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Potential Economic Impact of Wave Energy through Oscillating Water Column Technology

Diego Alorda and Richard Lewin, Rollins College

Abstract

Renewable energy technologies play a crucial role in addressing global challenges such as climate change, energy crises, and sustainable economic development. This paper emphasizes the importance of adopting renewable energy and its potential economic impacts, particularly through wave energy and the Oscillating Water Column (OWC) technology, highlighting its role in transitioning to clean energy sources and reducing greenhouse emissions, while also exploring the economic benefits of its adoption and role in driving financial growth in developing economies. Additionally, the paper discusses how developing renewable energy sectors can spur job creation, and technological innovation, contributing to global economic growth and stability.

JEL Codes: P28, Q42.
Key Words: Wave Energy, Renewables, Sustainability, OWC

Introduction

Harnessing the power of ocean waves, or wave energy power generation, is a significant component with respect to the advancement of renewable energy technology. The ocean is the greatest source of renewable energy yet to be exploited efficiently (Doyle and Aggidis, 2019). As opposed to solar or wind, waves are far more constant throughout each day and thus continuous high efficiency 24-hour electricity generation is feasible using wave energy technologies versus more familiar renewable methods which remain intermittent. Among the various technologies designed to capture wave energy, the Oscillating Water Column (OWC) stands out due to its simplicity, efficiency, and effectiveness which lends itself to a variety of global applications. Moreover, access to coastlines, water courses, and other hydrological systems is generally fairly widely distributed globally, providing an opportunity for a variety of implementations at varying scale to address immediate energy security across a plethora of countries, including lesser developed countries and remote islands where fossil fuels may be absent and economic growth may be inhibited due to energy resource constraints.

Wave energy is thus a potential contributor to energy equity, access and security as highlighted by the United Nations Sustainable Development Goal (SDG) number seven. SDG 7 is one of 17 Sustainable Development Goals established by the United Nations General Assembly back in 2015. It aims to 'ensure access to affordable, reliable, sustainable and modern energy for all.' Wave energy, specifically through adopting technologies like the OWC, may play a pivotal role in diversifying the global energy mix given a heavy reliance on fossil fuels and an increasing marginal cost of adopting renewable technologies in less accessible areas. Indeed, it has the potential to complement rather than usurp other renewable energy sources such as solar and wind, which are by their very nature inherently intermittent. Waves are far more predictable than either the sun or wind energy systems, offering a consistent and reliable form of energy, which allows potentially scalable implementation, a lower generation risk profile, and higher overall returns on initial investment based on such consistencies.

The exploration of renewable energy technologies, especially wave energy through OWC implementation, opens up a further frontier in the large view of economics and finance. This approach, while nontraditional, underscores an urgent need to diversify the existing energy portfolio in the face of climate change, energy security and economic development challenges given constraints within a fragile ecosystem. However, it is also essential to recognize that the adoption of such technologies is not without its challenges including environmental ones. While this paper advocates for the potential economic benefits and sustainability of wave energy, it also addresses the broader context, including the environmental and societal costs that are associated with its implementation, such as possible environmental impacts.

Furthermore, the pairing of wave energy alongside other renewable forms, such as offshore wind for example, can create a more stable and continuous energy output to support the national grid infrastructure of multiple countries. It also supports energy diversity and distributed energy production since when wind speeds are low, wave energy could potentially fill any gaps, leading to a more reliable and continuous form of renewable energy supply. Energy availability and consistency is especially important in respect of developing countries as it is considered to be a precursor and fundamental constraint to economic growth and prosperity. Furthermore providing greater accessibility to energy security especially for remote island economies where alternative fossil fuels may be unavailable would further sustainable development of such communities.

Literature Review

OWC technologies were among some of the earliest wave energy converters to be studied analytically, appearing for the first time in a published paper in 1978. Delmonte et al. (2014) provide a foundational technology review of OWC power conversion, highlighting the operational principles and the potential for integration into existing energy grids. Falcão and Henriques (2016) further this discussion by examining the advancements in air turbines for OWCs, underscoring the importance of optimizing turbine design to enhance energy conversion efficiencies.

Theoretical studies are still ongoing, trying to determine the maximum efficiency potential for the technology, although a combination of practical implementation tests, prototypes, pilot plants, and research using analytical investigations have already been proving its enduring viability over the past two decades. The first plant to be connected to a national grid was LIMPET (Land Installed Marine Power Energy Transmitter) installed in 2000 on the Hebridean Island of Islay, Scotland. A 500KW plant that provided clean energy to the electrical grid in the United Kingdom (The Queen's University of Belfast, 2002). The plant was decommissioned in 2012 due to structural issues such as resonant vibrations on the holding structure of the turbines.

Despite this unfortunate set back the evolution of the technology has also been seen in other recent plants that have changed aspects of the original implementation based upon data derived from the pilot LIMPET plant. This has included the Mutriku Plant in Spain, which restructured the column dimensions, as well as the direction of the turbine, among other engineering parameters which has allowed its functioning since inception in 2011. Ibarra Barestegi et al. (2017) expose both qualitative and quantitative data on this specific pilot plant by studying the correlation between turbine size, wave period, wave height, sea bed conditions, air chamber dimensions, and air pressure, with energy generation and production efficiency. As exposed within researcher Rui Gomes' report on OWC implementation and its subsequent commercialization analysis, the installation of this technology in a close-to-shore community could mean a decrease in electricity prices, and assuming it is designed around a breakwater model, as in the Mutriku plant prototype, it would also protect existing harbor facilities and lessen the rate of erosion along the shoreline (Gomes, 2021).

The idea of restructuring the approach to such technology was detailed by Siming Zheng in his research paper (Zheng, et al. 2019), where along with other authors they redefined the idea of an OWC. Yet such refinement was also expanded upon when Fox et al. (2021) and Howe et al. (2020) delve into specific configurations of OWCs, particularly their integration into caisson breakwaters and floating breakwaters, respectively. These studies illustrate the dual functionality of OWCs in energy generation and coastal erosion protection, offering insights into the practical applications and environmental benefits of OWC systems.

Draycott et al. (2018) assess the macro-economic benefits of installing a farm of OWCs in Scotland and Portugal, providing a comparative analysis that highlights the economic viability and potential job creation associated with OWC installations. It also studies the relationship between turbine structure position and its response to air pressure, a factor that will be taken into account when building the model for this project. This study offers a compelling argument for the further adoption of OWC technology based on economic incentives and regional economic development opportunities.

Quintero Lopez (2009) investigates the feasibility of converting ocean wave energy into electricity using OWC in Puerto Rico, presenting a case study that underscores the potential for island nations and remote communities to harness wave energy as a means to achieve energy independence and further the goals of sustainability. This paper dives into the mathematical and theoretical models of the OWC technology, providing the necessary and optimal process to transform wave characteristics into electricity generation predictions. Such research has also indicated that OWC technology not only offers a sustainable energy solution but also supports economic development by creating jobs, enhancing local industries, and providing stable energy prices, particularly in coastal and remote communities.

