Modelling Waste Management and Re-Utilization in Accommodation Sector: The Case of North Cyprus

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ABSTRACT

Tourism has been acknowledged as one of the fastest growing industries in the world. However, recently tourism activities have been noted as a double-edged sword, in that it not only creates positive impacts but also causes negative impacts on the physical environment (i.e., land pollution, ecosystem degradation, air and water pollution) if not well managed. Increasing concerns about the negative impacts of tourism have led various researchers to estimate and model the role of the different tourism sectors that contribute to greenhouse gas emissions and various aspects of climate change.

Northern Cyprus is a popular tourist destination in the Mediterranean region, boast of increasing number of tourists annually. Besides the massive economic benefits of the tourism industry of Northern Cyprus, there are serious environmental concerns on the basis of improper waste management. Hence, the present research focused on the statistical modelling of the waste generation rate of accommodation sectors of Northern Cyprus, management approach and the re-utilization of the generated wastes.

The research herein adopted a quantitative method and the data were collected through the questionnaire. Various accommodation types based on size were sampled in Famagusta, Girne and Nicosia districts of Northern Cyprus. Specifically, the thesis examines the type of wastes generated, the quantity of wastes generated considering the nationality of the tourists, waste management practices employed by

each sampled accommodation and established the relationship between these independent variables and the waste generation rate.

The quantifiable wastes generated per tourism seasons were modelled by three statistical models; central composite design, artificial neural network and multiple linear regressions. The results showed that 4159.9 kg and 2063.4 kg of waste were generated during the peak and lean season from the sampled hospitality facilities, respectively. In the sampled accommodation, 36% of the waste generated originated from the kitchen waste and about one-fourth (27.3%) of the total waste is non-wet waste which consists 7% of glass, 8% of nylon, 5% of wood, 4.2% disposable plastics and 2.8% of PET bottles. 35% of the sampled accommodation sector practices landfill waste disposal, while only 14% recycled the wastes generated in their facilities.

Considering the results, this thesis implied that the type of accommodation sector, the waste management practices adopted by the accommodation sector, nationality and the tourism season significantly influenced the waste generation rates. These findings are important for policymakers, environmentalist and development of sustainable green hotels. Recommendations concerning separation and re-utilization of generated wastes are suggested and future research directions are outlined. This study proposes the integration of the cost-benefit system into the waste management program of each accommodation sector to encourage hotels to manage their waste effectively. Also, the conversion of waste cooking oil into green energy (biofuel) is demonstrated and encouraged to incentivise better waste management.

Keywords: tourism, environmental pollution, waste generation, reutilization, forecasting

ÖZ

Turizm, dünyadaki en hızlı büyüyen endüstrilerden biri olarak kabul edilmiştir. Bununla birlikte, son zamanlarda turizm faaliyetleri çift taraflı bir kılıç olarak görülmüştür, çünkü bu sadece olumlu etkiler yaratmaz, aynı zamanda iyi yönetilmezse fiziksel çevre üzerinde olumsuz etkilere neden olur (ör: arazi kirliliği, ekosistem bozulması, hava ve su kirliliği). Turizmin olumsuz etkileri ile ilgili artan endişeler, çeşitli araştırmacıların sera gazı emisyonlarına ve iklim değişikliğinin çeşitli yönlerine katkıda bulunan farklı turizm sektörlerinin rolünü tahmin etmelerine ve modellemelerine neden olmuştur.

Kuzey Kıbrıs, Akdeniz bölgesinde popüler bir turizm beldesidir ve her yıl artan sayıda turist barındırmaktadır. Kuzey Kıbrıs turizm endüstrisinin büyük ekonomik faydalarının yanı sıra, uygun olmayan atık yönetimi temelinde ciddi çevresel kaygılar bulunmaktadır. Bu nedenle mevcut araştırma, Kuzey Kıbrıs'ın konaklama sektörlerinin atık üretim oranının istatistiksel modellenmesine, yönetim yaklaşımına ve üretilen atıkların yeniden kullanılmasına odaklanmıştır.

Buradaki araştırma kantitatif bir yöntemi benimsemiş ve veriler anket yoluyla toplanmıştır. Kuzey Kıbrıs'ın Mağusa, Girne ve Lefkoşa ilçelerinde boyutuna göre çeşitli konaklama türleri örneklenmiştir. Özellikle, tez, üretilen atıkların türünü, turistlerin uyruğunu göz önüne alarak oluşturulan atıkların miktarını, her bir örnekdeki konaklama tarafından kullanılan atık yönetimi uygulamalarını incelemekte ve bu bağımsız değişkenler ile atık üretim oranı arasındaki ilişkiyi ortaya koymaktadır.

Turizm mevsimlerine göre üretilen ölçülebilir atıklar üç istatistiksel modelle modellenmiştir; merkezi kompozit tasarım, yapay sinir ağı ve çoklu doğrusal regresyon. Sonuçlar, örneklenmiş konukseverlik tesislerinden en yüksek ve zayıf mevsim boyunca sırasıyla 4159.9 kg ve 2063.4 kg atık üretildiğini göstermiştir. Örneklenen konutta, üretilen atığın %36'sı mutfak atığından kaynaklanmakta ve toplam atığın yaklaşık dörtte biri (% 27.3) ıslak atık değildir, %7'si cam, %8'i naylon, %5'i odun, %4.2'sini tek kullanımlık plastikler ve %2,8 PET şişeler'den oluşmaktadır. Örneklenen konaklama sektörünün %35'i çöp atıklarının bertarafını gerçekleştirirken, sadece %14'ü tesislerinde üretilen atıkları geri dönüştürmektedir. Sonuçlar dikkate alındığında, bu tez, konaklama sektörünün türünün, konaklama sektörünün benimsediği atık yönetimi uygulamalarının, uyruk ve turizm mevsiminin atık üretim oranlarını önemli ölçüde etkilediğini göstermektedir. Bu bulgular politika yapıcılar, çevreci ve sürdürülebilir yeşil otellerin gelişimi için önemlidir. Üretilen atıkların ayrıştırılması ve yeniden kullanımı ile ilgili öneriler önerilmekte ve gelecekteki araştırma yönleri özetlenmektedir. Bu çalışma, otellerin atıklarını etkili bir şekilde yönetmelerini teşvik etmek için her bir konaklama sektörünün atık yönetim programına maliyet-fayda sisteminin entegrasyonunu önermektedir. Ayrıca, atık pişirme yağının yeşil enerjiye dönüştürülmesi (biyoyakıt) daha iyi atık yönetimini teşvik etmenin ıspatıdır.

Anahtar Kelimeler: turizm, çevre kirliliği, atık üretimi, yeniden kullanım, öngörme

To my beloved Family

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LIST OF ABBREVIATIONS

ASTM	American Society for Testing and Materials
ANOVA	Analysis of Variance
ANN	Artificial Neural Network
B/C	Benefit-Cost
CO2	Carbon Dioxide
CCD	Central Composite Design
R2	Correlation Coefficient
EPA	Environmental Protection Agency
EU	European Union
GDP	Gross domestic product
HYBRID	Hybrid Fractional Error Function
MAE	Mean Absolute Error
MLR	Multiple Linear Regressions
TRNC	Northern Cyprus
SEP	Standard Error of Prediction
SPSS	Statistical Package for the Social Sciences
UNEP	United Nations Environment Programme
UNWTO	United Nations World Tourism Organization
U.S.A	United States of America
WRAP	Waste and Resources Action Programme
WCO	Waste Cooking Oils
WGR	Waste Generation Rate
WMP	Waste Management Practices

WTO	World Tourism Organization

Chapter 1

INTRODUCTION

Cyprus, a small island with a long and rich culture that spans 10000 years has been recognized as a major tourist destination in the Mediterranean. Cyprus historical monuments and natural beauty enhance the growth of hotel and tourism industry. The Cyprus island is divided into two parts; Southern Cyprus (Greeks) and Northern Cyprus (TRNC). Specifically, tourism has affected the development of Cyprus and its share of the GDP of Cyprus is significant. The maximum number of tourists' arrivals occurs during summer and thus recognized as the peak season and lowest number of tourists arrive in winter (the lean season).

According to the World Economic Forum's 2017 Travel and Tourism Competitiveness Report, the Cyprus tourism industry ranks 52th in the world with regard to overall competitiveness. Furthermore, the report recorded that more than 1.5 million international tourists have arrived in Cyprus. Specifically, Figure 1.1 shows the increasing trend in the number of tourists from 2016 to 2017.

Table 1.1: The total tourist arrivals to North Cyprus in 2016-2017

Arrivals from Turkey/monthly.1000.			International arrivals/monthly.1000.			Total arrivals/monthly.1000.		
2016	2017	Change %	2016	2017	Change %	2016	2017	Change %
75,523	85,102	12,7	15,022	20,242	34.7	90,545	105.344	16.3
98,719	101.113	2.4	24,845	31.737	27.7	123.564	132.850	7.5
88.230	101.949	15,5	30.627	40.252	31,4	118.857	142.201	19,6
100.795	111.236	10,4	23.109	35.119	52,0	123.904	146.355	18,1
119.054	121.019	1,7	26.146	29.421	12,5	145.200	150.440	3,6
91.911	102.804	11,9	27.874	31.575	13,3	119.785	134.379	12,2
99.629	113.045	13,5	38.057	37.736	-0,8	137.686	150.781	9,5
98.014	105.107	7,2	40.049	37.593	-6,1	138.063	142.700	3,4
132.037	145.894	10,5	41.476	43.733	5,4	173.513	189.627	9,3
117.311	117.996	0,6	41.718	46.645	11,8	159.029	164.641	3,5
95.540	105.986	10,9	29.398	33.892	15,3	124.938	139.878	12,0
101.469	112.997	11,4	20.520	22.137	7,9	121.989	135.134	10,8
Total 1.218.232	**Total 1.324.248**	**8,7**	**Total 358.841**	**Total 410.082**	**14,3**	**Total 1.577.073**	**Total 1.734.330**	**10,0**

(Ministry of Tourism and Environment 2018).

From the above figures, it is clear that the cyprus tourism industry is booming and this has fuelled demand for various accommodation facilities. The hospitality industry is a significant waste generator. As expected, the increasing waste generation in the accommodation sector of TRNC constitutes adverse impacts on the environment. Note that, until now, no research as focused on the waste generation rates of the accommodation sector of TRNC hospitality industry.

Also, no integrated comprehensive plan has been reported on the sustainable ways to reduce the volume of wastes generated by the tourism activities in the TRNC. It is worthy to mention that due to globalization and industrialization in the hospitality industry, voluminous wastes are generated from hotels lodging, resorts activities, restaurants and kitchen areas (Radwan et al., 2012). The improper disposal or management of the hospitality industry wastes creates various social and ecological problems, for example, accumulation of these wastes in the densely populated areas

results in the spread of diseases or its discharged into water streams threatens aquatic species and human health.

Hence, to curtail the ugly face of tourism activities, sustainable waste management practices need to be enforced. Enforcing waste management would positively affect social, economic and environmental issues of the countries. This research focus on waste generation from the TRNC accommodation sector, factors influencing the waste generation, various challenges faced by the owners/managers of the accommodation sectors limiting the implementation of waste management practices, development of robust models to forecast waste generation and highlighting ways to reutilize the generated wastes to achieve profitability and environmental sustainability.

1.1 Overview of Research Area

The TRNC is estimated to cover an area of 3.355 square kilometres. Based on governmental statistics, the population of the TRNC was estimated as 313,626 in 2014 (TRNC SPO, 2015). Human presence on the island dates back to 10,000–12,000 years ago when sailor-hunter colonisers first arrived (Delipetrou et al., 2008).

Cyprus has diverse landscapes due to various climate and geology, and maintains natural beauty and thus attracts visitors. Due to the strategic location of Cyprus, as an island between Africa, Asia, and Europe, the tourism industry plays a significant role in its economy. Tourism is identified as one of the driving sectors of the TRNC economy, owing to its reputation as an unspoilt area, rich history, and mild climate. It is praised for its relative safety, and significant sectors of eco-tourism have been developed in TRNC (Katircioglu et al., 2007).

However, TRNC had to cope with the effects of being a non-recognised state and was coerced into political dependency on Turkey (Alipour et al., 2005). Thus, affected its promotion and volume of tourist arrivals (Altinay, 2006). In spite of these challenging circumstances, the tourist industry in Northern Cyprus succeeded in developing and is one of its major economic engines nowadays. As a major subsector of the tourism industry, the hotel sector is frequently adjudged to consuming large quantities of various solid materials, water, paper and as well as other products and (Bohdanowicz et al., 2007).

Resource utilisation efficiency has not been a priority in most hospitality sectors unless efficiency savings can provide a quick return on investment (Charara et al., 2011). Additionally, the hotel sub-sector categorization depends on the number of rooms, facilities, target market, services or beds in the establishment (Radwan et al., 2012). In general, the accommodation sectors specifically hotels are categorized majorly on the basis of the size as a small, medium, large (Radwan et al., 2012). In 2016, Turizm Planlama Daieresi, recorded the total number of registered hotels and accommodation facilities as 133 with a bed capacity of 21,425. These facilities were classified into 15 types (Turizm Planlama Daieresi, 2016) as presented in Table 1.1.

Table 1.2: Tourism statistics of North Cyprus 2016

Facility Class	Facility Number	Share (%)	Bed Number	Share (%)
5-star hotel	18	13	12,160	57
4-star hotel	5	4	1,738	8
3-star hotel	13	10	2,269	11
2-star hotel	17	13	1,303	6
1-star hotel	15	11	605	3
II. Class T.K.	4	3	624	3
Boutique hotel	5	4	486	2
Special certified hotel	1	1	34	0
Tourist bungalow	25	19	1550	7
Apart hotel	3	2	116	1
Local house	3	2	96	0
Touristic housing	2	1	108	1
Tourist pension	20	15	277	1
Facilities not yet classified	1	1	12	0
Facilities not yet classified and renovated	1	1	20	0
TOTAL	**133**	**100**	**21,425**	**100**

Source: (Turizm Planlama Daieresi, 2016)

One of the main concerns of the development of a sustainable tourism industry is to conserve the environment as a significant section of tourist attractions. The major disadvantage of tourism development is the waste generation which is highlighted by the United Nations Environment Programme (UNEP). In 2003, UNEP reported that international tourism sector generated around 4.8 million tonnes of solid wastes and

the tourism industry produced about 14% of the urban solid wastes. Moreover, UNEP announced that every European tourist produce around one kg per day of solid waste and also American tourists generate two kg per day.

However, some investigators stated that waste generation of some people could be twelve kilos per day. Furthermore, high amount of water and energy are consumed in tourism sectors such as in the pool, kitchen, laundry, restrooms, and bathrooms, and also a huge volume of solid wastes (industrial, animal-based and plant-based wastes) are generated in recreational or lodgings sections.

The types of waste that are generated by accommodation sectors of the tourism industry are shown in Table 1.2. Relatively little attention has been paid to wastes generated in accommodation sectors despite its potential for financial benefit. However, some studies reported on the minimization of wastes via various methods including cost management, waste management, consumers and employees training or recycling waste. Solid waste generation and disposal are one of the most negative environmental impacts of small hotels because small hotels often pay little attention to their environmental responsibilities (Radwan et al., 2012).

Table 1.3: Different categories of waste

Compostable	Waste material like organic waste, food, garden and paper
Recyclables	Wastes for reprocessing into raw material for creating a new product such as glass, paper.
Non- recoverable	These groups of waste are dangerous, involves an energetic process to reuse and no permanent recycling option.
General waste	Common wastes that are sent to the landfill
Bulk waste	Refers to as heavy wastes such as TV, bed, refrigerator, reconstruction waste

Source: (Hofstede et al., 2008)

1.2 The Scope of the Study

Increasing population and varying anthropogenic activities have resulted in huge environmental wastes and a significant concern for policymakers and environmentalists. Specifically, the increasing tourism activities have been associated with voluminous wastes. The accumulation of hospitality industry generated wastes in the environment causes loss to the economy, interrupts biosphere cycles, and damages historical monuments.

The scope of the study is to get the first-hand knowledge about the waste generation rate of accommodation sector of Northern Cyprus hospitality industry, investigate the relationship and correlation of independent factors influencing the waste generation rate, and establish the waste management practices employed by the accommodation sector and the behavioural constraints to implementing waste management practices. Specific focus will be directed towards the application of predictive models to

forecast waste generation rates in the accommodation sector. The reutilization of the generated wastes will also be considered and results herein will be discussed considering reported study cases and various other secondary data.

1.3 Research Objectives

This research had a broad range of objectives. The first objective is to investigate the waste generation rate of accommodation sectors. Secondly, to develop a better understanding of the relationships between the tourist's demographic characteristics, the accommodation sector waste management practices/belief system and the waste generation rate. It was expected that this study would be able to identify other influencing variables and key sources of wastes in the hospitality sector for future research that will increase the body of knowledge relating to the waste generation in the hospitality industry and to develop. Finally, this research provided practical guidance to the accommodation sector on sustainable ways to predict waste generation in their facility and to implement a robust and efficient waste management system.

1.4 Organization of Thesis

The present thesis is designed in-line with the objectives of the research and specifically incorporates primary and secondary data for an in-depth investigation. The structure of the thesis is presented in Figure 1.3, and as shown the study is organized into five chapters:

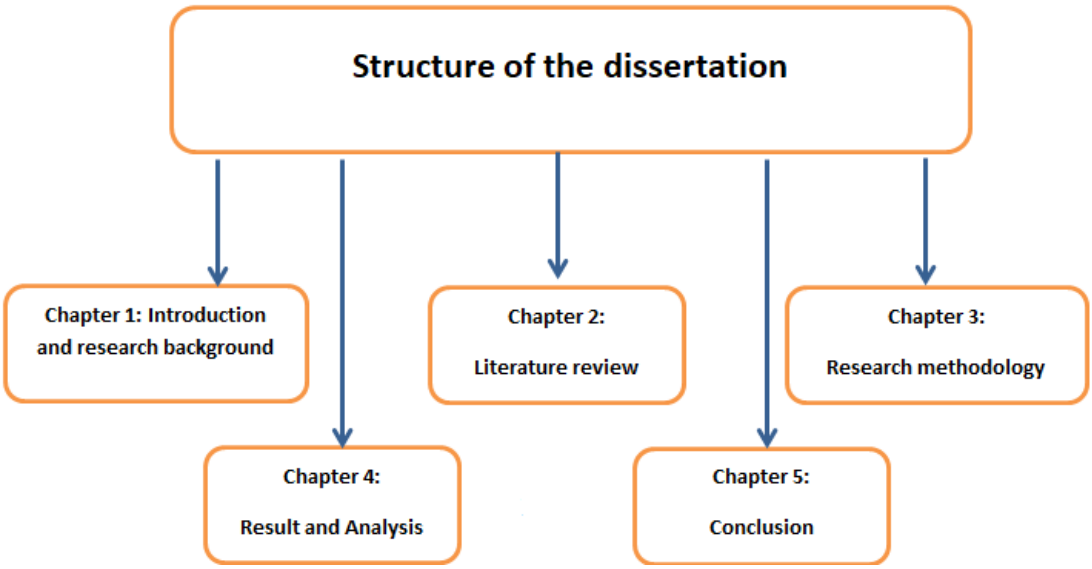


Figure 1.1: Structure of the dissertation

1.5 Theoretical Propose Model

In 1972, systems theory has suggested by Bertalanffy which is a group of theoretical ideas utilized to realize a various type of phenomena as a paradigm named a system (Bertalanffy, 1972). In addition, system theory is on the basis of method of reasoning, synthesis, which is holistic model that comprehends individual components with regard to interactions of objects and operations among the entire environment.

Tourism, as an intricate phenomenon, contains multiple separate environments, energy flows and interactions with other systems and parts. In 2004, researchers stated that systems theory is proper to consider widespread concepts connecting to interdisciplinary tourism (Farrrel & Twining, 2004; Jafari, 2005). Indeed, Panosso illustrated that there are tremendous researches on utilization of system theory in tourism sector (Panosso, 2007). Furthermore, Ackoff reported that the dynamic interactions of tourism on other systems such as environment, economy which could be analysed by system theory (Ackoff, 1999). Based on another study, sustainable

tourism can achievable with use of system theory which enables decision makers to renovate the tourism sector (Checkland, 2001).

