage			
% of utilized food (edible such as vegetables, fruits, grains, meat, etc., not including packaging): Total amount of purchased food - Food waste (discarded, expired, not consumed, etc.)	10		0
% of food packaging waste (not edible) from the total amount of the hotel waste. Substract the resulting number to 100% (e.g. 35% of packaging waste: 100% - 35% = 65%)	5		0
% of local food: Locally produced ingredients / total annual amount of purchased food	8		0
% of food suppliers with at least one ecolabel or certified organic sources from the total amount of food suppliers	5		0
% of food with non-related animal meat (excluding products from animals, i.e. eggs, milk, cheese, …) from total amount of purchased food	4		0
% of purchased bulk food from the total amount	7		0
% of purchased food with packaging (excluding bulk food) under the 9R framework (rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle, recovery) from the total amount of purchased food with packaging	10		0
% of food waste destinated to produce renewable energy (such as biomass, or to produce other subtances like compost, or fertilizers) from the total food waste	9		0
% of purchased beverages with packaging under the 9R framework from the total amount of purchased beverages	10		0
% of beverages suppliers with at least one ecolabel or certified organic sources from the total amount of beverage suppliers	5		0
Sum of points			**0**
Maximum possible score of the section		**100%**	73

Table 9 CE Assessment Tool for Hotels - Operation & Services n°2 (own illustration)

The hotel information should be inserted in the middle column, and the results, which are on the right side from it, will be the data multiplied with the weight of every statement. The maximum points of the *food and beverage* section will always vary, but considering 100%, as it is the best possible percentage that a hotel can give to the tool according to statement, multiplied

with the weight. In this case, the "maximum possible score of the section" would be of 73 points.

5.1.3. CE Assessment Tool: Operations & Services – Stakeholders

In Table 10, the stakeholders subsection containing the employees, customers and suppliers have a weight of 10% of the Operations & Services category. In here, the trainings for employees with the topic of Circular Economy and the budget for them is enquired, as well as the job positions related to this topic.

Stakeholders (Employees, Customers & Suppliers)			
% of trained employees with CE related topics in the lodging establishment from the total number of employees in the establishment	7		0
% of budget assigned for CE trainings: Amount of budget for CE trainings / Total amount of budget for trainings	5		0
% of CE or sustainability customer communications (onsite and offsite, e.g. emails explaining the hotel green policies regarding amenities or towel changes, etc.) from the total of sent communications	6		0
% of guests applying green policies from the hotel (e.g. not using the daily housekeeping services, or change of linens during stay) from the total amount of guests	8		0
% of all operations-related suppliers (lodging, food and beverage, events, conference rooms, wellness and fitness area, etc.) with at least one ecolabel from the total amount of operations-related suppliers	5		0
% of jobs related to CE or sustainability as their main functions from the total amount of jobs	4		0
% of hotel´s yearly goals alligned to CE strategies from all the yearly goals	9		0
Sum of points			**0**
Maximum possible score of the section		**100%**	44

Table 10 CE Assessment Tool for Hotels - Operation & Services n°3 (own illustration)

These questions are of importance to raise awareness on the corporate culture of firms and to have all associates on board and align on yearly circular goals that complement the business objectives; the initiatives directed to customers and the results from these communications reflected on guests taking

green actions (not asking for room cleaning services, etc.) are also valued for a transition into a CEBM; additionally, to know the number of suppliers from a general all operations perspective with sustainable or green certifications, helps lodging establishment to realize where an improvement can be made.

Similar to the other tables from this section of Operations & Services, the maximum possible score of stakeholders is of 44 points, which results from the multiplication of the weight of each one of the statements multiplied by 100% (which would represent the best percentage from the hotel data).

5.1.4. CE Assessment Tool: Operations & Services – Waste

Table 11 displays information about the *waste* and its separation that are generated from the Operations & Services that hotels manage and offer in their daily functions, including the lodging, events, the back office for the business operations, etc; but excluding the food and beverage area as this one was already mentioned in Table 9. The one question asking to subtract 100% minus the result, is done in this manner, as this percentage should ideally be zero to prevent waste.

Waste			
% of hotel waste from operations being collected and separated according to type: organic, paper, plastic, glass, others (biomedical, batteries, etc.) to be recycled from the total amount of operations-related waste	10		0
% of cleaning services waste (used for rooms, event spaces, common areas, and offices, including packaging, cloth, papers, etc.); from the total hotel waste. Substract the resulting number to 100% (e.g. 25% of cleaning waste: 100% - 25% = 75%)	10		0
% of waste from room amenities (packaging from shampoo, soap, shower cups, water cups, etc.), from the total hotel waste. *Substract this number from 100%* (e.g. 30% of amenities waste: 100% - 30% = 70%)	10		0
Sum of points			**0**
Maximum possible score of the section		**100%**	30

Table 11 CE Assessment Tool for Hotels - Operation & Services n°4 (own illustration)

All the questions in *waste* have the maximum weight as the garbage prevention is a strategy that companies should be implementing in contemplation of moving towards a CE model and stopping LE practices. According to the principles of this topic seen inside the thesis, one of them refers directly to the waste in "eliminate waste" (see Chapter 2.2). It has therefore, a 22% of overall importance.

The "maximum possible score" of *waste* is of 30 points, which results from the multiplication of the weight of each statement multiplied by 100% (ideal percentage from hotel data).

5.1.5. CE Assessment Tool: Operations & Services – Water

The subcategory of *water* in Table 12 is worth 18% of the total, and has only three questions, one regarding a specific water saving method (dual flush buttons for toilets to indicate the intensity of waterpower), and two from recycled water (which can come from different sources, including the self-supplied methods through rainwater collection, treatment of greywater for garden irrigation, etc.). The lowest weight aims to the self-recycled water, because on one hand, comparable to the energy subcategory, this activity is not the core business from hotels and can implicate different investments and expenses; but on the other hand, companies can opt for outsourcing recycled water through outsourcing it.

Water			
% of consumed recycled water (from both outsourced and self-supply, including cascading, untreated wastewater, etc.): Total annual recycled water / Total annual water consumption	8		0
% of internal recirculated or self-recycled (rainwater, greywater, …) from the total annual water inflow	5		0
% of toilets with dual flush buttons from the total amount of toilets	10		0
Sum of points			**0**
Maximum possible score of the section		**100%**	23

Table 12 CE Assessment for Tool Hotels - Operation & Services n°5 (own illustration)

The "maximum possible score" of *water* is of 23 points, which results from the multiplication of the weight of each statement multiplied by 100% (best percentage from hotel data).

5.1.6. CE Assessment Tool: Operations & Services – Others

In Table 13, *others* is the last subsection of Operations & Services, and has a percentage of 7%. It incorporates stationery and office supplies, as well as cleaning and personal care products (for both guests and employees) to know the extent in which these goods are being purchased from sustainable certified manufacturers and to appraise if they represent a damage to the planet via hazardous ingredients or non-circular materials.

Others			
% of documents, forms, and communication materials being given in an electronic manner instead of a printing version, from the total amount of documents, forms and communication materials	4		0
% of stationery and office supplies purchased from certified green suppliers from the total amount of purchased stationary and office supplies	5		0
% of personal care products (shampoos, soaps, gels, lotions) for employees and guests from certified green origins from the total purchased amount of care products	6		0
% of cleaning products purchased from certified green companies (without hazardous substances for the environment, and with at least one of the 9R process: rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle, recovery) from the total amount of purchased cleaning products	6		0
Sum of points			**0**
Maximum possible score of the section		**100%**	21

Table 13 CE Assessment Tool for Hotels - Operation & Services n°6 (own illustration)

The "maximum possible score" of *others* is 21 points, which results from the multiplication of the weight of each statement multiplied by 100% (best percentage from hotel data).

5.1.7. CE Assessment Tool: Operations & Services – Score

Table 14 is the last chart from the section of *Operations & Services* and in this location, the results from all the previous subcategories will be calculated. The "weighted score of the section" is the addition of the outcome from the multiplications of each and every weight of all the subsections (energy 23%, food and beverage 20%, stakeholders 10%, waste 22%, water 18%, and others 7%) with the obtained "sum of points" (see from Table 8 to Table 13).