Such integrated benefits of OWC adoption are crucial for developing economies, where energy access and economic diversification remain key challenges. This is considered worthy of further exploration within the paper given its potential has been proven, and it is close to implementation to foster a further boon in renewable energy production across multiple countries, as the technology transitions from a theoretical to a practical application at scale.

Wave Energy's Role in the Renewable Evolution

Tidal flows and wave energy are directly derived from the gravitational pull instigated by the phasing of the lunar cycle. Depending on the moon's orbital positioning, associated tides, winds, and weather, waves vary in size and strength across the Earth's oceans with a degree of predictability and uniformity. As such this form of energy is essentially continuously renewable and through a careful study of oceanography it is possible to identify areas with the highest energy potential coastlines are situated. The greatest concentration of wave energy lies along the south coast of Australia, the southern tip of Africa, the north-western flank of Canada, as well as the western flank of Ireland and indeed the British Isles. Whilst tides of differing energy levels occur globally, OWC is a type of scalable wave energy conversion that captures energy within ocean waves, and converts it directly into mechanical energy, which is then transformed via generators into electrical energy for engagement with the local grid infrastructure.

The OWC consists of a partially submerged, hollow structure that contains air above a column of water. As waves enter and exit the chamber, the water level inside rises and falls, causing the trapped air to oscillate. This oscillation of the air in turn drives a turbine connected to an electrical power generator. The turbine is bidirectional, and designed to rotate regardless of the airflow direction, i.e. whether the wave is advancing or retarding. This characteristic allows for near continuous generation of power, making the OWC technology particularly efficient as well as complementary to multiple forms of alternating current power infrastructure. Its further advantage being that it resides as a complementary energy generation system alongside other sustainable energy sources, making it a net contributor to renewable energy generation rather than being in competition with other sustainable solutions given its distinct geographical footprint. Moreover, whilst climate change is an important factor driving environmentally friendly energy production, it is also giving rise to greater energy within weather systems, further enhancing the scalar potential of wave energy production, which is undiminished despite such concerning climate changes.

The analysis of high-wave power locations around the world identifies specific communities that can be supplied by such technology, based on available Geographic Information System (GIS) data on existing wave energy that is measured globally. When viewing the wave energy, clearly some areas offer greater potential, but it is also necessary to analyze the qualities of the shorelines against which the waves break, given there are specific geological installation conditions, as well as proximity of communities close enough to shore to benefit from the production profile whilst minimizing transmission losses. There are thus two specific factors that must be contemporaneously taken into consideration, structural and financial. The interplay between both structural robustness and whole-of-life economic performance determines the likelihood of a successful implementation for any given OWC project. It is therefore critical to highlight the interplay between the following elements:

Structural

Design and Materials: The materials used for constructing OWC devices need to be able to withstand harsh marine environments, including saltwater corrosion, biofouling, and extreme weather conditions. The durability of materials like concrete or specialized steel directly impacts the lifespan and maintenance costs of any potential facilities.

Location and Site Selection: The feasibility of OWC technology is highly dependent on site-specific characteristics such as the local wave climate, water depth, seabed conditions, and shoreline qualities. Ideal locations require consistent and powerful waves and accessible infrastructure for onward energy transmission. The technological model of the structure highly depends on the qualities of the specific sea location (Draycott, 2018).

Energy Capture Efficiency: The design of the OWC impacts how effectively wave motion can be converted into pneumatic and subsequently mechanical and electrical energy. Factors like the shape of the chamber, the dimensions of the opening, and the design of the air turbine all influence energy transformation efficiency.

Environmental Impact: Environmental assessments must also ensure that the OWC's presence will not significantly disrupt existing marine life ecosystems or coastal processes, despite the potential to mitigate more extreme risks of coastal erosion. This includes considerations for marine life, sediment transport, and the potential for noise pollution.

Maintenance and Durability: The harsh marine environment demands regular and ongoing maintenance activities. The OWC's structural integrity over time remains a critical factor, as failures due to harmonic resonance can result in very costly repairs and extended downtimes, affecting the overall viability of the project.

Financial

Capital Expenditure (CAPEX): This includes the costs of designing, developing, and constructing OWC systems. It factors in material costs, labor, transport of materials to the site, the construction of supporting infrastructure such as grid connections, and the expense of relevant permits and regulatory compliance.

Operational Expenditure (OPEX): Once the OWC is installed, the operational costs include maintenance, repairs, insurance, and possibly lease payments for the marine area of usage. Regular maintenance to prevent corrosion and mechanical failures can also prove significant.

Funding and Investment: Securing upfront capital can be a hurdle. Investment attractiveness is gauged on the technology's maturity, the predictability of its energy output, and the overall risk profile. Government subsidies, renewable energy incentives, and carbon credits can further influence financial feasibility.

Energy Production and Revenue: The amount of energy the OWC produces determines any potential income. This depends on both the technology's efficiency and the nature of the local wave resource. Power Purchase Agreements (PPAs) establish long-term contracts that can guarantee revenue at a fixed price per kilowatt-hour generated, providing financial stability for the feasibility of any large-scale installations.

Return on Investment (ROI): Investors and stakeholders may look at the expected payoff period. Calculating how long the OWC will take to breakeven and start generating an economic profit, is therefore crucial. The ROI depends on a combination of CAPEX, OPEX, and the revenue from selling energy into the grid.

Economic Life and Decommissioning Costs: The economic lifespan of the OWC will significantly influence the investment decision. Additionally, the eventual decommissioning and potential salvage value or recycling at the end of operational life, may also affect its overall fiscal return; although this becomes less impactful as the overall lifespan of the project increases, since the fixed costs may be recovered over a longer amortization time frame.

Wave Data and Energy Transformation

To understand if the development of such a system is indeed feasible, it is first necessary to analyze energy costs, distribution, and diversification in tentative target communities. There are specific locations with geographical privileges, but available wave data and the energy potential are merely the first order conditions needed to simulate output, followed by second order considerations including local energy prices and local energy needs as well as projections for the same across the intended communities.

To answer the question of whether this technology can thrive based upon a positive economic impact, a desktop simulation of its implementation must be undertaken. Taking the coast of Ucluelet, British Columbia, Canada as an example, this has shown to have promising wave power potential for the generation of wave energy (PNNL, 2020). The data gathered for the ensuing analysis was taken directly from Station 46205- La Perouse Bank, an offshore Buoy monitored by Environment and Climate Change in Canada. In order to understand the amount of energy the technology could transform, this data set will be compared with the information given by a Wave Energy plant in Mutriku, Spain, which is owned and monitored by the Spanish governmental entity BIMEP, via pilot plant implementing the above OWC technology. Then based on this data a financial analysis can be run, viewing it from a business perspective to see if the investment case is justified.

