DRIVING SUSTAINABILITY: THE NEXUS OF CIRCULAR ECONOMY AND INNOVATION, THE EXAMPLE OF SINGAPORE'S DEVELOPMENT AS A LEADING MODEL

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1. Introduction

In a world marked by burgeoning populations, finite resources, and escalating environmental concerns, the traditional linear economic model of take-make-dispose is proving unsustainable. Enter the circular economy, a transformative concept reshaping the way we produce, consume, and discard. At its core, the circular economy aims to decouple economic growth from resource depletion by designing out waste and pollution, keeping products and materials in use, and regenerating natural systems. Yet, the realization of this vision hinges not only on visionary principles but also on the relentless pursuit of innovation.

Innovation lies at the heart of the circular economy, driving its evolution from theory to practice. It encompasses a spectrum of advancements spanning technological breakthroughs, business models, policy frameworks, and societal shifts. Through innovation, we reimagine products as services, embrace renewable energy sources, harness digital technologies for resource optimization, and forge symbiotic relationships within ecosystems. Moreover, innovation fosters resilience, empowering businesses to adapt to shifting market dynamics, regulatory landscapes, and consumer preferences.

2. Theoretical framework

Circular economy and sustainability are interconnected concepts aimed at addressing the environmental and social challenges associated with traditional linear economic models, where resources are extracted, used, and disposed of. Some theories and principles related to circular economy and sustainability include the mentioned above.

1. Cradle to Cradle Design: This theory, popularized by William McDonough and Michael Braungart, proposes that products should be designed with the intention that all materials used can be continuously cycled back into either nature or industry without loss of quality. It emphasizes the idea of waste as a resource and encourages the development of closed-loop systems.

2. Biomimicry: This concept draws inspiration from nature's designs and processes to create sustainable solutions. By emulating natural systems, which often operate in circular patterns, biomimicry aims to design products, processes, and systems that are inherently sustainable and regenerative.

3. Industrial Ecology: Industrial ecology applies ecological principles to industrial systems, treating them as ecosystems within larger natural systems. It seeks to optimize the use of resources and minimize waste by fostering symbiotic relationships between industries, similar to how organisms interact within ecosystems.

4. Product-Service Systems (PSS): PSS models shift the focus from selling products to providing services, thereby encouraging the longevity of products and reducing resource consumption. Examples include leasing, sharing, and subscription models, where the manufacturer retains ownership of the product and is responsible for its maintenance and eventual recycling or refurbishment.

5. Regenerative Economics: This theory proposes an economic system that not only sustains but also regenerates natural and social capital. It emphasizes the importance of creating economic structures that support thriving ecosystems, resilient communities, and equitable distribution of resources.

6. Doughnut Economics: Developed by economist Kate Raworth, this theory presents a visual framework that balances the needs of people within the ecological limits of the planet. It envisions an economy that operates within the „safe and just space for humanity," avoiding both social deprivation and ecological overshoot.

7. Extended Producer Responsibility (EPR): EPR holds manufacturers responsible for the entire lifecycle of their products, including post-consumer disposal. By incentivizing producers to design products for reuse, recycling, or safe disposal, EPR aims to reduce the environmental impact of products throughout their lifecycle.

8. Sustainable Development Goals (SDGs): Adopted by the United Nations, the SDGs provide a comprehensive framework for addressing global challenges, including poverty, inequality, and environmental degradation. Many of the goals are interconnected and contribute to the promotion of circular economy principles and sustainable development worldwide (Johnson, 2023).

Circular economy seeks the balance between economic growth, social development and environmental health. In their application, the existing paradigms are put under doubt, and hence the challenge for systemic changes in management, value priorities and consumption patterns arise. The circular economy is an alternative to the traditional linear economy (produce, use, discard) whereby resources are kept in use as long as possible and maximum value is extracted from them during use. Then, at the end of each useful life, products and materials are restored and regenerated. The green economy, intertwined with the circular economy, takes a step towards commercialization thanks to green marketing that promotes the values of these two economies.