Weighted score of the section		0,00
Maximum possible weighted score of the section		38,34
Maximum possible score of Operations & Services		65,00
Operations & Services Total Score	65%	**0,00**

Table 14 CE Assessment Tool for Hotels - Operation & Services n°7 (own illustration)

The "maximum possible weighted score of the section" is the addition of all the outcomes from the multiplications of every weight of all the subsections with the "maximum possible score of the section".

Finally, the "Operations & Services Total Score" is the division of the "weighted score of the section" with the "maximum possible weighted score of the section", multiplied with the "maximum possible score of Operations & Services" (which is the weight of 65% multiplied to 100). These information will be automatically filled in when the lodging establishments complete the hotel data column, so no further action from the hotels side is required.

In Chapter 5.4, an example of a hotel will be given to better understand the tool utilization.

5.2. CE Assessment Tool: Building Equipment

Table 15 introduces the second section of the CE tool related to *Building Equipment*. As also seen with Operations & Services, the Excel sheet follows the same structure, as the name of the tool is in the header jointly with the

explanation of how to insert the firm data, by taking into account either the BY or FY.

The name of the section and the weight, followed by the hotel data and results columns are equally displayed in the chart.

Circular Economy Assessment Tool for Hotels: Moving towards a CEBM Please fill in the Excel sheet with the lodging establishment data considering the information from the previous FY (or BY), then just complete the data column. The other results will be automatically filled in.			
Building Equipment (15% weight)	**Weight**	**Hotel Data (%)**	**Result**

Table 15 CE Assessment Tool for Hotels - Building Equipment nº1 (own illustration)

This category, as generally described in Chapter 5, includes all the equipment that supports the development of the establishment and the company operations, hence it has a 15% of weight from the total score. And as seen with the other subsections, every question has a weight between 1 – 10, being 1 the lowest priority and 10, the highest.

5.2.1. CE Assessment Tool: Building Equipment – Electrical Appliances

The first subcategory shown in Table 16 of Building Equipment is *Electrical Appliances*, which has an importance of 20%, according to the research and examination done in this master thesis and the judgement of the author.

In this subsection, there are three questions regarding the type of energy efficiency used and the suppliers from the artefacts found in diverse areas from the hotel. For example, for the first statement that is related to the EU energy ecolabel, it includes the appliances that are in the rooms such as the minibars and the air conditioners, those at the restaurant namely the kitchen, refrigerator, fridge freezers and dishwasher, and in the washing area like the washing machine and dryers. The more appliances with an A ecolabel or from certified environmentally friendly suppliers, will denote that there is a less energy

consumption when these electrical artefacts are working, resulting into a more efficient energy operation.

Electrical Appliances			
% of electrical appliances (kitchen, refrigerator, minibar, electric ovens, dryers, …) with an A category from the EU energy ecolabel from the total amount of electrical appliances	9		0
% of electrical appliances from companies with eco-labels or CE certifications	6		0
% of power saving lights bulbs from all light bulbs in the building	7		0
Sum of points			**0**
Maximum possible score of the section		**100%**	22

Table 16 CE Assessment Tool for Hotels - Building Equipment n°2 (own illustration)

The "maximum possible score" of *electrical appliances* is of 22 points, which results from the multiplication of the weight of each statement multiplied by 100% (ideal percentage from hotel data).

5.2.2. CE Assessment Tool: Building Equipment – Furniture

Table 17 features the subcategory of *Furniture* with a weight of 25%. It comprehends the movables that are located in diverse areas inside the lodging establishments. For instance, the bed, night tables, desk, chairs, sofa, closets, wardrobe, etc. in the rooms area; sofas, tables, reception desk in the lobby; toilet shelves, toilet vanity inside the toilets; shelves, countertops, and racks in the kitchen.

In the *Furniture* subsection, the tool asks the hotels to give them information regarding the percentages in which their furniture is complying the 9R framework (see Chapter 2.2.2 for additional input), namely if these movables are either being purchased from regional (local) suppliers, and if these providers have sustainable certifications or ecolabels for the manufacturing processes of their products and their green practices.

The 9R methodology was emphasised in many statements from different subcategories, due to the fact that it belongs to the second principle from the Circular Economy (see Chapter 2.2), which states that products and materials are to be circulated as much as possible inside the system.

Furniture			
% of purchased recycled furniture from the total amount of furniture	7		0
% of repaired and/ or refurbished and/ or remanufactured furniture from the total amount of furniture	8		0
% of recycling rate of all the furniture *(e.g. 40% for tables, 20% for desks = 30% average)*	9		0
% of furniture from certified sustainable suppliers from all furniture suppliers	5		0
% of purchased furniture from local suppliers	8		0
Sum of points			**0**
Maximum possible score of the section		**100%**	37

Table 17 CE Assessment Tool for Hotels - Building Equipment nº3 (own illustration)

The "maximum possible score" of *furniture* is of 37 points, which results from the multiplication of the weight of each statement multiplied by 100% (ideal percentage from hotel data).

5.2.3. CE Assessment Tool: Building Equipment – Textiles

The subcategory of *Textiles* is displayed in Table 18, which has a weight of 25% as previously mentioned. The objects inside this subsection are those found in many areas of the lodging establishments, for instance in the rooms department (bed sheets, pillowcases, duvets, covers, linen in general, towels, carpets); in the restaurant area (napkins, tablecloth, table runners, chair covers); in the reception area (carpets, table runners, sofa covers). Once more, the recycling process of the textiles is asked following the second principle of the CE (see Chapter 2.2).

The "maximum possible score" of *textiles* is of 20 points, which results from the multiplication of the weight of each statement multiplied by 100% (ideal percentage from hotel data).

Textiles			
% of purchased recycled textiles (linen, towels, napkins, carpets, etc.) from all purchased textiles	7		0
% of textiles from certified sustainable suppliers from all textiles suppliers	5		0
% of purchased textiles from local suppliers	8		0
Sum of points			**0**
Maximum possible score of the section		**100%**	20

Table 18 CE Assessment Tool for Hotels - Building Equipment n°4 (own illustration)

5.2.4. CE Assessment Tool: Building Equipment – Waste

Waste is the last subdivision of Building Equipment, which weights 30%, having the highest percentage in this category, in view of the reason that the first principle of the Circular Economy is of "eliminate waste" (see Chapter 2.2). It is, consequently, important to understand how hotels are currently dealing with the different garbage they produce through their whole business operations (in this certain case with electrical appliances, furniture, and textiles) and how they manage them after the end of their lifecycle (separation, collection, recycling).

Waste			
% of electronical appliances separated and collected to then be recycled, either on site or from a third party from all the electronical appliances waste	8		0
% of furniture separated and collected to then be recycled, either on site or from a third party from all the furniture waste	9		0
% of textiles separated and collected to then be recycled, either on site or from a third party from all the textile waste	7		0
Sum of points			**0**
Maximum possible score of the section		**100%**	24

Table 19 CE Assessment Tool for Hotels - Building Equipment n°5 (own illustration)

For that reason, in this subsection, all the statements have a high priority from 7, 8, and 9.

The maximum possible score of waste is of 24 points, which results from the multiplication of the weight of each statement multiplied by 100% (ideal percentage from hotel data).

5.2.5. CE Assessment Tool: Building Equipment – Score

Table 20 is the last chart from the Building Equipment section as it is where the final results will automatically be calculated after the data insertion from the hotel. As seen in the table, the "weighted score of the section" is the sum of the outcome from the multiplications of every weight of all the subsections (electrical appliances 20%, furniture 25%, textiles 25% and waste 30%) with the obtained "sum of points".

The sum of the number of outcomes (from the multiplications of each weight of all the subsections with the "maximum possible score of the section") is the "maximum possible weighted score of the section", so it is the highest score than a lodging establishment can obtain if having 100% in all of the statements. In the Chapter 5.4, an example of a hotel will be given to better understand the tool utilization.

Weighted score of the section		0,00
Maximum possible weighted score of the section		25,85
Maximum possible score of Building Equipment		15
Building Equipment Total Score	15%	**0,00**

Table 20 CE Assessment Tool for Hotels - Building Equipment n°6 (own illustration)

Lastly, the "Building Equipment Total Score" is the division of the "weighted score of the section" with the "maximum possible weighted score of the section", multiplied with the "maximum possible score of Building Equipment" (which is the weight of 15% multiplied to 100).