When calculating the Wave Energy Flux (KW/m) going through the Buoy (as mentioned previously), the direction of the waves is followed until their termination along the shoreline, which means it is possible to predict the energy endowment of the waves arriving at the specific plant's location as situated along the coast. Around ten Buoys were analyzed to derive this data, gathering simulation data to provide a range of potential energy output, and allowing one buoy to be specifically selected from this group due to it being the most viable shoreline structure for any actual positioning of OWC technology as found at the location where the waves hit this particular buoy marker consistently. The data for the waves as marked by the buoys can be statistically related to the precise characteristics of waves arriving at the shoreline (see Ibarra-Berastegi et al., 2018).

Table 1: Average Wave Energy at Ucluelet West Shore (Station 46- 205)

Avg. WVHT (ft)	Avg. DPD (sec)	Kw/m
11.8	8	50.73

To calculate the energy of the waves marked by this station, the formula as derived by Berrastegi et al.(2018) is applied

$$Kw/m = 0.491\ HWS^2 T_z \tag{1}$$

Where KW/m represents the wave power per meter of wave crest length in kilowatts; 0.491 is a constant that helps convert the measurements into kilowatts per meter, considering the density of water and the acceleration due to gravity in the calculation; HWS2: Represents the square of the significant wave height, which is the average height of the highest one-third of the waves in a wave spectrum, measured in meters. This factor is squared as wave power is directly proportional to the square of wave height; Tz: represents the zero up crossing wave period, which is the average period of waves passing a fixed point, measured in seconds.

Energy Costs in British Columbia and OWC Business Case

Calculating the average wave power arriving at Ucluelet shore in winter (50.73 Kw/m), is different from solar and wind, as waves are much more constant throughout the day and 24-hour electricity generation may be anticipated with current wave energy technologies, notwithstanding inevitably seasonal variations. To predict the amount of energy that the technology could produce therefore, the method used is based upon a direct comparison between markers of the buoys used by BIMEP's plant (Bilbao-Bizkaia buoy) as reviewed by energy specialist Gabriel Ibarra-Berasteg in his analysis of Mutriku's plant efficiency (Bersateg, 2018) and the energy it produces, compared to the markers at Station – 46205. Thus, it can be determined how much energy a hypothetical OWC plant could produce, assuming those precise wave types and implied energies. When the Buoy used by BIMEP marks at 4.06 Kw/m waves, for example the plant generates 7.73 Kw/h every 5 minutes (Ibarra-Berastegi et al., 2018). As Station-46205 marks at 50.73 Kw/m on average, a hypothetical OWC plant could generate up to 96.8 Kw/h every 5 minutes. Whilst this is approximate, based on consistent buoy data in the area and without assuming any scalar economies, none of these derived results could be absolutely precise in any event due to variations in respect of the shoreline and scalar differences in the size and type of potential installation.

Winter seasons are the most powerful whenever analyzing wave energy potential, and by connecting such a system to the grid and assuming a 300kw pilot plant scale, this technology could supply energy close to 90% of the time even allowing for maintenance and periods when the energy potential is low. It thus shows high energy supply reliability by operating at close to 90% of the time and by that reasoning implies a high-capacity factor, which is also very favorable when compared to other renewable sources such as solar or wind which often have much lower capacity factors due to higher weather-related variability. This should position OWCs as a far more dependable, reliable and continuous source of renewable energy.

An important factor for seeking such a high economic impact is related to financial viability, considering that the OWC should operate efficiently for most of the year, the energy produced could therefore reliably pay back the initial investment over time accordingly. Generating electricity and selling it back to the grid could provide a steady scalable revenue stream to support a debt financed investment structure, characteristic of global infrastructure funds. The 300kW plant, as a pilot scheme, could pave the way for larger-scale deployment if it is proven to be cost-effective and operationally reliable. Its integration with the grid infrastructure would involve negotiations with existing regulatory frameworks as well as ensuring compatibility with existing supply infrastructure. The generated energy would need to be consistent given grid demands and production standards. Such integration enhances the value of the OWC by providing utility-scale electricity that can be distributed onto consumers in proximity to the plant, thereby avoiding transmission losses over distance.

Assuming the pilot plant operates as expected at 90% of its capacity, it is predicted that it would produce approximately 2,3652 MWh of energy annually (300kW * 0.90 * 8760 hours/year). In this simplified scenario, assuming an average wholesale electricity price of $50 per MWh, the plant could potentially earn about $118,800 annually from direct electricity sales. Yet, wave energy is highly dependent on local meteorological and oceanographic conditions, and these can prove seasonal. If it is assumed further that the wave power is higher in the winter due to more intense storms and lower in the summer due to calmer seas, the electricity generation and consequently sales should also mirror this pattern.

High Wave Power Season (Winter): During these months, the OWC plant should operate at or near the 90% capacity assumption, and in some instances, it might briefly exceed this threshold if the waves are particularly strong, although safety mechanisms would likely prevent operation beyond any given designed capacity to avoid damage to the installed equipment.

Low Wave Power Season (Summer): In contrast, during the calmer wave conditions of summer, the plant might operate below the 90% capacity assumption, possibly at a significantly lower capacity depending on the wave climate. Yet there are ways to optimize performance and address inherent nonlinearities, studies have looked into advanced control systems, such as the use of fuzzy controllers optimized by genetic algorithms. These control strategies aim to improve the overall efficiency of OWC power plants by maximizing the performance of the power take-off system, which includes an air turbine coupled to an electrical generator. This approach demonstrates potential for enhancing energy generation during periods of lower wave activity by effectively managing the system's nonlinearities and modeling uncertainties (Rosati et al., 2022)

Based upon the aforementioned assumptions, if 60% of the highest capacity occurs in the winter months, and 40% in the summer (implying effectively 60% operating capacity in summer), it is possible to weight the annual production accordingly. The plant might produce (2,376 MWh * 60%) 1,425.6 MWh in the high season and (2,376 MWh * 40%) 950.4 MWh in the low season. According to the Canada Energy Regulator the average price of electricity sold to the United States from British Colombia was $53/MWh in 2021. This would generate $75,557 in the high season and $50,371 in the low season, modestly exceeding the annual initial estimate of $118,800.

Table 2: Indicative Power Plant Production and Revenue

Season	Capacity Utilization	Energy Produced (MW/h)	Revenue from Electricity Sales ($)
High Wave Power Season (Winter)	~90% (up to 100% with strong waves)	1,425.6	$75,557
Low Wave Power Season (Summer)	<90% (significantly lower depending on wave climate)	950.4	$50,371
Annual	90%	2,376	$122,928

The indicative earning potential may be reasonably compared to the cost estimation of the OWC breakwater construction budget used for Giardinin Naxos in Italy (see Table 2, Stephania et al., 2016) of €436,000 ($475,000) for a 600 MWh OWC system, as derived from the pioneering installation at Mutriku Spain. Even ignoring any potential economies of scale that a quadruple size OWC facility could provide and discounting the higher energy potential of the British Columbia site, the cost of implementation could be estimated at approximately $1.9m. This would facilitate a cash-on-cash annual return from energy sales as based upon the aforementioned infrastructure investment of approximately 6.63% This is favourable compared with the long term weighted average cost of debt for existing power renewable investments of circa 4% in 2023, as based on a typical net gearing of 55% for renewables (see Wood Mackenzie Corporate Strategy and Analytics Service for the World Economic Forum (2024)), thereby underpinning the likely financial viability for similar OWC proposals.

