PROFITABILITY AND SUSTAINABILITY FROM WASTE MANAGEMENT PRACTICES IN HOTELS AND ITS IMPACT ON ENVIRONMENT

Thesis submitted in fulfilment of the requirements for the Degree of

DOCTOR OF PHILOSOPHY

by

AMAR NATH

Jaypee Business School

JAYPEE INSTITUTE OF INFORMATION TECHNOLOGY

(Declared Deemed to be University U/S 3 of UGC Act)

A-10, SECTOR-62, NOIDA, INDIA

October 2014

© Copyright JAYPEE INSTITUTE OF INFORMATION TECHNOLOGY, NOIDA

(Declared Deemed to be University U/S 3 of UGC Act)

October 2014

ALL RIGHTS RESERVED

TABLE OF CONTENTS

	Page Number
Inner First Page	**i**
Declaration by Scholar	**vii**
Supervisors' Certificate	**viii**
Acknowledgement	**ix**
Abstract	**x**
List of Acronyms and Abbreviations	**xi**
List of Figures	**xii**
List of Tables	**xiv**
CHAPTER-1	
INTRODUCTION	
1.1 Introduction	**1**
1.2 Overview of Research Area	**3**
1.3 Scope of the Study	**5**
1.4 Research Objectives	**8**
1.5 Organization of Thesis	**8**
CHAPTER-2	
HOTEL INDUSTRY	
2.1 Definition of Hotel and Accommodation	**11**
2.2 The Indian Hotel industry: Overview	**12**
2.3 Growth and current status of Hotel industry	**12**
2.4 Types of Hotel	**15**
2.5 Classification of Hotel industry	**16**
2.5.1 Based on location	**16**
2.5.2 Based on size of property	**17**
2.5.3 Based on level of services	**17**
2.5.4 Based on the length of stay	**17**
2.5.5 Based on theme	**17**
2.5.6 Based on target market	**17**
CHAPTER-3	
WASTE MANAGEMENT	
3.1 Definition of Waste	**18**
3.2 Classification of waste	**19**
3.3 Waste Hierarchy	**22**
3.3.1 Waste Prevention	**22**
3.3.2 Reuse	**24**

3.3.3 Recycling and Composting	**24**
3.3.4 Energy Recovery	**25**
3.3.5 Disposal	**25**
3.4 Waste Policies and Law in India	**25**
3.4.1 Policies and Rules	**25**
3.4.2 Reports	**26**
3.4.3 National committees	**26**
3.4.4 Regional legislation	**27**
3.4.5 The Municipal Solid Waste Rules, 2000 Manual	**27**
3.5 Waste Processing Technique/Treatment	**27**
3.5.1 Recycling	**27**
3.5.2 Composting	**29**
3.5.3 Vermicomposting	**29**
3.5.4 Aerobic Digestion	**29**
3.5.5 Incineration	**30**
CHAPTER-4	
LITERATURE REVIEW	
4.1 Introduction	**31**
4.2 Present situation of Waste Management In India	**32**
4.3 Impact of Waste generation on Environment	**39**
4.4 Emission of Green House Gas (GHG) from Waste generation	**44**
4.5 Currently status of waste management practices in Hotel industry	**52**
4.6 Audit process for Waste Minimization	**58**
4.7Customer preference for Green Hotel	**61**
CHAPTER-5	
RESEARCH METHODOLOGY	
5.1 Introduction	**62**
5.2 Types of Research method used in Study	**62**
5.2.1 Exploratory Research	**63**
5.2.2 Descriptive Research	**63**
5.3 Exploratory Research	**64**
5.3.1 Waste Audit	**64**
5.3.2 Waste Audit Instrument Development	**64**
5.4 Sampling and Data Collection	**74**
5.4.1 Sampling Plan	**74**
5.5 Data Analysis Technique	**77**
CHAPTER-6	
DATA ANALYSIS	
6.1 Introduction	**80**

6.2 Waste Audit	**81**
6.2.1 Audit in La-Shangri-la Hotel	**82**
6.2.2 Audit in Hilton Hotel	**85**
6.2.3 Audit in Country INN Hotel	**88**
6.2.4 Audit in Park Plaza Hotel	**91**
6.2.5 Audit in JaypeeVasant Continental Hotel	**94**
6.2.6 Audit in Jaypee Greens, Golf and Spa Resort	**96**
6.2.7 Audit in JaypeeSiddhart Hotel	**98**
6.2.8 Audit in Lemon Tree Hotel	**100**
6.2.9 Average Waste generated across Eight Hotels	**102**
6.3 WARM Model	**105**
6.3.1 Emission from single Star Rated Hotel	**108**
6.3.2 Emission from all-star Rated Hotel in Delhi-NCR	**111**
6.4 Equivalency Calculator	**113**
6.4.1 Equivalency conversion from one hotel	**113**
6.4.2 Equivalency conversion from all-star Delhi-NCR hotels	**114**
6.5 Cost Benefit Analysis	**115**
6.5.1 Treatment of Recyclable Waste	**116**
6.5.2 Treatment of Compostable Waste	**118**
6.5.3 Calculation of Saving from Recyclable Material	**121**
6.5.4 Calculation of Saving from Compostable Material	**126**
6.6 Model or Framework Development	**133**
6.6.1 Profitability from recyclable and compostable waste	**134**
6.6.2 Sustainability from waste management	**136**
6.6.3 Final framework or model	**137**
CHAPTER-7	
FINDINGS	
7.1 Overview of Study	**140**
7.2 Findings of Study	**141**
7.2.1 Objective number One Achieved	**141**
7.2.2 Objective number Two Achieved	**142**
7.2.3 Objective number Three Achieved	**145**
7.2.4 Objective number Four Achieved	**148**
CHAPTER-8	
CONCLUSION AND IMPLICATIONS	
8.1 Conclusion	**150**
8.2 Contribution of Study	**151**
8.3 Limitations of Study	**151**
8.4 Future Research	**152**

REFRENCES	**153**
APPENDICES	
Appendix A:	**177**
Appendix B:	**179**
Appendix C:	**180**
Appendix D:	**182**
Appendix E:	**183**
Appendix F:	**185**
List of Publications	**187**
Synopsis	**Synopsis 1-18**

DECLARATION BY THE SCHOLAR

I hereby declare that the work reported in the Ph.D. thesis entitled **"Profitability and Sustainability from Waste Management Practices in Hotels and its Impact on Environment"** submitted at **Jaypee Institute of Information Technology,Noida, India,** is an authentic record of my work carried out under the supervision of **Dr. Nripendra Singh**. I have not submitted this work elsewhere for any other degree or diploma. I am fully responsible for the contents of my Ph.D. Thesis.

