

The Contributing Factors of Carbon Footprints Among Hotels on the Island of Mauritius: A Comparative Analysis

By Makoondlall-Chadee Toshima¹, Goolamally Naadir², Ramasamy-Coolen Priya¹, Bokhoree Chandradeo¹ and Foogoa Ravi¹

Abstract

The tourism and hospitality industry is a worldwide known trillion-dollar industry and a major economic generator for several economies. Despite a positive economic contributor, the challenges of the tourism industry cannot be overlooked. The tourism industry is right now definitely more involved on the broader aspects of sustainable tourism but nevertheless still contributes 8% of the GHG emissions globally. This work aims at identifying and addressing the main contributing areas responsible for the greenhouse gas emissions for the hotel industry in Mauritius. A quantitative approach based on an adapted framework of the hotel carbon measurement initiative (HCMI) was used to collect data from four hotels with different ratings and which were selected through convenience sampling. Land use for buildings, energy consumption and emissions, refrigerants being used in the hotel, water consumption and wastes being produced are researched as major contributors of GHG from the hotels and these were captured and analyzed. Comparatively, the findings revealed that the carbon footprint for 4-star, 5-star and 5-star plus hotels were found to be lower than the average carbon footprint of other hotels of similar categories worldwide. However, for 3-star hotels, the latter was found to be higher. Plausible recommendations were made accordingly to reduce carbon emissions for each hotel type.

Keywords: Tourism Sustainability Assessment, Greenhouse gas emissions (GHG), hotel carbon measurement initiative (HCMI)

1. Introduction

The global travel and hospitality industry worldwide is known both for its positive economic contributions as well as its related negative environmental impacts. The contribution from travel and tourism in 2019 was recorded at 10.4% of global GDP (World travel and tourism Council, 2019); a share which however witnesses a decrease to 5.5% in 2020 due to ongoing restrictions to mobility. It is also worth noting that the carbon emissions from the travel and tourism sector reported by the UN Climate Change conference COP 25 in December (2019), was recorded at roughly 8% of world's carbon emissions. Tourism is similarly a major economic contributor to the local economy of the island of Mauritius with a recorded contribution of 23.9% of GDP (Knoema, 2019)). The tourism and hospitality sector being a multi-stakeholder and multi-activity industry, it is hence important to understand and demarcate the relative carbon emissions from all

¹Department of Environment, Science and Social Sustainability School of Sustainable Development and Tourism (SSDT), University of Technology, Mauritius

²Constance Hotels, Resort and Golf

major tourism related components. Other than the travel sector of the tourism industry, emissions from the lodging component of the tourism industry is also among the highest as they tend to be energy-intensive operations given that they rely on heating and air conditioning, warm showers, heated pools and spas to meet their ongoing customer needs and demands (International Sustainable travel, 2020). The Caribbean Hotel Energy Efficiency action program of October (Caribbean Hotel Energy efficiency action, 2012), reinforces that due to the modern services provided by larger resort hotels they tend to emit far more emissions than traditional lodging such as homestays and guesthouses. This current study attempts to analyze and assess the carbon emissions from selected hotels of various categories to quantify their relative emissions. A quantitative analysis was completed with an adapted framework of the hotel carbon measurement initiative (HCMI) to collect data. Furthermore, the gathered data was scrutinized to determine what major hotel operations contribute the highest to carbon emissions whereby relevant best practices were then proposed to achieve sustainable accommodation in island states such as Mauritius.