Naturally the future path of long-term debt financing is itself dependent on real interest rates, which are perhaps the most important consideration facing any utility or infrastructure funding, alongside electricity price regulation and the hedging potential of forward power purchase agreements. Nonetheless the fact that a substantial and established export market from British Colombia to the United States already exists, in the guise of the Western Electricity Coordinating Council that coordinates transmission in the electrical grid in western Canada and the western U.S. to ensure reliability demand is readily apparent. This coupled with increasing pressure on the mainstay of hydroelectric power supplies in British Columbia due to increasingly unreliable rainfall, the compelling case for complementing existing capacity with an OWC installation remains a commercially robust reinforcement.

Economic Impact on Advanced and Developing Economies

By propelling a diversification of income, the introduction of a wave energy plant would diversify local economies, particularly in coastal areas that might be heavily reliant on fishing or tourism. As well as fostering job creation, the construction and maintenance of the plant provides local jobs and could lead to skill development in areas from technical engineering roles to maintenance and operational positions, also providing stability in energy prices, since locally generated renewable energy mitigates the volatility in energy prices, particularly in areas that are heavily dependent on imported fossil fuels. Concerning remote communities that do not have access to the grid, local wave-generated electricity directly reduces the community's dependence on such a pre-existing system.

Research has shown that the macro-economic benefits of installing OWC wave energy devices are significant, as seen in a study assessing the impact of a 500kW OWC farm in Scotland and 400kW Portugal. This study found that the installation and manufacturing stages could create up to 420 jobs in Portugal and 190 in Scotland, with a considerable gross value added (GVA) impact, demonstrating the potential for wave energy projects to stimulate economic growth across various industry sectors (Draycott et al., 2018)

Despite the promising aspects of OWC technology in contributing to sustainable development, energy security, and economic impact, it is crucial to critically assess the environmental footprint and societal effects it might cause. Unlike traditional energy sources, wave energy installations can have significant interactions with marine ecosystems, potentially disrupting habitats and species patterns, even though profound analysis of sea beds and marine environments can reduce such impact, a disruption of a natural cycle will always happen. For example, the distribution and behavior of marine species, including fish, marine mammals, and benthic organisms. The physical structures may interfere with migratory paths or disrupt the natural habitats of these species. Noise pollution is also a factor to consider, whereas OWC installations generate noise during both the construction and operation phases. The underwater noise, particularly from the turbine operation, can affect marine life, especially species that rely on sound for communication, navigation, and hunting, such as dolphins and whales.

Moreover, the aesthetic and physical alterations to coastlines may raise concerns among local communities and stakeholders about the preservation of natural landscapes and the implications for tourism and recreation. These considerations must be weighed against the benefits of wave energy, ensuring that its development is both environmentally sensitive and socially inclusive.

The widespread adoption of wave energy, including OWC technology, faces many challenges beyond technical feasibility and economic viability. One of the pivotal questions is why, despite its potential, wave energy has not been adopted on a larger scale. The answer likely involves complex combinations of factors, including environmental concerns, regulatory hurdles, and the adaptability that communities can have to embrace changes to their coastal environments. Addressing these challenges requires a comprehensive strategy that includes not only technological innovation but also innovative engagement, policy support, and environmental stewardship. By acknowledging these barriers and actively seeking solutions, the path toward integrating wave energy into the renewable energy portfolio can be made clearer and more achievable.

Conclusion

While OWC technology provides potential economic benefits and improved energy security, it is inevitably also essential to conduct thorough feasibility studies alongside any implementation proposals. Such studies should consider technical and socio-economic factors to fully grasp the impact and viability of wave energy. The analyzed case demonstrated a financially viable and energy-wise solution based on economic and location analysis, for the implementation of such technology. However there are important considerations including the local wave climate, the potential ecological impact, community needs, and how the wave energy systems will integrate with existing energy infrastructure. Such analyses are critical initial steps in ensuring that wave energy can effectively support the growth and empowerment of developing communities around the world and directly substitute more sustainable alternatives to fossil fuels. Not only underscoring the potential of OWC technology as a sustainable energy source but highlighting the importance of comprehensive feasibility studies to assess its technical, environmental, and socio-economic impacts comprehensively has been outlined.

By prioritizing detailed evaluations, wave energy projects may be developed in harmony with local environments and communities, thereby supporting the sustainable growth and empowerment of developing regions worldwide. This approach also solidifies wave energy's role as a direct, more sustainable alternative to fossil fuels, and as a complement to existing renewable infrastructure, whilst contributing significantly to global energy security and furthering economic development and environmental conservation efforts.

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Cooperative Workforce Education Opportunities In The Hospitality Industry

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Abstract

The demand for skilled and well-trained workers across all segments of the global hospitality industry is at an all-time high. Evidence suggests that a cooperative experiential education approach, whereby academic institutions partner with commercially operated hospitality enterprises, particularly hotels, provides significant value to all stakeholders, including students, educators, hotel owners, and property managers. Empirical evidence indicates that in several locations across the United States, hotel owners and operators have partnered with local colleges and universities to create experiential learning laboratories to deliver mutual benefit in terms of employee training and retention, along with enhanced business curriculum and student career outcomes.

Key Words: Hospitality, Experiential Learning
JEL Codes: L85, Z31

Introduction

Very few industries have been hiring as aggressively as the hospitality sector since the Covid hiatus. Yet across the hotel operator space many remain structurally understaffed, creating a growing risk of guest backlash. Guests continue to face reduced levels of service as owners have to make do with far fewer employees than industry guidelines historically implied. Moreover, it also means that guests are paying up for rooms, whilst hoteliers try to offset the enduring rise in wages necessary to lure back experienced workers.

As universities are being asked to demonstrate their social impact and business proficiencies, they are seeking to integrate more practical elements into their curricula. This is both to optimize learning outcomes and enhance work placement opportunities to directly launch careers, which has fostered a growing role of industry within the higher education system. This is likely to remain an increasing trend as demographics are driving fewer traditional graduate students within the developed world. However, the level of development of cooperative education and work-integrated learning varies while work-integrated learning has a long tradition, due to vocational institutions having strong links with industry.

Students may gain valuable work experience and may build industry-specific career connections through paid, on-the-job training that can lead to full-time employment within the hospitality sector. Students should generally complete a minimum of two 3*160-hour paid work terms during two of the three summer periods while in the program at the Alfond Inn. The department provides a preparatory laboratory seminar to help students prepare for their initial co-op experience.