Amar Nath

Jaypee Business School

Jaypee Institute of Information Technology, Noida, India

Date:

SUPERVISORS' CERTIFICATE

This is to certify that the work reported in the Ph.D. thesis entitled **"Profitability and Sustainability from Waste Management Practices in Hotels and its Impact on Environment"** submitted by **Amar Nath** at **Jaypee Institute of Information Technology,Noida**, **India,** is a bonafide record of his original work carried out under our supervision. This work has not been submitted elsewhere for any other degree or diploma.

Dr. Nripendra Singh

Associate Professor

Jaypee Business School

Date:

ACKNOWLEDGEMENT

I express my profound gratitude to my research supervisors Dr.Nripendra Singh, Associate Professor, Jaypee Business School for the support and guidance in completing this meaningful and learning journey.

Dr.Nripendra Singh guided and encouraged me throughout this journey. His trust and confidence in me helped me to complete this arduous task. Interactions with him always boosted my confidence that in turn helped me to successfully complete this research.

I am thankful to all faculty members of JBS especially my DPMAC members; Dr.MoonisShakeel and Dr.Mukta Mani for their invaluable suggestions and inputs.

I am highly grateful to our Head of Department, Prof. Irfan A. Rizvi for his great support and encouragement. His continuous encouragement gave impetus to my work. I earnestly thank him for giving me constructive feedback.

I express my deep gratitude to our Vice Chancellor Prof. S.C Saxena for motivating me for this research. I sincerely acknowledge Prof. Krishna Gopal, Dean, and Col. Vijay Kumar (Retd.), Registrar for their valuable guidance and support.

I am happy to acknowledge the support of the Hotel staff and management. Without their great support I would not have been able to collect valuable data for this study. I would also like to express gratitude to all the participants along with domain and industry experts' organization, who have helped me in completing this study from time to time.

I am fortunate to have wonderful scholar colleagues at management department, JBS. I am grateful to them for their support and encouragement. I am deeply grateful to my parents for this continuous encouragement, showing confidence in me, and their continuous prayers for my success and happiness. I will remain indebted for their continuous and unwavering support.

Above all, I am grateful to the God, Almighty, whose grace enabled me to complete this work.

ABSTRACT

Service industries are the place where we serve the people that dealalmost intangible services but neglect some tangible challenges like improper resource management, environment degradation and lack of green practices. Solid waste is serious concerns applicable to hotel industry. This industry is major contributors of the waste with almost half of municipal solid waste coming from this sector only. The major challenge in hotel service industry is their produced waste. Waste generation from hotel industries is one of the major issues in India just because waste is not treated well due to non-segregation process and out-dated technologies. Management of waste is one problem today as it negatively impacts the environment. The emission of greenhouse gases (GHG) from improper waste dumping has negative impact on environment. Methane and carbon dioxide are one of the most dangerous gases of GHG that continuously degrade the environment. Hotel industry in India is growing at the rate of 17% and at the same rate these industry also produces various types of biodegradable and non-biodegradable waste. But their proper management before and delivering services is more essential for creating sustainability and profitability in near future.

This study focuses on the most complex and worst situation of improper waste management practices in hotel industry. Thus we can find that there is a gap of environment protection and business sustainability and profitability, which need to bridged. The study determines the gap and establishes a relationship between environment and sustainability practice to utilize waste material. Research also analyzes the amount of recycling material and possibility of minimization of waste at the source. This research proved that waste is not a waste; it is a revenue earning source.

This thesis is about the management of hotel waste to create sustainable business along with generating profit from waste. Finally,a holistic model or framework has been developed that consist of profitability and sustainability from waste. This model helps to reduce waste at source and utilize each waste material to add profit in overall business.

LIST OF ACRONYMS AND ABBREVATIONS

CBA: Cost Benefit Analysis

CPCB: Central Pollution Control Board

DEFRA: Department of Environment Food and Rural Affaires

EPA: Environment Protection Agency

EU: European Union

FOD: First Order Decay

FTA: Foreign Tourist Arrival

GDP: Gross Domestic Product

GHG: Green House Gas

IPCC: Intergovernmental Panel on Climate Change

ISWM: Integrated Solid Waste Management

LFG: Land Fill Gas

MRF: Material Recovery Facility

MSW: Municipal Solid Waste

NEERI: National Environmental Engineering Research Institute

NSWAI: National Solid Waste Association of India

QSR: Quick Service Restaurants

TERI: The Energy and Research Institute

UNEP: United Nation Environmental Program

USA: United States of America

WARM: Waste Reduction Model

WEF: World Economic Forum

WTTC: World Travel and Tourism Council

LIST OF FIGURES

Figure Number	Caption	Page Number
2.1	Classification of Hotel	**15**
2.2	Criteria for hotel classification	**16**
3.1	Structure of classifying waste	**19**
3.2	Classification of waste	**21**
3.3	The waste hierarchy	**22**
3.4	Re-define waste hierarchy	**23**
3.5	Waste processing technique	**30**
4.1	Structure of Literature review	**31**
4.2	Solid waste and per capita waste generation	**37**
4.3	Methane emission from various sources	**47**
4.4	Nitrous oxide emission from various sources	**48**
4.5	Best practices model of SWM in small hotel	**55**

4.6 Waste minimization program/Methodology **57**

4.7 Waste audit programme- Overview **59**

5.1 Research method used in study **63**

5.2 Development of waste audit instrument **64**

5.3 Sampling Design **75**

5.4 Objective wise data analysis technique **78**

6.1 Data analysis **80**

6.2 Options for waste treatment **116**

6.3 Composting options for waste treatment **126**

6.4 Multi pit composting option for waste treatment **128**

6.5 Aspects of hotel waste management framework **133**

6.6 Profit generation from organic and recyclable waste **134**

6.7 Profit generated from recyclable waste**135**

6.8 Aspect of sustainability **136**

6.9 Framework or Model for hotel waste management **138**

LIST OF TABLES

Table Number	Caption	Page Number
2.1	Forecasting of percentage of growth in hotel industry	**13**
2.2	Numbers of hotel units	**13**
2.3	Numbers of hotel room units	**14**
2.4	Forecast of number of accommodation unit (2022)	**14**
4.1	Sources and type of municipal waste	**32**
4.2	Population growth, urban waste and future prediction	**37**
4.3	Area of land required for sanitary disposal of MSW	**38**
4.4	Adverse effect of waste reach landfill and open dumpsite	**42**
4.5	Growth in GHG emission from waste	**46**
4.6	Comparison of by GHG emission by different sector	**48**
4.7	Waste generation and methane emission from waste disposal	**50**
4.8	Present scenario of landfill sites in Delhi	**51**