Among the literature, authors categorized tourism sector, on the basis of sustainability, to mass tourism and sustainable tourism which mass tourism causes adverse social and environmental effects (Pearce, 1992; Clarke, 1997; Palafox, 2011). To achieve sustainable development in tourism industry, the long-term economic, environmental and social objectives is one of the most complex scientific problems, and translating the concepts of sustainability into decision making is particularly critical.

To protect natural resources, sustainable tourism has proposed by Weaver which needs environmental legislation to prevent harmful activities of tourism sector (Weaver, 2000). Furthermore, investigators stated that there is asymmetrical relationship between the environment and tourism (Romero, and Arriaga 2007). This topic goes beyond the traditional areas of process development, process design, and industrial ecology, and encompasses multi-scale phenomena and complex interactions of multiple disciplines. Systems theory is a valuable tool since it enables the integration of these multi-scale, multi-disciplinary components using a computational platform.

In this study, sustainable tourism has considered by author to overcome on negative environmental impact of tourism. The system theory of this investigation consists of modelling, optimization, analysis, collaboration, science and technology and policy. The central theme of research in our laboratory, therefore, is to develop and apply systems theory-based approaches, including modelling, simulation, optimization, and

stochastic analysis, at the interface of engineering and natural systems for sustainable decision-making Figure 1.4.

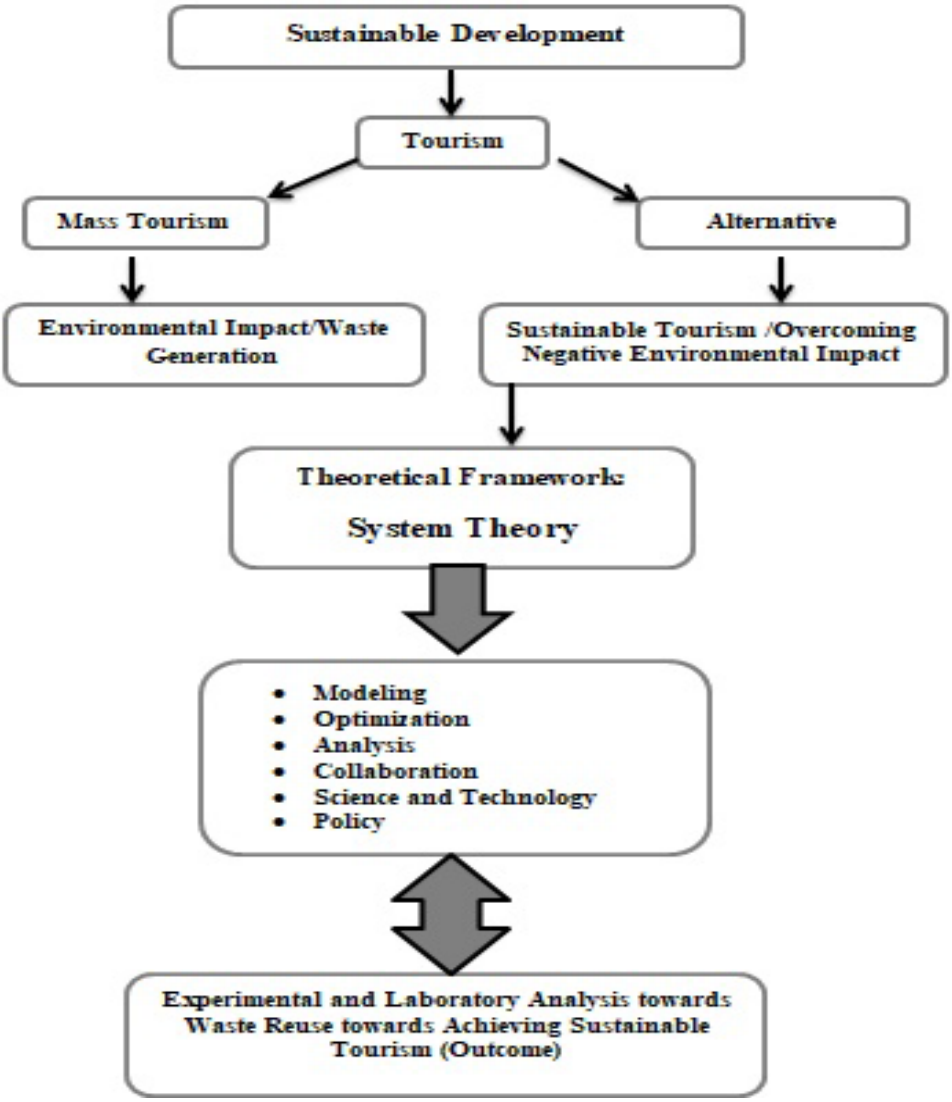


Figure 1.2: Theoretical propose model (Mieczkowski ,1995)

Following the appropriate theoretical framework, an operational frame work designed for the practical part of the research Figure 1.5.

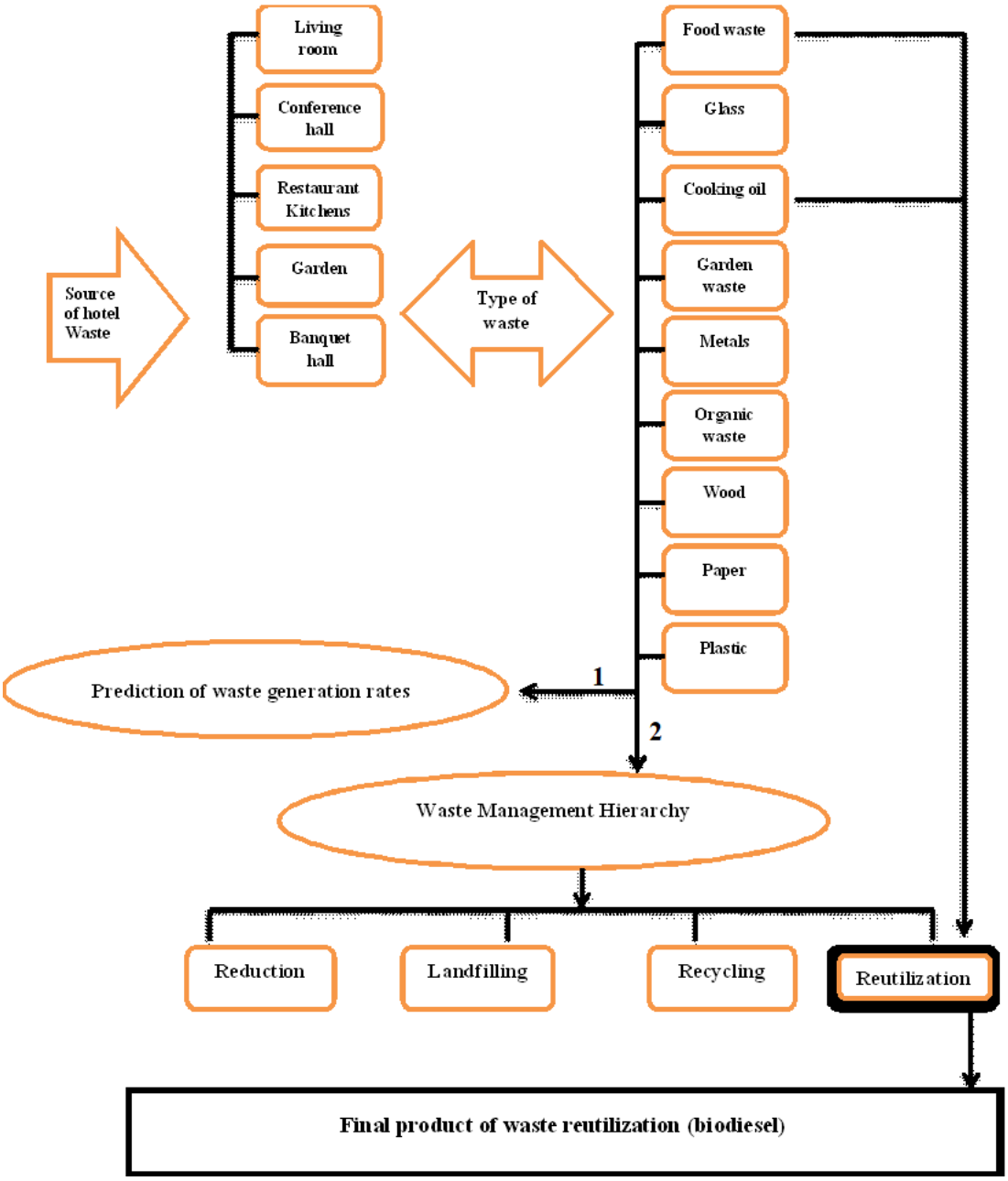


Figure 1.3: Practical Framework (Figure by Author)

Chapter 2

LITERATURE REVIEW

2.1 Introduction

The literature review chapter takes into consideration the important issue related to solid waste generation by various sectors of the tourism industry and is followed with a discussion of the problems which occur in relation to the environment and human life. Specific focus is directed towards the type of wastes and various waste disposal and management practices.

2.2 Tourism

In recent years, an increasing trend in both the local and international tourism activities have been recorded, making the tourism sector an important aspect of various countries' economies. The tourism industry has played vital roles in many countries around the world such as the development of local infrastructure, foreign exchange earnings and cultural connections according to the World Tourism Organization (WTO, 2002).

The tourism industry is divided into following sectors: accommodation, transportation, food and beverage, travel trade, tourism services, events and conferences, attractions, adventure tourism and recreation. These sectors help attract tourists and capital, in fact, the tourism industry generates a lot of job opportunities and increases household and government income.

According to a (WTO) report in 2017, 1,323 million tourists travelled around the world and the total expenditures were $593 billion, meaning the earning per day was 1.62 billion. In addition, tourist spending is an alternative to exports and foreign exchange earnings. In traditional definition, tourism could bring foreign exchange money which will be used in import and export by helping the production of goods and services.

2.3 Definition of Accommodation and Hotels

Hotels are the best alternative when people stay away from home with the benefit of receiving some services. The hotel's name was first presented by Norman people in 1760 (Dix et al., 2006). Accommodations meet the basic needs of travellers at their destination. In fact, accommodations are the point of gravity for the tourism industry (Andrews, 2008). According to (Braham, 1990) the owner or manager of the hotel should make sound use of art and science to increase the loyalty and attract customers.

The " Hospes" comes from Latin which means hospitality, according to (Brody, 2009) hospitality is a beautiful behaviour of kindness and welcoming to attract tourist. Nowadays the hospitality industry provides wide-spread services and products to travellers including transport, accommodation, food and beverage, recreation and entertainment (Walker, 2005). The hospitality industry plays a major role in developing and developed countries.

2.4 Classification of Hotel Industry

The hotel classification is a complex system and varies by country, cultural and economic contexts. In general, the accommodation sectors are classified by size of the facility which includes the number of rooms, by location, services offered and

ownership and brands ((Minazzi, 2010) as represented in Figure 2-1. In 2016, TRNC Ministry of Economic and Tourism classified hotels and accommodations into 15 types (Turizm İstatistikleri, 2016) as presented in chapter one.

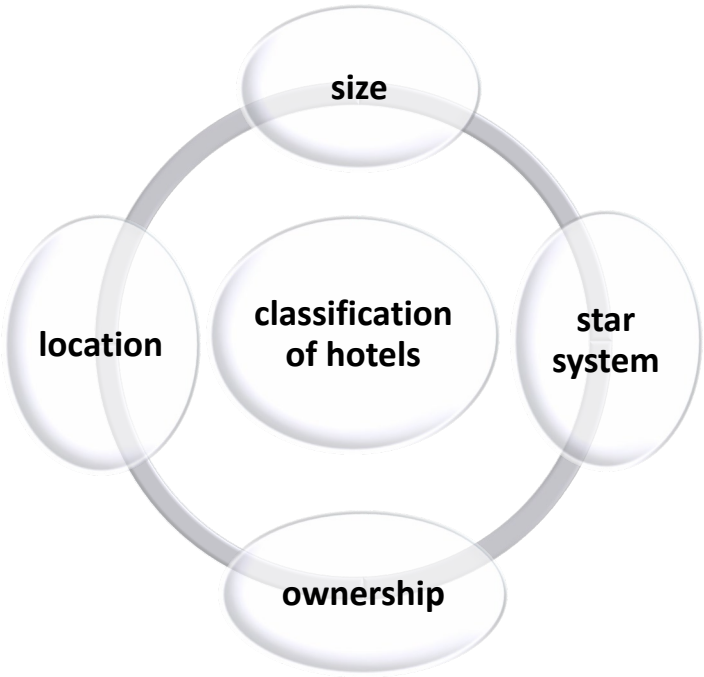


Figure 2.1: Classification of Hotel

Definitions of size were taken from VisitScotland as the national tourism agency and based on room numbers (small 20–25, medium 26–80, large >81). Hotels with 20 to 25 rooms are classified as small hotels, Hotel with 26to 80 rooms are called medium hotels, Hotels with above 81 guest rooms are regarded as large hotels and Guest house has 1 to 20 room with limited services and facilities .The blue lines are shown of minimum number of rooms and the red line in graph shown the maximum number of rooms in hotels (VisitScotland 2003).

2.5 Waste

The definition of waste is an issue of contradictory Based on environmental protection agency (EPA), a waste is any material or object that is no longer used, corrupted, scrapped, broken, and disposed of. This kind of product has no value (Lox, 1994; DEFRA, 2014). Garbage or waste can be defined as any material that the people throw away or aim to destroy (Council Directive, 1975). One person can either be the owner or producer of waste, then, it may be discarded or used as a source (Williams 2005; Barrett et al., 2004). Nowadays the environment is such a source and waste is a material which has no any value (White, 1995; Pongrácz, 2003). The current definition of waste used in the European Union countries is not specific as each Member State interprets it differently. This causes problems in the recycling industry due to commercial barriers (Lox, 1994).

2.5.1 Classification of Waste

Based on the World Bank report, waste is classified according to the sources of the wastes and categorized into 8 as shown in Figure 2.2 (MSW Manual, 2001).

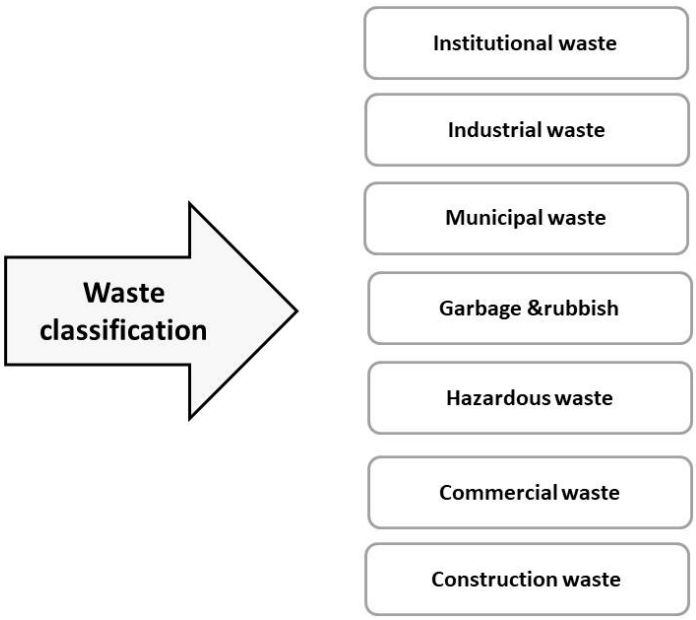


Figure 2.2: Waste Classification (Gilmour and Manns 2001)

a. **Institutional waste:** the group of waste generated by the public sector and building such as hospitals, universities etc.
b. **Industrial waste:** generated by industry sections, these wastes are considered dangerous to human health and environment over a long-term exposure - includes plastic, chemical materials, industrial gases etc.
c. **Municipal waste:** this type of waste is commonly generated from the sewage and the bulk of the waste stream originates from households, though similar wastes from sources such as public institutions, offices, commerce, and selected municipal services.
d. **Garbage and rubbish:** such as spoiled food wastes, paper, empty containers, rubbish, hazardous wastes.
e. **Hazardous waste:** these types of waste are seriously hazardous to human health including hospital waste, radioactive waste and chemical waste.
f. **Commercial waste:** the group of waste generated by commercial institutions such as markets, supermarkets, retail and wholesale institute etc.
g. **Construction waste:** construction materials and limestone waste from building, reconstruction, maintenance, renovation and destruction of homes, commercial constructions and factories.
h. **Residential waste:** the general wastes which are generated at houses like rubbish, food etc, (MSW Manual, 2009).

2.5.2 Type of Common Wastes in the Hospitality Industry

Among the literature, scholars stated that waste of hospitality industry is categorized into dry waste and wet waste which food waste as a principle section of wet waste consists primarily of food waste (Wagh 2008; Curry 2012). In addition, different

investigations illustrated that tremendous waste fractions such as glass, cardboard, aluminium, food waste and plastics are generated by hotel industry (Kirk,1995).

In 2018, Pham Phu reported that biodegradable waste accounted for the highest percentage of 58.5%, includes kitchen waste (35.5%), garden waste (15.5%) and tissue paper (7.5%). Also, recyclable waste accounted for about one-fourth of total waste which consists 1.2% of metal, 4.2% of cardboard, 12.9% of plastic including plastic bags, 2% of glass and 4.7% of the paper. The other components belong to combustible and incombustible waste with the proportions less than 3.5% for each element. (Pham Phu et all ., 2018).

Based on survey of International Hotel Environmental Initiative, the tourist generates one kg of waste daily and hence immense amount of waste being created around the globe yearly (International Hotel Environmental Initiative, 2002). In 2011, waste and resources action programme (WRAP) stated that 66 tonnes waste have generated by the hotels of UK yearly (WRAP, 2011). This study shows the composition of mixed waste of hospitality industry in UK which food waste plays the significant role among them, Figure 2.3.

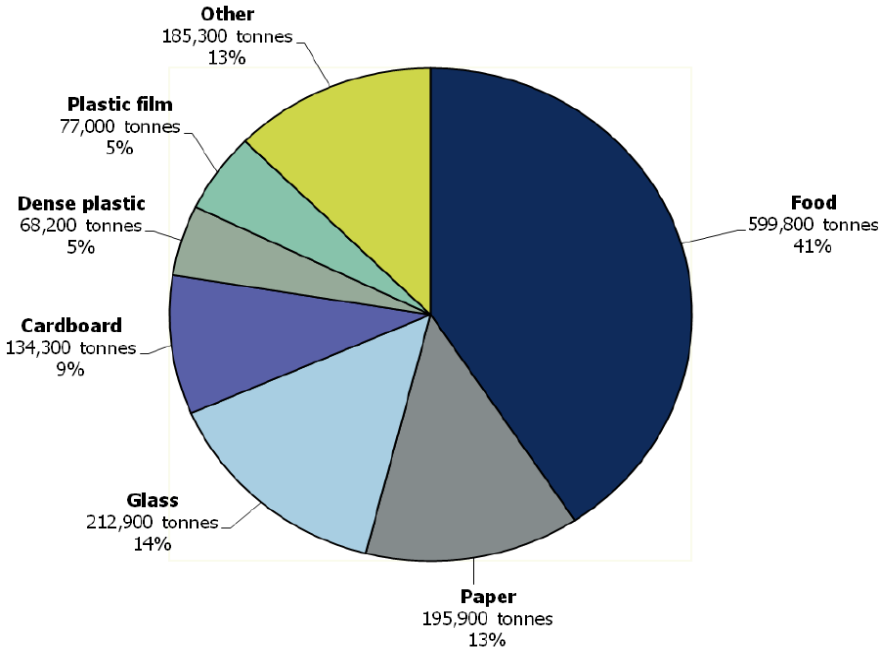


Figure 2.3: Composition of mixed waste of hospitality industry (WRAP, 2011).