Literature Review

Experiential learning through internships are already common practice in hospitality education. The primary stakeholders in hospitality internships, students, hospitality industry professionals, and educators, are well cited in the literature while the benefits to educators and the hospitality industry are not as well researched (Zopiatis et al, 2021). Related research on cooperative education in the hospitality industry has focused on student expectations (Waryszak, 1999), entrepreneurship in the hospitality industry (Goryushkina et al., 2019), and virtual internships in the context of the Covid-19 pandemic (Bowen, 2020). Common themes within these strands of literature are focused on the extent to which experiential learning provides the student with advantages when the student graduates and seeks employment, and how the experiential learning opportunity can help students adapt to changes in the marketplace. While internships are typically referenced as advantageous for future employment in any industry, the nature of the hospitality industry seems to warrant an even stronger need for experiential learning on the way to degree. Customer service, interacting with guests, and dealing guest issues is at the very core of the hospitality industry. Furthermore, the need to understand guest needs and day-to-day issues makes promotion from within more commonplace than most other industries and places a premium value on customer service experience. Specifics of the internship program, procedures, and quality have also been widely studied in the literature (Zopiatis et al., 2021). The type of internship, length, location, funding, and weekly time commitment all have meaningful influence the benefits and opportunity cost of the experiential learning opportunity for all stakeholders, among other things.

The program proposed in this research has potential for significant overlap with much of what has been pointed out within recent literature. The focus on benefits to all stakeholders, not only students, and the ability to train students who can adapt to new trends and technology will remain an important component of this program. However, the connection between Rollins College and the Alfond in will allow for unique opportunities, and a research focus, that are novel in the industry and in the hospitality literature. The symbiotic relationship between the hotel and the College allow for a stronger focus on program development and individualization of the student experience. Furthermore, this connection allows experiential learning to play a more consistent role in the entire curriculum.

Among the areas cited for future research and focus by Zopiatis et al. (2021) are the need for more longitudinal studies to follow the careers of students and examine the impact of the experiential learning as they age, the development of custom made empirical tools to measure "specific elements of the internship experience", stronger focus on the benefits to stakeholders other than students, and more mixed methods designs used to evaluate effectiveness of the experiential learning experience. The unique relationship between the Alfond Inn and Rollins College will provide us with an opportunity to pursue novel research and program offerings in the context of Hospitality Management. Following students career paths, evaluating the success of the program through multiple methods of analysis, and development of customized empirical tools to analyze and research the effectiveness of this program will all be aligned with the mission of this program. The primary contribution of this work, and this proposed program in general, is in the creation of a novel experiential learning environment in the hospitality industry which can provide benefits to all primary stakeholders in a more sincere and tractable way than standard industry-higher education collaborations for internships.

The Alfond Inn at Rollins College

The Alfond Inn at Rollins College is located in Winter Park, Florida within blocks from the Rollins College campus, and a short walk to premier shops and restaurants on Park Avenue. The Alfond Inn features 183 well-appointed luxury guestrooms equipped with high-speed wireless internet access, iPod docking stations and large flat screen televisions, as well as oversized workstations. The Alfond Inn offers its guests access to two swimming pools, an exercise room, coffee house, restaurant, room service, lobby bar, conference rooms, and world renown artwork.

The 183-room boutique hotel conceived around the theme of a museum with guest rooms, is also an investment in future students of Rollins, a private school founded in 1885. The Inn features over 12,000 square feet of divisible meeting space, including a 1,000 square foot board room, a 1,700 sqft Interlachen Room and the elegant 5,000 square foot divisible Grand Ballroom can seat up to 300 dinner guests. The lavish gardens surrounding The Alfond Inn offer an additional 20,000 square feet for Alfresco events. A well-equipped business center and small library complete a delightful picture of peaceful, high-quality insouciance. It is a popular wedding venue, too. Its rooms range from generous-sized standard kings and double queens to massive signature suites, all beautifully furnished and with high-quality accent fabrics and linens, and many with balconies. The one-off luxury suite is better equipped than many apartments. Bathrooms have oversized showers and designer toiletries, and the overall style is fresh, clean and invigorating thanks to indulgent soft furnishings and mellow dark-wood furniture. Some decorative elements are a nod to Rollins College – from the school colors to art prints of campus buildings – adding accents without making it feel like you're in a college building. And the school motto is printed on every full-length mirror.

The Alfond Inn offers the perfect setting for business meetings or special events and was developed on a 3-acre parcel of land that the College acquired in 2008 for $9.9 million (formerly being the home of the former Langford Hotel). The initial $36.3 million boutique hotel was funded in part by a $12.5-million grant from the Harold Alfond Foundation. the College received a further unprecedented $30 million pledge for the expansion of The Alfond Inn providing 73 additional rooms, 12,400 sqft of conference space, a full-service spa and second swimming pool. The project officially broke ground during the summer of 2021 and the total cost of Phase II was estimated at $48 million. The completion and grand opening coincided with the award-winning hotel's 10-year celebration in November 2023. The Alfond Inn has been recognized as one of the top hotels in Florida by Condé Nast Traveler, Traveler + Leisure, and Triple AAA.

Curriculum

All components of the curriculum will share a focus on long-term operational, financial, and environmental sustainability of a business in the hospitality industry with a specific focus on hotels and resorts. Managers face unique challenges in the hospitality industry regarding daily operations, security, human resources, seasonality, geography, and environmental impact. Coursework will be designed to help inform students of these challenges and common industry approaches to handling them, while summer work will provide real world exposure, and research development can provide insight into trends and new opportunities.

The Business Department at Rollins College currently includes of two majors, the Business Management Major and the International Business major, along with optional concentrations in Finance, Marketing, and Family Business and Entrepreneurship. The initial curricular goals of this proposal would result in an additional concentration option in the field of

Hospitality Management. The current concentrations in the Business department require one core course and three additional elective courses. The Business department has created a working group to devise a curriculum around hospitality management which will provide synergy with the existing operator and showcase curricular development in the hospitality sector. The curriculum proposed for the Hospitality Management concentration would consist of required coursework and full-time work commitments, along with elective coursework and optional research components. There will be two required courses along with two elective courses and two summer work terms as discussed above. The first required course will be a course titled Managing Hospitality Organizations. The second required course will be a lab-based course with rotations in the different operational areas of the Alfond Inn. The rotations for the course are described in Table 1 below.

Table 1: Industry based components for the proposed interdisciplinary Hospitality Management Course:

- Managing Hospitality Operations 1 with Operational Lab Rotations: Front Desk, Housekeeping, and Grounds/Maintenance,
- Managing Hospitality Operations 2 with Service Lab Rotations: Valet, Food & Beverage, Meeting Planning, and Spa
- Managing Hospitality Operations 3 with Administrative Lab Rotations: Management, Finance, Development, Human Resources and Sales & Marketing

Additional elective courses would fill out the requirements for the concentration.
Options for electives would be sourced from a combination of existing courses, new courses, and independent studies focused on research in the Hospitality Industry. New courses focused specifically on Hospitality Management include:

- Customer Service Training and Management: A focused study of the primary tenants of popular customer service orientation training for high level hospitality companies and the most revered hospitality industry ranking agency criteria. This will include a review of the typical strategies for training and motivating human resources and challenges related to seasonality.
- Marketing, Sales, and Revenue Management in the Hospitality Industry: A more focused look at the challenges and opportunities surrounding marketing and sales in the hotel industry. This includes strategies, research, and trends related to revenue management and optimization with a particular focus on data analytics.
- Sustainability in the Hospitality Industry: This course includes a focus on the different aspects of sustainability in the hospitality industry. Challenges related to retaining high caliber employees, sourcing and environmental impact, customer consumption behavior, inventory and waste, and remaining “in demand” are all included.