5.3. CE Assessment Tool: Building Structure

The last section of the CE Assessment tool is shown in Table 21. *Building Structure* has a weight of 20% of the final score as it includes all the materials that belong to the building, that have the functions of delimitating, enclosing, supporting, shaping, and protecting the lodging architecture.

The Excel sheet displays identical information than with the other categories as seen with Operation & Services and Building Equipment; the variation relies on the time slot to take into consideration for the hotel data insertion, due that for *Building Structure* can either be Business Year, Fiscal Year, or the last completed project.

Circular Economy Assessment Tool for Hotels: Moving towards a CEBM Please fill in the Excel sheet with the lodging establishment data considering the information from the previous FY (or BY), or last project, then just complete the data column. The other results will be automatically filled in.			
Building Structure (20% weight)	**Weight**	**Hotel Data (%)**	**Result**

Table 21 CE Assessment Tool for Hotels - Building Structure n°1 (own illustration)

The sheet for this category is also arranged into the statements/questions, the value of each one of them from 1 – 10 (1 being the lowest priority, and 10 the highest), the hotel data expressed in percentage to be filled in by the hotels, and the result column.

5.3.1. CE Assessment Tool: Building Structure – Construction and Building Materials

The subsection of *Construction and Building Materials* is shown in Table 22, with a weight of 35%. This area consists of all the resources (brick, cement, concrete, clay, wood, glass, plastics) that will be employed to create the hotel's structure including foundation, pillars, walls, roofs, flooring, etc. which correspond to the architectural design and are not movable elements as it is the case with the Building Equipment.

There are questions related to certified sustainable suppliers, as these ecolabel can assure the proper use of resources for the elaboration of the products, while not harming the planet. Moreover, in this subsection, the 9R methodology (Chapter 2.2.2) is once again borne in mind on account of the second principle of the CE strategy "circulate products and materials" (see Chapter 2.2). Therefore, and according to the previous theoretical background developed in this thesis, the percentage of circular design, that complies with the three CE principles, is also asked to hotels.

Construction and Building Materials			
% of building materials from certified eco suppliers from the total amount of construction and building materials	6		0
% of building materials with non-virgin elements (reused, recycled, refurbished, etc.) from the total amount of construction and building materials	7		0
% of building facade with insulation materials (walls, roofs, windows, etc.)	8		0
% of wood (for roofs, flooring, walls) sourced from certified sustainable companies from the total amount of wood suppliers	9		0
% of planned circular design for the building from the total building desing	6		0
% of local building materials	8		0
% of building facade covered with vertical garden (walls, and roof)	4		0
% of paints for both the external and internal building structure purchased from certified green companies (without hazardous substances for the environment) from the total amount of used paints	6		0
Sum of points			**0**
Maximum possible score of the section		**100%**	54

Table 22 CE Assessment Tool for Hotels - Building Structure n°2 (own illustration)

In the case of the insulation materials, it is a statement with a high importance as this materials will act as barriers to prevent either cold or heat flows from outside and inside the building. In this manner, the energy consumption for air conditioners and/or heating systems will reduce as the

temperatures will be kept and there will not be exchange with the outside of the establishment.

Vertical gardens are related to the third principle of the CE "regenerate nature", as they will be part of the hotel structure and can create new natural resources for the atmosphere, whereas the statement regarding local/regional materials, prevent the creation of CO_2 from transportation.

The maximum possible score of *construction and building materials* is of 54 points, which results from the multiplication of the weight of each statement multiplied by 100% (ideal percentage from hotel data).

5.3.2. CE Assessment Tool: Building Structure – Waste

Table 23 shows the last subcategory of the tool being *Waste* with a 65% of importance. This subsection is related to the building materials and how hotels manage their waste produced by construction activities.

The three statements have a direct correlation with the first and second principle of Circular Economy of "eliminate waste" and "circulate products and materials" (Chapter 2.2). Therefore, they have high values of 7 and 10, which will have a strong influence on the results. These questions focus on the collection, separation and after use process of both construction and demolition activities, as well as on the waste prevention.

Waste			
% of used material: Purchased construction material - construction waste	10		0
Collection rate of construction waste: % of construction waste (cement, sand, brick, etc.) that is separated and collected for a recycling process from all the construction waste	7		0
Collection rate of demolition waste: Percentage of demolition waste (cement, sand, brick, etc.) that is separated and collected for a recycling process from all the demolition waste	7		0
Sum of points			**0**
Maximum possible score of the section		**100%**	24

Table 23 CE Assessment Tool for Hotels - Building Structure n°3 (own illustration)

The maximum possible score of *waste* is of 24 points, which results from the multiplication of the weight of each statement multiplied by 100% (ideal percentage from hotel data).

5.3.3. CE Assessment Tool: Building Structure – Score

The last chart from the category of Building Structure shown in Table 24 is where the results will be immediately displayed after the successful data input from hotels, and as with the other categories, this is how it can be calculated:

The "weighted score of the section" is the addition of the result of the multiplications of every weight of all the subsections (Construction and Building Materials 35%, Waste 65%) with the obtained "sum of points".

The sum of the number of outcomes (from the multiplications of each weight of all the subsections with the "maximum possible score of the section") is the "maximum possible weighted score of the section", so it is the highest score than a lodging establishment can obtain if having 100% in all of the statements. In the Chapter 5.4, an example of a hotel will be given to better understand the tool utilization

The "Building Structure Total Score" is the division of the "weighted score of the section" with the "maximum possible weighted score of the section", multiplied with the "maximum possible score of Building Structure" (which is the weight of 15% multiplied to 100).

Weighted score of the section		0,00
Maximum possible weighted score of the section		34,5
Maximum possible score of Building Structure		20
Building Structure Total Score	20%	**0,00**

Table 24 CE Assessment Tool for Hotels - Building Structure n°4 (own illustration)

5.4. CE Assessment Tool: Results

A part of the information from the initial table (see Table 1) is displayed once more in Table 25. This information, being previously completed by the hotel, will not require of any further action as that it will automatically be filled in by Excel.

Circular Economy Assessment Tool for Hotels: Moving towards a CEBM The information shown in this section will be automatically displayed.	**CE Score** **0,00**
Hotel Name: **Location:** **Type of Accomodation:** **Total Square Meters:** **# of Rooms:** **Available room night (total number of rooms*days):**	
Operations & Services	
Energy Food & Beverage Stakeholders (Employees, Customers & Suppliers) Waste Water Others	
Total Score	**0,00**

Table 25 CE Assessment Tool for Hotels - Results n°1 (own illustration)

On the top ride side of the same chart (Table 25), next to the title, the CE Score is indicated with the punctuation which will be obtained from the tool final score according to the given information and the respective calculations.

Followed by the first block of the hotel's general information and the CE Score, Table 25 and 26 display the subsections priorly explained. They contain the scores received from "Operations & Services Total Score" (Table 14), "Building Equipment Total Score" (Table 20), and "Building Structure Total Score" (Table 24). The "Total CE Score" is the addition of the total score of each category, whereas the "maximum possible score of CE in the hotel" is the sum of the "maximum possible score" of the three sections.

Building Equipment	
Electrical Appliances	
Furniture	
Textiles	
Waste	
Total Score	**0,00**

Building Structure	
Construction and Building Materials	
Waste	
Total Score	**0,00**

Maximum possible score of CE in the hotel	100,00
Total CE Score	**0,00**

Points	**CE Performance**
76 - 100	Very high
51 - 75	High
26 - 50	Medium
0 - 25	Low

Table 26 CE Assessment Tool for Hotels - Results n°2 (own illustration)

The "Total CE Score" will result into a number from 0 to 100, being 0 the worst and 100 the maximum. Afterwards, lodging firms can see the range of their results according to punctuation and have an idea if their applied strategies in

the establishment have a CE performance considered "low", "medium", "high" or "very high".

5.5. CE Assessment Tool: An Example

In this subchapter, a hotel and its data were created by the author to better explain how the tool works and how the results are calculated based on the theoretical previous explanation. Even though the outcomes do not require of any action from the hotel side, they will be nonetheless shown for a better understanding of the weighting and calculating methodology.

In Table 27, 28, and 29 the category of *Operations & Services* is displayed, and for each one of its subcategories, percentages were created as if they were hotel input to understand how the tool will look when the lodging establishments finish inserting their information.

The subcategory of *Energy* will be the only one from the Operations & Services category taken as an example for a more detailed explanation. However, all the other subcategories will be also exhibited in the next charts.