4.9	Waste audit check in school	**60**
4.10	Waste characteristic	**60**
5.1	Types of waste generation and degenerate time	**65**
5.2	Waste audit by eco recycle	**65**
5.3	Categorization of paper waste	**66**
5.4	Categorization of plastic waste	**66**
5.5	Categorization of textile waste	**67**
5.6	Categorization of leather waste	**67**
5.7	Categorization of garden waste	**68**
5.8	Categorization of glass waste	**68**
5.9	Categorization of aluminium waste	**68**
5.10	Categorization of food waste	**69**
5.11	Categorization of oil waste	**69**
5.12	Initial hotel waste audit form	**70**
5.13	Detail of panel of experts	**72**

5.14	Detail of waste vendor and contractor	**72**
5.15	Final hotel waste audit form	**73**
5.16	Hotel selected for auditing process	**76**
5.17	Name of the hotel for waste auditing	**76**
5.18	Sample size	**76**
6.1	Audit form	**81**
6.2	Audit in La-Shangri-la hotel	**83**
6.3	Audit in Hilton hotel	**86**
6.4	Audit in Country INN hotel	**89**
6.5	Audit in Park Plaza hotel	**92**
6.6	Audit in JaypeeVasant Continental hotel	**94**
6.7	Audit in Jaypee green, golf and spa resort	**97**
6.8	Audit in JaypeeSiddhart hotel	**98**
6.9	Audit in Lemon tree hotel	**101**
6.10	Average waste generation from all eight hotels	**103**

6.11	Number of star rated hotels in Delhi-NCR	**104**
6.12	Waste generation in Delhi-NCR	**104**
6.13	Type of waste generation in hotel industry	**106**
6.14	Baseline scenario and alternate scenario	**107**
6.15	Report generation of single hotel	**110**
6.16	Change in emission	**111**
6.17	Report generation of all-star rated hotel in Delhi-NCR	**112**
6.18	Change in emission (Delhi-NCR hotel)	**113**
6.19	Saving of GHG emission	**113**
6.20	Utilization of emission from one hotel to other sectors	**114**
6.21	Utilization of emission from all Delhi-NCR hotel to other sectors	**115**
6.22	Recyclable waste treatment	**117**
6.23	Compostable waste treatment	**119**
6.24	Number of labour required for waste handling	**121**
6.25	Salary paid to labour	**122**

6.26	Number of bin required	**123**
6.27	Miscellaneous expenses	**123**
6.28	Salvage value	**124**
6.29	Revenue generation from salvage value	**125**
6.30	Cost of installation of Bio-digester	**127**
6.31	Saving from Bio-digester	**128**
6.32	Cost of Multi pit composting	**129**
6.33	Saving from Multi pit composting	**130**
6.34	Cost Benefit Analysis	**131**
6.35	Employment generation	**137**
6.36	Saving land resources	**137**
7.1	Calculation of waste volume	**141**
7.2	Emission from a hotel	**143**
7.3	Emission from Delhi-NCR hotel	**143**
7.4	Saving of emission	**144**

7.5	Utilization of emission to other sector	**144**
7.6	Calculation of total cost and benefit	**145**
7.7	Cost and saving from Bio-digester	**146**
7.8	Cost and saving from Multi pit	**146**
7.9	Detail of cost benefit analysis	**147**
7.10	Profit generation	**148**

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

India is central attraction countries among the world because of their incredible natural beauty and culture. These qualities enhance the growth of hotel and tourism industry. The future of hospitality industry is shaped by many factors, like investment, growing capital needs and most important customers' needs and their expectation. World Travel and Tourism Council's (WTTC) Economic impact 2012 says India's domestic traveling contributed 82.2% of the directtravel and tourism in GDP of 2011 as compared to 17.8% by foreign visitors spending that highlights that domestic visitation in Indian tourism [1]. Hospitality and tourism ranks third in foreign exchange earner worth US$ 15billion [2]. This industry contributes6.4% in Indian GDP with annual increment of 7.8% per annum whileits contribution in world's GDP is 9.1%which is rising at rate of 4.3% per annum. Its significance also lies in the context that industry is one of the largest employer generating 254,941,000 jobs [3]. This clearly indicates the economic importance of the sector, and maximum of the country's tourism potential is still untapped. From the above facts and figures it is clear that tourism industry is going through an unprecedented growth in the recent decade. This has fuelled demand for hotels which in turn has serious implication in terms of addressing challenge of waste generation.

Whenever we verbalize about hotel industry usually it means lodging or staying but the conception is now changed because of globalization and industrialization impact. Now it comprises of restaurants, spa, lounge, bar and resorts. According to Middleton and Clarke [4], guest roomis keyto facilities that make travel convenient. Apart from that, hotels make an important contribution to overall visitors' satisfaction at a particular destination. Study [5] also suggested that accommodation provides an inspiration for travellers.

Solid wasteisundesirable and left substances or material. These materials cannot be reused directly by the society because of its ill effect. Most of the waste materials have the hazardous negative effect on human health. Waste can be any type either in the form of various

vegetables waste; fruits waste and cooked material or in the form of plastic waste, aluminium waste, paper waste etc.

Waste generation is one of the complex issues now days as it emerges as a global problem for environment and human health. Hotel industry is main source of waste generation, a large chunk of waste generated from hotels lodging, storing and kitchen areas. Anthropogenic sources quote that ecosystem is changing because of pollution. Management of waste is more important for the ecological balance and to maintain human health. Managing waste positively affect social, economic and environmental issues of countries and organization [6]. It is indeed acting as an effective tool for the hospitality industry as more and more hotels today are resorting to the effective resource management practices and reaping the rich monetary benefits from the available limited resources. Green practices maintain the ecological balance with business processes. This research focus on issue of waste generation from hotel industry along with various challenges and opportunity that identifying gap which is challengeable in environment protection and highlighting way to deal these issues to achieve profitability and sustainability.