2. Sustainable Tourism

The amount of carbon being emitted through either travel or hotel activities is an important indicator to assess the environmental impact that tourism generates (Cadarsó, Driml, & Maria, 2020). To balance tourism growth as well as improve carbon efficiencies, island developing states like Mauritius and other countries worldwide have adopted the principles and practices of Sustainable Tourism (Makoondlall-Chadee, ChandradeoBokhoree, & Deepa, 2017). Stojanovska-Stefanova, A., & Atanasoski, D., (2018) defines sustainable tourism as “*A well designed and well-managed tourism can make a significant contribution to the three dimensions of sustainable development and has close linkages to other sectors and can create decent jobs and generate trade opportunities*”. As the economic, social and technological processes are still expanding the analysis of new business practices and models is crucial to ensure the survival of sustainable development of tourism more so in developing countries (Dalia, Biruta, Edmundas, & Simanavicius, 2020)

Since mid-1990's, the tourism industry green practices which at that time was most known as green hospitality (Balasubramanian, Ragavan, & Ari, 2019) started with initiatives such as water saving programs in the relevant companies or hotels. Gradually, sustainable tourism was seen as a solution capable of creating positive changes and started to play a pivotal role in identifying and securing positive benefits through legislative and control monitoring approaches (Habib, Farzad, & Arezoo, 2019). Throughout 1990 till now, there has been an increased demand from green consumers which caused the tourism industry to shift their business strategy towards a greener approach to be able to gain a competitive edge on the global tourism market (Chandran & Bhattacharya, 2019)

Nowadays, alongside green practices, there is an increase interest from businesses of the tourism industry to have eco labels such as green globe; travel life and green key (Yılmaz, Üngüren, & Kaçmaz, 2019). The tourism industry is more involved on a broader aspect in terms of sustainable tourism now, by adopting sustainability practices based on the Eco labels, as well as the hotel industry which is more concerned with the eco label standards criteria's in terms of legal compliances, Green purchasing, Protection of cultural heritage,

Training and retention of their employees among others (Sucharan, Arulapan, & Lucinda, 2020). Since the year 1990's, the tourism industry has shown considerable growth in terms of green/sustainable practices being implemented (Balasubramanian, Ragavan, & Ari, 2019).

3. GHG Emissions in Tourism Industry

It is an undeniable fact that GHG level is increasing around the world as shown in figure 1 below. Out of this global emission, Tourism sector contributes 8% of the GHG emissions (Lenzen, et al., 2018).

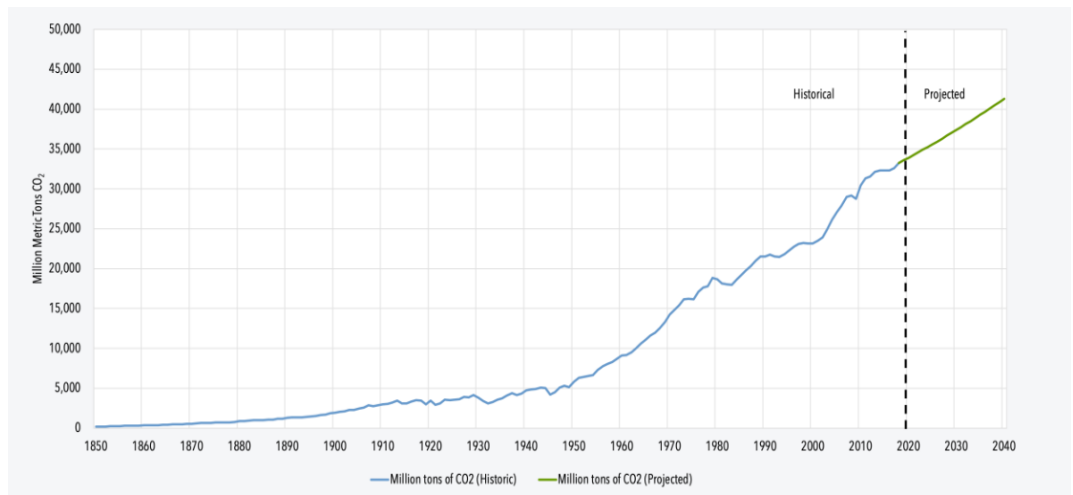


Figure 1: Global Carbon Dioxide Emissions, 1850–2040 (IEA, 2019)