In Table 27, the "result" column of every statement is the multiplication of "weight" with "hotel data", being for the first question 10 * 85% = **8,5**; for the second 4 * 5% = **0,2**; for the third 9 * 70% = **6,3**; and for the fourth 8 * 65% = **5,2**.

"The sum of points", englobes the outcome of each statement as they are added up together: 8,5 + 0,2 + 6,3 + 5,2 = **20,2**.

The "maximum possible score of the section", as priorly explained, is the multiplication of every weight with the maximum percentage (in this case 100%) that the company can have in every statement. Being 10 * 100% = **10**; 4 * 100% = **4**; 9 * 100% = **9**; 8 * 100% = **8**; and the sum up of outcomes: 10 + 4 + 9 + 8 = **31.**

The demonstrated process for Energy, is also done for the other subcategories of Food & Beverage, Stakeholders, Waste, Water, and Others.

Circular Economy Assessment Tool for Hotels: Moving towards a CEBM Please fill in the Excel sheet with the lodging establishment data considering the information from the previous FY (or BY), then just complete the data column. The other results will be automatically filled in.			
Operations & Services (65% weight) This section includes all the operations of the hotel, including lodging, food and beverage service, event and conference rooms, wellness and fitness area; and the resources used for these purposes.	**Weight**	**Hotel Data (%)**	**Result**
Energy			
% of consumed renewable energy (solar, wind, biomass, etc. from both outsourced and self-supply): Total annual renewable energy / Total annual energy consumption	10	**85%**	8,5
% of self-generated energy (solar, wind, biomass): Total annual self-supplied energy / total annual energy consumption	4	**5%**	0,2
% of heating and cooling from renewable sources (heat pumps, geothermal, solar thermal, bioliquids, etc.) / Total energy for heating and cooling consumption	9	**70%**	6,3
% of carbon footprint compensation: Amount of carbon footprint compensation / Total annual carbon footprint	8	**65%**	5,2
Sum of points			**20,2**
Maximum possible score of the section		**100%**	31
Food & Beverage			
% of utilized food (edible such as vegetables, fruits, grains, meat, etc., not including packaging): Total amount of purchased food - Food waste (discarded, expired, not consumed, etc.)	10	**85%**	8,5
% of food packaging waste (not edible) from the total amount of the hotel waste. Substract the resulting number to 100% (e.g. 35% of packaging waste: 100% - 35% = 65%)	5	**80%**	4
% of local food: Locally produced ingredients / total annual amount of purchased food	8	**90%**	7,2
% of food suppliers with at least one ecolabel or certified organic sources from the total amount of food suppliers	5	**30%**	1,5
% of food with non-related animal meat (excluding products from animals, i.e. eggs, milk, cheese, …) from total amount of purchased food	4	**60%**	2,4
% of purchased bulk food from the total amount	7	**40%**	2,8
% of purchased food with packaging (excluding bulk food) under the 9R framework (rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle, recovery) from the total amount of purchased food with packaging	10	**30%**	3
% of food waste destinated to produce renewable energy (such as biomass, or to produce other subtances like compost, or fertilizers) from the total food waste	9	**20%**	1,8
% of purchased beverages with packaging under the 9R framework from the total amount of purchased beverages	10	**20%**	2
% of beverages suppliers with at least one ecolabel or certified organic sources from the total amount of beverage suppliers	5	**35%**	1,75
Sum of points			**34,95**
Maximum possible score of the section		**100%**	73

Table 27 CE Assessment Tool for Hotels - Example n°1 (own illustration)

Stakeholders (Employees, Customers & Suppliers)			
% of trained employees with CE related topics in the lodging establishment from the total number of employees in the establishment	7	**35%**	2,45
% of budget assigned for CE trainings: Amount of budget for CE trainings / Total amount of budget for trainings	5	**10%**	0,5
% of CE or sustainability customer communications (onsite and offsite, e.g. emails explaining the hotel green policies regarding amenities or towel changes, etc.) from the total of sent communications	6	**80%**	4,8
% of guests applying green policies from the hotel (e.g. not using the daily housekeeping services, or change of linens during stay) from the total amount of guests	8	**45%**	3,6
% of all operations-related suppliers (lodging, food and beverage, events, conference rooms, wellness and fitness area, etc.) with at least one ecolabel from the total amount of operations-related suppliers	5	**30%**	1,5
% of jobs related to CE or sustainability as their main functions from the total amount of jobs	4	**20%**	0,8
% of hotel´s yearly goals alligned to CE strategies from all the yearly goals	9	**35%**	3,15
Sum of points			**16,8**
Maximum possible score of the section		**100%**	44
Waste			
% of hotel waste from operations being collected and separated according to type: organic, paper, plastic, glass, others (biomedical, batteries, etc.) to be recycled from the total amount of operations-related waste	10	**60%**	6
% of cleaning services waste (used for rooms, event spaces, common areas, and offices, including packaging, cloth, papers, etc.); from the total hotel waste. Substract the resulting number to 100% (e.g. 25% of cleaning waste: 100% - 25% = 75%)	10	**26%**	2,6
% of waste from room amenities (packaging from shampoo, soap, shower cups, water cups, etc.), from the total hotel waste. *Substract this number from 100%* (e.g. 30% of amenities waste: 100% - 30% = 70%)	10	**35%**	3,5
Sum of points			**12,1**
Maximum possible score of the section		**100%**	30
Water			
% of consumed recycled water (from both outsourced and self-supply, including cascading, untreated wastewater, etc.): Total annual recycled water / Total annual water consumption	8	**25%**	2
% of internal recirculated or self-recycled (rainwater, greywater, …) from the total annual water inflow	5	**35%**	1,75
% of toilets with dual flush buttons from the total amount of toilets	10	**90%**	9
Sum of points			**12,75**
Maximum possible score of the section		**100%**	23

Table 28 CE Assessment Tool for Hotels - Example n°2 (own illustration)

Others			
% of documents, forms, and communication materials being given in an electronic manner instead of a printing version, from the total amount of documents, forms and communication materials	4	**90%**	3,6
% of stationery and office supplies purchased from certified green suppliers from the total amount of purchased stationary and office supplies	5	**35%**	1,75
% of personal care products (shampoos, soaps, gels, lotions) for employees and guests from certified green origins from the total purchased amount of care products	6	**30%**	1,8
% of cleaning products purchased from certified green companies (without hazardous substances for the environment, and with at least one of the 9R process: rethink, reduce, reuse, repair, refurbish, remanufacture, repurpose, recycle, recovery) from the total amount of purchased cleaning products	6	**40%**	2,4
Sum of points			**9,55**
Maximum possible score of the section		**100%**	21
Weighted score of the section			18,94
Maximum possible weighted score of the section			38,34
Maximum possible score of Operations & Services			65,00
Operations & Services Total Score		65%	**32,11**

Table 29 CE Assessment Tool for Hotels - Example n°3 (own illustration)

In Table 29, the "weighted score of the section" is calculated by multiplying the "sum of points" with the weight of the same subcategory (the weights of every subsection can be found in Table 3): For Energy 20,2 * 23% = **4,65**; for Food & Beverage 34,95 * 20% = **6,98**; for Stakeholders 16,8 * 10% = **1,68**; for Waste 12,1 * 22% = **2,66**; for Water 12,75 * 18% = **2,3**; and for Others 9,55 * 7% = **0,67**. These results are then sum up to obtain the "weighted score of the section": 4,65 + 6,98 + 1,68 + 2,66 + 2,3 + 0,67 = **18,94.**

Equally displayed in Table 29, in order to find the "maximum possible weighted score of the section", the same steps are to be followed such as with the "weighted score of the section". Nonetheless, in this circumstance, instead of taking the real "sum of points" from each subcategory, the "maximum possible score of the section" should be considered and multiplied with the weight of the same subcategory: For Energy 31 * 23% = **7,13**; for Food & Beverage 73 * 20% = **14,6**; for Stakeholders 44 * 10% = **4,4**; for Waste 30 * 22% = **6,6**; for Water

23 * 18% = **4,14**; for Others 21 * 7% = **1,47**. Afterwards, the results are taken and added: 7,13 + 14,6 + 4,4 + 6,6 + 4,14 + 1,47 = **38,34.**

The "maximum possible score of Operations & Services" is the percentage of the whole section multiplied by 100, being in this case 65% * 100 = **65 points**. Whereas the "Operations & Services Total Score" is the "weighted score of the section" divided by the "maximum possible weighted score of the section" and finally multiplied by the "maximum possible score of Operations & Services": 18,94 / 38,34 * 65 = **32,11 points.** These points will be subsequently added to the other results obtained from the remaining two categories to lead into a final total CE score.