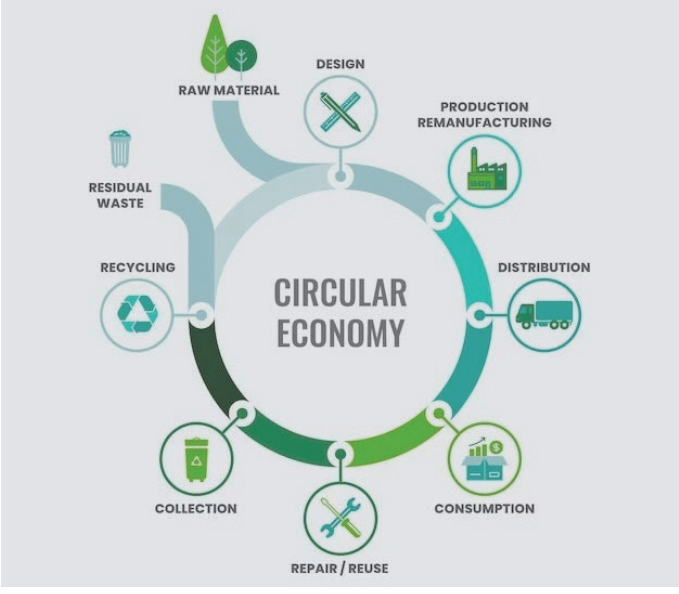
The current model of production and management of resources, goods and services that seeks to promote consumption in the short term is leading the planet to an unsustainable situation. The current economic system stands out diametrically from the life cycle of nature and collides with sustainable development, focused on the long term.

Taking the cyclical model of nature as an example, the circular economy is presented as a system for the use of resources where the reduction of elements prevails: minimizing production to the essential minimum, and when it is necessary to use the product, betting on reuse of the elements that, due to their properties, cannot return to the environment (Medina, 2016).

In other words, the circular economy advocates using as many biodegradable materials as possible in the manufacture of consumer goods -biological nutrients- so that they can return to nature without causing environmental damage at the end of their useful life. In cases where it is not possible to use eco-friendly materials –technical nutrients: electronic components, metal, batteries - the objective will be to facilitate a simple decoupling to give it a new life by reincorporating them into the production cycle and composing a new piece. When this is not possible, it will be recycled in an environmentally friendly way. By definition, the circular economy is restorative and regenerative, and aims to ensure that products, components and resources in general maintain their utility and value at all times. The circular economy is the intersection of environmental and economic aspects. The circular economy is generating employment. The waste management sector represents thousands of jobs. In a context of scarcity and fluctuating costs of raw materials, the circular economy contributes to the security of supply and the reindustrialization of the national territory.

The circular economy is very aware of production processes and proposes reusing, repairing or recycling, increasing sustainable manufacturing and consumption. In this way, in addition to reducing waste, energy is saved and it contributes to avoiding the irreversible damage caused in terms of climate and biodiversity, and air, soil and water pollution, due to the use of waste resources at a rate that exceeds the Earth's capacity to renew them (Fuentes, 2017).

Figure 1: *The cycle of the circular economy*



Source: Ellen MacArthur Foundation (2024)

The objective is to implement an economy based on the principle of „closing the life cycle“ of products, producing goods and services while reducing the consumption and waste of raw materials, water and energy.

One of the problems facing the Circular Economy is that many products are difficult to recycle or disassemble. The designers of current products do not take waste management into account and for now, they do not have solid reasons to create, taking into account the end of life of their products. Therefore, the Circular Economy requires an integration of the product life cycle, which goes from the extraction of raw materials to disposal, reuse and/or recycling. This can be done individually (if companies own the entire life cycle of a product) or through intense inter-company collaboration (Guzmán, 2017).

3. Methodology

To carry out the study, different scientific methods are used on the basis of which the corresponding conclusions are drawn. The objective of the article is to show how circular economy, sustainable development and innovation change the way of working and producing in different companies in order to make them eco-friendly, more efficient and through a good example using some marketing techniques, save the nature and the recourses of the planet. The methodology used is of a qualitative nature and comparison is used to show some of the good practices used by now, using the good example of the development of those concepts in

Singapore. The study also uses historical and descriptive analysis in order to show the good practices used so far in Singapore and the world and the way in which they change the perspective of production processes and take care of the environment.

A method used to obtain more results based on the historical information about the development of Singapore in the sustainable development area are the comparative statistics. Comparative statistics involve the analysis and interpretation of data from different sources or groups to identify similarities, differences, and trends. This process is essential in fields such as economics, social sciences, healthcare, and marketing. The steps to evaluate are: Define Objectives, Data Collection, Data Cleaning, Descriptive Analysis, Statistical Testing and Interpret Results. In the case of Singapore, the date evaluated was from the past ten years and the changes observed in the sustainability index, development and infrastructure are explained in the results 'part of this article.

4. Results and discussion

In this article, the author uses the example of Singapore as a benchmark of how sustainable development and green innovations can lead to a better development of a country.

Singapore's approach to sustainable development is guided by three key principles: an integrated approach and long-term strategic planning; investments in R&D and innovative solutions; and forging partnerships.