Various studies have tried to record the GHG level of different countries as well on a global perspective: With the considerable growth in the Tourism sector, Emissions have increased from 3.9 Gigatonnes of co₂ in 2009 to 4.5 Gigatonnes in 2013 (Michael, 2018). In the study done by (Faturay, Ting, & Malik, 2018), using a life cycle assessment methodology, the global emissions of tourism industry was shown to increase from 3.9 to 4.5 billion tons of co₂ annually from 2009 to 2013 analyzing data from 160 countries which accounts for 8% of the global emissions. SIDS have through several studies been characterized as vulnerable and very impact-sensitive (Barnett & Waters, 2016) Similarly, the study found that that in SIDS such as Maldives, Mauritius and Seychelles, the tourism sector accounted for 30 to 80% of the national annual emissions. Throughout the years, there has been an undeniable increase in the GHG emissions despite the fact that since 1990's the industry turned to green hospitality practices (Kaitano & Godwell, 2020). Various reasons can explain this effect, some of which are an increase in the number of travellers around the world and more and more accommodations services and respective facilities are being consumed. Such an increase can be recorded due to the emergence of new travel trends such as eco-tourism, golf tourism, medical, religious, wildlife tourism and millennials travel priorities as different as compared to others (OECD, 2018). All the

above arguments reiterate the importance of continuous GHG measurement to know where matters stand taking into consideration present situation and to be able to take actions thereof. Similarly, throughout the last decades, there has been an increased use of the Hotel Carbon Measurement Initiative (HCMI) that is a tailor-made tool for the hotel industry to calculate their Green House Gas emissions and render the sector a more sustainable one.

4. Mauritius Tourism Industry

Tourism started in Mauritius in 1950's where the need for economic diversification was felt as well as the potential for the island in terms of attractive sun, sand and sea was noted (Su-Marie, 2018). The development of the airport and the civil aviation back in 1952 brought a boost in the tourism industry with main accommodation areas being park hotel, followed by beach hotel concept in 1954 named as le morne plage Ltee among others. . The national development plan (1971-1975) boosted up the diversification of the economy to promote the tourism sector as third pillar of the economy whereby government bodies such as Mauritius Government Tourist office (MGTO) from 1959 to 1996 and currently known as the Mauritius Tourism Promotion Authority (MTPA) is responsible for promoting tourism (African center for economic transformation, 2021). The Tourism industry has seen an increase from 34 establishments in 1975 to 1029 establishments at end of December 2018, including guesthouses, hotels and tourist residences (Tourism, Ministry of, 2018). Tourist's arrivals and earnings can be summarized in the table below.

	1995	2005	2016
Contribution of Tourism to Employment (%)	4.8	8.7	9.7
Tourist Arrivals	422,463	761,063	1,275,227
Tourism Earnings (Rs Mn)	7,472	25,704	55,867
Average Length of Stay	10.7	10.7	10.4
Hotel Occupancy Rates (%) – All Hotels	66	63	73
Hotel Stock	95	99	111

Source: *Statistics Mauritius (2019)*

For the year 2019, there was 1,876,736 of tourist who visited the country (Tourism, 2019). An increase in the numbers of tourists causes a direct increase in related impact, mostly environmental impacts such as coral bleaching, beach sand loss and contamination of coastal waters by hotel waste water (Rajendra, 2020). Such increased impacts further lead to the coming up of the Environment Protection Act for Mauritius in September 2002, further amended in 2008 to legislate environment protection in Mauritius. Accordingly, there was a closer watch on environmentally related impacts before any hotel development as promoters were compulsorily required to conduct an Environmental Impact Assessment (EIA) which encompasses all the environmental aspect of any hotel development (Mollie & Sundberg, 2020). The GHG level of Mauritius recorded an increase from 5,613Gg co2 equivalent in 2018 to 5,777 Gg co2 equivalent, which represent an increase of 2.9% for Mauritius (Ministry of Environment, 2019). Main areas of consumption have been assessed such as energy sector, waste and agriculture; however,

no specific data is available for the tourism industry, which is a disadvantage for a tourism, based economy for SIDS such as Mauritius. This again reiterates the urgency and relevance of having a proper measurement mechanism for the Green House Gases within the tourism and hospitality industry. Objectively, this paper concentrated on analyzing the Carbon footprint of the hotel sector in Mauritius