Tables 30, 31 and 32 show the section of Building Equipment from which also the author created the data for a better exemplification when testing the tool methodology and utilization.

The subcategories of Electrical Appliances, Furniture, Textiles and Waste from Building Equipment (see Table 4 for their weights) are displayed in both charts and can be inferred that the "sum of points" of each subsection are as well attained with the same logic as for the ones of the Operations & Services category.

Circular Economy Assessment Tool for Hotels: Moving towards a CEBM Please fill in the Excel sheet with the lodging establishment data considering the information from the previous FY (or BY), then just complete the data column. The other results will be automatically filled in.			
Building Equipment (15% weight)	**Weight**	**Hotel Data (%)**	**Result**
Electrical Appliances			
% of electrical appliances (kitchen, refrigerator, minibar, oven, irons, dryers, …) with an A category from the EU energy ecolabel from the total amount of electrical appliances	9	**80%**	7,2
% of electrical appliances from companies with eco-labels or CE certifications	6	**70%**	4,2
% of power saving lights bulbs from all light bulbs in the building	7	**100%**	7
Sum of points			**18,4**
Maximum possible score of the section		**100%**	22

Table 30 CE Assessment Tool for Hotels - Example n°4 (own illustration)

Furniture			
% of purchased recycled furniture from the total amount of furniture	7	**20%**	1,4
% of repaired and/ or refurbished and/ or remanufactured furniture from the total amount of furniture	8	**30%**	2,4
% of recycling rate of all the furniture *(e.g. 40% for tables, 20% for desks = 30% average)*	9	**45%**	4,05
% of furniture from certified sustainable suppliers from all furniture suppliers	5	**90%**	4,5
% of purchased furniture from local suppliers	8	**15%**	1,2
Sum of points			**13,55**
Maximum possible score of the section		**100%**	37
Textiles			
% of purchased recycled textiles (linen, towels, napkins, carpets, etc.) from all purchased textiles	7	**50%**	3,5
% of textiles from certified sustainable suppliers from all textiles suppliers	5	**40%**	2
% of purchased textiles from local suppliers	8	**25%**	2
Sum of points			**7,5**
Maximum possible score of the section		**100%**	20

Table 31 CE Assessment Tool for Hotels - Example n°5 (own illustration)

The last part of Table 32 shows the "weighted score of the section" as a result from the multiplication of the "sum of points" with the weight of the subcategory, and the addition of those results: (For Electrical Appliances) 18,4 * 20 **+** (for Furniture) 13,55 * 25% **+** (for Textiles) 7,5 * 25% **+** (for Waste) 9,75 * 30% = **11,87.**

Following the same method to obtain the "maximum possible weighted score of the section" results into **25,85** for Building Equipment when doing the same calculation than for the "weighted score of the section", but instead of taking the "sum of points", taking the "maximum possible score of the section" and multiplying it with the weight of the subcategory.

The "maximum possible score of Building Equipment" is the weight of the section multiplied by 100: 15% * 100 = **15 points.** While the "Building Equipment Total Score" is the "weighted score of the section" divided by the

"maximum possible weighted score of the section" and multiplied by the "maximum possible score of Building Equipment": 11,87 / 25,85 * 15 = **6,89 points**.

Waste			
% of electronical appliances separated and collected to then be recycled, either on site or from a third party from all the electronical appliances waste	8	**20%**	1,6
% of furniture separated and collected to then be recycled, either on site or from a third party from all the furniture waste	9	**40%**	3,6
% of textiles separated and collected to then be recycled, either on site or from a third party from all the textile waste	7	**65%**	4,55
Sum of points			**9,75**
Maximum possible score of the section		**100%**	24
Weighted score of the section			11,87
Maximum possible weighted score of the section			25,85
Maximum possible score of Building Equipment			15
Building Equipment Total Score		15%	**6,89**

Table 32 CE Assessment Tool for Hotels - Example n°6 (own illustration)

In Table 33, the section of Building Structure is presented and also displays information created by the author to have an enhanced impression of how the CE tool will look like when it is completed.

The subcategories of Construction and Building Materials, as well as Waste follow the same methodology of multiplying the statements with each individual weight to reach the "sum of points".

The "weighted score of the section" is the multiplication of Construction and Building Materials "sum of points" with its weight (see Table 5), and then added to the multiplication of Waste "sum of points" and its weight: 21,9 * 35% **+** 7,45 * 65% = **12,51.**

The "maximum possible weighted score of the section" is the same calculation; however, the "maximum possible score of the section" is taken instead of the real "sum of points": 54 * 35% **+** 24 * 65% = **34,5**.

Circular Economy Assessment Tool for Hotels: Moving towards a CEBM

Please fill in the Excel sheet with the lodging establishment data considering the information from the previous FY (or BY), or last project, then just complete the data column. The other results will be automatically filled in.

Building Structure (20% weight)	Weight	Hotel Data (%)	Result
Construction and Building Materials			
% of building materials from certified eco suppliers from the total amount of construction and building materials	6	**40%**	2,4
% of building materials with non-virgin elements (reused, recycled, refurbished, etc.) from the total amount of construction and building materials	7	**60%**	4,2
% of building facade with insulation materials (walls, roofs, windows, etc.)	8	**20%**	1,6
% of wood (for roofs, flooring, walls) sourced from certified sustainable companies from the total amount of wood suppliers	9	**10%**	0,9
% of planned circular design for the building from the total building desing	6	**90%**	5,4
% of local building materials	8	**25%**	2
% of building facade covered with vertical garden (walls, and roof)	4	**30%**	1,2
% of paints for both the external and internal building structure purchased from certified green companies (without hazardous substances for the environment) from the total amount of used paints	6	**70%**	4,2
Sum of points			**21,9**
Maximum possible score of the section		**100%**	54
Waste			
% of used material: Purchased construction material - construction waste	10	**22%**	2,2
Collection rate of construction waste: % of construction waste (cement, sand, brick, etc.) that is separated and collected for a recycling process from all the construction waste	7	**45%**	3,15
Collection rate of demolition waste: Percentage of demolition waste (cement, sand, brick, etc.) that is separated and collected for a recycling process from all the demolition waste	7	**30%**	2,1
Sum of points			**7,45**
Maximum possible score of the section		**100%**	24
Weighted score of the section			12,51
Maximum possible weighted score of the section			34,5
Maximum possible score of Building Structure			20
Building Structure Total Score		20%	**7,25**

Table 33 CE Assessment Tool for Hotels - Example n°7 (own illustration)

The "maximum possible score of Building Structure" is the weight of the category, in this rationale 20% multiplied by 100: 20% * 100 = **20 points**.

The score that will go into the total addition to find a CE score is the "Building Structure Total Score". To reach that number, the "weighted score of the section" is divided by the "maximum possible weighted score of the section" and multiplied to the "maximum possible score of Building Structure": 12,51 / 34,5 * 20 = **7,25 points.**

In every category the maximum of points can always be appreciated in every category to help hotels understand how they are performing in that specific section.

Circular Economy Assessment Tool for Hotels: Moving towards a CEBM The information shown in this section will be automatically displayed.	**CE Score** **46,25**
Hotel Name:	Hotel the Gre-inn Paradise
Location:	Spain
Type of Accomodation:	Hotel
Total Square Meters:	300 m²
# of Rooms:	45
Available room night (total number of rooms*days):	16425

Operations & Services	
Energy	
Food & Beverage	
Stakeholders (Employees, Customers & Suppliers)	
Waste	
Water	
Others	
Total Score	**32,11**

Building Equipment	
Electrical Appliances	
Furniture	
Textiles	
Waste	
Total Score	**6,89**

Building Structure	
Construction and Building Materials	
Waste	
Total Score	**7,25**

Maximum possible score of CE in the hotel	100,00
Total CE Score	**46,25**

Points	**CE Performance**
76 - 100	Very high
51 - 75	High
26 - 50	**Medium**
0 - 25	Low

Table 34 CE Assessment Tool for Hotels - Example nº8 (own illustration)

Finally, in Table 34, the general information of the hotel is once more displayed (it happens by default and the lodging establishment does not need to insert its information again).