1.2 OVERVIEW OF RESEARCH AREA

In today's competitive scenario, competitive advantage is indispensible for sustainability of any business. Service industries are the industry dealing almost intangible services but neglect some tangible challenges like resource management, environment consciousness and green practices. Solid waste is a key concern in the hotel industry. Hospitality industry is main source of the waste [7]. The major challenge in hotel service industry is their waste production. Waste production from hotel industries is one of the major issues in India just because waste is not treated well due to non-segregation process and out-dated technologies. Services which are delivered from hotel such as serving food, drinks and all material which use in hotel for guest generate a huge amount of waste. The increasing hotel solid waste generation along with the high fraction of organic waste and a common disposal of open dumping is the current scenario in many areas in India. Services delivered from hospitality sector are easy but their proper management before and after delivered service is essential for sustainability and profitability. Management of waste is globalproblem that negatively affects

environment. This sector is growing at the rate of 17% in India [8] and in the same pace intensity of waste increases.

There is an estimated report by Ministry of tourism [9] thatin 2010, there will be a total of 2.9 million hotel rooms, more than twice the numbers in 2002. Star category hotels will have almost 100,000 hotel rooms. In the year 2020, there should be approximately 6.6 million hotel rooms, if the full potential of tourism is tapped [9].

Various facts indicate that one to six kg/day is waste originated by per room of hotel in India [10]. For example only two metro cities, Delhi and Mumbai, with 14,757 hotel rooms generate around 147.57 to 885.42 tons of solid waste per day, which will increase to 27,438 hotel rooms in near future [11]. Thus, this research is focused on developing a strategy to manage hotel waste in India.

Low-lying areas are generally chosen for disposal of solid waste without any specific measures. Therefore, Solid waste management is one of the major environmental problems of Indian megacities [12]. Some of the problems due to this are litter, dust, bad odour, rodents, pests, fire, failure of slop, soil erosion, etc. [13]. When the waste from hotel industry is dumped directly to the landfill sites, it contaminate with other metals and thus produce methane, a most hazardous gas greenhouse gas (GHG)[1].India ranks third in GHG emissioncontributing 5.3% [14]. Increasing pace of waste leads to increase in temperature, the climate is projected to warm another 1.0 to 3.50 C over the next century due to projected increase in atmospheric concentration of GHGs [15].

In the same manner, improper management of waste has adverse effect on the health of staff and the community associated with waste dealing. The adverse impacts of waste on human being are in the form of various communicable and non-communicable diseases. Like communicable diseases in form of diarrhoea, jaundice, skin diseases etc. and non-communicable diseases like poisoning, hearing defects, dust etc. All diseases are grown through dumping of waste at landfill sites. Rag pickers and conservancy staff are highly affected with these diseases because they are directly contact with waste dealing.

The ultimate goal of all hotel managers is to obtain the best return possible on their investments. This can only be achieved when the right strategic choices are made about gaining competitive advantage. . The cost of waste can be categories into visible cost and hidden cost. Visible cost contain: gaseous emission, waste disposal either solid or liquid and hazardous waste treatment whereas hidden cost contain: processing inefficiency, energy inefficiency, lost revenue, reduced profit, re-working of materials and the purchase cost of materials. Many small hotel operators have very little interest in reducing or recycling waste. They believe that such activities are too expensive and time-consuming. This has encouraged households for moving towards waste reduction activities [16].

Thus, wefind that there is gap of environment protection and business sustainability and profitability, which need to bridged. Thestudy determines the gap and establishes a relationship between environment and sustainability practice to utilize waste material. It also analyzes the amount of recycling material and possibility of minimization of waste at the source. This thesis is about the management of hotel waste to create sustainable business along with generating profitability from waste. The purpose is to find potential for the improvement though a survey of current achievements. The findings shall suggest the possible development in green practices which helps to reduce various environmental impacts from the services and activities at hotels. These findings will also demonstrate the real situation that a hotel facing which could lead to or impede such development in environmental management.

The study develops a sustainable waste management framework for hotel industry to reduce waste at source and help industry to add profit in their revenue. Study computes the value from cost benefit analysis that helps to implement any green practices accordingly. It is mandatory to create solution to cope with waste generation issue. Effective and efficient green practices are not only generating profit through recycling and composting but also help in environment protection.

1.3 SCOPE OF THE STUDY

Waste management is inevitable. Waste has adverse effect on environment. It continues to degrade the ecological balance of environment. When waste dumped to the landfill sites without any proper treatment, it creates the problem of leachate [17]. It emphasized on the

problems such as flies, odour and noise faced by surrounding communities near to landfill and dumped areas.There are many reports on environment concern articulate about the deterioration of environment, recently some reports like Central Pollution Control Board (CPCB), Intergovernmental Panel of Climatic Change (IPCC), United Nation Environmental Program (UNEP) etc. emphasis that there is a planetary emergency of saving the mother earth because waste emit various hazardous gases like methane, carbon dioxide, sulphur dioxide etc.

Generation of solid waste and related services like collection, transportation, processing and final disposal of waste are important both in terms of health of the public and environment. 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 [18].

There is scarcity of land all around the globe, especially in India which is second largest country after China in terms of population. There is limited land resource for human development. In this scenario we can't expect more and more landfill for waste dumping. Metro cities like Delhi, Mumbai, Kolkata, Chennai, Bengaluru etc. are dense city of India by population and industries, already these cities have at least three to four operating landfill but it is not possible to build more landfill in future. Expected to be around forty thousand tons of garbage at least one acre of usable land [19].

This study focuses on the complex situation of improper waste management practices in hotel industry. The study develops a sustainable waste management framework for the hotel industry that shows the optimum utilization of each waste material.The framework will include current practices by hotels of different categories and feasible solutions for the collection, segregation, processing, and disposal of waste. Effective and efficient green practices are not only essential for environment protection but also add to the profitability of hotels.

The study can be categorized into five parts. The first part of the study will explain the present scenario of solid waste generation in India with special focus on hotel industry also introduces the current waste handling hierarchy of waste management. Second part is to segregate each waste material generated from hotel industry. Third part is to emphasis the impact of waste on

environment through greenhouse gas emissionand its adverse impact on human health. Fourth is to conduct cost benefit analysis (CBA) that creates a link between green practices and monetary and non-monetary benefit associated with it. In fifth and final stage, study develops a waste management framework to handle waste effectively and efficiently.

This study fulfils the gap and establishes a relationship between environment and sustainability practice to utilize waste material. The study also analyses the amount of recycling material and possibility of minimization of waste at the source.Therefore the main contributions of the study are as follows:

1. The concept of waste management has been revisited thoroughly and comprehensively to ascertain its nature and importance in the wake of increased environmental dynamism. Starting with broader perspective, study then focuses down to various aspects of waste management. Then the role and contribution of hotel industry has been explored. This will be useful in clearing the ambiguity that surrounds the concept of waste management in hotel industry and its sustainability and profitability.