Benefits

This section considers the primary stakeholders and the benefits of this program, as opposed to standard hospitality management programs or hospitality internships, to those stakeholders. The primary stakeholders under consideration are the Rollins students and faculty, the local community of Winter Park and the Alfond Inn.

Located in historic Winter Park, Florida the Alfond Inn, was commissioned by Rollins College, a leading liberal arts institution, with three core objectives:

1. To create a luxury hotel that would reflect the College's values of excellence, innovation and community and to serve the needs of students and faculty.
2. To create an amenity that met the needs of the entire community: a living room for both "town" and "gown."
3. To create a property positioned for success with net operating income committed to a permanent endowment for student scholarships.

The Alfond Inn at Rollins would stand out if it were simply luxury writ large. Yet from the get-go, the hotel has distinguished itself with two unique features: philanthropy and art. Conceived as an extension of the Cornell Fine Arts Museum as a repository of a growing Contemporary Art collection. This collection of paintings, photographs, sculptures, and alternative visual forms is valued for its wonder and beauty, but is also equally eager to manifest art’s power to generate curiosity, evoke empathy, inspire passion, elicit reflection, and hone the analytical skills and visual literacy of a community of learners. The hotel is used continuously during the academic year as a live learning laboratory for individual and group study tours and as part of a wide range of class activities across a range of liberal disciplines. Furthermore, public Tours of The Alfond Inn’s contemporary art collection, guided by staff or curators from the Cornell Fine Arts Museum at Rollins College, take place on Sundays.

The Alfond Inn, as an extension of a teaching museum and art gallery, provides a visual syllabus of rotating contemporary art installations which are designed to be experienced, providing a sense of timing and place, and opening up a world of perspectives & choices. This makes the hotel unique with an educational intention to foster discussion and debate without being judgmental, via a living contemporary collection that provides a visual arts curriculum for Rollins. The intention being to instill an enduring love of the fine arts within young people being in their formative college years, when they are eager to learn and sort out from a confusion of conflicting interest the things that matter deeply to them. The Alfond Inn also serves as a classroom for Rollins students and the community, integrating art learning into daily life. Conceptual art is particularly well-suited to an educational community, because it demands that the viewer ask questions and think critically. At any given time, there are about 140 artworks displayed throughout the hotel, and they're rotated once a year.

The hotel has at its heart a crucial philanthropic mission, directing all net operating income to scholarships. Since 2013, the Alfond Scholars Program has awarded millions of dollars in scholarships to deserving Rollins students, allowing the best & brightest from across the globe to gain a Liberal Arts education. Rollins partnered with the Harold Alfond Foundation to build the Mediterranean-style hotel, with the provision that profits go to the Alfond scholarship program for 25 years, or until the endowment reaches $50 million. In the 2022-2023 academic year alone, over 30 students attended Rollins on this full four-year scholarship, with an average award of $66,000 per student per year. Longtime donors and alumni Barbara '68 and Ted Alfond '68 established The Alfond Collection of Contemporary Art for Rollins. The various works were chosen specifically because they embody the themes relevant to a liberal arts education. Emerging and established artists are part of art of this moment - because all art serves to explain and express the complexity of this particular here and now zeitgeist.

Conclusions

This study has provided the foundational scope for the creation of a new interdisciplinary course relating to a niche area of hospitality management. This is designed around an interactive program providing student-centered internships across the various departments and service offerings at a unique boutique hotel operation at the Alfond Inn at Rollins College. This is a unique opportunity for differentiation with the hospitality education sector, addressing the needs of the industry by providing academically rigorous experiential training to support the development of career ready employees for this crucially understaffed travel and tourism sector.

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How Company Age Affects ESG Ratings

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Abstract

With the increased popularity of environmental, social, and governance, or ESG, in recent years, a great host of data has become available from company's sustainability reports which have yet to be fully analyzed. This paper examines the ESG ratings of publicly traded companies based on the different ages of the companies using company founding dates from FactSet Research Systems Inc. and ESG ratings from HIP Investor Inc. The results show that the average ESG rating for older companies are mostly greater than those for younger companies.

JEL Code: O16
Keywords: ESG, Company Age, Corporate Governance, Investments

Introduction

For the past few decades, organizations have begun to include environmental, social, and governance factors in their decision-making. In recent history, there has been a significant increase in the number of companies around the globe that measure and report environmental data, such as carbon emissions and water consumption, social data, such as product safety and information, and governance data, such as lobbying and board diversity, which is more commonly referred to as ESG data (Amel-Zaeh et al., 2018). However, it has been seen recently that the use of ESG factors as an indicator for investing in companies has gained more attention. With more companies releasing their ESG data in the 21st century, investor interest in using this new data has also increased; although, people have been looking for a relation between ESG criteria and corporate financial performance (CFP) since the 1970s (Friede et al., 2015). The increase in the number of companies releasing their ESG data has led to a greater diversity of companies within the data, from different nationalities, to different sizes, and to different ages.

With this great diversity in companies, it seems important to find what differentiates between the companies in the data set. Thus, this paper looks to see if there are significant differences between companies of different ages who have committed to ESG practices in terms of the HIP pillars and investment ratios. This paper will be analyzing companies based on their ages as it is a factor that is yet to be explored in a research setting when it comes to ESG companies. Before undertaking this research, a hypothesis was created that the age of the company would be proven to be a significant variable when comparing companies and that it would be the younger companies who would have the higher scores in comparison to the older companies. The second hypothesis was developed after finding a study that younger investors were more likely to invest into companies pursuing ESG objectives than older investors, leading to the idea that younger companies would invest more into ESG than older ones (Gelfand, 2022).