The outcomes are taken into the last Excel sheet to have an overview of the points obtained in each category. For Operations & Services, the final points were of 32,11 (see Table 29); for Building Equipment the points were of 6,89 (see Table 32); and for Building Structure the results were of 7,25 points (see Table 33).

The "maximum possible score of CE in the hotel" will be the sum of the "maximum possible score" of every section, being 100 points. Nevertheless, the most important outcome is the one coming from the hotel data under "Total CE Score", which is the addition of every "Total Score": 32,11 + 6,89 + 7,25 = **46,25 points.**

The last chart inside Table 34 shows the quantity of points obtained and how this result can be interpretated. In the case of this created data, the hotel will have a medium CE performance according to the range of points.

6. Conclusions of the thesis

The transition from a conventional economic model, formally called a Linear Economy, into a Circular Economy in businesses ought to first be understood for an appropriate analysis and application. The definition of setting Circular Economy principles in practice in any company or system, or as in the service industry as in this specific case with hotels, has the capability to be a complex subject if there is not an awareness of what this concept involves. Therefore, this research had the purpose of complying both theoretical aspects through literature review, and practical regards by the creation of a final CE tool.

Chapter 2 and 3 focused on explaining the definitions, principles, methodologies, and indicators that give a background for firms to have a better comprehension of how they can employ the CE theory and its implications in their context. Consequently, it can be extracted that the importance of switching to a CEBM include environmental, economic, and societal aspects and it is to be noted that this transition is becoming a growing global concern, that even though it can be perceived as a challenge, it is possible to enacted it by the right methodologies and tools as developed inside this project.

The hospitality sector was also explored to identify the factors that call for a transition towards a CEBM being the large extraction of natural resources and carbon footprint production the main reasons, the models and legislations that are being used for a progression into this economic framework were also displayed, and the conclusion of the chapter was that all the beforementioned factors were recognized as an important matter and hence the transition as a critical subject.

In an attempt to help service firms change into a circular model, Chapter 5 showed the development of a new tool that is able to assess the circularity rate in hotels. This methodology followed the acquired knowledge from the deep research of the topic and the already existing different proposed models and tools that currently assess CE in business that were created by various organizations.

In Brief, this new tool can examine how hotels are performing towards circular actions by considering many areas such as Operations & Services,

Building Equipment and Building Structure. The assessment is made through indicators that are relevant, viable and useful for the industry. Subsequently, the result from this assessment can give the participant hotel an idea of how it is performing according to the general points obtained but also in each individual category, which can help lodging establishments understand the actions that are not performed correctly or that can be enhanced in the circumstance of pursuing a CEBM.

There are, nonetheless, many areas where there is room for improvement for hotel businesses and as long as companies take the initiative to implement circular strategies in their daily activities, they can already contribute to the regeneration of the nature, the elimination of waste, and the rotation of all the elements and resources as much as they are able to (three principles of Circular Economy).

Finally, it is important to state that this analytical tool can be upgraded in the future to include more areas of application when further studies are conducted in the topic. Furthermore, the CE assessment tool was inspired on hotels with basic lodging activities without considering other types of establishments such as resorts or bigger hotels that count with additional services and buildings such as malls, theatres, night clubs, etc. For that reason, the tool can be enhanced according to each type of establishment by adding other areas and viable indicators.

Overall, considering the initial goals of this project, it can be concluded that they were met in this conferred research, as it is capable of assisting hotels in understanding the importance to transit into a Circular Economy Business Model on account of the negative effects that bring the conventional "take, make and dispose" model; and at the same time, aid these service companies into assessing their current circular activities through accurate indicators in diverse areas and give a final raise of awareness in how they can improve their daily operations to be more sustainable through the obtained results.

References

Azapagic, A. (2004). *Appendix: Life Cycle Thinking and Life Cycle Assessment (LCA). In Sustainable Development in Practice: Case Studies for Engineers and Scientists.* (J. W. Ltd, Hrsg.) Azapagic, Adisa; Perdan, Slobodan; Clift, Roland.

Banaite, D. (2016). Towards Circular Economy: Analysis Of Indicators In The Context Of Sustainable Development. *Social Transformation in Contemporary Society*, 142 - 150.

CE Center. (2018). Indicators for a Circular Economy. *CE Center Circular Economy: Policy Research Centre*, 1 - 43.

CE Grow Circular. (2021). *9R Framework: Circular business models .* Von https://grow-circular.eu/knowledge-base/9r-framework/ abgerufen

Compton, N. B. (2022). *What does it mean for a hotel to be carbon neutral?* Von The Washington Post: https://www.washingtonpost.com/travel/2022/06/29/carbon-neutral-hotels-green/ abgerufen

Comunidad Autónoma de las Illes Balears. (2022). *Boletín Oficial del Estado 136.*

de Jesus, A., & Mendonça, S. (2018). Lost in Transition? Drivers and Barriers in the Eco-innovation Road to the Circular Economy. *Ecological Economics*, S. 75-89.

De Pascale, A., Arbolino, R., & Szopik-Depczynska, K. ,. (2021). A systematic review for measuring circular economy: The 61 indicators. *Journal of Cleaner Production 281* , 1-37.

Ellen MacArthur Foundation. (2013). *Towards the circular economy: an economic and business rationale for an accelerated transition*, S. 22-24. Von https://ellenmacarthurfoundation.org/towards-the-circular-economy-vol-1-an-economic-and-business-rationale-for-an abgerufen

Ellen MacArthur Foundation. (2014). From linear to circular — Accelerating a proven concept. *Towards the circular economy. Accelerating the scale-up*

across global supply-chains, pp. 14-15. Retrieved from https://ellenmacarthurfoundation.org/towards-the-circular-economy-vol-3-accelerating-the-scale-up-across-global

Ellen MacArthur Foundation. (2019). Circular economy systems diagram. Von https://ellenmacarthurfoundation.org/articles/the-biological-cycle-of-the-butterfly-diagram abgerufen

Esposito, M., Tse, T., & Soufani, K. (2018). Introducing a Circular Economy: New Thinking with new managerial and policy implications. *California Management Review, 60(3), 5–19*.

European Comission, x. (2022). *Circular economy: definition, importance and benefits*. Von https://www.europarl.europa.eu/news/en/headlines/economy/20151201STO05603/circular-economy-definition-importance-and-benefits#:~:text=The%20circular%20economy%20is%20a,cycle%20of%20products%20is%20extended. abgerufen

European Commission. (2023). *A European Green Deal: Striving to be the first climate-neutral continent*. Von European Commission: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en abgerufen

European Commission. (2023). *Circular Economy*. Von European Commission: https://environment.ec.europa.eu/topics/circular-economy_en abgerufen

European Environment Agency. (2021). *A framework for enabling circular business models in Europe*. Von https://www.eea.europa.eu/publications/a-framework-for-enabling-circular abgerufen

Eurostat. (2023). *Circular Econmy: Policy Content*. Von Eurostat: https://ec.europa.eu/eurostat/web/circular-economy/policy-context abgerufen

EY Abogados. (2022). *Informative Alert – March 2022: Approval of Decree Law 3/2022, of 11 February, on Urgent Measures for the Sustainability and Circularity of Leisure industry in the Balearic Islands.* Spain. Von https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwjPq5TZxZr9AhV2RPEDHWXYASgQFnoECA8QAQ&url=https%3A%2F%2Fassets.ey.com%2Fcontent%2Fdam%2Fey-sites%2Fey-com%2Fen_es%2Ftopics%2Falertas%2Fey-22-03-11-decree-law-3-2022-on-urgent-measure abgerufen

Farjana, S. H., Mahmud, P., & Huda, N. (2021). Chapter 1 - Introduction to Life Cycle Assessment. *Life Cycle Assessment for Sustainable Mining*, S. 1-13.

Fundación Impulsa Balears. (2020). *Circularidad hotelera y competitividad: Manual para la implementación de buenas prácticas.*

Geissdoerfer, M., Pieroni, M., Pigosso, D., & Soufani, K. (2020). Circular business models: A review. *Journal of Cleaner Production*, S. 1-33.