5. Methodology

While there are both qualitative and quantitative methods of research, quantitative analysis has been shown to increase in technical research works such as carbon footprints to be able to provide a proper data recording, analysis and assessment (George, 2019). Various methods exist with their own pros and cons. One of the widely used methods by well-known operators in the industry is the Hotel Carbon Measurement Initiative (HCMI). The model was developed in June 2012, by Sustainable Hospitality Alliance (the Alliance) and the World Travel & Tourism Council (WTTC), in collaboration with 23 leading global hospitality companies. It is to be noted that the above model has been chosen for this study due to the practicability of the HCMI model and its industry-oriented methodology designed specifically for the hotel industries. This specific methodology allows hotels through their carbon footprint to relate the direct link of their operations to their consumption in terms of energy and fuels used as well as their related environmental impact being created through carbon emissions. Furthermore, this methodology allows for the calculation of the total hotel carbon footprint as well as the footprint of an occupied room, while considering the various types of energy sources required for the various actions being undertaken in the hotel. Such measurements are very useful, more so for island developing states such as Mauritius as the constraints on natural resources and the measurement and monitoring of carbon emissions is a crucial step towards the sustainability of a core industry such as tourism.

The data is represented as CO₂ equivalents (CO₂e) and is calculated using conversion factors as advised in the Green House Gas (GHG) protocol. The involved criteria are further explained below:

1. Occupied rooms- the total number of rooms sold minus no shows for the reporting year were considered
2. Outsourced laundry- To ensure a fair comparison between hotels that are doing in-house or private laundry, if total laundry tonnage cannot be received from suppliers, an estimate can be input by weighting the average amount of laundry per room * by number of occupied rooms in the reporting year.
3. Private space: Any area where hotel guests or conference guests do not have access is considered as a private space and the energy consumption was removed from the overall consumption.
4. Renovations: The methodology is designed for calculations during normal operations. Extensive renovations were not considered.
5. Unit conversion- The following conversion factors have been used for this study for energy; The universally known conversion factors for energy units and volume units shall be used and for weight and distance, the universally known conversion factors for weight/mass units and distance units which shall be used in case of any conversion of

result that must be done to ensure a uniform result.

6. Emission factors- The emission factors convert the different consumptions to their respective greenhouse gases emissions. Most common sources for emissions considered are from DEFRA -UK.

7. Total hotel carbon footprint- Regroups the total energy usage (gas, gas oil, electricity and any additional energy sources) plus energy usage from outsourced laundry (if any) minus the energy in the private space (if applicable) and was equivalently converted to co2 using the most appropriate factor for the country.

8. Reporting Division- for reporting purposes, the hotel is divided into meeting space and guestroom areas. Carbon footprint for all rooms and all meetings are calculated as follows:

Rooms Allocation × (Total Energy × Emission factors) = Carbon footprint for all room

Meetings Allocation × (Total Energy × Emission Factors) = Carbon footprint for all

9. Wastes: Wastes have been classified in terms of different categories and recyclables later accordingly converted in terms of co2 emissions by multiplying the quantity of specific waste being produced using the relevant equivalence factors from DEFRA.

6. Target Population

The target population for this study was the hotel industry of Mauritius. One hotel of each category, i.e., 3 star, 4 star, 5 star and 5 star plus were chosen for this study. The latter is based on the classification and star rating audit of the Mauritius Tourism Authority whereby it is assessed as per the Tourism Authority Act Regulations which is also cited as the Tourism Authority Classification Regulation 2015 (Authority, 2021). Every hotel is assessed as per a list of criteria whereby they should score not less than 80 % for each criterion, where available in their field to be eligible for a star rating Every hotel is assessed as per a list of criteria's whereby they should score not less than 80 % for each criterion, where available in their field to be eligible for a star rating. For this study, it has been assumed that the operations of similar categories of hotels are almost the same apart from number of rooms available due to various reasons such as the assessment rating of the authorities in Mauritius as well as Sustainable development practices in place in every resort in Mauritius as mentioned above.