2. Study has identified currently being used waste management practices in hotel industry. It is also identified the amount of waste generated from hotel in per day basis and per year basis, which is further extrapolate to the hotels in Delhi NCR to know the intensity of waste generated in metro cities. Extensive literature review has been done to identify all the crucial and impact oriented dimension that have been often neglected in other studies.

3. After identifying the problem of waste intensity, impact of waste is computed through various predefined techniques like Waste Reduction Model (WARM), Equivalency calculator etc. with the help of published reports and detailed literature review.

4. Cost benefit analysis (CBA), which is one of the most important technique to estimate the cost vs. benefit. Basically it estimates the actual cost of any business activity and their expected outcome along with its payback period. As the area of waste management in hotel industry has been underexplored and there is significant dearth of studies. This research has made a contribution by filling this gap we came across after doing a literature review.

5. Finally a waste management framework has been developed to minimize the adverse impact of waste and reduce the amount of waste to its initial operations with the help of recycling and composting activities. As hotel industry in India is one of the most affected

sectors reeling under the heat of continuous change and turbulence, study assumes a special significance for the industry.

This frameworkhelps byreducing the burden of waste on hotel along with generating some profit through recycling and composting activities. It will also help to maintain the ecological balance of environment. Thus this study will be beneficial for hotel industry in order to cope up with the increasing pressure of environment dynamism and turbulence.

1.4 RESEARCH OBJECTIVES

Following are the research objectives of study:

1. To estimate the waste generation from hotel industry.

2. To know the impact of waste generated from hotel industry on environment.

3. To conduct cost-benefit analysis (CBA) that creates a link between green practices and monetary and non-monetary benefit associated with it.

4. To develop a holistic framework/model for waste management in hotel industry.

1.5 ORGANIZATION OF THESIS

This research is aimed to develop a framework for waste management in hotel industry. This whole study is organized into six chapters and following is their brief outline:

Chapter 1: First chapter is about the introduction of research that introduces the concept of research in addition to its title and broad area. Scope of study and research gaps is highlighted in this introductory chapter. Contribution of the research, research objectives and brief introduce waste and its impact on environment that follows the highlighted research gaps.

Chapter throws light on the concept of waste generation, its impact and sources of waste generation.

Chapter 2: Second chapter is about the hotel industry, which talks about its introduction, meaning and its growth. Further there is the discussion of types of hotel in India and its classification like on the basis of location, basis of size of property, based on level of service, based on length of stay, based on themes et. It is the base of research because entire study is on hotel industry.

Chapter 3: Chapter three is all about waste management,a most complex issue ever. Chapter start with the definition of waste and then talk about the waste classification. Then move to the hierarchy of waste, logically waste treatment are discussed here. Policies, law, act related to waste management in India were discussed. Chapter moves to the most efficient and effective waste management treatments like recycling, composting, incineration etc.

Chapter 4: Chapter four is about the literature review. This chapterpresents a comprehensive and exhaustive literature review of concepts related to study. Literature are divided into five parts such as present situation of waste management in India, impact of waste generation on environment, emission of greenhouse gases from waste dumping, waste management practices in hotel industry and lastly audit process for waste minimization.

Chapter 5: This chapterdeals in detail with research methodology used in carrying out the research. Both exploratory and descriptive research is used in the study. Exploratory phase is carried out with help of literature review and expert review while descriptive part is accomplished with help of primary data collected from marketing/sales personnel of hotel industry. Chapter describes the questionnaire format, sample size and audit process.

Chapter 6: Chapter sixth is the detail of research, it explains the way of data handling. This is the data analysis chapter. On the basis of objective, analyses tools are define for example to know the waste intensity or volume of waste, an audit form is used. To know the greenhouse gas emission, waste reduction mode and equivalency calculator is used. To know the green practices of waste management and its associated cost, cost benefit analyses have been taken. Cost benefit analysis gives the idea of the cost of waste handling and monetary and non-monetary benefit generated from it. Finally, a model or framework has been developed to manage waste effectively generated from hotel industry.

Chapter 7: Chapter seventh is the gist of study that means chapter seven is finding of the study. The final outputs from all technique have been discussed here. It gives the detailed information about findings of the study. All the objectives are listed one by one and their achievement has been discussed in detail.

Chapter 8: Chapter eight represents the conclusion of study. In this chapter relevance of hotel waste management in the wake of changed business environment is been discussed. Further this chapter talks about the contribution of the study to knowledge field. Following the knowledge contribution is limitations of the study that is discussed in detail. Chapter then ends with future scope of study.

CHAPTER 2

HOTEL INDUSTRY

2.1 DEFINITION OF HOTEL AND ACCOMMODATION

Away from the home, Hotels present one of the convenient staying alternatives. Initially hotel was used as a place where families host their guests by providing lodging, boarding, and service facilities. Back then, “hostel” was term used for this and persons availing this facility were called “hostelier”. The Norman people invented the word “hotel”. The word “hotel” was originally originated in England in 1760 both for business or pleasure [20].

Accommodation provides the base from which tourists can engage in theprocess of staying at a destination. It is an element of the widen hospitalitysector that is used by tourist. Accommodation has emerged as the focal point forthe hosting of guests and visitors through the ages but according toAndrews [21], "Hotel" or "Inn" under British Law is defined as a place where a bonafidetraveller. But Al-sairafi [22] gave twodefinitions for Hotel in his book which has been issued in the Arabic languageunder “Edaratalfanadeq –ManzorEdari” (Hotel managementManagerial Overview) (Perspective) Comprehensive Guide, helping you inunderstanding the required skills and Etekit of Successful Hotel Management. Following are key terms as explained by author:

A- The word hotel equal in Latin language the word hospitality which the French word “Hotel” has been derive from this word which means a special place for guest accommodation.

B- In Arabic, the Hotel pronunciation is related to the “pandokia” word which means a place for accommodation which provides the shelter, food and service to the guest and pay money in return for.

Furthermore, according to Braham [23], hotelier should use both art and science in order to attract customers. According to Brody [24], true meaning of hospitality lies in kindness and in welcoming strangers or guests with an affection. The word comes from the Latin “Hospes”,

meaning guest, and developed into hospice, a place of shelter for travellers. These days, the services (or products) offered to the modem traveller by hospitality establishments can cater for every human comfort. The hospitality business is a massive industryencompassing all forms of transport, tourism, accommodation, eating, drinking, entertainment, recreation and activities [25]. One of the most best quoted statement to describe the term hospitality is as following:

"Hospitality industry or broadly speaking the Hospitality sector is the cornerstone of most Developing and developed nations affected by Transactions of business among humans" [26]

The Hospitality has been known as reception and very kindly treatment with strangers, the Hospitality word has been derived from the word "HOSPICE" which has been known by different nations in different times, and this word also has been Maniacal in "The Holy Curran" [27].