Furthermore, the researchers identified that food waste produced become as the major part of waste in hospitality industry. In 2012, investigators reported that hospitality industry generated one third of all the food waste in Nordic countries (Marthinsen et al. 2012).

2.6 Impact of Waste Generation on Environment

The literature on environmental issues is immense but dispersed and often concentrated on very specific problems that are sometimes highly technical in nature. There are many reports available on environmental concern and problem (Gopalan, 1982). A similar sentiment was expressed by Gurunanak when he said "Air is like God, Water is Father and Earth is Mother", it is through the harmonious interaction of all these vital ingredients that the whole universe is being sustained (Wasir, 1997).

Natural resources are sparse and their consumption is high (Abelson, 1996; Manivasakam, 1995). Manivasakam (1995) commented that pollution is like a tiger lurking in the bush, ready to pounce upon us at any time leading to total destruction.

According to Macniell et al. (1991), developed countries are over-exploiting natural resources for so long that these resources will become limited. Therefore, renewable resources should be preferred in usage. Lahiry (1997) revealed that globalization and industrialization are responsible for the growth of the economy as well as environmental degradation. Varshney (1993) said that population and material growth result in global warming. It is also responsible for ozone depletion and loss of biodiversity.

Kamath (1976) expressed that urbanisation is growing at a tremendous pace leading to "a world of agglomerations, megapolis piled on megapolis". He also extended that, as the urban man satisfies his needs and desires, he spoils the environment. In this regard, urbanisation is considered as a menace to the survival of homosapiens and a crime against humanity. Venketaswaran (1994) established a relationship between the problem of waste and urbanization; the author reported that the development of human life from cave to the community is significantly influenced by urbanization. This rapid development supports waste generation.

Solid waste is a complex mixture of different substances. The potential health effects of such solid waste are a subject of research (CPCB, 2006). Although most of the studies focused on the health of the people, particularly those living near a waste disposal site or landfill. Improper management of solid waste has considerable adverse effects on the health of staff and also the community associated with dealing solid wastes. In some cases, improper waste management can lead to the spread of infectious diseases. Some of the specific case studies, given below, discuss wet waste that decomposes and releases a bad odour, owing to unhygienic conditions; thereby leading to health problems.

2.6.1 Impact of Tourism Sector on Environment

The traditional tourism sector could destroy the natural resources such as water, soil and air. Recently, the changes in ecosystems resulting from human activities are becoming more obvious than ever. The tourism industry creates an array of noise pollution. According to the Washington Post (1999), the noise pollution in Grand Canyon was produced by air tour operators who carried around one million passengers on scenic overflights. The tourism development program of Jamaican government damaged more than 700 acres of wetlands (Bacon, 1987).

According to Goodall (1992), tourism development ignored the environmental issues and permitted the tourism activists to exploit natural resources dangerously. For instance, Andereck (1993) reported the negative impacts of the development of Everglades National Park in Florida on wetland and estuarine environment. The author stated that construction of roads and accommodations along this park damaged the wetlands significantly.

The lack of knowledge and education of tourism firms is the main reason for environmental problems in the tourism sector. In the late 1990s, establishments of the hospitality industry were not very concerned with their environmental impact and a sustainable way of dealing with their waste was not given much priority (Radwan et al., 2010). Gartner (1996) reported that off-road vehicle races were abandoned in Nevada and California deserts to protect the tortoise populations (Gartner, 1996). Salm (1986) reported damages that emanated from the activities of tourists on coral reefs in Kenya, Madagascar, and Tanzania.

Davies and Cahill (2000) utilised a novel framework to analyse the effects of the tourism sector on the environment. In their survey, the effects of different parts of the tourism industry such as development, activities and transportation are determined. Based on their results, the tourist-related development has a remarkable effect on the environment. In 2001, the United Nation Environment Programme (UNEP) reported that the construction of tourism activities and littering influences significantly on ruining the natural environment via deforestation and erosion of ecosystems

Another study investigated the effect of the tourism sector on the marine environment in Chabahar, Gulf of IRAN. The study showed that coral shores are demolished by building hotels and facilities accommodation which produced a huge amount of wastewater (Yazdi et al., 2008). Koncul (2008) demonstrated that environmental problems in the tourism sector could be solved by implementing sustainable practices and sensible utilisation of natural sources. Moreover, the author stated that the activities of companies and the government should be sustained to achieve the proper tourism development plan.

Wang and Miko (1997) reported that cars of tourists played a major role in the pollution of national parks of U.S.A. Based on the governmental reports, recreational vessels and cruise industry produced 6.2% and 1.6% of whole events in U.S.A waters, respectively (U.S. House of Representatives, 1998). The magazine of UNEP reported that cruise vessels are majorly responsible for the production of huge wastes along the coast as compared with other ship types and every passenger of cruise vessel generates 3.5 Kg wastes per day (Our Planet Magazine, 1999).

2.6.2 Impact of Hotels on the Environment

One of the significant sub-sectors of the tourism industry is the accommodation facilities. There is considerable consumption of liquid, solid and energy in the tourism industry. Waste generation is considered by some to be the most noticeable effect which the accommodation sector has on the environment, especially because many of the establishments which make up this sector, utilising large quantities of materials as part of their operations (Bohdanowicz, 2005).

Waste is unused material generated as a result of inefficient consumption and/or production practices which puts environmental and economic costs on society through its collection, treatment and disposal (Sarkis, 2005). Lodging facilities have negative impacts on the natural environment by the generation of sewage pollution and solid waste. The sewage pollution jeopardises the health of local people, tourist and animals and could destroy the natural attractions.

Tourist attractions such as flora and fauna, rivers, seas and lakes are frequently polluted by liquid and solid wastes from various tourist facilities. Dziegielewski et al. (2000) reported that the water consumption in hotels of the United States was 15 per cent of total water consumption in the commercial sector. Their study demonstrated that the major water use was in laundry, kitchens, restrooms and landscaping of hotels. According to recent studies, the small hotels play a major role in producing maximum waste which is transfer to landfill (IHEI, 2002).

In 1989, Goldman stated that the degradation of water quality happened in the process of development of hotels by runoff sewage to Lake. In his study, he proposed that hotels should utilise an impervious surface to filter the dangerous pollutant

(Goldman, 1989). In an investigation, Bohdanowicz (2005) determined that hotels generate one kilogramme of waste per guest every day, and also 30 per cent of waste is utilised for recycling.

Azilah et al., (2014) studied the grey, black and white water recycling system for the various types of hotels in Malaysia. Based on their study, they proposed a 4Rs model which includes innovative reducing, innovative reusing, innovative reaching and innovative recycling. Thus, they predicted that hotels could effectively reduce their wastes by the use of their novel model. Shanklin (1993) reported that the average rate of solid waste generated at some hotels in Florida was between 132.7 and 220.3 pounds per room monthly.

Kharbanda and Stallworthy (1990) reported that landfills generate methane which could create several problems for the environment including unfavourable smells and noise. In another research, Becklak (1991) stated that landfill wastes from accommodation sectors cause the destruction of the environment such as pollution of underground water by leachate or by dangerous gases such as methane. Radwan et al. (2010) investigated wastes generated in green and non-green small Welsh hotels. Their results showed that the majority of non-green small Welsh hotels utilised landfill to dispose of the solid wastes with no interest to utilise other sustainable alternatives.

2.6.3 Impact of Food Waste Generation on Environment

Food waste is regarded as food residue that is discarded or lost uneaten. The causes of food waste are numerous and occur at the different stages of producing, processing, retailing and consuming. In 2017, Food and Agriculture Organisation of the United Nations reported that 1.3 billion tonnes of food produced have wasted

annually in the world (FAO, 2017). Among the literature, Authors stated that the food wastes are categorized to two types. Their study ilusterated that pre-consumer food waste refers to kitchen leftovers such as remains of fruit, vegetable and peel and the post-consumer food waste refers to food served to the tourists, Table 2.1, (Baldwin & Shakman, 2012; Cuglin et al. 2016).

Table 2.1: Causes of pre-consumer and post-consumer food waste

Causes of Food Waste	
Pre-consumer	Post-consumer
Unidentified demand	Large portion sizes
Overstocking	
Inefficient production	Inefficient service model
Poor communication	
Staff behaviour	
Unskilled trimming	Customers menu acceptance
Over-merchandising	
Food safety	

Source: Baldwin and Shakman ,2012.

In 2014, the Food Waste Reduction Alliance reported that around 85 percent of food waste produced was discarded which has harmful effects on society, econmy and nature (Business for Social Responsibility, 2014).

The investigators ilustrated that the hazardous green house gases such as Methane, nirous oxide and carbon dioxide were generated during the procedure of transfere food waste landfilling and incineration (Baldwin & Shakman, 2012). In 2013, Food

and Agriculture Organization stated that food waste was located at third place among thetowenty countries which emit the huge amount of greenhouses, Figure 2.4 (FAO, 2013, 17).

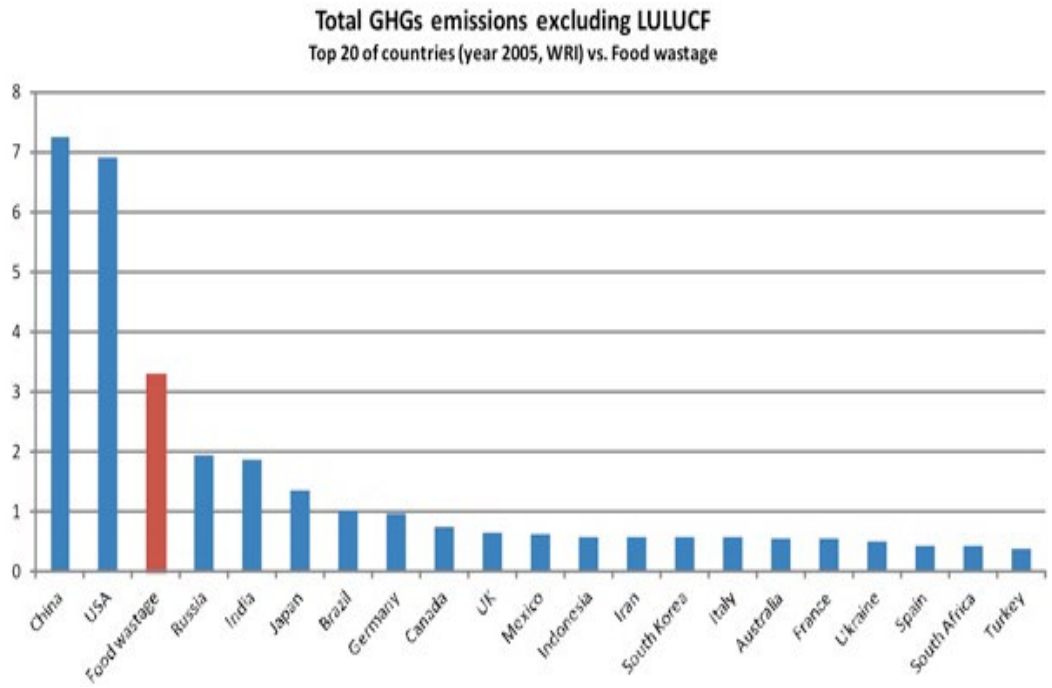


Figure 2.4: List of top 20 countries which emit the huge amount of greenhouses (FAO,2013,17).

As Figure 2.5 shows, the rate of unavoidable food waste products is more than the other types of food waste.

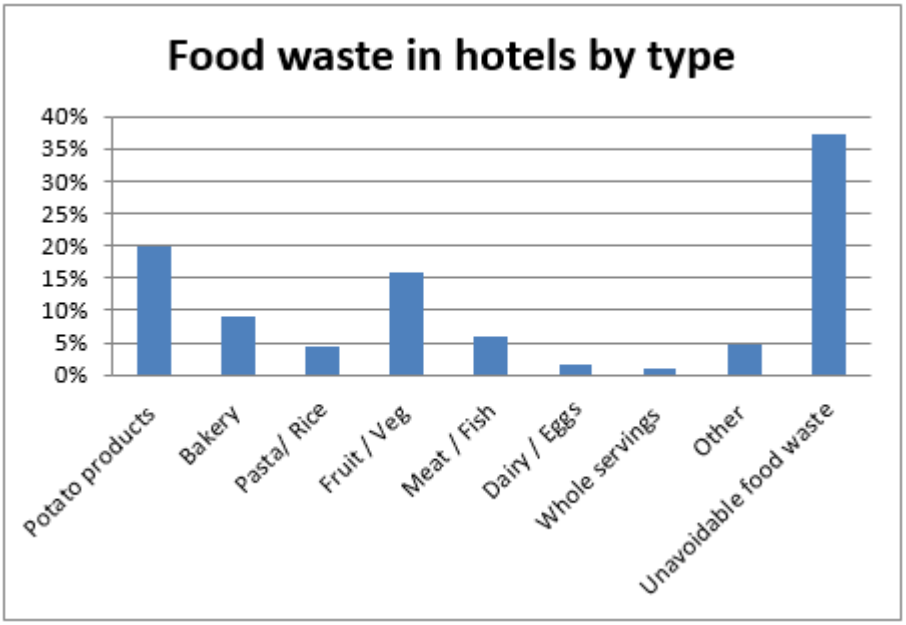


Figure 2.5: UK Hotels: The Composition of Food Waste (FAO,2013,17).

2.6.4 Impact of Waste Cooking Oil on Environment

During the process of frying various types of food in vegetable oil, there are huge amounts of waste cooking oils (WCOs) as an unwanted by-product. Kulkarni (2005) stated that WCOs are increasingly generated annually and thus pose significant threats to the environment. Based on the statistics, 800000 tons WCO have been produced in European countries and 40000 tons of WCO generated in Asian counties annually (Razali, 2005).

Due to the immiscibility of waste cooking oil and water, the interfacial layer of oil-water reduces sunlight and oxygen penetration, the discharge of waste cooking oil into water streams threatens marine biota. Furthermore, WCO creates carcinogenic compositions in water resources that could be absorbed by sea creatures which damage the health of humans in the food chain (Jafari, 2010; Marjadi et al., 2010).

In 2002, Groschen stated that the majority amounts of WCOs are discharged into the sewage system of the cities and only low amounts of WCOs are reutilized in villages. The growth of production of WCO from domestic and industrial sections make tremendous difficulties for the environment such as the contamination of water sources and underground water, energy loss and adverse effects on human health (Wilsee, 1998; Neto et al., 2000; Hamasaki et al., 2001).

2.7 Waste Management/Disposal Practices

Waste management refers to the practice of waste monitoring, collecting, transporting, processing or disposing of and managing. It is important to consider sustainability in this aspect so that every bit of waste can be managed in an efficient manner rather than just dumping it all in landfills. In 1975, The European Union's Waste Framework Directive introduced the waste management hierarchy concept into European waste policy (European Commission, 2014).

The waste management framework emphasized the importance of waste reduction, the protection of the environment and human health, as a priority. The purpose of the waste hierarchy is to give priority to waste prevention. Food waste collection and composting fit into the recycling stage of the waste hierarchy. Only when all other options have been considered should waste be disposed of, usually in the form of the landfill. The higher up the waste hierarchy a waste management strategy is, the more desirable it is as shown in Figure 2.6.

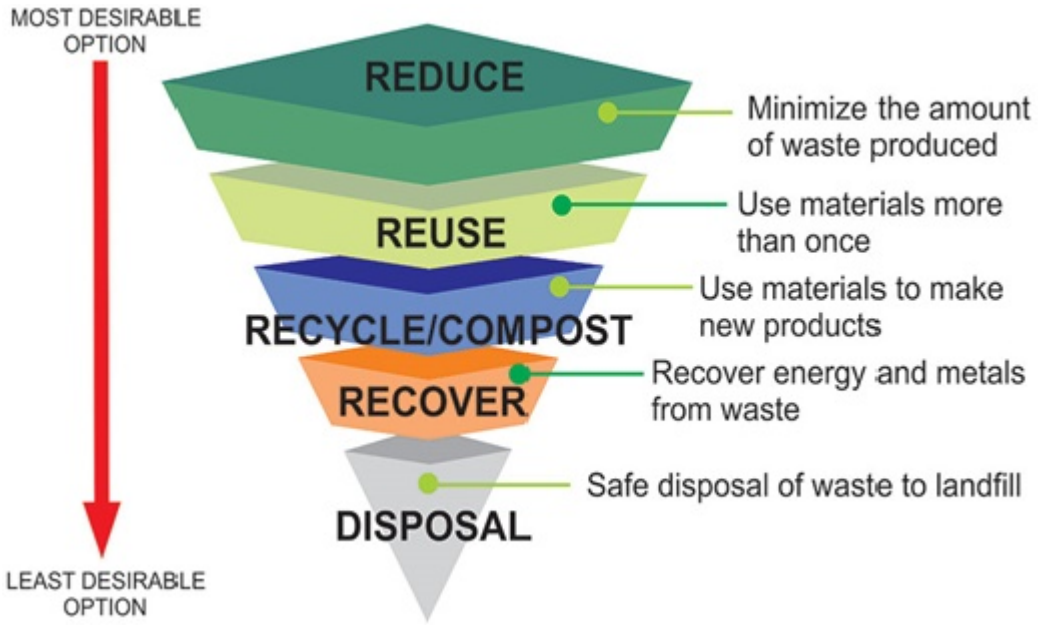


Figure 2.6: The Waste hierarchy (Holman, 2016)

The common waste management and disposal practices are discussed below:

2.7.1 Reduce

This concept focuses on the measures to be taken so as not to create any type of wastes in the first place. This is given the top priority in the waste management program. According to this principle, the manufacturing industries should make use of less hazardous materials in the design and manufacturing of the products. They should develop strategies to have a cleaner and environment friendly production.The reduction of wastes or source reduction is the second preferred option of the waste management hierarchy**.** According to this concept, the companies should take action to make changes in the type of materials that are being used for the production of the specific products, so as to ensure that the by-products are of the least toxicity. This approach helps the industries in various ways. In this way, the industries can be able to effectively save the natural resources (EEA, 2009).

2.7.2 Reuse

Reuse is the process whereby an item can be used repeatedly for the same purpose. According to the (EEA, 2009), reuse is defined as “any operation by which end of life products and equipment (such as electrical and electronic goods) and its components are used for the same purpose for which they are conceived”. The reuse of materials has been known to provide social, economic and environmental benefits especially in the voluntary and community waste sector which pioneered the re-use of furniture and white goods (DEFRA, 2010).

2.7.3 Recycling

Waste recycling is very beneficial in terms of energy savings and the reduction of pressure on natural resources and emissions from landfill (POSTNOTE, 2005). In a study carried out by Wrap (WRAP, 2006) on the benefits of recycling in the UK, the author found out that recycling saved 10-15 million tonnes of CO_2 equivalent per year and in the transport sector, it is the equivalent of taking 3.5 million cars off UK roads thereby highlighting its environmental benefits.

Recycled materials need a market for the end product and by generating a long-term and stable economic market locally, this will help to reduce pressure on virgin materials, energy consumption and CO_2 emissions (POSTNOTE, 2005).

2.7.4 Composting

Composting is nature's way of recycling carried out under controlled aerobic conditions (in presence of oxygen). This process recycles various organic materials, specifically kitchen and garden wastes to produces a soil conditioner. Composting the biodegradable waste stream especially food and garden has been viewed as having a great potential in diverting biodegradable waste from landfill and has been encouraged so as to derive compost which is a form of organic or green fertilizer.

The EU has taken steps to promote this new form of recycling and have worked on standards which have been put in the revised framework directive defining standards in quality to boost the market for compost products (European Union, 2014).

2.7.5 Recover Energy

The energy recovery process is also called as waste to energy conversion. In this process; the wastes that cannot be recycled are being converted into useable forms of energy such as heat, light and electricity etc. This helps in the saving of various natural resources. Various processes such as combustion, anaerobic digestion, landfill gas recovery, pyrolization and gasification are being implemented to carry out the conversion process (WRAP, 2006).