7. Findings and Discussion

The results below report the carbon footprint calculated for each of the surveyed hotels. The common factor known and discussed in the literature is the carbon footprint per occupied room daily is 76.6 kg/ co2e/year, 16kg/co2/year, 86.9 kg/co2e/year and 123.3 kg/co2e/year for the 3, 4, 5 and 5 plus star respectively. It must be pointed that the recorded carbon footprints were comparatively analysed with other countries and hotel operations of 3 Star, 4 Star and 5 Star Hotels. Several works by Japan, Italy etc. ((Ricaute, 2018)) were considered and analysed. Carbon footprint per occupied room will vary greatly depending on country and regions due to various factors such as electricity source, water consumption among others.

Results	3-Star	4-Star	5-Star	5-Star Plus
Total CO ₂ e for reporting period (tCO ₂ e)	2634.06	1557.98	3929.96	2634
Total guestrooms carbon footprint (tCO ₂ e)	1700	961	3910	2612
Total meetings carbon footprint (tCO ₂ e)	934	597	20	22
Carbon footprint per occupied room daily (kgCO ₂ e)	76.6	16	86.9	123.3
Carbon footprint per area of meeting space on an hourly basis (kg CO ₂ e)	255.9	163.5	5.3	6.0

For the 3-star hotel, the gathered carbon footprint per occupied room daily is higher than the mean carbon footprint per occupied room for 3 star hotels surveyed in countries such as china (36.26kg/co₂), Indonesia(42.58kg/co₂) and Japan (51.49kg/co₂). The result obtained in Mauritius is benchmarked as high compared to those countries. Several reasons may be the factors for this as discussed by (Pérez, et al., 2019)the different factors influencing a hotel's footprint ranges from the outside temperature, air conditioning system and room occupancy among others. Such variables are determinant as we do realise that Mauritius has a very tropical climate year-round and in terms of technological appliances working on a bulk buying process hotel appliances for air conditioning might not be the best performing ones (Bekaroo et al, 2012; Lopez at 2021). It is also worth pointing that is a known fact that that generally 3 star hotels do not invest much into environmental management as they do not necessarily have a very good control on major variables like energy and water consumption which were surveyed by Bokhoree et al (2014). There needs to be better control over their energy and water usage and awareness session on the latter among their clientele will need to be conducted to make them interested in staying in an environmental friendly hotel (Choi et al, 2018). Such considerations are crucial as this can appear as a hindrance for low rated accommodation and it will be a bigger challenge to effectively work towards an overall reduction in carbon emissions.

Data gathered for studied 4-star hotel, carbon footprint per occupied room on a daily basis is in the range of the mean carbon footprint per occupied room for 4 star hotels surveyed in Italy (17.22 kg/ CO₂), Brazil (15.44 kg/ CO₂), and Colombia (17.59 kg/ CO₂). For other countries like Japan, the mean surveyed value for the 4 Star hotels is 63.84 kg/ CO₂ and the value obtained in Mauritius i.e., 16kg/ CO₂ is considered as low. The 4-star hotel concerned in the survey had a high number of selling rooms due to various marketing approaches used which for instance also captured targeted local market. To further understand the findings for 4-Star hotels, it is to be noted that the selected hotels affirmed working towards adopting mechanisms to mitigate and reduce their energy and refrigerant consumption patterns by adopting more environmentally friendly initiatives as it confirmed by the research of (Wanga, Zhaoad, Caoa, & Zenga, 2021) that refrigerants are among the heavy carbon emitters. Hotels reported to be using mainly chillers whereas many administration areas have split units. 4-Star rated hotels recorded acceptable carbon footprint as they are currently adopting as described by Camilleri-Fenech et al (2018), composting of the green fraction of their waste. Similar activities were also recorded for the surveyed higher rated hotels. Furthermore, other initiatives towards carbon reduction measures as described by Mu and Kanu et al (2019), are also being adopted by the surveyed hotels; e.g., food wastes being re-used. Despite that, the carbon footprint per occupied