Literature Review

It has been seen that in recent years, more investors and funds have been investing in companies that have a strong commitment towards ESG performance. In previous studies, it has been found that ESG factors had an effect on stock returns despite not being financial factors. In their study, Boadi and Amegbe found that the quality of governance significantly affects stock market performance (2017). Amel-Zadeh and Serafiem concluded that investors are financially motivated to use ESG data (2018). Furthermore, they found out that the information that investors use varies systematically across countries depending on the major issues in those areas. Jieqiong Suna et al. in their research concluded that corporate social responsibility affects corporate social performance (2019). Additionally, they found that corporate social responsibility has a weaker effect on corporate financial performance in firms located in indulgent countries. Research by Friede et al. looked at the ESG's effect on financial performance and found evidence from more than 2000 empirical studies that roughly 90% of studies find a nonnegative ESG-CFP relation (2015). Moreover, through their research they have concluded that most studies find positive findings. A recent study by Susec and Sardy discovered that companies who had shown some commitment to ESG practices on average outperformed the main stock indexes of their countries, using HIP scores to determine the companies' commitment. (2021) A similar study was done by Tahmid, Hoque, Said, Saona, and Azad where they made the same revelation that ESG initiatives had a positive impact on firm value and performance using Thomson Reuters ESG Scores. (2022)

There has been some research done using company age as an independent variable when analyzing companies, though there is a need for research using company age as an independent variable when analyzing specifically ESG-committed companies. Abdullah et al discovered that older companies were more likely to do internet financial reporting in Indonesia. (2017) Hapsoro et al found that company age positively influenced the likelihood of disclosure of carbon emissions. (2020) Further analysis by Hapsoro et al had found that the disclosure of their carbon emissions had a positive influence on those companies' trading volume, implying that stakeholders will respond positively to companies that care about the environment. (2020) Another report by Solikah and others confirmed that company age did have a positive influence on the disclosure of carbon emissions. (2021) In a study on family businesses, Kurniawan, Istiatin, and Luhgiatno saw no significant differences in company age toward the firms' performances, concluding that the firm's performance cannot be determined only by knowing its age. (2022) These studies show that company age can have a correlation to the company's social behavior, but not on its financial performance. In this study, we are hoping to find that by using a company's age, then it can be determined whether a company's ESG ratings are higher or lower, so it can be used as a better comparison to find whether a company will have better investing performance.

ESG And Company Age Data

In order to conduct the analysis, HIP Investor Inc., an ESG rating and investment advisory firm, provided a dataset comprising ESG ratings of publicly traded companies around the world. HIP Investor Inc. creates these ratings through a process called the "HIP Score", which stands for "Human Impact + Profit", and this process involves assessing each company for its ESG rating through detailed research that they gather from publicly available information as well as from third-party data collectors. The HIP Score is composed of 7 HIP Pillars: Health, Wealth, Earth, Equality, Trust, Management Practices, and Products and Services. The Health pillar consists of the health effects from the firm's behavior on the employees, shareholders, and users based on the employees' access to healthcare, overall job safety, employee retention, and employee and customer satisfaction. The Wealth pillar is rated based on how the company affects the financial status of everyone involved. Specifically, it consists of employee access to stock options, employee pay, comparison between the CEO and employee's pay, and the company's investments in community development. The Earth pillar is conducted out of the company's earth and resource efficiency, carbon reductions, water usage, waste production, and more. The Equality pillar is assessed from the data of board diversity, LGTBQ+ policies, the number of women within the firm and the number of women managers, the supplier sourcing, and finally the diversity of the population served. The Trust pillar consists of rating the third-party certifications, firm's lobbying, customer guarantee policies, lobbying, and disclosure of data. Company's Management Practices are valued based on the organization's long-term vision, decision making, financial performance – considering return on equity and beta, as well as accountability to public commitments. Lastly, the Products and Services pillar comprises the impact that company's products and services cause and to what extent they solve real human problems. The data on the age of the companies was gathered from FactSet.

Methodology

The data used in this study from HIP Investor Inc. was divided into four groups based on their age. The first group consisted of companies that originated from 2010 to 2023, the second group were companies created between 1995 to 2009, the third group contains companies formed between 1980 to 1994, and the fourth group consists of companies founded in 1979 and earlier. The decision to split the groups by these years was meant to divide the great economic events that would have affected the companies such as the Covid-19 pandemic and the Great Recession. In addition, as corporate social responsibility and ESG ratings are newer subjects, we decided to split the company age groups closer to the present, since we do not believe that companies founded in 1979 and earlier would differ greatly in their beliefs in the importance of ESG. Additionally, the United States was excluded from this analysis because it is the largest dataset available and would have dominated the analysis, when the purpose of this study is to understand the global differences between the older and newer companies.

The HIP pillars and investment ratios of all of the companies in each of the age groups were averaged for each year from 2016 to 2023. The differences between each of the age groups were then found at two groups at a time, and thus there were six differences to look for significance for: the differences between groups 1 and 2, groups 1 and 3, groups 1 and 4, groups 2 and 3, groups 2 and 4, and groups 3 and 4. The mean and the standard deviation was then found for each of the differences across the years, and a two-tailed t-test distribution was used to find if the differences were significant. The following formula was used to calculate the test statistic t:

$$(x_1 - x_2) \ / \ s_p(\sqrt{1/n_1 + 1/n_2}) \tag{1}$$

In this formula, x_1 and x_2 are the sample means, n_1 and n_2 are the sample sizes and s_p is found with the formula:

$$s_p = \sqrt{(n_1-1)s_1^2 + (n_2-1)s_2^2 / (n_1+n_2-2)} \qquad (2)$$

The values s_1 and s_2 are the sample variances. The p-values for each of t values were then found using a two-tailed t distribution table, and that value was used to determine whether the difference between the two age groups was significant.

Results

The results of the differences between groups 1 and 2, groups 1 and 3, groups 1 and 4, groups 2 and 3, groups 2 and 4, and groups 3 and 4 for pillars of Health, Wealth, Earth, Equality, Trust, and Management Practices, as well as for the total HIP rating can be found in table 1.

Table 1: Average Differences in HIP Ratings Across Age Groups, 2016-2023 (in %) (rounded to nearest ten thousandth)

	1 – 2	1 – 3	1 – 4	2 – 3	2 – 4	3 – 4
Total HIP Rating	0.0000 **	0.0000 **	0.0000 **	0.0002 **	0.0000 **	0.0000 **
Health	0.0000 **	0.0000 **	0.0000 **	0.0000 **	0.0000 **	0.0000 **
Wealth	0.0000 **	0.0000 **	0.0001 **	5.7957 +	37.1066	36.1895
Earth	0.0002 **	0.0000 **	0.0000 **	0.0002 **	0.0000 **	0.0000 **
Equality	0.0002 **	0.0000 **	0.0000 **	0.0000 **	0.0000 **	0.0000 **
Trust	0.0000 **	0.0000 **	0.0000 **	0.0000 **	0.0000 **	0.0000 **
Management Practices	0.0000 **	0.0000 **	0.0000 **	0.0000 **	0.0000 **	0.0000 **
Products and Services	0.0002 **	0.0001 **	0.0000 **	0.0004 **	0.0000 **	0.0000 **

** significant at 1% level, * significant at 5% level, + significant at 10% level

The results of the differences between groups 1 and 2, groups 1 and 3, groups 1 and 4, groups 2 and 3, groups 2 and 4, and groups 3 and 4 for the investment ratios: index return, stock return, price to book, price to earnings, price to cash flow, and capex ebitda, as well as for alpha and beta can be found in Table 2.