2.7.6 Disposal of Waste to Landfill

Dumping is the most common way of dealing with waste in developing parts of the world and landfilling is probably the cheapest way to treat waste. Therefore, up to 80% of the world practices open dumping or landfilling. Due to this reason, special attention should be paid to this final disposal option mainly in developing countries. In the African continent, where most of the countries have developing world character, 95% of all solid waste is either dumped or landfilled. Sometimes, dump sites are openly burnt which causes health problems by releasing dangerous pollutants into the air (Christian et al., 2003).

In some cities of the developing countries, management of solid wastes has started to be improved. The priority has been to find a suitable location for a controlled landfill, based on hydro-geological considerations, as well as on climatic conditions. Adequate hydro-geological conditions are important to prevent groundwater contamination, mainly in cases where financial problems impose limits on investment in bottom liners (Hogland et al., 2000).

Even where the hydro-geological conditions have been fulfilled, the landfill design should include at least the following components:

a) A bottom layer of clay and/or a plastic liner
b) A drainage and collection system for the leachate
c) A collection system landfill gas
d) A treatment system for leachate that can be located on-site or in a wastewater treatment plant (Hogland et al., 2000)

2.8 System Theory

Systems theory has suggested by Bertalanffy in 1972, which is a group of theoretical ideas utilized to realize a various type of phenomena as a paradigm named a system. In addition, system theory is on the basis of method of reasoning, synthesis, which is holistic model that comprehends individual components with regard to interactions of objects and operations among the entire environment (Bertalanffy, 1972).

Tourism, as an intricate phenomenon, contains multiple separate environments, energy flows and interactions with other systems and parts. In 2004, researchers stated that systems theory is proper to consider widespread concepts connecting to interdisciplinary tourism (Farrrel & Twining, 2004; Jafari, 2005). Indeed, Panosso illustrated that there are tremendous researches on utilization of system theory in tourism sector (Panosso, 2007). Furthermore, Ackoff reported that the dynamic interactions of tourism on other systems such as environment, economy which could be analysed by system theory (Ackoff, 1999). Based on another study, sustainable tourism can achievable with use of system theory which enables decision makers to renovate the tourism sector (Checkland, 2001).

Nowadays, there is a significant approach for implementation of sustainable development around the globe. Furthermore, the concepts and methodology of system theory are proper for utilization in planning and managing. Due to the environmental problems created by waste generation, and to achieve a sustainable development in the environment as well as in the tourism industry, the theoretical system model has been utilized in this research. To overcome the drawbacks of current sustainable development, the author suggested reutilization of waste and generate the new product to preserve the environment.

Chapter 3

RESEARCH METHODOLOGY

This chapter describes the tools and methods of data collection used by the author during the research. The methodology herein supports the scope of the thesis and the reason for the selection of the research approach is discussed. An overview of the sample area, data collection procedure, and data analysis and reutilization procedure are presented. The literature study conducted showed a lack of data in the area of hospitality waste generation rates, hence, a triangulation and statistical approach were applied to improve the reliability and validity of the research as discussed.

3.1 Research Approach and Design

For the present study, the research approach was primarily quantitative. Also, secondary data were collected to complement the quantitative responses and to further gain an in-depth understanding of the findings. The research approach herein allows for triangulation of the results. The quantitative approach focuses on collecting numerical data to construct statistical models in an attempt to explain a specific phenomenon (Babbie, 2010).

3.2 Data Collection Methods

First, a pilot study was carried out randomly and the results helped to reduce ambiguity in the sampling questions. The quantitative primary data were collected through the questionnaire. This enabled the author to establish significant statistical relationships between the independent and dependent variables. To maintain an accurate representation, the sampled accommodation sectors were classified into a

guesthouse, small, medium and large hotels based on the room capacity and services offered.

The questionnaire consists of five characteristics open and closed-ended questions designed to answer the research questions. The questions herein build on previous research by the lead investigators on waste generation rate by hospitality industry (Abdulredha et al. 2017 and Ajith, 2014). The questionnaire was delivered to the operation personnel of the accommodation sectors and collected later. The first part of the questionnaire was designed to obtain the ***accommodation characteristics*** including the nationality of most visited tourists, type of wastes generated etc. The second section of the questionnaire explored the waste management practices employed by each accommodation sector. The third section examined the barriers to implementing the waste management practices. The fourth section collected quantitative data on waste generated in each sector of the sampled facility. Lastly, the wastes disposal methods were examined in the fifth section of the questionnaire. The response rate was quite high in Girne and average response rates were recorded in Nicosia and Famagusta.

3.3 Sampling Technique and Size

In this research judgment sampling technique was used. Judgmental sampling is a non-probability sampling technique where the researcher selects units to be sampled based on his own existing knowledge, or his professional judgment (Maruyama and Garey, 2014). Specifically, the prepared questionnaires were served to the operational managers of each sampled accommodation sector and the operation manager distributed to the appropriate personnel. The study was carried out in five districts (Girne, Nicosia, Famagusta, Iskele and Guzelyurt) of Northern Cyprus

during the lean and peak seasons of 2017. It is worth mentioning that, data from previous years were also extracted from the sampled accommodation. 50 questionnaires were delivered, however, less than 50% were returned to the author. Totally 22 accommodations sectors returned the questioners, 13 in Girne, Nicosia 5 and Famagusta 4.

3.4 Waste Reutilization Procedure and Benefit-cost Analysis

According to Cummings (1997) hierarchy model, the reuse or energy recovery from hospitality wastes provides sustainable ways to manage the accommodation sectors wastes and to also benefit from the energy recovered. The key aim is to minimize the pollution at the source and to reduce secondary emissions due to the wastes. The present study converted the waste cooking oils from the hotel kitchen into biofuel and the benefit-cost analysis was performed. The benefit-cost (B/C) analysis shows the potential of waste reutilization and its positive implementation to the hospitality industry as well as to the environment. Here, the net benefit was obtained as follows and the modified benefit-cost expression was utilized. It was observed that the B/C ratio ≥ 1.00, hence, the reutilization approach is favourable.

$$\text{Net benefit} = \text{Benefit} - \text{Cost} \tag{1}$$

$$\text{Modified B/C} = \frac{\text{benefits} - \text{disbenefits} - \text{operation cost}}{\text{total investment cost}} \tag{2}$$

3.5 Data Analysis

The quantitative data collected were examined for consistency and completeness, and then discussed via a descriptive statistic using an SPSS version 22, SigmaXL version 8.0 and Neuroph version 2.94. Data analysis was performed for each of the 22 accommodation sectors, grouped by class of accommodation sector, and by category of hospitality, wastes generated.

The normality test was applied to explore the distribution of the waste generation data, which confirmed that the data were statistically distributed. Also, the variables that influence the quantity of wastes generated from the accommodation sectors were identified, then predictive models (artificial neural network (ANN), central composite design (CCD) and multiple linear regression (MLR) were applied in forecasting or estimating the hospitality waste generation rate. The detailed description of the models was given in the author's recent report (Azarmi et al., 2018). The significant effect of each variable was demonstrated via the *F-test* tool of the analysis of variance (ANOVA). Finally, the prediction performance of the selected models was established via four statistical indices including mean absolute error (MAE), standard error of prediction (SEP), hybrid fractional error function (HYBRID) and the correlation coefficient (R^2) (Jahandideh et al., 2009; Oladipo and Gazi, 2015; Azarmi et al., 2018).

3.6 Reliability, Validity and Generalizability

Following the procedure described by Kananen (2013) and Seale (2004), the quality of the present research is measured by the concept of reliability, validity and generalizability. During the data collection, a triangulation approach was employed to improve the reliability of the research.

Reliability refers to the consistency or repeatability of the findings (Seale, 2004), validity relates to the correctness or truthfulness of the measurement (Kananen, 2013) and generalizability describes the extent to which findings herein can be applied outside its own settings. For the reliability and sustainability of the quantitative data, a factor analysis was conducted. Note that the alpha coefficient of

reliability (Cronbach's alpha, α) for the whole questionnaire was obtained as ~0.97, indicating a perfect reliability of the data collection method.

Chapter 4

DATA ANALYSIS AND FINDINGS

Here, the analysis of the data collected and findings drawn from them are discussed both graphically and numerically. Majorly, the research sought to investigate the hospitality wastes generation rates, significant factors contributing to the waste generation, the effect of waste management practices on the operational performance of the sampled accommodation sector, waste disposal and reuse strategies employed by the facility.

The data was exclusively collected from questionnaires designed in line with the objective of the research. The analysis is categorized thematically according to the research questions; the quantitative data are supported by trend extracted from the secondary data within each theme. Firstly, analysis of demographical characteristics of the accommodation sectors is presented. Followed by the description of the waste composition of the sampled accommodation sector and the waste generation rate analysis.

4.1 Demographic Characteristics

The study was carried out in five districts (Girne, Nicosia, Famagusta, Iskele and Guzelyurt) of Northern Cyprus during the lean and peak seasons of 2017. It is worth mentioning that, data from previous years were also extracted from the sampled accommodation. 50 questionnaires were delivered, however, less than 50% were returned to the author. Specifically, a 74% response rate was recorded in Girne,

while 35% and 22% response rates were recorded in Nicosia and Famagusta, respectively. No responses from Iskele and Guzelyurt, the lower response rates may be due to language (English) of the questionnaire. Midway through the data collection, the author suspected lack of records on waste generated per accommodation facility may also contribute to the low response rate. As indicated in Figure 4.1, 13 accommodation sectors were sampled in Girne, 5 facilities returned the filled questionnaires from Nicosia and 4 from Famagusta.

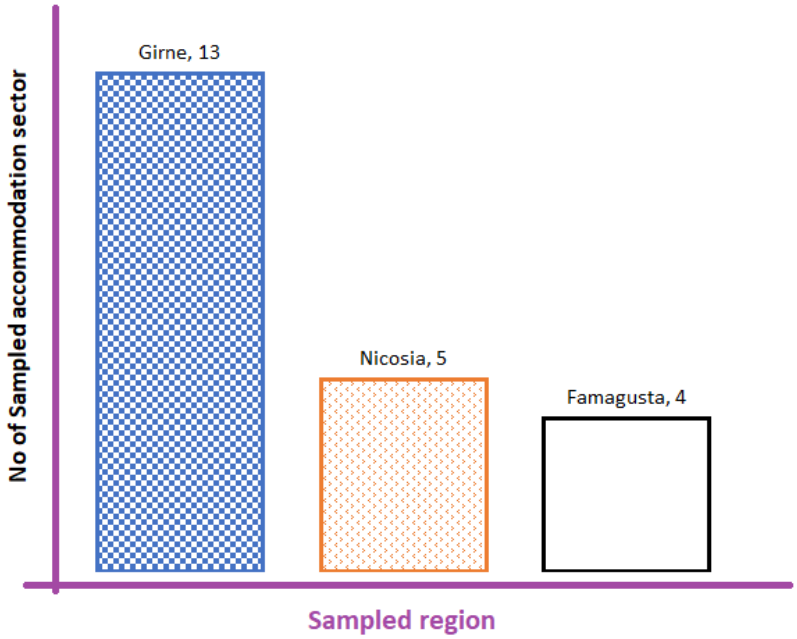


Figure 4.1: Number of sampled accommodation sector per district

As a tourism hub, Girne district is flourished with a varying collection of accommodation sectors and is considered the most popular destination for tourists visiting Northern Cyprus. Hence, the high response rate was recorded. Figure 4.2 represents the nationality of the majority of the guests visiting the accommodation sectors. As obtained, the majority of the tourists are British (33%), 18% of the tourists that visited the sampled facilities are Russian, followed by 16% Turkish, 10% guests from Scandinavian countries, 8% arrivals hold German nationality, 7%

are Arabs (note that Iranian are classified in this group), French (5%) and the least arrivals are African (3%).

The high in-flow of the British could be attributed to lower currency (Turkish lira to British pounds) and cheaper direct flights through the South Cyprus airports. The author inferred that the higher currency (Turkish lira to most African currency), lack of direct flight and the need to obtain tourist visas contributed to lowest arrival from African countries.

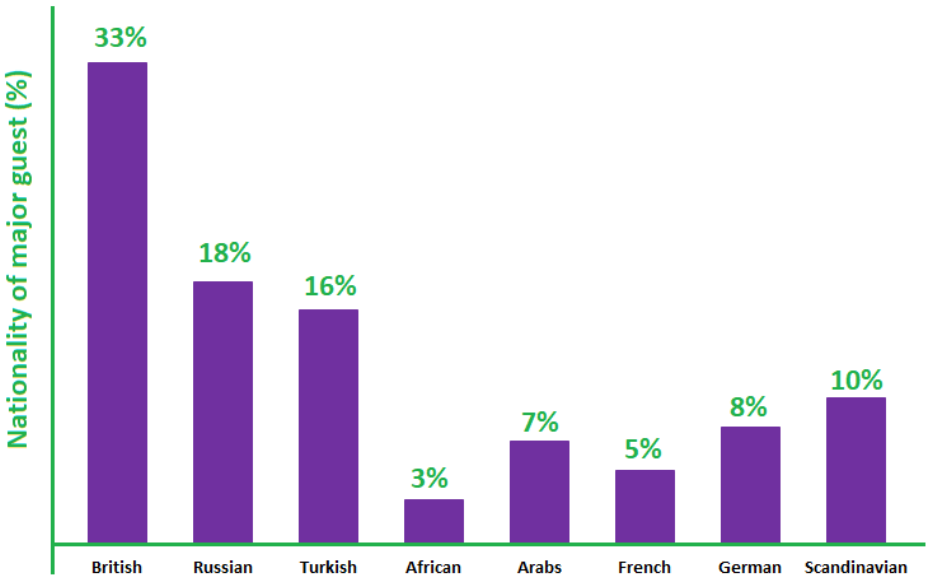


Figure 4.2: Nationality of the majority of tourists visiting the sampled accommodation

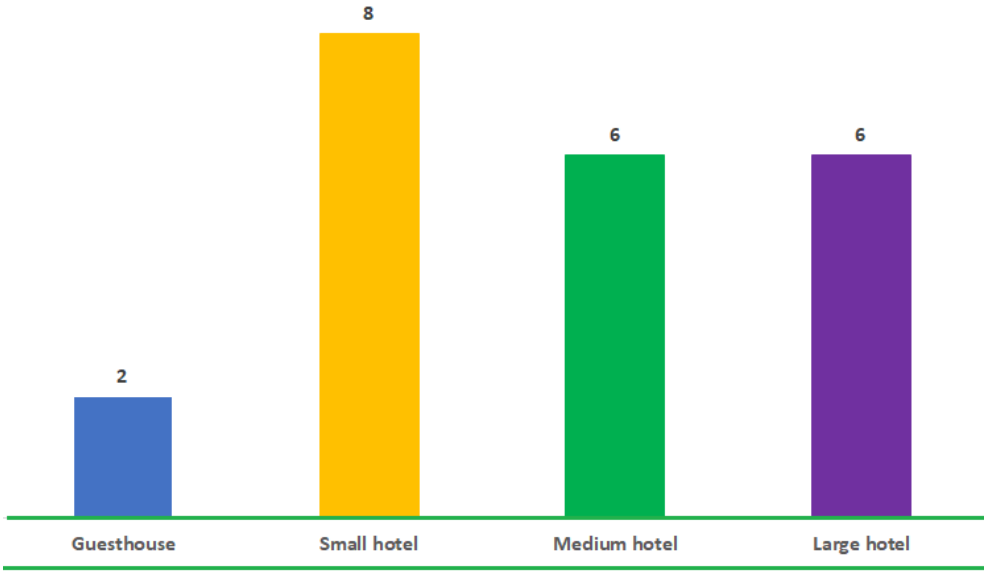


Figure 4.3: Classification of the sampled accommodation

By observation on the accommodation scale, a number of beds and service, the author categorized the 22 sampled accommodation into four categories (guesthouse, small hotel, medium hotel and large hotel). As represented in Figure 4.3, the majority of the sampled accommodation is categorized as a small hotel (8), 2 of the sampled accommodation were guesthouses, the medium and large hotels are 6 each.

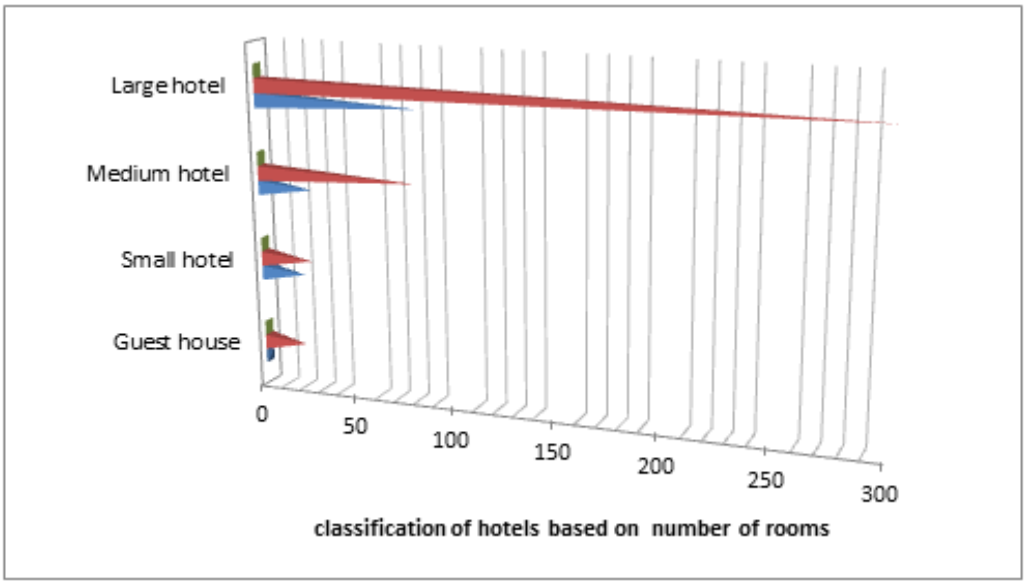


Figure 4.4: Range of rooms per accommodation classification

Definitions of size were taken from VisitScotland as the national tourism agency and based on room numbers (small 0–25, medium 26–80, large >81). Hotels with 20 to 25 rooms are classified as small hotels, Hotel with 26to 80 rooms are called medium hotels, Hotels with above 81 guest rooms are regarded as large hotels and Guest house has 1 to 20 room with limited services and facilities .The blue lines are shown of minimum number of rooms and the red line in graph shown the maximum number of rooms in hotels (Briggs,Sutherland,& Drummond, 2007).

4.2 Descriptive Analysis of the Waste Composition

The graphical display in Figure 4-5 showed the composition of the wastes generated in the sampled accommodation sector. Notably, wet waste accounted for the highest percentage of 56.3%, including cooking oil (14%), tissue paper (6.3%) and kitchen waste (36%). Also, about one-fourth (27.3%) of the total waste is non-wet waste which consists 7% of glass, 8% of nylon, 5% of wood, 4.2% disposable plastics and 2.8% of PET bottles. The other components are 4.7% paper and12% garden wastes. No hazardous wastes were recorded in the sampled facilities.

In comparison with other countries, the percentage of the wet wastes recorded here is consistent with those generated from accommodation sectors of Vietnam, Romania, UK and Italy (Trang, 2016), however, the waste cooking oil is slightly higher than that in European countries (Claver-Cortes et al., 2007).

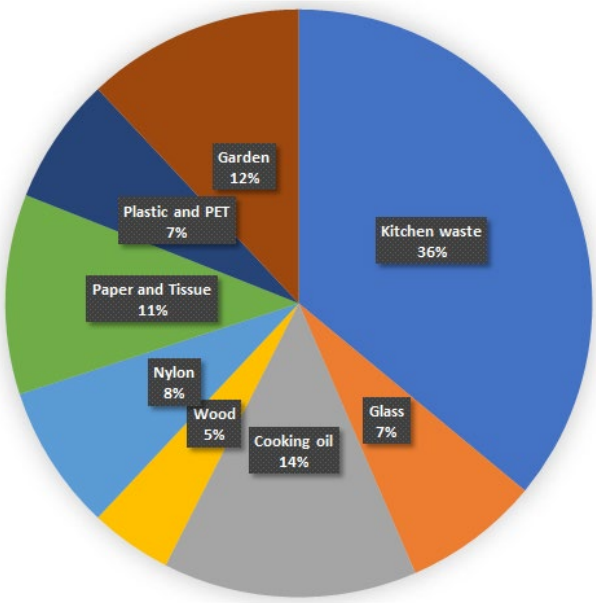


Figure 4.5: Waste composition of the sampled accommodation sector

The slight differences could be attributed to characteristics of the regional tourism as a type of the culinary. Note that, the percentage composition of wastes reported here is an average of lean and peak seasons of tourism activities. As expected, the proportions of kitchen wastes were higher (4.5%) in the peak seasons compared to that of the lean tourism season.