room daily is within the approximate range of the other countries as mentioned above, hotels still need to thrive towards their commitment in managing and working on adopting alternate and more technologically advanced (Bekaroo et al, 2016), eco-friendly practices and work on carbon reduction mechanisms.

The 5-Star hotel carbon footprint for the hotels within this study per occupied room is lower than the mean surveyed value for the 5 star hotels in Japan (107.44kg/ CO₂), India (94.87 kg/ CO₂) and Indonesia (158.24 kg/ CO₂). While the latter is a marketing tool whereby they can attract clients who are also known as green travellers, the different measures in the respective sustainability certifications ensures that they are meeting respective targets concerning energy management, water consumption, laundry activities and refrigerants, which help to lower down their carbon footprints. (Khalifa, 2020) supports that effective environmental strategies are crucial in tourism organisations. The carbon footprint recorded for the 5-Star hotel in Mauritius are below the average mean and many hotels have adopted and have international sustainability certifications such as the Green Globe, Earth check and Travel life whereby they are audited each year to ensure that they maintain this certification. Such practices and initiatives confirms a reduction in for instance electricity consumption known to increase hotel's carbon footprint. Similarly, this work recorded that for the targeted 5-star hotels, the Energy Use Intensity (EUI) in Mauritius is lower than the average reported by Shenga et al (2018), from studies done from 310 five star hotels in China as well as from the five star hotels in Turkey where the EUI for 5 star hotels were found to be 245 kWh/m²/year and 389 kWh/m²/year respectively.

The 5 star plus hotel carbon footprint per occupied room daily is lower than that of the mean of the surveyed hotels in United Arab Emirates (UAE) - 147.23kg/ CO₂, and Saudi Arabia (205.32 kg/ CO₂) however is in the range of that of Thailand (123.5 kg/ CO₂). 5 star plus hotel in Mauritius are surely not as luxurious and advanced as the Emirates region nevertheless the selected hotels are known for its high standard level of amenities such their own golf-courses for two of the selected hotels and in terms of enhancing the stays for their specific niche market no stone if left unturned which can hence explain the high carbon footprint per occupied room for that specific market.

8. Conclusion

As cited by (Elimelech, 2018), Peter Drucker wrote the famous lines “What gets measured gets managed” going by the principle that tourism development must ensure the sustainable development of ecology, economy and society while reducing its impact and there are different tools and techniques present to assess the impact and performance however there is no common accepted method (Song, Fisher, Jian-Lin, & WangLian-Biao, 2018).

Hotels are specifically known to have a non-negligible contribution in the latter as the industry uses a large amount of energy, raw materials, water and other products as well as produces a large amount of waste which at the end have a significant contribution to the greenhouse gases being produced (H.K.Lai, 2016). While it is undeniable that the hotel sector does have a contribution in the footprint of the tourism industry (Ricoa, et al, 2019), it is important to know the exact sources and their specific contributions. It has been recorded through this work and other research that the main hotel areas which are

concerned with the greenhouse gas emissions are land use of the buildings, energy consumption and emissions, Refrigerants being used in the hotel, water consumption and wastes being produced (Hu, Huang, & Chen, 2015). This work has hence considered the HCMI methodology which clearly considers specific measurables such as energy consumption, refrigerant, waste components among others for the calculation of the total carbon emissions of hotels. Through such assessment methodologies the predicted contributions of tourism related activities forecasted at approximately 7.5 % of the global CO₂ emissions in 2035 (Chen & Yan, 2018) can be mitigated.

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