The findings suggest that between the years of 2016 to 2023, the average differences between HIP pillar ratings as evaluated by HIP Investor Inc., excluding Wealth, are significant between all of the different age groups of companies who have shown some commitment to ESG practices. The reasoning for why Wealth could be less significant between the older companies is that the issue of a wage gap is more visible in those older companies than the newest ones, since those older companies are more likely to be more bound to tradition when it comes to employee compensation. Moreover, it is interesting to note that most of the differences in investment ratios are not significant between the age groups of the ESG-committed companies. This would align with the previous research by Susec and Sardy (2021) showed companies had shown commitment to ESG practices had outperformed their countries' indexes.

Table 2: Average Differences in Investment Ratios and Others Across Age Groups, 2016-2023 (in %) (rounded to nearest ten thousandth)

	1 – 2	1 – 3	1 – 4	2 – 3	2 – 4	3 – 4
Index Return	22.9207	30.5750	56.0681	81.8911	84.0302	76.4229
Stock Return	34.5615	61.4532	81.7163	34.5642	34.5110	26.4429

Alpha	15.3561	11.4703	51.7258	15.5323	15.4482	13.3126
Beta	46.6074	82.8415	2.7138 *	46.6875	44.4196	3.8815 *
Price to Book	31.6635	37.3319	10.1441	42.7535	14.0132	3.5328 *
Price to Earnings	35.2681	25.3669	10.5572	32.2174	1.1448 *	36.6544
Price to Cash Flow	9.0762 +	11.8018	43.9359	70.4280	0.7061 **	0.3775 **
Capex Ebitda	66.6408	14.5312	95.1401 *	27.1772	75.6288	24.5587

** significant at 1% level, * significant at 5% level, + significant at 10% level

The average HIP rating for each group from 2016 to 2023 can be found in table 3. The average HIP scores from 2016 to 2023 for companies founded between 2010 and 2023 can be found in Table 4. The average HIP scores from 2016 to 2023 for companies founded between 1995 and 2009 can be found in Table 5. The average HIP scores from 2016 to 2023 for companies founded between 1980 and 1994 can be found in Table 6. The average HIP scores from 2016 to 2023 for companies founded before 1980 can be found in table 7.

Table 3: Average HIP Rating Across Age Groups, 2016-2023

	2016	2017	2018	2019	2020	2021	2022	2023
Group 1 (2010-2023)	0.18	0.27	0.26	0.25	0.26	0.27	0.26	0.27
Group 2 (1995-2009)	0.23	0.29	0.29	0.30	0.30	0.30	0.30	0.31
Group 3 (1980-1994)	0.27	0.32	0.31	0.32	0.33	0.33	0.33	0.33
Group 4 (Pre-1980)	0.31	0.36	0.36	0.36	0.38	0.38	0.38	0.37

Table 4: Average HIP Scores for Companies in Group 1 (Founded Between 2010 and 2023), 2016-2023

	2016	2017	2018	2019	2020	2021	2022	2023
Health	0.07	0.18	0.17	0.14	0.16	0.17	0.17	0.18
Wealth	0.16	0.30	0.31	0.29	0.29	0.30	0.28	0.28
Earth	0.05	0.10	0.10	0.07	0.10	0.12	0.13	0.16
Equality	0.13	0.21	0.20	0.17	0.18	0.19	0.19	0.20
Trust	0.06	0.13	0.11	0.09	0.10	0.11	0.11	0.12
Management Practices	0.18	0.30	0.28	0.25	0.22	0.22	0.19	0.17
Products and Services	0.09	0.19	0.18	0.15	0.17	0.18	0.17	0.19

Table 5: Average HIP Scores for Companies in Group 2 (Founded Between 1995 and 2009), 2016-2023

	2016	2017	2018	2019	2020	2021	2022	2023
Health	0.15	0.22	0.21	0.20	0.21	0.21	0.22	0.23
Wealth	0.25	0.36	0.38	0.39	0.41	0.40	0.39	0.38
Earth	0.10	0.12	0.12	0.12	0.14	0.14	0.16	0.19
Equality	0.17	0.22	0.21	0.23	0.23	0.23	0.23	0.24
Trust	0.11	0.16	0.15	0.15	0.15	0.15	0.15	0.16
Management Practices	0.27	0.35	0.33	0.31	0.27	0.27	0.26	0.24
Products and Services	0.16	0.22	0.22	0.22	0.23	0.23	0.23	0.24

Table 6: Average HIP Scores for Companies in Group 3 (Founded Between 1980 and 1994), 2016-2023

	2016	2017	2018	2019	2020	2021	2022	2023
Health	0.19	0.24	0.23	0.23	0.24	0.24	0.25	0.25
Wealth	0.29	0.37	0.38	0.38	0.41	0.41	0.42	0.41
Earth	0.14	0.14	0.14	0.14	0.17	0.17	0.19	0.22
Equality	0.21	0.25	0.25	0.26	0.27	0.27	0.28	0.28
Trust	0.14	0.19	0.17	0.18	0.18	0.18	0.19	0.19
Management Practices	0.33	0.39	0.37	0.35	0.33	0.33	0.32	0.29
Products and Services	0.19	0.24	0.23	0.24	0.25	0.26	0.26	0.27

Table 7: Average HIP Scores for Companies in Group 4 (Founded Before 1980), 2016-2023

	2016	2017	2018	2019	2020	2021	2022	2023
Health	0.23	0.29	0.29	0.28	0.30	0.30	0.30	0.30
Wealth	0.31	0.36	0.37	0.37	0.40	0.40	0.43	0.42
Earth	0.23	0.24	0.24	0.24	0.27	0.27	0.29	0.30
Equality	0.27	0.31	0.32	0.33	0.34	0.34	0.34	0.34
Trust	0.22	0.27	0.26	0.27	0.28	0.28	0.28	0.27
Management Practices	0.42	0.47	0.46	0.43	0.44	0.44	0.40	0.37
Products and Services	0.25	0.30	0.30	0.30	0.32	0.32	0.33	0.32

When comparing the average HIP scores across the different age groups, contrary to what had been hypothesized, it is actually the older companies who have committed to ESG who have the higher scores in comparison to the younger ones. Perhaps it is the stability of being an established company that allows them to invest more into ESG practices and because the data set already excludes companies that haven’t committed to ESG.

Conclusion

The results provide us with the differences between each combination of age groups, defined as group one consisting of companies founded between 2010 and 2023, group two from 1995 to 2009, group three from 1980 to 1984, and group four from 1979 and earlier. In all cases except Wealth, it was found that there was significance in the differences between all of the age groups, showing that while these companies are similar in having committed to ESG practices, they are different in how their ESG practices are rated. It was interesting to find that the differences between groups were less significant for investment ratios, meaning that ESG practices either have a similar effect on the firm's financial performance or that companies with similar financial performance commit to ESG practices.

While this paper serves to look at one factor that differs amongst companies committed to ESG practices, it also serves for others to look into any other factors that might set these companies apart from each other. Future research can be done to see if those factors do have an effect so that there can be a better understanding of companies who undertake this initiative.

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