4.3 Descriptive Analysis of Waste Generation Rate

The daily amount of quantifiable waste generated by the sampled accommodation sector was collected over 3 consecutive days. Also, an estimated amount of waste generated during both the lean and peak tourism seasons were collected. The averages of the total waste amount for each sampled accommodation sector were calculated considering the standard deviation. The total amount of daily waste generated by the categorized accommodation sector with mean, standard deviation and ANOVA (analysis of variance) results are presented in Table 4.1.

Table 4.1: ANOVA of estimated total waste generation amount (kg/day)

Accommodation	***n***	**Mean peak**	**Mean lean**	**Std. Dev.**	**F-*value***	***p-value***
Guesthouse	2	88.5	52.9	9.23	89.89	<0.001
Small hotel	8	864.1	399.5	14.67		
Medium hotel	6	479.5	233.7	7.11		
Large hotel	6	2727.8	1377.3	2.39		

The ANOVA results obviously showed that there was a significant difference among sampled accommodation sectors ($p<0.001$). The difference can be attributed to the varying services, size and scale of operations in the different class of the sampled accommodation sectors. The large and medium-sized hotels have a significant tendency to generate higher waste because they offer services such as coffee shops/bars and restaurants that serve breakfast, lunch and dinner. However, the author could not find any restaurant services at the sampled guesthouse and majority of the small-sized hotels do not offer lunch or dinner. The ANOVA also shows that the hospitality waste generation rate has a high *F*-value of 89.89, implying consistency in the daily waste generation.

Note that the standard deviations were very small at the medium-sized and large hotels while that of the guesthouse and small-sized hotels were relatively large. This observation revealed that a slight difference occurred in the average of total waste generated by the large and medium-sized hotels, but significant fluctuation occurred among the guesthouse and small-sized hotels. The composition and quantity of waste generated by each sampled accommodation sector during the peak and lean seasons of tourism are represented in Figure 4.6.

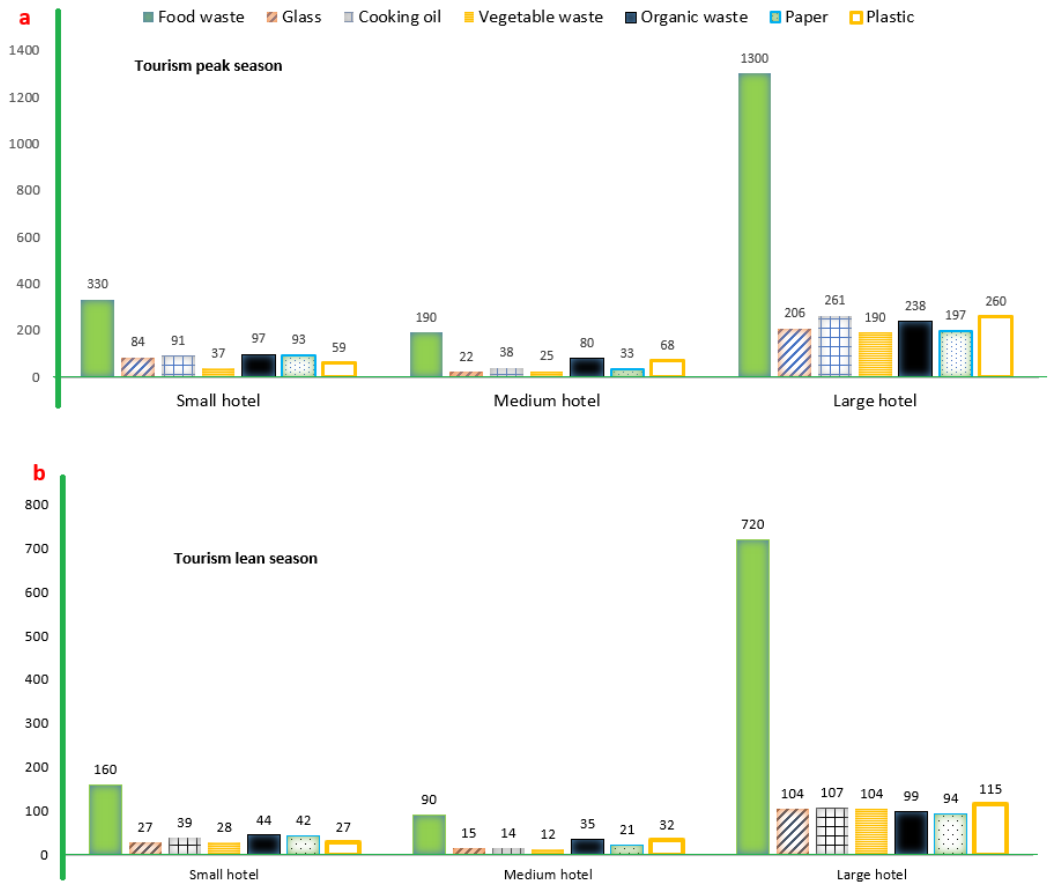


Figure 4.6: Estimated waste generated (kg) per peak and lean tourism seasons

Notably, while the range of average waste amount produced by large hotels during the lean season was 190 to 1300 kg, that by medium and small-sized hotels were 22 to 190 kg and 37 to 330 kg, respectively. It is worth mentioning that the sampled guesthouse does not keep a record of the wastes in each season which was attributed to the very low quantity of wastes generated. As expected, the estimated waste generation rate decreased by about 1.95% during the lean season, which is attributed to the reduced number of guests.

In brief, the kitchen is among the sectors of the hospitality facility that generated a significant quantity of waste, since it is responsible for the preparation of meals served within the facility. Hence, the food waste is the most generated waste in all the investigated facilities. In the lean season, a total of 970 kg of food waste was

generated per day, while this figure increased by almost 1.9% in the peak season. Organic waste (vegetables, milk, bread, etc.) is also commonly generated in all facilities. A total of 415 kg/day of organic waste is generated during the peak season when the large hotels account for 57%, small hotels 23.4% and medium hotels 19.6%.

During the lean season, the organic waste generated decreased to 178.5 kg/day; small hotels generated the least (19.7%). An obvious quantity of cooking oil was generated in all the facilities. During the peak season, an average of 390 kg/day of waste cooking oil was recorded while the average quantity reduced by ~2.43% during the lean season (160 kg/day). This study shows that the category of accommodation sector determines the total quantity of the waste generated due to varying services and events in each facility.

4.4 Relevant Factor Influencing Waste Generation Amount

Various authors have reported that the amount of municipal waste generated is influenced by population and the socio-economic factors in the selected studied region (Al-Momani 1994; Afroz et al., 2011; Monavari et al. 2012). However, only a few have considered the relevant factors influencing waste generation rate in the hospitality industries. Specifically, Trang (2016) reported that hotel class, number of bed, net-sale, number of room, staff and event guests contributed significantly to waste generation in the hospitality facilities. Here, different parameters that affect the generation rate of hospitality waste were selected, including the nationality of tourists visiting the investigated facilities, the nature of waste management practices in each facility, the type of waste generated, the seasonal flow and the type of the

accommodation. Similar factors have been reported to have an influence on the waste generation in the hospitality industries (Radwan et al., 2010; Zorpas et al., 2012).

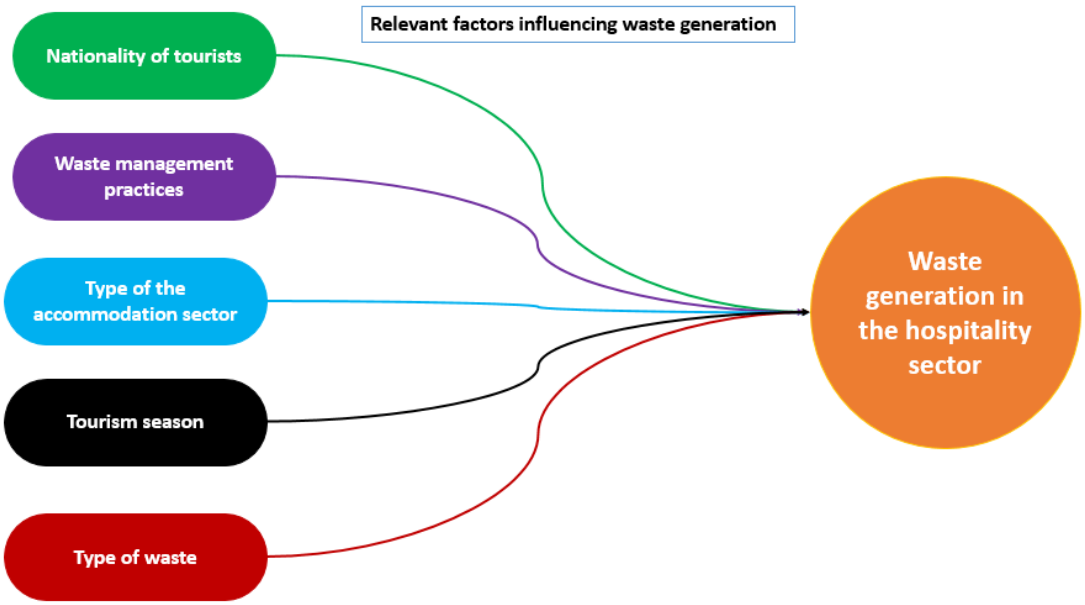


Figure 4.7: Relevant factors influencing waste generation in the accommodation sector

The author applied bivariate correlation (**Pearson's *r***) to check the correlation between waste generation rate and the selected factors shown in Figure 4.7. The bivariate correlation is a measure of the linear correlation between two variables *X* and *Y*. It has values between -1 and 1 that indicates the extent to which the two variables are linearly related (Katz, 2006). The results revealed that the selected factors affected the amount of waste generated by a strong correlation ($p<0.001$). Specifically, the scatterplot represented in Figure 4.8 shows a strong relationship between waste generation rate and the nationality of the tourists. This relation is obviously linear with **Pearson's *r*** correlation coefficient of 0.92, indicating that two variables (Y: waste generation rate and X: nationality of tourists) are positively linearly related on a straight ascending line. The extent to which the dots lie on the straight line indicates the strength of the relation.

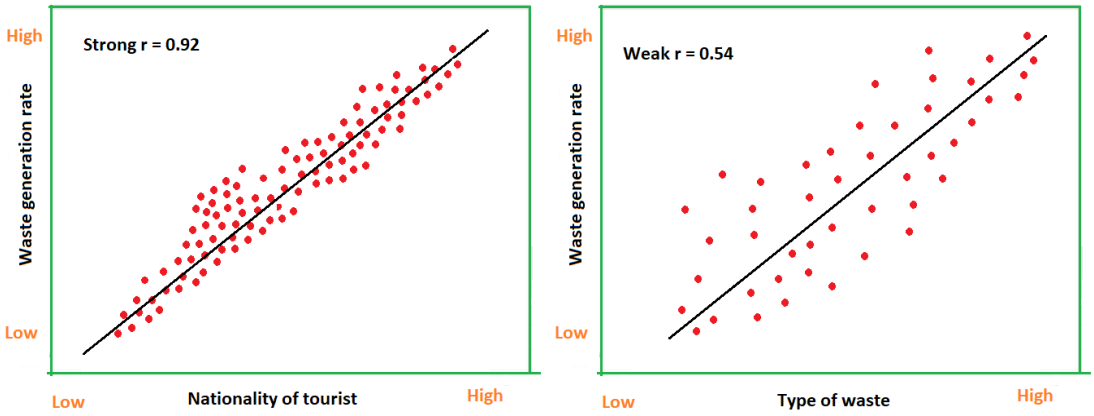


Figure 4.8: Pearson correlation visualized as scatter plot for selected factors affecting waste generation rate in the sampled accommodation sector

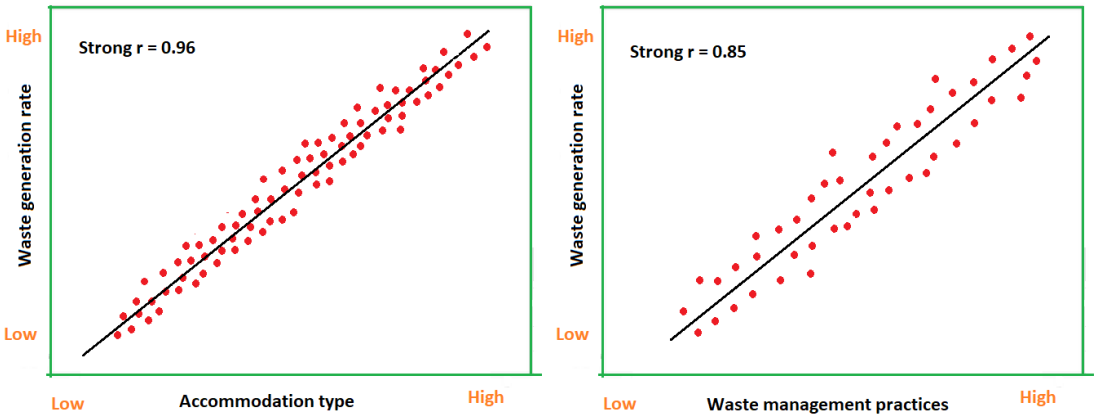


Figure 4.9: Pearson correlation visualized as scatter plot for selected factors affecting waste generation rate in the sampled accommodation sector

The **Pearson's *r*** correlation coefficient of 0.54, indicates the roughly linear relation between the Y: waste generation rate and X: type of waste generated. The extent to which the vertical variable increases as the horizontal one does signifies a positive correlation. Similar positive correlations were observed between the waste generation rates and the waste management practices and the accommodation type in the sampled accommodation sectors. In all cases, the values of the **Pearson's *r*** > 0.5, indicating that the selected factors linearly influence the waste generation rate. Figure 4.10 shows the waste generation rate (WGR %) per day based on the tourist nationality considering the peak season.

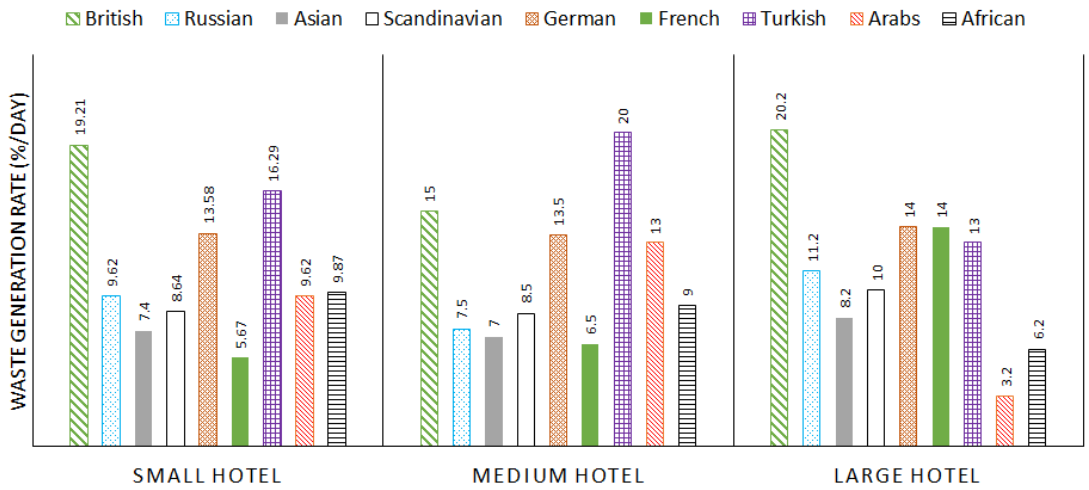


Figure 4.10: Waste generation rate (%)/day based on tourist nationality

In the small-sized hotel, 19.21% waste is generated by British tourists per day (85.6 kg), Turkish tourists generated 65.8 kg waste, which is 16.29 WGR (%)/day, and the least waste was generated by French tourists (5.67%) per day. A similar pattern is observed in medium-sized hotels; however, Arabs generated the least waste in the large-sized hotel, accounting for 3.2% WGR per day. British tourists generated the most waste in large hotels (20.2%), followed by the French and German tourists (14%).

The results here helped to understand the pattern of visitors in each facility and their range of waste generating practices. As shown in Figure 4.11, the average waste generation rate of the British tourists in the sampled accommodation sector was estimated as 54.4%, followed by the Turkish tourists (49.3%) and German (41.1%). The author observed that hotels that have tourists from Arab countries have high food wastage, while those with guests from Britain presented high water consumption and more organic waste, which could be attributed to lifestyle.

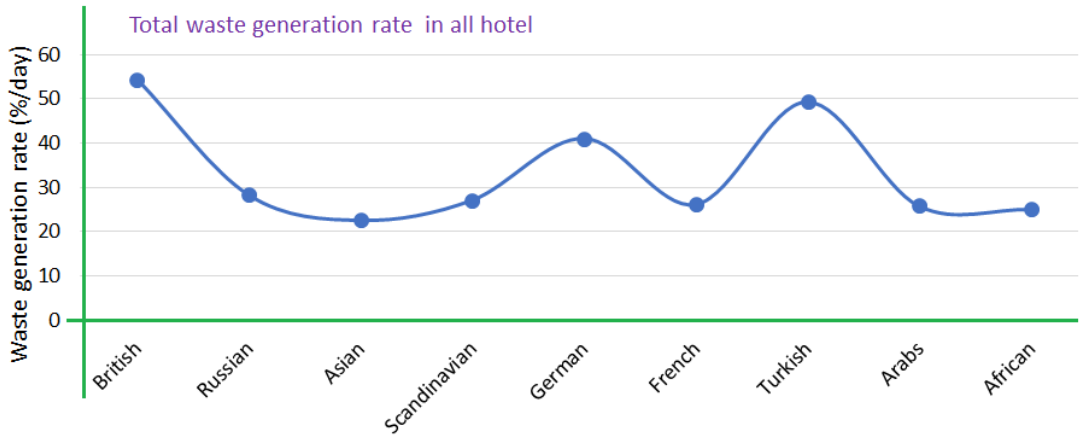


Figure 4.11: Estimated total waste generation rate in the sampled accommodation sector

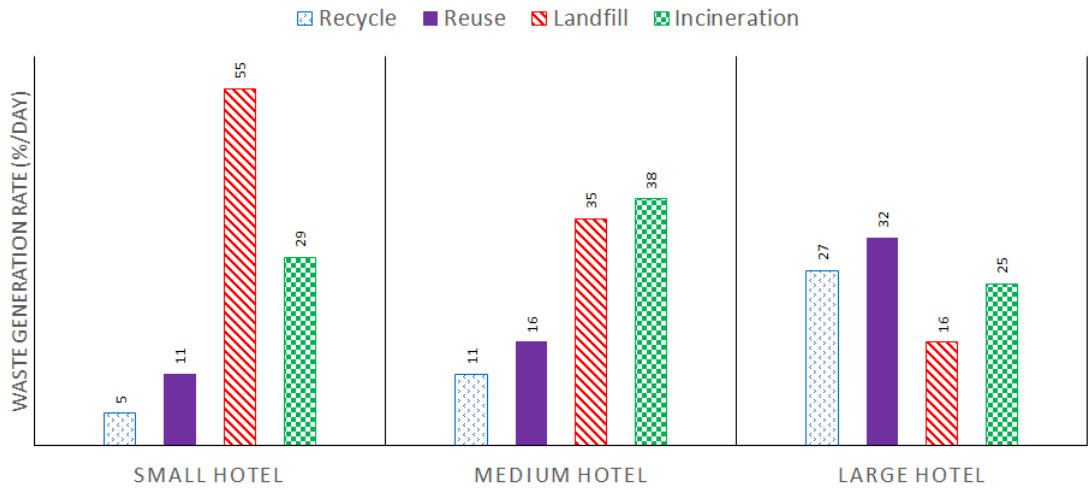


Figure 4.12: Waste generation rate (%)/day based on waste management practices

The waste generation rate based on the type of waste management practices is shown in Figure 4.12. Many hotel facilities take very little action to reduce their environmental impact; specifically, small hotels regard their environmental responsibility as a secondary objective (Radwan et al., 2010; Mateu-Sbert et al., 2013). In most cases, small hotels commonly generate low quantities of waste that are unattractive to waste recycling firms since they often require specific quantities of waste to be collected (Zorpas et al., 2012).