Greenview. (2022). *Cornell Hotel Sustainability Benchmarking Index*. Von Greenview: https://greenview.sg/services/chsb-index/ abgerufen

Guldmann, E. (2019). Circular Business Models - Innovation Journeys Towards a Circular Economy.

Guldmann, E., Bocken, N. M., & Brezet, H. (2019). A Design Thinking Framework for Circular Business Model Innovation. *Journal of Business Models*, S. 39-70.

Hina, M., Chauhan, C., Kaur, P., Kraus, S., & Dhir, A. (2022). Drivers and barriers of circular economy business models: Where we are now, and where we are heading. *Journal of Cleaner Production*, S. 1-18.

HOTREC. (2020). *Towards sustainable tourism in Europe*. Von Hospitality Europe: https://www.hotrec.eu/wp-content/customer-area/storage/6e9fe1e368a40191054f97b88d336dff/Final-HOTREC-Position-Paper-on-sustainability-in-the-hospitality-sector.pdf abgerufen

IISD. (2018). *UNWTO Report Links Sustainable Tourism to 17 SDGs*. Von International Institute for Sustainable Development: https://sdg.iisd.org/news/unwto-report-links-sustainable-tourism-to-17-sdgs/ abgerufen

Julião, J., Gaspar, M., & Tjahjono, B. (2018). Exploring Circular Economy in the Hospitality Industry. In *Innovation, Engineering and Entrepreneurship* (S. 953–960). Lecture Notes in Electrical Engineering, vol 505: Springer.

Kanda, W., Geissdoerfer, M., & Hjelm, O. (2021). From circular business models to circular business ecosystems. *Business Strategy and the Environment*, S. 2814-2829.

Khajuria, A. (2020). Integrated Approach between DPSIR, Planetary Boundaries and Sustainable Development Goals - towards 3Rs and Resource Efficiency. *World Environment 10(2)*, 52 - 56.

Kirchherr, J., Piscicellia, L., Boura, R., Kostense-Smit, E., Mullerb, J., Huibrechtse-Truijens, A., & Hekkert, M. (2018). Barriers to the Circular Economy: Evidence From the European Union (EU). *Ecological Economics*, S. 264–272.

Kirchherr, J., Reike, D., & Hekkert, M. (2017). Conceptualizing the circular economy: An analysis of 114 definitions. *Resources, Conservation and Recycling Volume 127*, pp. 221-232. Retrieved from https://www.sciencedirect.com/science/article/pii/S0921344917302835

Koçak, E., Ulucak, R., & Ulucak, Z. Ş. (2020). The impact of tourism developments on CO2 emissions: An advanced panel data estimation. *Tourism Management Perspectives* , 1 - 10.

Kristensen, H. S., & Mosgaard, M. A. (2020). A review of micro level indicators for a circular economy - moving away from the three dimensions of sustainability? *Journal of Cleaner Production 243*, 1 - 20.

Lambert, S. (2008). A Conceptual Framework for Business Model Research. *21st Bled eConference eCollaboration: Overcoming Boundaries through Multi-Channel Interaction*, (S. 277-289).

Lei, H., Li, L., Yang, W., Bian, Y., & Li, C.-Q. (2021). An analytical review on application of life cycle assessment in circular economy for built environment. *Journal of Building Engineering 44*.

Liviu, M., Razvan, P., & Alina, M. (2021). The Relationship Between the Circular Economy and Sustainable Waste Management in European Union. *Journal of Business Administration Research 4(1)*, 37 - 44.

Majorošová, M. (2016). DPSIR Framework - A decision - Making tool for Municipalities. *Slovak Journal of Civil Engineering 25(4)*, 45 - 50.

Michelini, G., Moraes, R. N., Cunha, R. N., Costa, J. M., & Ometto, A. R. (2017). From linear to circular economy: PSS conducting the transition. *Procedia CIRP, Vol 64.*, 2-6.

Moraga, G., Huysveld, S., Mathieux, F., Blengini, G. A., Alaerts, L., Van Acker, K., Dewulf, J. (2019). Circular economy indicators: What do they measure? *Resources, Conservation and Recycling 146*, 452-461.

Nikolaou, I., Jones, N., & Stefanakis, A. (2021). Circular Economy and Sustainability: the Past, the Present and the Future Directions. *Circular Economy and Sustainability*, S. 1-20.

OECD. (2014). Measuring and managing results in development co-operation: A review of challenges and practices among DAC members and observers. *The Development Assistance Committee: Enabling Effective Development*, 1 - 68.

OECD. (2020). *The OECD Inventory of Circular Economy Indicators.* Von https://www.oecd.org/cfe/cities/InventoryCircularEconomyIndicators.pdf abgerufen

Peña, C., Civit, B., Gallego-Schmid, A., Druckman, A., & Caldeira- Pires, A. (2021). Using life cycle assessment to achieve a circular economy. *The International Journal of Life Cycle Assessment* , S. 26:215–220.

Potting, J., Hanemaaijer, A., Delahaye, R., & Ganzevles, J. (2018). *Circular Economy: What we want to know and can measure.*

Potting, J., Hekkert, M., Worrell, E., & Hanemaaijer, A. (2017). CIRCULAR ECONOMY: MEASURING INNOVATION IN THE PRODUCT CHAIN. *PBL Netherlands Environmental Assessment Agency*.

Reim, W., Sjödin, D., & Parida, V. (2021). Circular business model implementation: A capability development case study from the manufacturing industry. *Business Strategy and the Environment*, S. 2745-2757.

Rodriguez, C., Florido, C., & Jacob, M. (2020). Circular Economy Contributions to the Tourism Sector: A Critical Literature Review. *Sustainability 12*, 1-27.

Saidani, M., Yannou, B., Leroy, Y., Cluzel, F., & Kendall, A. (2019). A taxonomy of circular economy indicators . *Journal of Cleaner Production 207* , 542 - 559.

Sariatli, F. (2017). Linear Economy versus Circular Economy: A comparative and analyzer study for optimization of economy for sustainability. *Visegrad Journal on Bioeconomy and Sustainable Development*, S. 31-34.

Sillanpää, M., & Ncibi, C. (2019). *The Circular Economy: Case Studies about the Transition from the Linear Economy. .* Von https://books.google.de/books?hl=de&lr=&id=WRGnDwAAQBAJ&oi=fnd&pg=PP1&dq=linear+economy+definitions&ots=qg7m1i8h6v&sig=i7gLm8IDEnDNCS5y2lv30bfeO4w&redir_esc=y#v=onepage&q=linear%20economy%20definitions&f=false abgerufen

Smeets, E., & Weterings, R. (1999). *Environmental indicators: Typology and overview.* European Environment Agency.

Smith-Gillespie, A. (2020). Defining the Concept of Circular Economy Business Model. *The route to circular economy*.

Sørensen, F., & Bærenholdt, J. O. (2020). Tourist practices in the circular economy. *Annals of Tourism Research 85*, 1-12.

Sorin, F., & Sivarajah, U. (2021). Exploring Circular economy in the hospitality industry: empirical evidence from Scandinavian hotel operators. *Scandinavian Journal of Hospitality and Tourism*.

Statista Research Department. (2023). *Total contribution of travel and tourism to gross domestic product (GDP) worldwide from 2019 to 2021*. Von Statista: https://www.statista.com/statistics/233223/travel-and-tourism--total-economic-contribution-worldwide/ abgerufen

Sustainable Hospitality Alliance. (2016). *Hotel Water Measurement Initiative (HWMI)*. Von Sustainable Hospitality Alliance: https://sustainablehospitalityalliance.org/resource/hotel-water-measurement-initiative/ abgerufen

Sustainable Travel International. (2020). *Sustainable Travel International*. Von Carbon Footprint of Tourism: https://sustainabletravel.org/issues/carbon-footprint-tourism/#:~:text=Tourism%20is%20responsible%20for%20roughly,the%20top%20of%20the%20list. abgerufen

Szita, K. T. (2017). The application of life cycle assessment in circular economy. *HUNGARIAN AGRICULTURAL ENGINEERING N° 31*, S. 5-9.