Singapore stands as a global exemplar in sustainable development, showcasing a holistic approach that balances economic growth with environmental protection and social well-being. At the heart of Singapore's sustainability efforts lies a comprehensive strategy that integrates environmental conservation, urban planning, technological innovation, and social inclusivity. One notable aspect of sustainable development in Singapore is its commitment to environmental conservation despite its limited land area. The city-state has implemented rigorous policies to safeguard its natural resources, including the protection of green spaces, water management initiatives, and ambitious targets for reducing carbon emissions. The government's proactive stance on environmental preservation is further evidenced by its investments in renewable energy sources, such as solar power, and efforts to enhance energy efficiency across industries.

Urban planning plays a pivotal role in Singapore's sustainability journey, with the city being renowned for its efficient infrastructure, green buildings, and emphasis on public transportation. The integration of nature into urban spaces, exemplified by initiatives like the Gardens by the Bay and the Park Connector Network, underscores Singapore's commitment to creating livable and resilient communities.

Technological innovation is another cornerstone of Singapore's sustainable development strategy. The city-state leverages cutting-edge technologies in areas such as waste management, water recycling, and smart infrastructure to optimize resource utilization and minimize environmental impact. By fostering a conducive ecosystem for research and development, Singapore continually seeks innovative solutions to address sustainability challenges and enhance its competitiveness on the global stage. Social inclusivity is integral to Singapore's vision of sustainable development, with policies aimed at fostering social cohesion, equitable access to opportunities, and a high quality of life for all residents. The government's emphasis on education, healthcare, and affordable housing ensures that Singaporeans can thrive in a sustainable and inclusive society.

An important part of the Singapore's development is its plan for sustainability - The Singapore Green Plan 2030, it is a whole-of-nation movement to advance Singapore's national agenda on sustainable development. The Green Plan charts ambitious and concrete

targets over the next 10 years, strengthening Singapore's commitments under the UN's 2030 Sustainable Development Agenda and Paris Agreement, and positioning the country to achieve a long-term net zero emissions aspiration by 2050. The Green Plan´s Key Targets are: to plant 1 million more trees, to quadruple solar energy deployment by 2025, to reduce the waste sent to landfill by 30% by 2030, to have at least 20% of schools with carbon neutral by 2030 and that all newly registered cars can be cleaner-energy models from 2030. For the next 2 years the targets include: over 130 ha of new parks, to enhance around 170 ha of existing parks with more lush vegetation and natural landscapes. Sustainable Living is another important part of the concept of sustainable changes in Singapore. 2030 targets in the area are reducing household water consumption to 130 liters per capita per day and reducing the amount of waste to landfill per capita per day by 30%. An important part of the plan is to achieve 75% mass public transport (i.e. rail and bus), electric buses to make up half of the public bus fleet by 2030 and expand rail network to 360km by early 2030s.

Energy and Green Reset is also a considerable solution for the sustainable development in the city. Part of the targets for 2030-s are to make green 80% of Singapore's buildings, to have best-in-class green buildings to see an 80% improvement in energy efficiency. Also to acquire vehicles running on cleaner energy by 2040. The Green Plan, as a whole, comprises 5 pillars that will influence all aspects of the lives of the citizens: City in Nature, Energy Reset, Sustainable Living, Green Economy and Resilient Future.

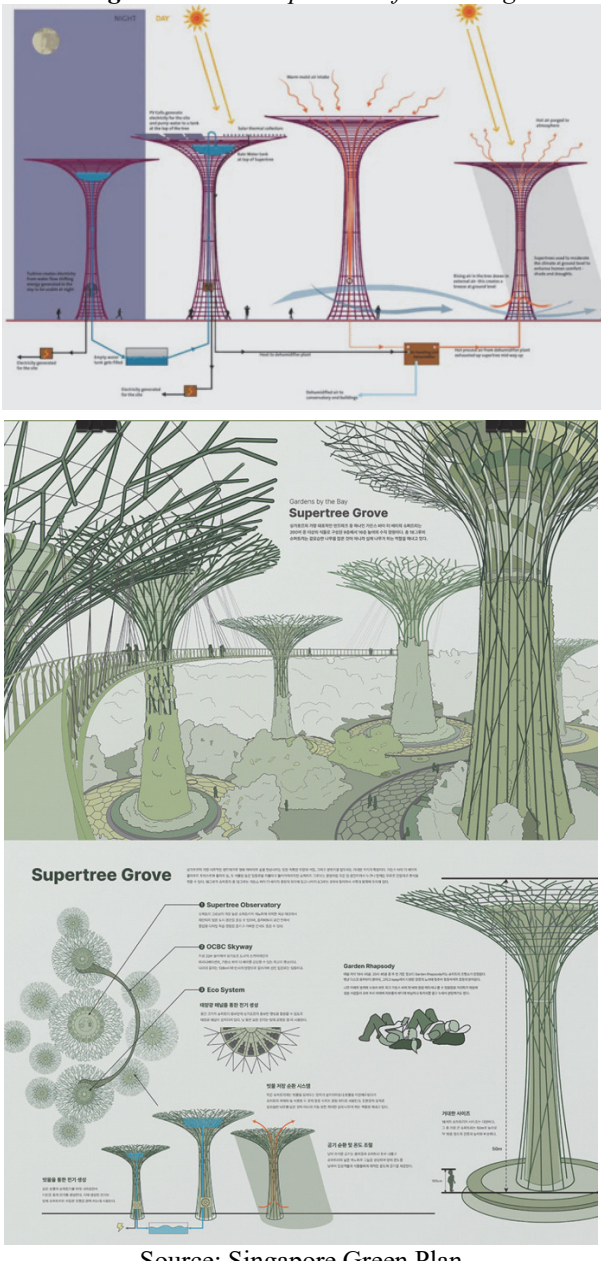
Figure 2: *Super Trees circular economy*