In this research, the WGR/day of the hotel that recycles their waste is 43%, while the WGR of those that engaged in landfill practice is 106% per day. Notably, the waste generation rate of large-sized hotels with varying waste management practices is relatively lower even though they have higher room occupancy and range of waste generating services compared with small and medium-sized hotels.

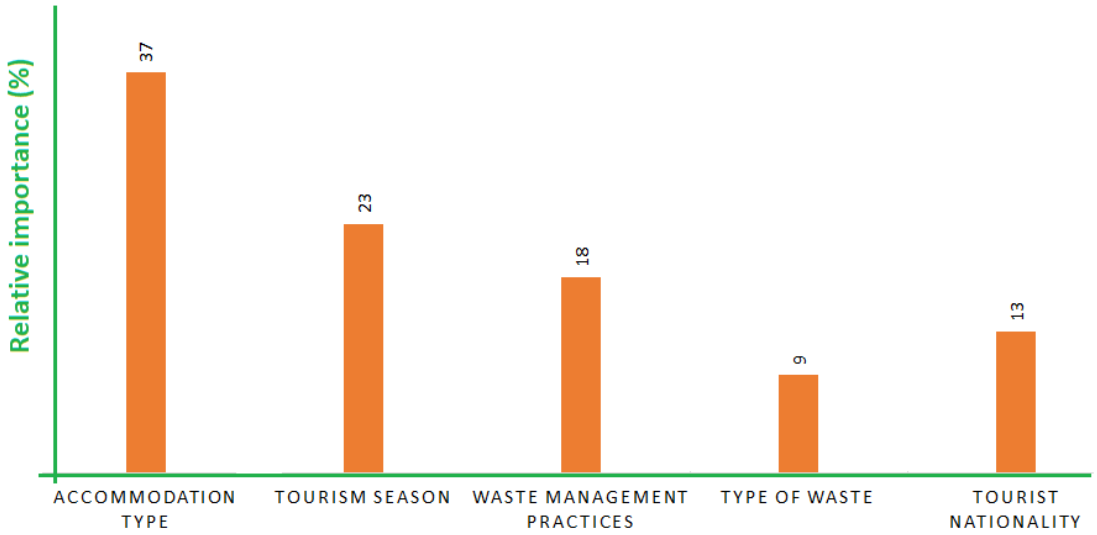


Figure 4.13: The relative importance of the factors influencing waste generation rate

Figure 4.13 shows the relative importance of each factor on the waste generation rate. It is important to stress that all the factors had an impact on the waste generation rates. Obviously, the accommodation type is the most influential factor (37%) on the waste generation rate (WGR), while the second most influential factor is the tourism season (23%), followed by waste management practice (18%), tourist nationality (13%) and the type of waste (9%) contributed the least impact on the WGR.

4.5 Predictive Model of Waste Generation in Accommodation Sector

To manage the accommodation sector waste in a sustainable way, accurate prediction of the waste generation rate is important (Beigl et al., 2008; Batinic et al., 2011; Intharathirat et al., 2015). A failure to make accurate waste generation predictions

and assessments could lead to increased environmental impacts as well as inadequate or overestimated capacity of disposal infrastructures (Abbas et al., 2016). In particular, improperly managed or operated recycling/incineration plants cause air pollution or spread of disease.

For instance, kitchen wastes from various accommodation sectors ferment after a short time, creating conditions favorable to the growth and survival of microbial pathogens and resulting in the spread of infectious diseases (Azarmi et al., 2018). Furthermore, unattended spent cooking oil attracts flies, vermin and rats, which could create a health hazard and pest control problem.

To mitigate the impact of hospitality waste on the ecosystem, we need reliable data concerning the waste generation. Meanwhile, the process of predicting the hospitality waste generation is challenging and often intensified by uncontrollable parameters (Batinic et al., 2011; Intharathirat et al., 2015). In recent years, various models have been used to predict waste generation and waste minimization behaviour (Jahandideh et al., 2009; Noori et al., 2010; Afroz et al., 2011).

In this study, multiple linear regression (MLR), central composite design (CCD) and artificial neural network (ANN) models were applied in predicting the rate of hospitality sector waste generation. Briefly, the MLR attempts to explain the relationship between a dependent variable and two or more explanatory variables. The CCD is an efficient approach for modelling complex problems in which the responses are influenced by various independent variables. CCD minimise time consumption and reduce experimental complexities (Oladipo et al., 2018).

ANN is a bio-inspired computational processing system akin to the vast network of brain neurons (Oladipo et al., 2018). Lately, research activities in forecasting with ANN have indicated that it can be a promising substitute for conventional linear methods. ANN is highly attractive due to its remarkable characteristics, high parallelism, learning and generalisation capabilities, and nonlinearity (Zhang et al., 1998, 2005; Palmer et al., 2006).

The strengths and weaknesses of the proposed models (CCD, ANN and MLR) were elucidated and an optimal prediction model was established based on conformity with the actual dataset and sensitivity analyses. A full description of the selected predictive models is given in Azarmi et al. 2018. To evaluate the prediction performance of the models, four statistical indices were applied; the hybrid fractional error function (HYBRID), standard error of prediction (SEP), mean absolute error (MAE) and correlation coefficient (R^2) values were derived using the following equations:

$$HYBRID = \frac{100}{n-p}\sum_{i=1}^{n}\left|\frac{\left(w_o(t)-w_p(t)\right)^2}{w_o(t)}\right| \tag{3}$$

$$SEP = \sqrt{\frac{\sum_{i=1}^{n}\left(w_o(t)-w_p(t)\right)^2}{n-1}} \tag{4}$$

$$MAE = \frac{1}{n}\sum_{i=1}^{n}\left|w_o(t)-w_p(t)\right| \tag{5}$$

$$R^2 = 1-\frac{\sum_{i=1}^{n}\left(w_o(t)-w_p(t)\right)^2}{\sum_{i=1}^{n}\left(w_o(t)-w_o^{'}(t)\right)^2} \tag{6}$$

Where n is the number of observations, w_o is the observed values of rate of waste generation for type t, p is the number of independent parameters, w_o' is the average of waste generation and w_p is the predicted value of waste generation for type t. R^2 measures the closeness of the observed data to the predicted data, MAE is a statistical quantity that measures how close predictions are to the eventual outcomes, and SEP is a measure of the accuracy of the predictions. The smaller the value of the error indices for a specified model, the higher the prediction performance of the model (Oladipo et al., 2018).

Table 4.2 summarises the estimated total waste generated by each facility investigated and comparative predictive performance of each model. Herein, a statistical analysis was performed to compare the constructed ANN, CCD and MLR models, in terms of their predictive performance, using HYBRID, R^2, MAE and SEP. The ANN model shows the lowest error values and highest R^2 compared to the CCD and MLR models.

The data obtained from the respondents were fed into each of the predictive model and an average predicted data are compared with the actual data. Figure 4.14 shows the actual data and predicted data considering the ANN, CCD and MLR predictive models. Based on the obtained results, the ANN is considered more reliable and accurate in terms of predictive capability and exhibited the lowest error (MAE=1.378, SEP=2.153 and HYBRID= 98.781) comparatively.

Also, the relatively higher R^2=0.9982 of the ANN indicates high fitting of the actual data. Thus, the ANN was selected as suitable to explain the non-linear relationship between the independent variables and hospitality waste generation rate. On the other

hand, one of the most significant advantages of the CCD-based model is its ability to clarify the interactive effect of the variables on the response (WGR), which highlights its usefulness in predicting the rate of HSW generation. Hence, combining the abilities of CCD and ANN models in a hybrid fashion could result in powerful modelling and predictive models.

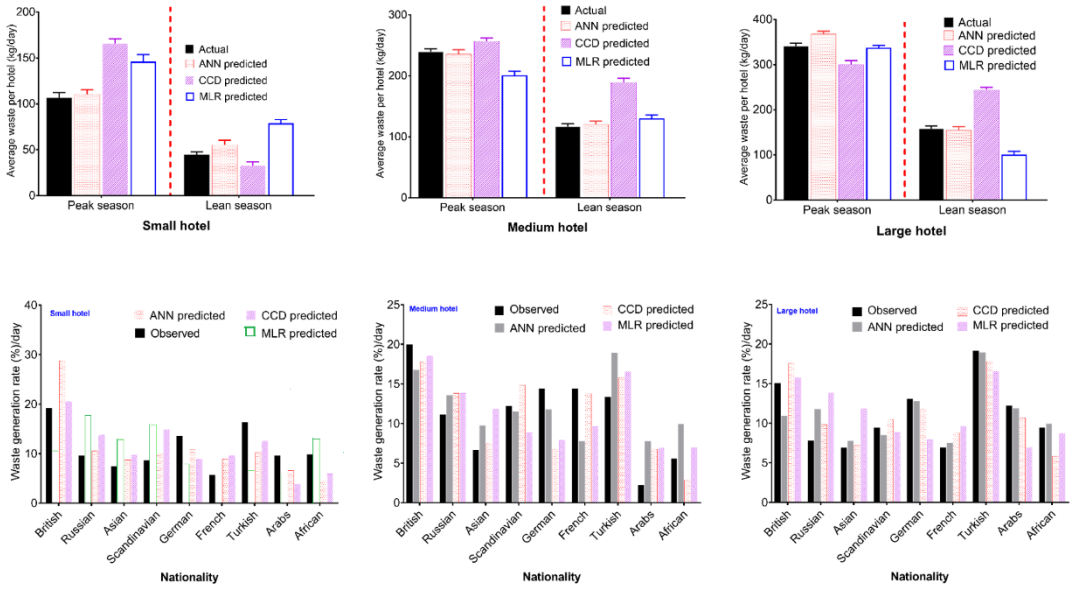


Figure 4.14: Comparison between the actual and predicted waste generation rate

Table 4.2: Observed waste generated and predicted quantity of waste with

Accommodation Type	Season	Per Day	Predicted for Next 3 Years (kg)		
		Observed (kg)	ANN	CCD	MLR
Small hotel	Peak	864.1	3092.3	2292.3	2679.8
	Lean	399.5	1848.5	1679.6	1799.5
Medium hotel	Peak	479.5	1870.1	1822.1	1987.9
	Lean	233.7	934.8	978.9	698.7
Large hotel	Peak	2727.8	12275.1	11891.7	12098.5
	Lean	1377.3	7898.9	9873.9	88761.8
Guesthouse	Peak	88.5	389.8	334.9	278.6
	Lean	52.9	198.6	160.7	256.8
Statistical Parameters	**ANN**	**CCD**	**MLR**		
R^2	0.9982	0.8982	0.9054		
MAE	1.378	1.469	3.981		
SEP	2.153	4.71	9.891		
HYBRID	98.781	103.4	145.9		

Based on the observed data obtained for the peak and lean tourism seasons in the year 2017, the average waste generated by each accommodation sector is forecasted using the ANN as shown in Figure 4.15. The predicted results revealed that the average waste in the medium-sized hotels would be reduced by 1.4%, however, guesthouse and small-sized hotels increased by 2.9% and 3.6% respectively. Notably, the ANN predicted that ~48.5% increases in the waste generation rate are expected in the large hotels compared to the average quantity of waste generated in 2017. It is inferred that the ANN can be employed to suitably predict the complex behaviour of the selected factors in any form of non-linearity and can effectively overcome the limitation of quadratic correlation assumed in CCD and MLR.

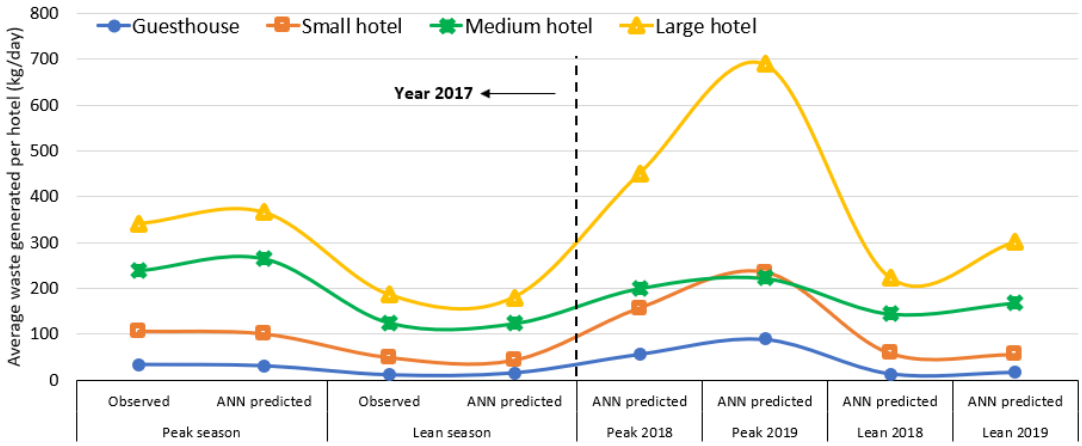


Figure 4.15: ANN predicted average waste generation for the sampled accommodation sector

The relative importance of the factors influencing waste generation rate was investigated considering the predictive models. The desirability function (D) was applied to select the acceptable ranking of the predictive models. The minimum, middle and maximum values of desirability were configured as D = 0.0, 0.5 and 1.0, respectively. A desirability value closer to 1.0 means that the corresponding sensitivity analysis is able to represent the actual scenario. The ranking of the predictive models is as follows; ANN (D = 0.99) > CCD (D = 0.78) > MLR (0.65). Figure 4.16 shows the relative significance of the factors influencing waste generation in the accommodation sector.

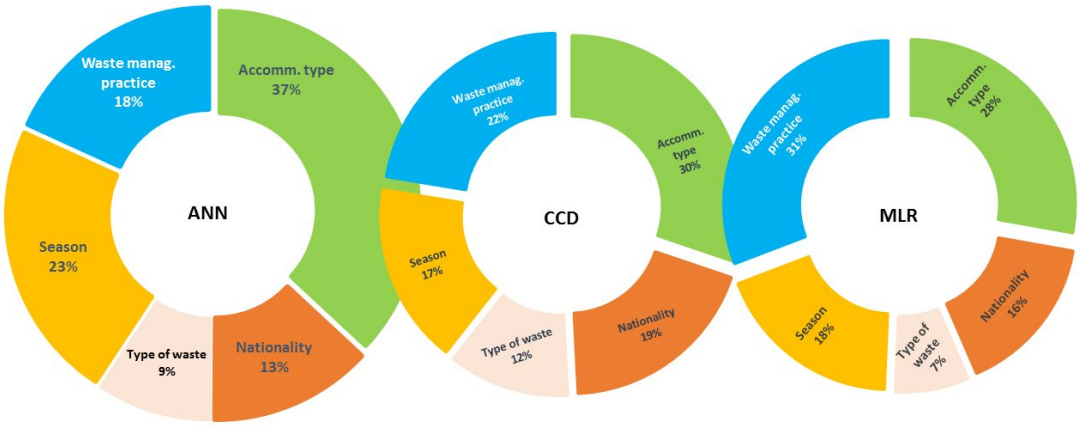


Figure 4.16: Relative importance of factors influencing waste generation in the hospitality sector forecasted by ANN, CDD and MLR

4.6 Analysis of the Waste Management Practices (WMP)

Waste management practices are the fundamentals of hospitality waste management hierarchy developed by Cummings (1992). To understand the waste management practices employed by the sampled accommodation sectors, 10 closed-ended questions (section B) designed in line with the objective of this research were asked (Ajith, 2014).

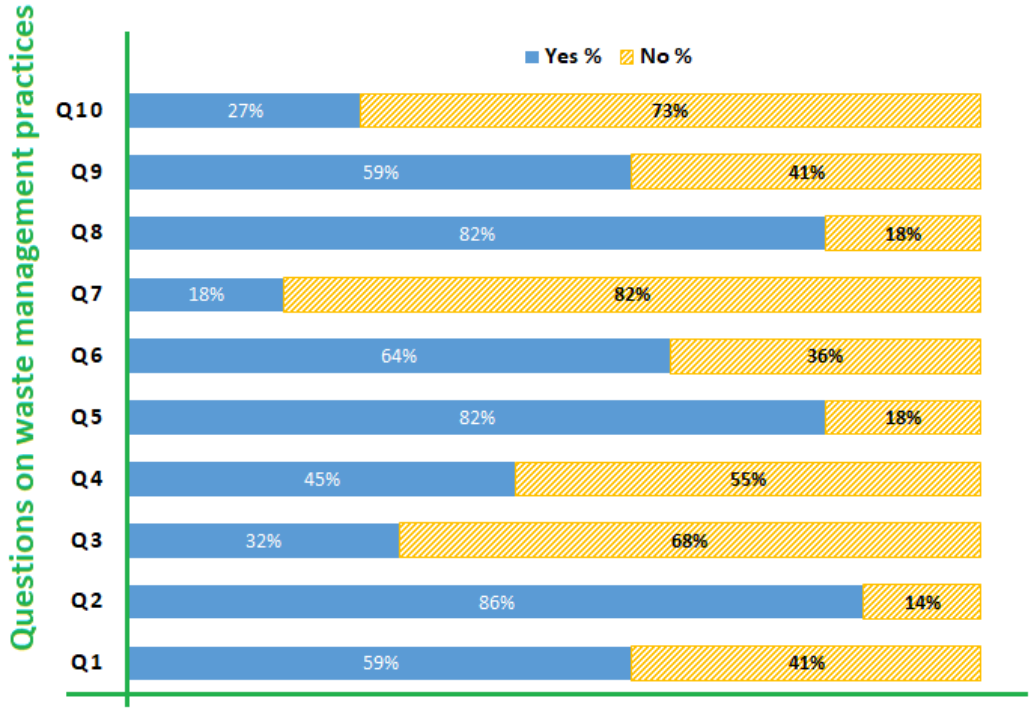


Figure 4.17: Responses regarding the waste management practices utilized by the facility

Figure 4.17 illustrated the status of the waste management practices of the sampled accommodation sectors. The results here revealed a significant correlation between the quantitative data from the questionnaire and the waste audit regression analysis, suggesting high reliability and validity of the data presented in this research.

In question 1 (Q1), the respondents were asked if they "*provide waste receptacles marked to segregate recyclables*". 59% of the sampled accommodation sector

answered in affirmative while 41% do not provide waste receptacles marked to segregate recyclables. Note that 90% and 37.5% of the large and small hotels, respectively provide waste receptacles marked to segregate recyclables. In Q2, 86% of the sampled accommodation sector used "*reusable service ware*" while 14% do not use.

In Q3, 68% of the sampled accommodation sector do not provide *"sustainable waste management practices training"* to their employees, while 32% provide. It is worth mentioning that the two guesthouses sampled and 80% of the small hotels do not provide waste management practices training, however, 75% of the large hotels provide waste management practices training. The author inferred that the lower quantity of wastes generated by the guesthouse and small hotels may contribute to lack of waste management practices training in these facilities.