Teuffel Engineering Consultants. (2020). *LCA - Life Cycle Assessment*. Von Teuffel Engineering Consultants: https://www.patrick-teuffel.eu/life-cycle-assessment/ abgerufen

The Ellen MacArthur Foundation. (2021). *Measure business circularity: Circulytics*. Von The Ellen MacArthur Foundation: https://ellenmacarthurfoundation.org/resources/circulytics/insights abgerufen

The Ellen MacArthur Foundation. (2022). *Life Cycle Assessment for the circular economy*. Von Ellen MacArthur Foundation: https://ellenmacarthurfoundation.org/life-cycle-assessment-for-the-circular-economy abgerufen

UN Environment Programme. (2022). *UNEP Circularity Platform.* Von https://buildingcircularity.org/ abgerufen

UN: Department of Economic and Social Affairs. (2023). *UN*. Von Sustainable Development: The 17 goals: https://sdgs.un.org/goals abgerufen

UNFCCC. (2018). *UN Works with Global Hotel Industry to Reduce Emissions*. Von United Nations Climate Change: https://unfccc.int/news/un-works-with-global-hotel-industry-to-reduce-emissions abgerufen

UNWTO. (2019). *TOURISM'S CARBON EMISSIONS MEASURED IN LANDMARK REPORT LAUNCHED AT COP25*. Von UNWTO: https://www.unwto.org/news/tourisms-carbon-emissions-measured-in-landmark-report-launched-at-cop25 abgerufen

UNWTO. (2020). *Circular Economy in travela and tourism – A conceptual framework for a sustainable, resilient, and future proof industry transition*. Von World Tourism Organization: https://www.unwto.org/covid-19-oneplanet-responsible-recovery-initiatives/circular-economy-in-travel-and-tourism-a-conceptual-framework-for-a-sustainable-resilient-and-future-proof-industry-transition abgerufen

WTTC. (2022). *Economic Impact Reports*. Von World Travel & Tourism Council: https://wttc.org/research/economic-impact abgerufen

Xu, A., Wang, C., Tang, D., & Ye, W. (2022). Tourism circular economy: Identification and measurement of tourism industry ecologization. *Ecological Indicators 144*, 1-11.

Zhou, G., Singh, J., Wu, J., Sinha, R., Laurenti, R., & Frostell, B. (2015). Evaluating low-carbon city initiatives from the DPSIR framework perspective. *Habitat International 50* , 289 - 299.

Annexes

Annex 1: Sustainable Development Goals (UN: Department of Economic and Social Affairs, 2023)

This master thesis includes the SGD 12 related to the responsible consumption and production, due to the fact that this CEBM tool can be contemplated for achieving the purposes of a Circular Economy in different businesses, leading to a more conscious utilization of available resources and their adequate reintegration into the system.

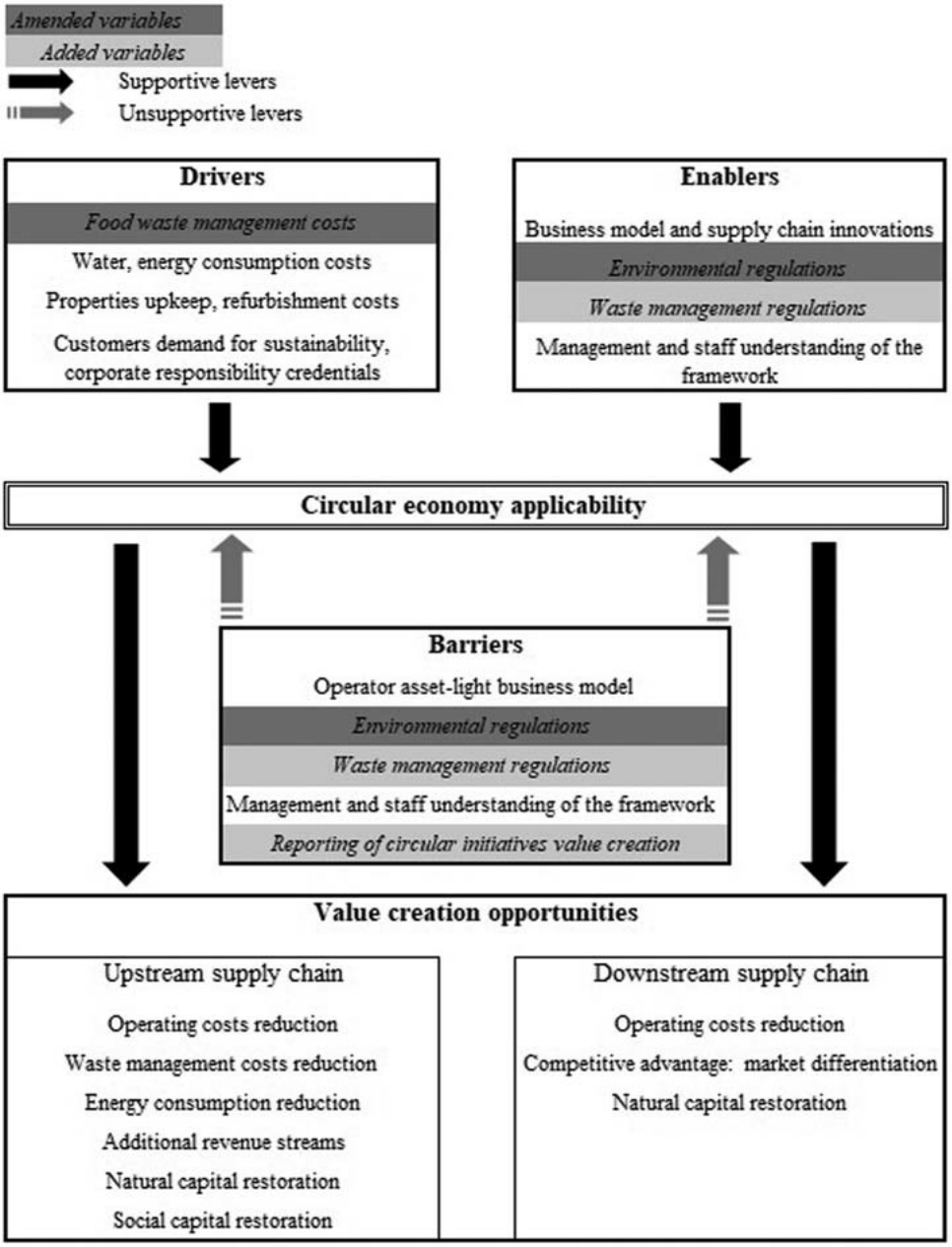
Annex 2: Origin of the Circular Economy Concept (Rodriguez, Florido, & Jacob, 2020)

Year	Author	Topic/School of Thought
1928	Leontief	'The Economy as a circular flow'
1937	Von Bertalanffy	'The general system theory'
1966	Boulding	Improved durability
1977	Stahel and Reday	Performance economy
1989	Frosch and Gallopoulus	Industrial ecology
1990	Pearce and Turner	Closed system of economy-environment interactions
1991	Robèrt	'Most environmental problems are based on the same systemic error, linear processing of material'
1994	Pauli	Blue economy
1996	Lyle /regenerative design	Regenerative design
1997	Benyus	Biomimicry
1999	Hawken et al.	Natural capitalism
2002	McDonough and Braungart	Cradle to Cradle
2011	Mathews and Tan	'Closed-loop economy'

Annex 3: Evaluation Index System of Ecologization based on DPSIR (Xu, Wang, Tang, & Ye, 2022)

Subsystem	Evaluation Indicator	Measuring unit	polarity
Driving	Tourism income growth	%	+
	GDP growth	%	+
	Tourist growth rate	%	+
	Urbanization rate	%	+
Pressure	SO_2 emission	10,000 Tons	–
	CO_2 emission intensity	Tons/10000 Yuan	–
	Chemical oxygen demand	10,000 Tons	–
State	Forest coverage	%	+
	Per capita park green space	Person/m^2	+
	Nature reserves as a proportion of area	%	+
	Wetlands as a proportion of area	%	+
	Tourist Attractions Taste Index	%	+
Impact	Ecological land space	10,000 Ha	+
	Frequency of natural disasters	Time/Year	+
	Rate of tertiary sector to GDP	%	+
	Rate of tourism revenue to GDP	%	+
Response	Sewage treatment rate	%	+
	Life garbage treatment rate	%	+
	Rate of Environmental protection expenditure to fiscal budget	%	+

Annex 4: Amended circular applicability framework in the Scandinavian hotel sector (Sorin & Sivarajah, 2021)



Annex 5: Simple model for Circular Economy in tourism (Sørensen & Bærenholdt, 2020)