2.2THE INDIAN HOTEL INDUSTRY: OVERVIEW

Hotels are main constituents of the Tourism [28]. The Indian tourism focus is on the "AtithiDevoBhavah" campaign, targeted at the inbound foreign tourists in the country. Translated literally this means "Guest is God" [29]. Now ownership has turned into franchises business way [30].

Delhi-NCR has rated high growth though increase in waste has also manifold [31]. Improvements in infrastructure and the construction of new residential projects have made the areas attractive for investment.Delhi, the second largest hotel market in India after Mumbai, saw a compounded increase in supply of 15% over the past three years. Hotel industry continuous grows as the same pace of real estate industries grown in Delhi NCR area. Despite moderate supply pressures in the next few years, Delhi remains a strong market for hotels [32].

2.3 GROWTH AND CURRENT STATUS OF HOTEL INDUSTRY

According to estimates, hotel industry will grow at 7.8% per annum in 2013 – 2023 [33]. India current rank is 12 here and will increase in future [34]. On the basis of growth of Indian economy and foreign tourist arrivals (FTA) and other supporting factors forced Ministry of

tourism to forecast the percentage growth of hotel industry in coming futurein each zone like East, North, South, West, North East (refer table 2.1)[35].

Table 2.1: Forecasting of percentage of growth in hotel industry

Growth in Hotels					
	East	**North**	**South**	**West**	**N. East**
% Growth in 4 Starupwards Accommodation units	9	10	17	9	11
% Growth in 1 – 3 Star Accommodation units	3	0	12	8	14
% Growth in Unclassified Accommodation units	5	2	6	15	7
% Growth in Motels	2	2	2	2	2

Source: Ministry of tourism [35]

In all, there are total of 56,792 hotels in India consisting of categories of 4-star & upward, 1 – 3 star and unclassified hotels in India. Whereas approximately 75000 motels in India in 2010, with 4% in the star category. There are a total of 2229 star category hotels in India i.e. 1 to 4 star upward hotels; out of it a little over 26%, i.e. 599 hotel is 4 star upwards hotels. North India has the largest number of five/ four star hotels followed by the Southern region. North India also accounts for almost 40% of all accommodation units in India (refer table 2.2) [35].

Table 2.2: Number of hotels unit (2010)

Number of Accommodation Units in March 2010				
Region	**4 Star upwards Hotels**	**1 – 3 Star Hotels**	**Unclassified Units**	**Motels**
East	40	67	2937	12407
North	237	276	20870	21389
South	183	911	10290	16477
West	134	348	19731	15794
North East	5	28	735	8970
All India	599	1630	54563	75037

Source: Ministry of tourism [35]

Apart from the numbers of hotel unit, some reputed consultancy like Cushman & Wakefield expects the hotel industry will grow 65 per cent rise in the total number of hotel rooms by 2017. According to a report, approximately 52,000 new hotel rooms are expected to come into

the system in the next five years. There are over 2.7 million rooms available in the accommodation units across India, with almost 39% of them being in North India. Most of them are in the unclassified category (refer table 2.3) [35].

Table 2.3: Number of hotel's room unit (2010)

Number of Accommodation Units in March 2010				
Region	**4 Star upwards Hotels**	**1 – 3 Star Hotels**	**Unclassified Units**	**Motels**
East	3810	2725	94083	173730
North	25236	9151	609974	299499
South	20206	33291	369977	230697
West	17875	16086	441438	221143
North East	298	930	17371	125606
All India	**67425**	**62183**	**1532844**	**1050675**

Source: Ministry of tourism [35]

As per the estimation of hotel and rooms in each region by ministry of tourism in March 2010, further it is extrapolating for the estimation of hotels and rooms in the year 2022 (refer table 2.4).

Table 2.4: Forecast of Number of Accommodation Units (2022)

Number of Accommodation Units – March 2022				
Region	**4 Star upwards Hotels**	**1 – 3 Star Hotels**	**Unclassified Units**	**Motels**
East	119	99	5545	15255
North	707	289	27456	26298
South	1235	3527	19830	20257
West	378	859	107543	19418
North East	17	141	1603	11029
All India	**2457**	**4916**	**161977**	**92257**

Source: Ministry of tourism [35]

Facts and figure above shows that there is tremendous growth in 12 year from 2012 to 2022. Southern region is expected to increase its 4 star upward hotel to unclassified hotels up to 44849 units whereas a motel increases by 20257 units. As compare to 2010 star rated hotels are 2229 units and 7373 units in 2022 respectively, which is grown by 5144 more units. Similarly unclassified units are grown by 107414 more units as compare to previous year

2010. In the same vain motels are continue to increase by 17220 units in year 2022 compare to year 2010.

2.4TYPES OF HOTELS

There are three major types of hotels [36]. The ratings are reviewed once in every five years.

Starred Hotels – These hotels are rated 1,2,3,4,5 star category

Approved Hotels - Hotels which have acquired approval from Ministry of Tourism but not classified into any star categories.