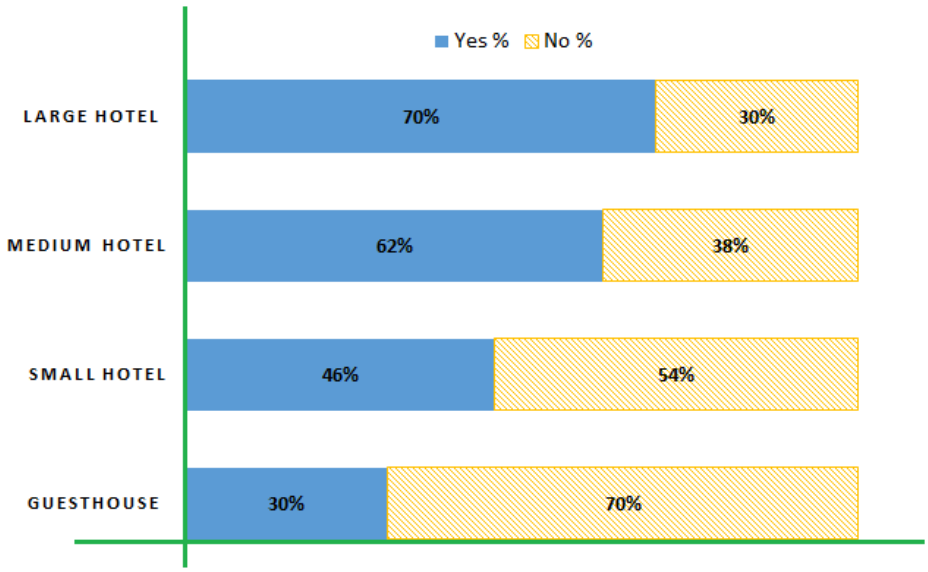


Figure 4.18: Status of the categorized accommodation sector regarding WMP

Figure 4.18 presents the average responses of the categorized sampled accommodation sector. Notably, 70% of large hotels said that they encourage

sustainable waste management practices and responded “YES” to the 10 closed-ended questions in section B, while an average of 30% of the large hotels replied “NO” to the questions.

A similar trend was observed with the medium-sized hotel, while about half of the small hotels (46%) responded affirmatively. As expected, only 30% YES was recorded for guesthouse which could be attributed to the size of the facility, quantity of wastes generated and volume of guests. It is inferred that almost 60% of the sampled accommodation sector take little action to decrease their environmental impacts. In particular, the guesthouse and the small hotels generate low quantities of waste and consider their environmental responsibilities as a secondary objective (Radwan et al., 2010).

4.6.1 Regression Analysis of WMP on Operational Cost

Regression analysis was performed to investigate the relationships between selected waste management practice independent variables (biodegradable disposable products, sustainable waste management practices, monitoring customer food wastes and development of waste reduction strategies) and dependent variable (operational cost). The regression model used in this research is expressed as follows:

$$Y = \beta + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \varepsilon \quad (7)$$

Where;

Y= Operational cost;

β.....β_4 represents regression constants to be estimated;

x_1= biodegradable disposable products

x_2= sustainable waste management practices

x_3= monitoring customer food wastes

x_4= development of waste reduction strategies

ε= error index

The waste management practices were measured using the mean score indices as explanatory independent variable and regressed against the operational costs as a measure of accommodation sector's performance (dependent variable) to explore the relationship. Table 4.3 presents the summary of the obtained statistics estimated by the regression model. The correlation regression coefficient R^2= 0.968 shows the strength of the relationship between the selected independent variable and the response variable. The regression model was able to explain ~90% of the observations.

Table 4.3: ANOVA for waste management practices on operation cost

Source	**Std Dev.**	**R^2**	**Adj. R^2**	**Pred. R^2**	**PRESS**	**Remark**
Linear	34.89	0.4345	0.6541	0.8961	2255.11	
2FI	4.678	0.8023	0.7681	0.6893	3109.23	
Quadratic	1.678	0.9680	0.10211	0.9833	334.45	Suggested
Cubic	4.678	0.7891	0.8679	0.5691	5302.44	Aliased
Source	SS	d*f*	MS	*F*-value	Prob > F	
Model	4266.67	4	1066.66	89.66	0.0006	Significant
x_1	738.38	1	738.38		0.0036	
x_2	3544.33	1	3544.33		0.0044	
x_3	3318.32	1	3318.32		<0.0001	
x_4	307.43	1	307.43		0.0039	
Residual	1239.345	6	206.556			
Lack of fit	678.4321	4	169.608		0.6239	Not significant
Pure error	560.9128	2	280.456			
Total	**5506.02**	**10**				

SS: Sum of squares; MS: Mean square; d*f*: degree of freedom; PRESS: predicted residual error sum of squares

Also, note that the adjusted R^2 indicate that there was 10.2% positive variation observed in the accommodation operational cost due to the adopted waste management practices explained by the regression model. In summary, the statistical significance of the regression model is significant (Sig. = 0.0006), hence, the author concluded that there was a statistically significant relationship between the operational costs and the waste management practices adopted by the accommodation sectors. After analysis, the following regression model was obtained:

$$Y = -0.821 + 0.7991x_1 + 0.1981x_2 + 0.6781x_3 + 0.0189x_4 + 0.0012 \quad (8)$$

As noted in Equation 8, at β= -0.0321 (sig.0.997), a unit increase in the use of biodegradable disposable product in the sampled accommodation sectors would positively influence the operational cost performance by 0.821 units (sig. 0.879), while implementing sustainable waste management practices in each sampled accommodation sector leads to increase in operational cost performance by 0.7991 units (sig. 0.756). Additionally, monitoring food wastes and development of waste reduction strategies at each facility positively enhanced the operational cost performance by 0.6781 and 0.0189 units (sig. 0.459–0.678), respectively.

4.6.2 Regression Analysis of WMP on Operational Efficiency

In a similar vein, the mean score indices measuring waste management practices as independent variables (x_1…..x_4) were regressed against the accommodation sector operational efficiency as the dependent variable (Y_2) to estimate the relationship. The regression model used here is expressed as follows:

$$Y_2 = \alpha + \alpha_1 x_1 + \alpha_2 x_2 + \alpha_3 x_3 + \alpha_4 x_4 + \varepsilon \quad (9)$$

Where;

Y_2= Operational efficiency;

α.....α_4 represents regression constants to be estimated.

Table 4.4 presents the summary of the obtained statistics estimated by the regression model. The correlation regression coefficient R^2= 0.988 indicates a positive relationship between the selected independent variable and the response variable. The regression model was able to explain ~95% of the observations. The regression analysis is expressed as follows:

$$Y_2 = -0.2334 + 0.045x_1 + 0.3689x_2 + 1.224x_3 + 0.1918x_4 - 0.0012 \quad (10)$$

As seen in Equation 10, at α= -0.2334 (sig. 0.342), an increase in the use of the biodegradable disposable product in the sampled accommodation sectors positively enhanced the operational efficiency by 0.045 units (sig. 0.679). Note that monitoring the food wastes (x_3) obviously had positive impact on the operational efficiency of the sampled accommodation sector by 1.224 units (sig. 0.987), while implementing sustainable waste management practices and the development of waste reduction strategies at each facility moderately enhanced the operational efficiency by 0.63689 and 0.1918 units (sig. 0.678–0.789), respectively.

Table 4.4: ANOVA for waste management practices on operation efficiency

Source	Std Dev.	R^2	Adj. R^2	Pred. R^2	PRESS	Remark
Linear	69.67	0.8799	0.8919	0.8989	4509.89	
2FI	7.781	0.9118	0.9019	0.9621	2389.66	
Quadratic	1.317	0.9880	0.9998	0.9889	278.98	Suggested
Cubic	9.298	0.6541	0.5979	0.5896	4598.89	Aliased
Source	SS	d*f*	MS	*F*-value	Prob > F	
Model	5283.54	4	1320.885	65.89	0.0005	Significant
x_1	456.44	1	456.44		0.0022	
x_2	2489.15	1	2489.15		0.0167	
x_3	4578.56	1	4578.56		0.0035	
x_4	249.89	1	249.89		0.0119	
Residual	1899.23	6	316.538			
Lack of fit	456.438	4	114.109		0.8917	Not significant
Pure error	349.876	2	174.938			
Total	**7182.77**	**10**				

SS: Sum of squares; MS: Mean square; d*f*: degree of freedom; PRESS: predicted residual error sum of squares

4.7 Analysis of Behavioral Beliefs Towards Implementing WMP

Respondents were asked eight (8) close-ended questions (section C of the questionnaire) designed to examine their behavioural beliefs towards implementing waste management practices in the sampled accommodation sector. Figure 4.19 presents the overall results obtained in section C.

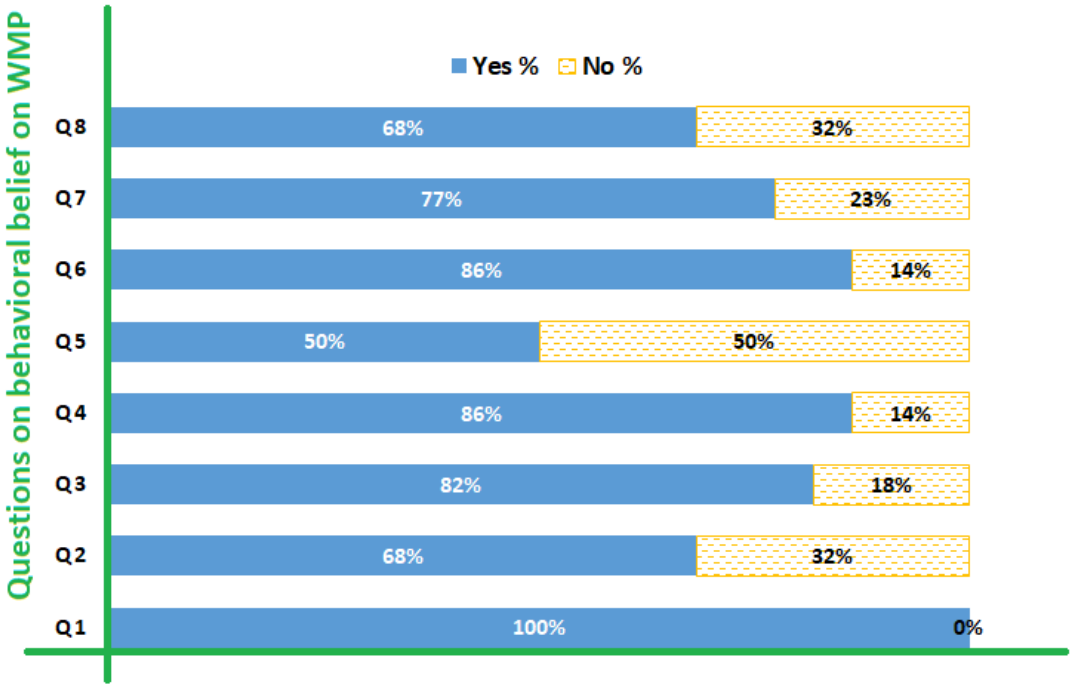


Figure 4.19: Behavioral beliefs towards implementing waste management practices

From the graphical illustration, it is observed that all the sampled accommodation sectors agreed with question 1 (Q1) which states that "Implementing a WMP program will be better for the environment" (Ajith, 2014). This shows that the various accommodation sectors believe that adoption of sustainable waste management practices would curtail the wastes generated from the hospitality industry. It is worth mentioning that 32% of the sampled accommodation sectors do not agree that implementing WMP will increase their reputation (Q2), (Ajith, 2014).

More precisely, the guesthouse and majority of the small hotels do not believe that implementing WMP would enhance their reputation and this may be attributed to the quantity of wastes they generated or the size of their guests. As expected 82% of the sampled accommodation sectors believe that implementing WMP will be good for the local community (Q3) as this practice will significantly reduce environmental footprints. Similarly, in Q4 and Q6, 86% of the respondents believe that

implementing WMP will decrease food wastes and will be supported by the employee of the sampled accommodation sector. 50% of the respondents believe that implementing the WMP will improve the customer satisfaction. Overall, medium- and large-sized hotels agreed that implementing sustainable waste management practices will significantly decrease the waste generation rates in the hospitality industry, while some of the small-sized hotels and guesthouses responded otherwise. All questions in the questionnaire are based on the Ajith, 2014 comprehensive study, which collected all questions in the field of waste management befor 2014.

4.8 Analysis of Barriers to Implement WMP Program

The implementation of waste management practices is widespread across the hospitality industry, however, many hospitality sectors are not implementing the waste management practices due to a number of reasons. Particularly, some managers of the hospitality facilities do not truly recognise the need and value of the environment in relation to their business (Bohdanowicz, 2006). The barriers to implementing waste management practices in the hospitality industry are classified as “Knowledge Deficiency”, “Owner/ Manager Attitudes”, “Operational and Financial Resources” and “Legislation”. The analysis of the barriers to implementing WMP in the sampled hospitality facilities indicates that utmost barriers were related to operational and financial resources. The most significant barrier was the lack of recycling and waste storage resources (operational). 59% of the surveyed facilities denoted operational resources as the most significant barrier to the waste management practices.

Another important barrier constitutes the financial resources (24%) as presented in Figure 4.20. 12% of the surveyed accommodation sectors considered lack of training

and knowledge as a barrier limiting the implementation of waste management practices. 5% considered the owner's/manager's attitude as the least significant barriers limiting the implementation of waste management practices in the sampled accommodation sectors.

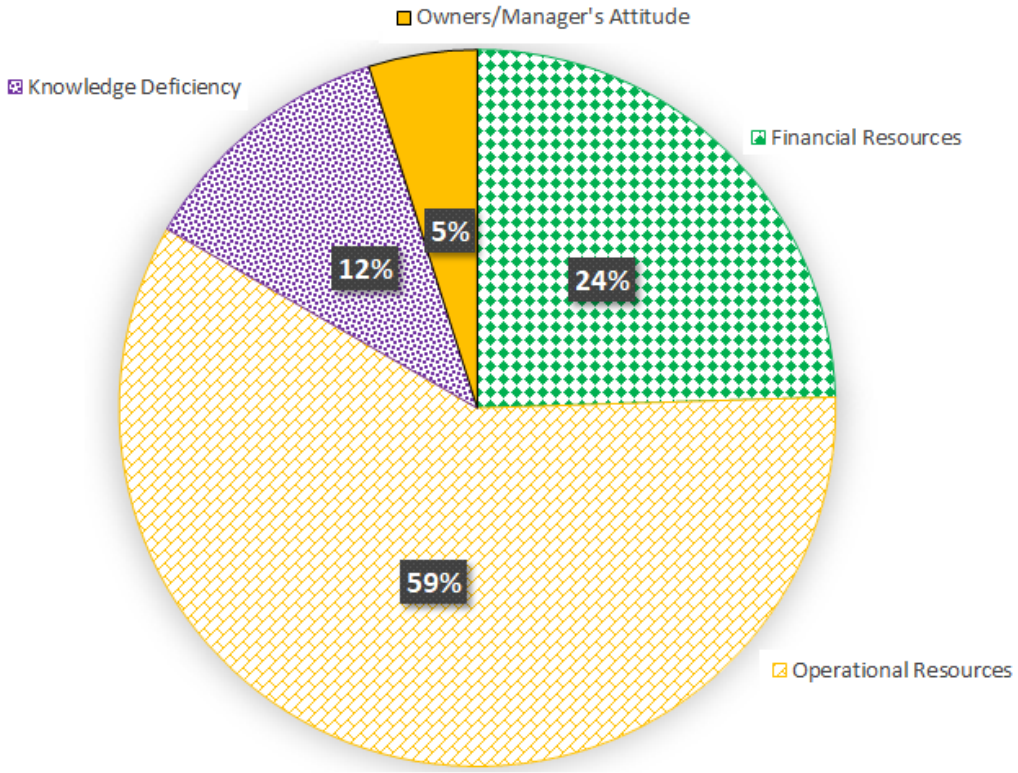


Figure 4.20: Barriers for introducing waste management practices

It is worth mentioning that both the financial and operational barriers to introducing waste management practices were different at the sampled large hotels in comparison with guesthouse and small-sized hotels. The large-sized hotels have a significantly higher financial base for the implementation of waste management practices. On the contrary, small-sized hotels and guesthouse do not have the similar financial strength to introduce sustainable waste management practices.

No significant differences in the responses regarding the “knowledge deficiency” and “attitude of owners/managers” of the sampled accommodation sectors. Even though, resistance by the accommodation sector managers to undertake waste management programmes exist, this may be attributed to the lack of knowledge and training that is required to comply with standards and procedures of waste management leading to additional barriers to implementation. A similar observation has been reported by Novacká and Topaloğlu (2015). They reported that 29% of the hotels surveyed denoted financial resources as the major barrier to the introduction of environmental waste management practices.

4.9 Descriptive Analysis of Waste Disposal Methods

Waste is not desirable because storing it is impractical and may cause health and environmental problems including undesired odours and spread of insects (Kirk, 1995) Therefore, the author explored the waste disposal methods employed by the sampled accommodation sector. The outcome of the research revealed that all the sampled accommodation sector embraces the concept of waste disposal method on their daily operation (Figure 4.21). The most used disposal methods include but not limited to waste reuse, incineration, landfill and recycling.

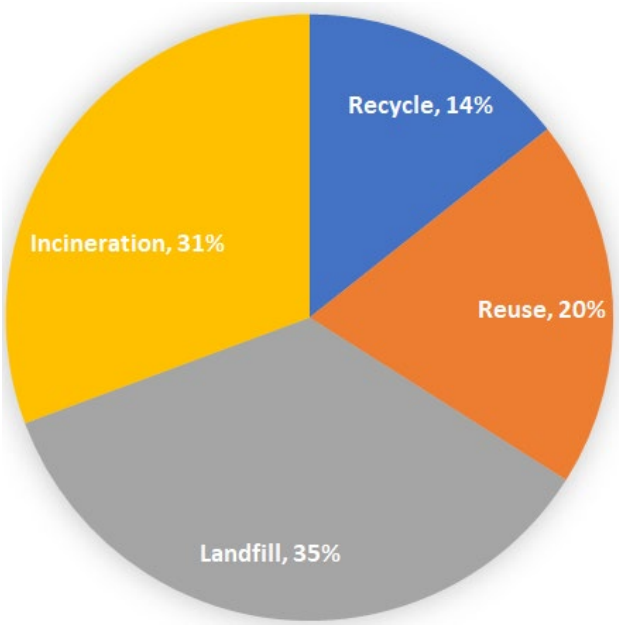


Figure 4.21: Waste disposal methods employed in the sampled accommodation sector

Emphasis is placed on the reuse and recycles (34%). Notably, 35% of the accommodation sector practices landfill method even though the landfill method is associated with toxins, leachate and greenhouse gases. Also, the study indicated that none of the sampled accommodation uses the generated waste for energy technology nor the recycle the spent even though the respondents agreed that recycling spent water and conversion of solid wastes to bioenergy are indeed important to the hotel industry. Recycling the wastes is preferred; 1.1, 62.8, 25.5 and 10.6 % of the guesthouse, large, small and medium-sized hotels recycle their wastes. The study also revealed that 15.1% of large hotels practices landfill and 51.9% of the small-sized hotels preferred landfilling practices.