Source: own photography

Singapore has created a project named the Super-tree groves to search a better and more futuristic solutions for sustainability. They are positioned in the Singapore´s most famous garden and green place – Gardens by the bay. The Super Tree Grove features towering artificial trees, ranging from 25 to 50 meters in height, that are designed to mimic the functions of real trees. They are designed with large canopies that provide shade during the day and illuminate with colorful lights at night. The structures are covered in living plants, including ferns, vines, and orchids, giving them a natural, eco-friendly appearance. Beyond their visual appeal, the Super Trees have practical functions in environmental sustainability. They are equipped with photovoltaic cells to harvest solar energy, which powers the lighting displays and

other systems within Gardens by the Bay. Additionally, they serve as vertical gardens, enhancing biodiversity by providing habitats for various plant and animal species. The project also serves as a hub for environmental education and conservation efforts. Through exhibitions, guided tours, and interactive displays, visitors can learn about topics such as sustainable gardening practices, biodiversity, and the importance of preserving natural habitats.

Figure 3 and 4: *Super Trees functioning*



Source: Singapore Green Plan

The Super trees are not the only project related to this type of sustainable development created in the country. Singapore has operated incineration plants and water reclamation plants independently for over 30 years. They are now seeking to realize synergies by co-locating these plants. When it opens in 2025, the Tuas Nexus plant will be the world's first facility to co-digest wastewater sludge and food waste into biogas, which will help power the plant's operations. The integration of processes at Tuas Nexus will harness synergies via the water-energy-waste nexus, and save more than 200,000 tons of carbon emissions annually–equivalent to taking 42,500 cars off the road.

All those activities can be known and become a benchmark thanks to the green marketing activities. Marketing plays a crucial role in promoting sustainable development by raising awareness, influencing consumer behaviour, and driving demand for environmentally and socially responsible products and practices. Marketing can stimulate innovation in sustainable product design, manufacturing processes, and business models. Marketing can also be used as a tool for advocacy and social change, raising awareness about pressing environmental and social issues and mobilizing public support for sustainable development goals. Through impactful storytelling, compelling messaging, and calls to action, marketers can inspire individuals, businesses, and policymakers to take action to address sustainability challenges. Marketing plays a critical role in promoting sustainable development by shaping consumer behaviour, influencing business practices, and fostering collective action to create a more sustainable and equitable future. Singapore is not an exception, by promoting all the initiatives that are created in the country, those actions serve and a benchmark and an example for many countries and industries.

5. Conclusion

Circular economy, innovation, and marketing intersect at the forefront of sustainable business practices, shaping the future of economic development. Through the lens of circular economy principles, businesses are increasingly recognizing the imperative to innovate their products, processes, and business models to minimize waste, maximize resource efficiency, and promote environmental sustainability. Innovation plays a pivotal role in this paradigm shift, driving the creation of products designed for longevity, reuse, and recycling, while also spurring the development of new technologies and systems that facilitate closed-loop cycles.

Marketing serves as the bridge between innovation and consumer adoption, communicating the value proposition of circular economy solutions to stakeholders across the supply chain and society at large. Effective marketing strategies not only raise awareness of the environmental benefits of circular products and services but also highlight the economic advantages and societal impacts, thereby driving demand and influencing purchasing decisions.

In conclusion, the synergy between circular economy, innovation, and marketing presents a powerful opportunity for businesses to thrive in a resource-constrained world while simultaneously addressing pressing environmental challenges. By embracing circularity, fostering innovation, and leveraging strategic marketing approaches, organizations can not only enhance their competitiveness but also contribute positively to the planet and society, ushering in a more sustainable and prosperous future for generations to come.

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