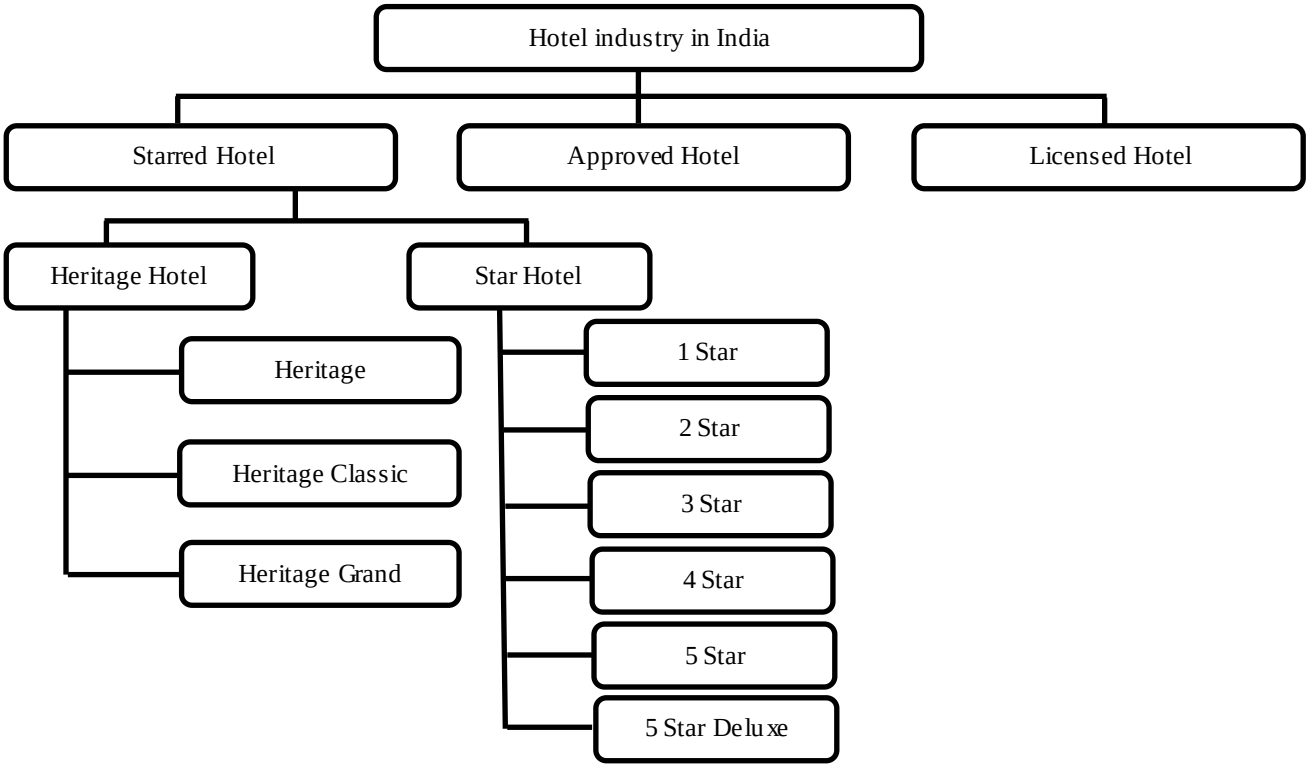


Figure 2.1 : Classification of Hotel

Source: Pictorial representation of concept by Ministry of Tourism [36]

Licensed Units – These acquire license from MCD or local authority.

Luxury –These are having 4,5 and 5 star deluxe rating.

Budget - Hotels having classification between 1 Star – 3 Star has been defined as a Budget accommodation unit.

Others – Includes approved (awaiting classification) as well as licensed units.

2.5CLASSIFICATION OF HOTEL INDUSTRY

There are many criteria that help to classify the hotels in India as follows:

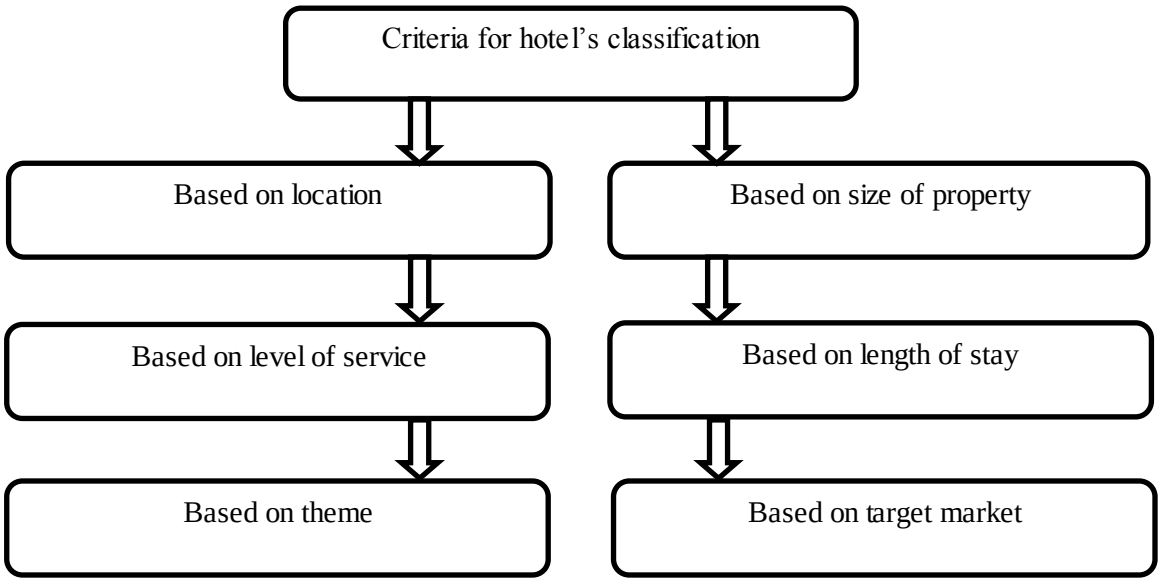


Figure 2.2 : Criteria for hotel's classification

Source: Pictorial representation of criteria for hotel's classification [65]

2.5.1 BASED ON LOCATION

- **City centre**
- **Motels**
- **Suburban hotels**
- **Airport hotels**
- **Resort hotels**
- **Floating hotels**
- **Boatels**
- **Rotels**

2.5.2 BASED ON SIZE OF PROPERTY

The main yardstick for the categorization of hotel is by size the number of rooms available in the hotel.

Small hotel, Medium-Sized hotel, Large hotels, Mega hotels and Chain hotels

2.5.3 BASED ON LEVEL OF SERVICE

Hotels may be classified into economy, and luxury hotels on the basis of the level of service they offer.

Economy/ Budget hotels, Mid-market hotels, Luxury hotels

2.5.4 BASED ON THE LENGTH OF STAY

Hotel can be classified into transient, residential and semi residential hotels depending on the stay of a guest.

Transient Hotel, Residential hotels, Semi residential hotels

2.5.5 BASED ON THEME

Depending on theme hotel may be classified into Heritage hotels, Ecotels, Boutique hotels and Spas.