Regression analysis was performed to investigate the relationships between waste disposal method as independent variables (reuse, recycle, landfill and incineration) and dependent variable (waste management). The regression model is expressed as follows:

$$Y_{wm} = \varphi + \varphi_1 x_1 + \varphi_2 x_2 + \varphi_3 x_3 + \varphi_4 x_4 + \varepsilon \quad (11)$$

Where;

Y_{wm}= Waste management;

φ……φ_4 represents regression constants to be estimated;

φ_1= recycle

φ_2= reuse

φ_3= landfill

φ_4= incineration

ε= error index

According to the bivariate correlation analysis, the **Pearson's *r*** coefficient of correlation of 0.92 was obtained, indicating that there is a significant positive relationship between the independent variables and waste management (dependent variable). Although, landfilling have a weak correlation of r=0.28. As expected, the regression analysis shows a high positive relationship between the waste disposal methods and waste management in the sampled accommodation sector. Here, the regression equation was established as follows:

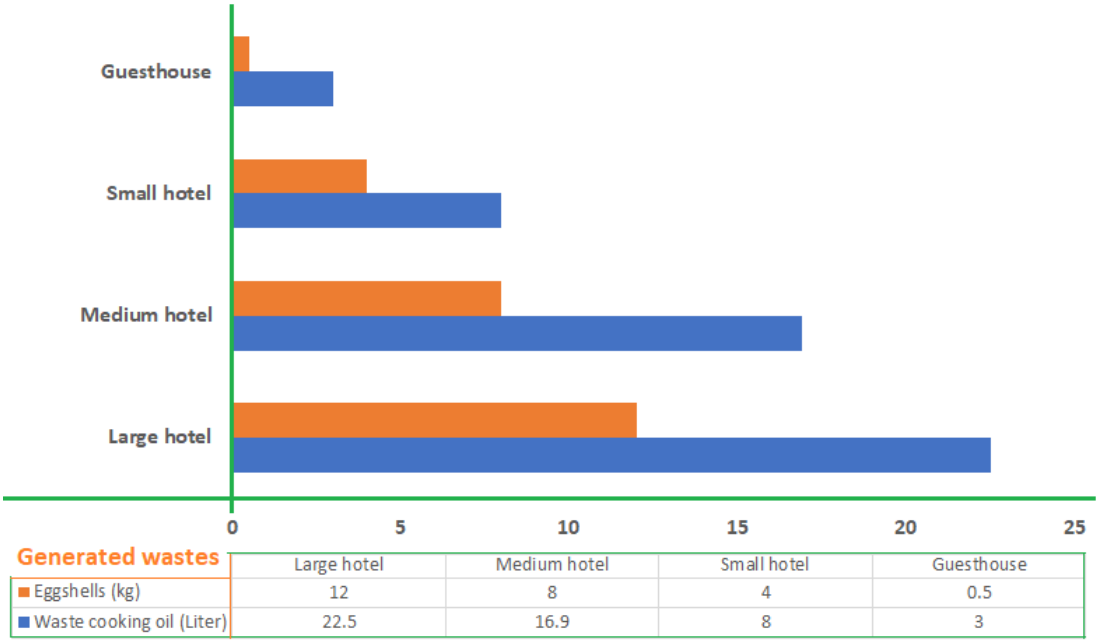
$$Y_{wm} = 0.5681 + 0.8912\varphi_1 + 0.7891\varphi_2 - 0.2396\varphi_3 + 0.3418\varphi_4 + 0.0051 \quad (12)$$

From Equation 12, it was observed that holding the waste management at a constant of φ =0.5681, a unit increase in implementation of waste recycling, reuse and incineration methods at the sampled accommodation sector would significantly improve the waste management by 0.8912, 0.7891 and 0.341 units (sig. 0.897), respectively. However, landfill practice leads to a decline in the waste management by 0.2396 units (sig. 0.356).

4.10 Re-utilization of Accommodation Sector Wastes

Increase in the quantity and hazard of accommodation wastes has severe impacts on the public health, local economy, global environment and living conditions, hence threatens the attainment of millennium development goals. According to the waste management hierarchy model adopted by the European Union (EU) strategy on waste (Williams, 2005), accommodation sector wastes can be managed through 3R principle (reduce, reuse, recycle) to provide a clean environment for future generation.

The policy that incorporates waste reduction, reuse and recycling is called “zero waste” which means zero disposals and zero warming from the generated wastes (Samiha, 2013). In a practical case, the recycling of waste is not energy efficient and can be costly. However, re-utilization of generated wastes can reduce disposal costs, or even generate profit through the sale of the new products from the precursor materials. Here, the author collected waste cooking oils and waste eggshells from the sampled hotel facilities and converted the waste cooking oil into biodiesel for energy purpose. Figure 4.22 shows the average daily waste cooking oil and eggshells from each sampled accommodation sector. The quantity of wastes used here was collected over 3 consecutive days during the peak tourism season. As shown, the large hotel generated an average of 22.5 litres of waste cooking oil and 12 kg of eggshells attributed varying services and events in the large-sized hotels. As expected, the guesthouse generated the least quantity of waste cooking oil (3 litres) and eggshell (0.5 kg).



Generated wastes	Large hotel	Medium hotel	Small hotel	Guesthouse
Eggshells (kg)	12	8	4	0.5
Waste cooking oil (Liter)	22.5	16.9	8	3

Figure 4.22: Average quantity of waste cooking oil and eggshells generated from the sampled accommodation sector

The total quantity of waste cooking oil, eggshell and biodiesel produced is represented in Figure 4.23. The biodiesel was produced from the waste cooking oil using the eggshell as a catalyst through the transesterification reaction procedure as fully explained in the author's paper (Oladipo et al., 2018). The quality of the biodiesel fuel produced from the waste cooking oil was evaluated and found to be within the appropriate range of American Society for Testing and Materials (ASTM D6751-12), specified for biodiesel. Considering the net profit and modified benefit-cost (Equations 1 and 2), re-utilizing the generated waste cooking oil will be profitable and beneficial to the accommodation sectors.

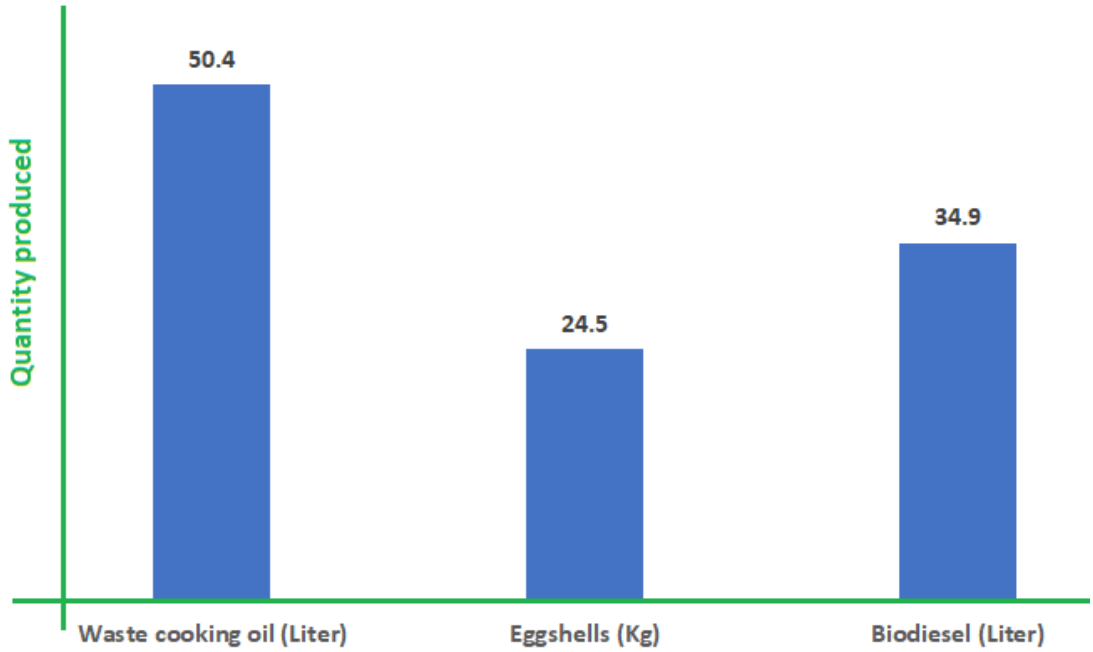


Figure 4.23: Total quantity of waste cooking oil, eggshell and biodiesel produced from the accommodation sector wastes

The total cost of production of 1 litre of biodiesel from the transesterification reaction procedure is 2.68 TL, note that the major costs factored are the price of the chemicals (methanol, sodium hydroxide etc.) used, while the precursors (catalyst and waste cooking oil) are considered to be zero cost since they are wastes. Based on the Turkish Republic of Northern Cyprus market, the Euro diesel cost an average of 3.78 TL (August 2018).

The modified benefit-cost (B/C) ratio confirmed that the re-utilization of the waste cooking oils is economically favourable (B/C=1.16). The net profit = (3.78 TL X 34.9 Liter) – (2.68 TL X 34.9 Liter) per litre is 1.1 TL and total profit is 38.39 TL. Hence, re-utilizing the generated wastes for bioenergy is not only profitable for the accommodation sectors but also creates less air pollution and reduces climate emissions, such as greenhouse gas and CO_2 emissions.

A magnetically recyclable eggshell-based catalyst (MKEC) was synthesized to circumvent saponification during the conversion of neem, Jatropha, and waste cooking oils (free fatty acid, 2.3e6.6%) to biodiesel. The characterization results indicated that MKEC had amesoporous structure with the pore width of 3.24 nm, a specific surface area of 128 m2/g, and a pore volume of 0.045 cm3/g. The results confirmed that the MKEC is more tolerant to fatty acid poisoning than calcined eggshell. The effects of process parameters for maximum fatty acid methyl ester (FAME) content were evaluated by central composite design (CCD) and artificial neural network (ANN). The experimental FAME content of 94.5% was achieved for neem oil with a standard deviation (SD) of 0.68, which was in reasonable agreement with predicted values (CCD, 96.9%; ANN, 95.9%; SD, 0.73). The reusability studies showed that the mesoporous catalyst can be reused efficiently for five cycleswithout much deterioration in its activity.

4.11 Re-utilization of waste cooking oil and egg-shell to the biodiesel

Fossil oil resources are of great importance because they generate significant amounts of energy; nevertheless their production and use have significant environmental and health impacts, including global warming, environmental pollution, and degradation (Al-Mulla, 2015). In addition, the global fluctuation in petroleum prices and the emission of greenhouse gases have necessitated the search for alternative fuel from renewable sources (de Araújo,et all,2013). Biodiesel appears to be the most attractive alternative because it is nontoxic, renewable, and environment-friendly that can substitute fossil-based fuel (de Araújo,2013).

The production cost of biodiesel regarding the source of feedstock is the major drawback for its commercialization (Maity,et al,2014). In recent years, researchers

have focused on use of various abundantly available resources and economical production technique to make biodiesel-based fuel more competitive relative to petroleum-based fuels. Biodiesel is commonly produced by transesterification of vegetable oils and alcohol in the presence of a suitable homogeneous or heterogeneous catalyst. There are several shortcomings to the use of the homogeneous catalysts, including the difficulty in product isolation (Sarve,.et al, 2015).

To overcome the soap formation, huge amounts of wastewater, and environmental pollution during the production of biodiesel, researchers have focused on heterogeneously catalyzed transesterification.Unlike the homogeneous catalysts, the heterogeneous catalysts can be easily recovered, regenerated, and reused and thus known to be eco-friendly (Lee.,et al, 2015). A variety of solid-based heterogeneous catalysts such as alkaliearth metal oxides (CaO, MgO, SrO, and BaO), transition metal oxides (ZrO, TiO, and ZnO), and zeolite were used in the transesterification reactions without the presence of free fatty acid (FFA) and water (Lee.,et al, 2015). These catalysts are less corrosive, react faster, and have higher activity as compared to solid acid catalysts (Lee.,et al, 2015). However, they are unfavorable for feedstock with high FFAs and moisture content leading to saponification and hydration, respectively (Ajala ,.et al 2017). To mitigate the saponification issues during base-catalyzed transesterification, a two-step method is often used (Ajala ,.et al 2017). However, the two-step method increases system complexity and the cost of production(Lee.,et al, 2015).

The present work is focused on exploiting crude neem oil as a source of biodiesel production via a single-stage transesterification in the presence of potassium fluoride

enhanced eggshell catalyst. Here, the heterogeneous catalyst was prepared from adequately available eggshells. The recyclability and efficiency of the as-prepared eggshell based catalyst were enhanced via the integration of magnetite (Fe3O4) nanoparticles. Predictive modeling and optimization of parameters were achieved using the response surface methodology and the artificial neural network (ANN).

This is the first report on the single-stage transesterification behaviour of KF/eggshelleFe3O4 (MKEC) for neem, Jatropha, and waste cooking oils having high FFA (2.3e6.6%). Finally, leaching test, acid tolerance, and reusability of the KF/eggshelleFe3O4 mesoporous catalysts were studied. Heterogeneous KF-functionalized magnetic catalyst(MKEC) was prepared from chicken eggshells. The MKEC heterogeneously catalyzed oil yielded 94.5% and 97% biodiesel from neem oil (FFA, 4.2%) and waste cooking oil (FFA,3.16%), respectively. It is worth mentioning that saponification was circumvented in the proposed single-stage transesterification process. The efficacy of MKEC outperformed commercial CaO and nonmagnetic KF functionalized catalyst (KEC) under same reaction conditions. The maximum biodiesel conversion (97%) from neem oil was achieved under the optimum reaction condition of 6 wt % catalyst, 15:1 methanol/oil molar ratio, 65 _C reaction temperature, and in 2 h reaction time. The MKEC can be reused up to five times without much deterioration in its activity, and the catalyst recovery is more than 75% after five recycling runs.

Chapter 5

CONCLUSION

5.1 Discussion

In the field of waste management, there are many investigations which their data are very similar to the obtained results of this study. However, in the field of waste recycling, particularly in the accommodations sector, there is no similar research has been done. Due to this reason, this survey has been done. Among the previous researches, the scholars focused on the amount of waste produced such as plastics, iron, paper, fabric for different sectors of the hotel. However, the amount of solid waste generation has calculated for each part of the hotel, such as restaurants, bars, rooms, etc. In addition, the effects of waste management practices on a variety of small, large and medium hotels have been investigated meanwhile the results can be used to identify the barriers to waste management. In this study, for the first time, the hotel waste cooking oil and eggs shell are used for biodiesel recovery, which the results are illustrated in this research. Furthermore, to encourage the hotel directors, the profitability of this recycling has been calculated to preserve the environment and achieving to sustainable tourism.

5.2 Conclusion

This study aimed to investigate the waste generation rate of accommodation sectors in the hospitality industry, apply predictive models to forecast waste generation trend and re-utilized the generated wastes. The accommodation sector is an essential component of the tourism and travel business. It is worth mentioning that increases

in hospitality sector operations result in increased quantities of municipal waste, constituting ecosystem damage and a significant increase in the environmental footprint. To curtail the ugly face of tourism activities, precise prediction of the quantity of hospitality waste generated is required to enable the development of an integrated waste management and reutilization system. Note that inaccurate prediction of hospitality waste generated may result in a negative impact on the environment.

For the first time, this study has shown that wastes from hospitality facilities can be precisely forecasted by considering measurable parameters via a non-time consuming predictive model. Specifically, three predictive models (central composite design (CCD), artificial neural network (ANN) and multiple linear regression (MLR)) were utilized to predict the average hospitality waste generation rate using nationality of tourists, type of waste, tourism season, accommodation type, and type of waste management practices as predictors. These predictors were selected based on the correlation test and Cronbach's alpha of 0.93. The results showed that 4159.9 kg and 2063.4 kg of waste were generated during the peak and lean season from the 22 sampled hospitality facilities, respectively.

Importantly, the use of the ANN model to predict the average hospitality waste generation rate led to reliable results and the difference between the observed and predicted values was not statistically significant. However, the MLR model demonstrated lower prediction accuracy compared to CCD. It was found that Turkish tourists generated more waste (19.16% WGR/day) in large hotels compared with the British (15.1% WGR/day), and Asians generated the least average waste (20.96%) in all the facilities investigated. Notably, wet waste accounted for the highest

percentage of 56.3%, including cooking oil (14%), tissue paper (6.3%) and kitchen waste (36%).

The waste cooking oil was converted to biodiesel and the cost-benefit analysis indicated that the accommodation sector gains approximately 1.1 TL per litre of waste cooking oil if converted to biodiesel and most importantly the suggested re-utilization practice would reduce climate emissions, such as greenhouse gas and CO2 emissions. The findings herein imply the need for further research to investigate the possible sources of the waste and factors limiting hotels from managing the waste effectively. In conclusion, the results herein are promising and would be useful in establishing a sustainable waste management plans for the hospitality industry.

5.3 Limitations

The limitation of this study is that the sources where the wastes are generated were not recorded by the majority of the accommodation sector. Besides, responses from accommodation sectors located in other cities (Guzelyurt, Famagusta and Iskele) were poor, specifically the lower class accommodation sectors. Also, the majority of the sampled accommodation sectors only record quantifiable amount of wet wastes (food wastes, cooking oil), suggesting that not all wastes generated are accounted for.

5.4 Recommendations

Findings of this study are important for policymakers, environmentalist and development of sustainable green hotels. Recommendations concerning separation and re-utilization of generated wastes are suggested and future research directions are outlined. This study proposes the integration of the cost-benefit system into the waste management program of each accommodation sector to encourage hotels to manage their waste effectively. Also, the conversion of waste cooking oil into green energy

(biofuel) is demonstrated and encouraged to incentivize better waste management. It is also advised to hotel managers to use other sustainable green growth methods in the future to help their economies as well as the environment. One of the basic requirements for this purpose is to accurately record the appearance of the hotel waste generation in different parts and sectors of the hotel to increase economic and environmental benefits.

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APPENDIX

QUESTIONNAIRE

Waste Generation and Management Practices in Accommodation Sectors of TRNC

Research Integrity and Assurance: This survey is part of the research for PhD thesis on the waste generation and management plans in the accommodation industry. Through this survey, I intend to obtain data useful to design effective waste management system for accommodation sectors. The survey is anonymous and all the information provided will be kept confidential and will not be shared with any other party in any case. I greatly appreciate your help for completing the survey!

Please note: The survey will be completed in both the lean and peak tourism seasons.

Respondent details:

Name: ……. Position of respondent: ……... Location: ……

Type of accommodation: ……. Class of hotel/accommodation type: ……

Years of operation: …….....Target market: ……....

Section A: Accommodation Characteristics

1. Number of rooms in the accommodation: ……..
2. Nationality of most tourists visiting your hotel (a) British (b) Russian (c) African (d) Asian (e) Scandinavian (f) German (g) French (h) Turkish (i) Arabs (j) Others
3. Kindly tick the common wastes in your facility
    a) Food waste
    b) Glass
    c) Cooking oils
    d) Garden waste
    e) Organic waste
    f) Wood

g) Paper

h) Water

i) Plastic

j) Aluminum and metal wastes

Section B: Waste Management Practices

1. Do you have waste receptacles marked to segregate *recyclables*? (Yes) or (No)
2. Do you use reusable service ware (e.g. cups and glassware)? (Yes) or (No)
3. You provide sustainable waste management practices training? (Yes) or (No)
4. Use biodegradable disposable products? (Yes) or (No)
5. Use refillable containers for drinks? (Yes) or (No)
6. Monitor customer food waste to develop polices? (Yes) or (No)
7. Compost food waste? (Yes) or (No)
8. Donate reusable (e.g. leftover food, old uniforms, and linens)? (Yes) or (No)
9. Develop solid waste reduction strategies? (Yes) or (No)
10. Performing a cost/benefit analysis for recycling programs? (Yes) or (No)

Section C: Behavioral beliefs towards implementing waste management practices (WMP)

1. Implementing a WMP program will be better for the environment? (Yes) or (No)
2. Implementing a WMP program will give us a better reputation? (Yes) or (No)
3. Implementing a WMP program will be good for the local community? (Yes) or (No)
4. Implementing a WMP program will decrease food waste? (Yes) or (No)
5. Implementing a WMP program will improve customer satisfaction? (Yes) or (No)

6. Implementing a WMP program will be supported by our employees? (Yes) or (No)
7. Implementing a WMP program will give increase competition power? (Yes) or (No)
8. Implementing a WMP program will decrease costs? (Yes) or (No)

Section D: Barriers to implement WMP, Kindly tick as much as possible.

1. Lack of financial resources
2. Lack of training/education about how to implement (knowledge deficiency)
3. Manager's/owner's attitude
4. Lack of sustainable storage/recycling/reutilization units (operational issues)

Section E: Waste generated in different sectors of the facility

Waste materials per day	kitchen	Room	Pool	Garden	Restur.	Casino	Bathroom/ toilet	Cafeteria
Food								
Water								
Plastic								
Paper								
Packaging								
Cooking oils								
Metal								

Nationality of tourist	Activities	Common waste generated	Average waste (g/day)	Average waste (kg/lean)	Average waste (kg/peak)
British					
African					
Arabs					
Turkish					

German

French

Scandinavian

Russian

Asian

Kindly tick the waste disposal methods employ by your facility

1. Recycle
2. Reuse
3. Landfill
4. Incineration
5. Any other……..