- **Heritage hotel**
- **Ecotels**
- **Boutique hotels**
- **Spas**

2.5.6 BASED ON TARGET MARKET

Commercial hotel

Convention hotels

Resort hotels

Suite hotels

Casino hotels

CHAPTER 3

WASTE MANAGEMENT

3.1 DEFINATION OF WASTE

Defining waste is a contentious issue. In essence definition of waste is subjective. For legislation to be enforced there must be a clear definition of waste in order to identify what needs to be controlled and monitored. Waste can be defined as

"Any substance or object which the holder discards or intends to discard (Council Directive 75/442/EEC 1975)"

The 'holder' can either be the producer of waste or be in possession of waste [37]. Waste, however, is very subjective; one person may deem an item to be waste whilst another might see it as a resource [37][38].The natural environment now acts as the source for resources and the sink for wastes [39]. Waste is something that doesn't have any value [40] [41]. State that the current definition of waste used by the European Union (EU) lacks precision, and therefore each member state interprets it differently. This creates problems within the recycling industry due to trade barriers. [42] Proposes the definition:

"Either an output with (a negative market) no economic value from an industrial system or any substance or object that has been used for its intended purpose (or served its intended function) by the consumer and will not be reused".

The environment act 1995 sets out a number of categories in which a number of different wastes are defined. This study is concerned with household waste. In the act, it is defined as:

"Household waste means waste from private domestic accommodation, caravans, residential homes, universities or schools or other educational establishment, hospital premises and nursing homes (Environmental Act 1995)"

There is no one definition of food waste. Using these definitions, for the purpose of this report municipal food waste is defined as:

"Waste material resulting from pre and post preparation of food, which is of a quality suitable for recycling via composting"

The Environmental Protection Act (EPA) 1990 defines waste as "any substance which constitutes scrap metal or an affluent or any unwanted substance arising from the application of a process or any substance which requires to be disposed of as being broken, worn out, contaminated or otherwise spoiled" [43] [44]. It is by-product which is having no value [45]. Solid waste is broadly comprised of many types like from houses, from industry, from residences etc. [46].

3.2 CLASSIFICATION OF WASTE

Following are schematic representation of waste types which includes all three forms ie.e solid, liquid and gaseous.

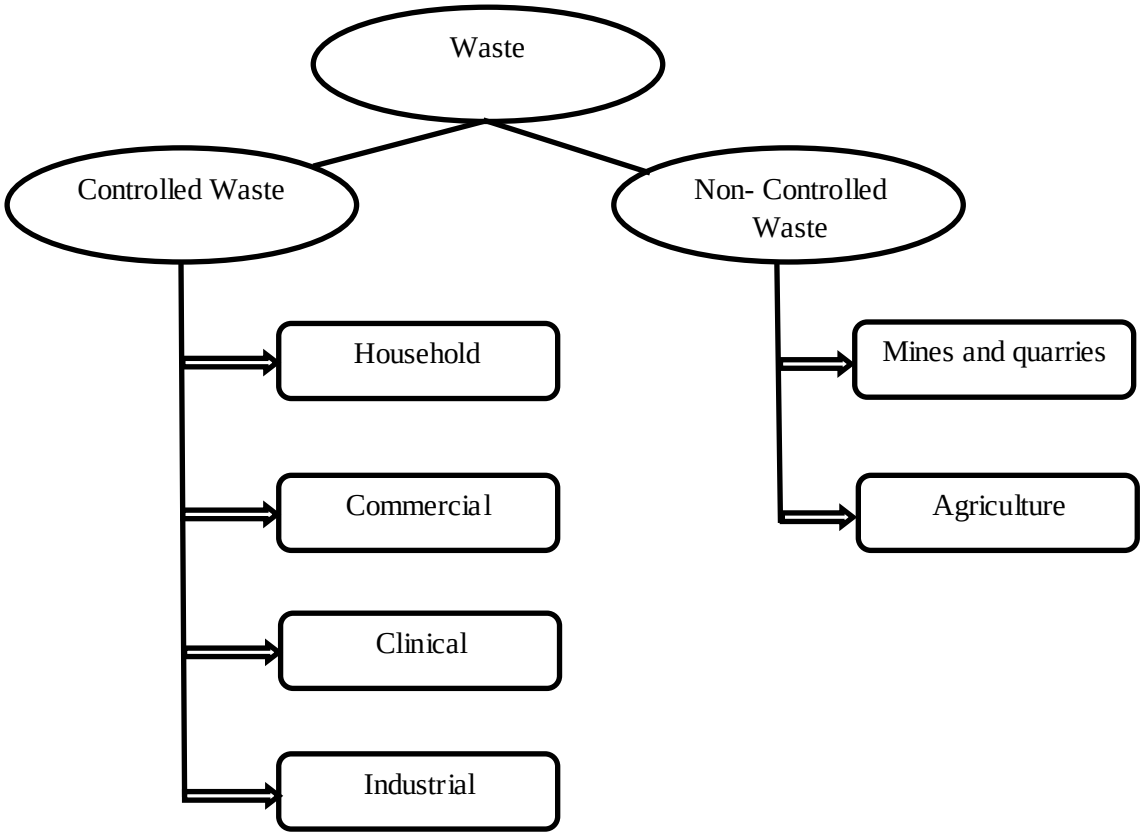


Figure 3.1 : Structure for classifying waste

Source: Classification of waste [47]

A report prepared by World Bank [48] lists eight major sectors that generate solid waste:

1. **Residential:** Includes waste generated in household units, such as food and fruit peels, rubbish, ashes etc.
2. **Industrial:** Has two components hazardous, which is toxic; corrosive; flammable; a strong sensitizer or irritant and may pose a substantial present or potential danger to human health or the environment when improperly processed, stored, transported, or disposed of or otherwise managed. Non-hazardous which includes inert and essentially insoluble industrial solid waste, usually including, but not limited to, materials such as rock, brick, glass, dirt, and certain plastics and rubber, etc., that are not readily decomposable.
3. **Commercial:** Waste produced from various commercial establishments like by wholesale, retail or service establishments, such as restaurants, stores, markets, supers-stores, malls etc.
4. **Institutional:** Waste that originates in schools, hospitals, institutions and public buildings.
5. **Construction and demolition:** Waste building material and rubble resulting from construction, remodelling, repair, and demolition operations on houses, commercial buildings, pavements and other structures.
6. **Municipal services:** Sludge from a sewage treatment plant which has been digested and dewatered and does not require liquid handling equipment etc.
7. **Process:** Treatment plant wastes principally composed of residual sludge.
8. **Agricultural:** Spoiled food wastes, agricultural wastes, rubbish, hazardous wastes.

As per the manual of Municipal solid waste, waste can be classified on the basis of source, origin and type of waste. A comprehensive classification is described below [49]:

(i) Domestic/Residential Waste

(ii) Municipal Waste

(iii) Commercial Waste

(iv) InstitutionalWaste

(v) Garbage

(vi) Rubbish

(vii) Ashes

(viii) Bulky Wastes

(ix) Street Sweeping

(x) Dead Animals

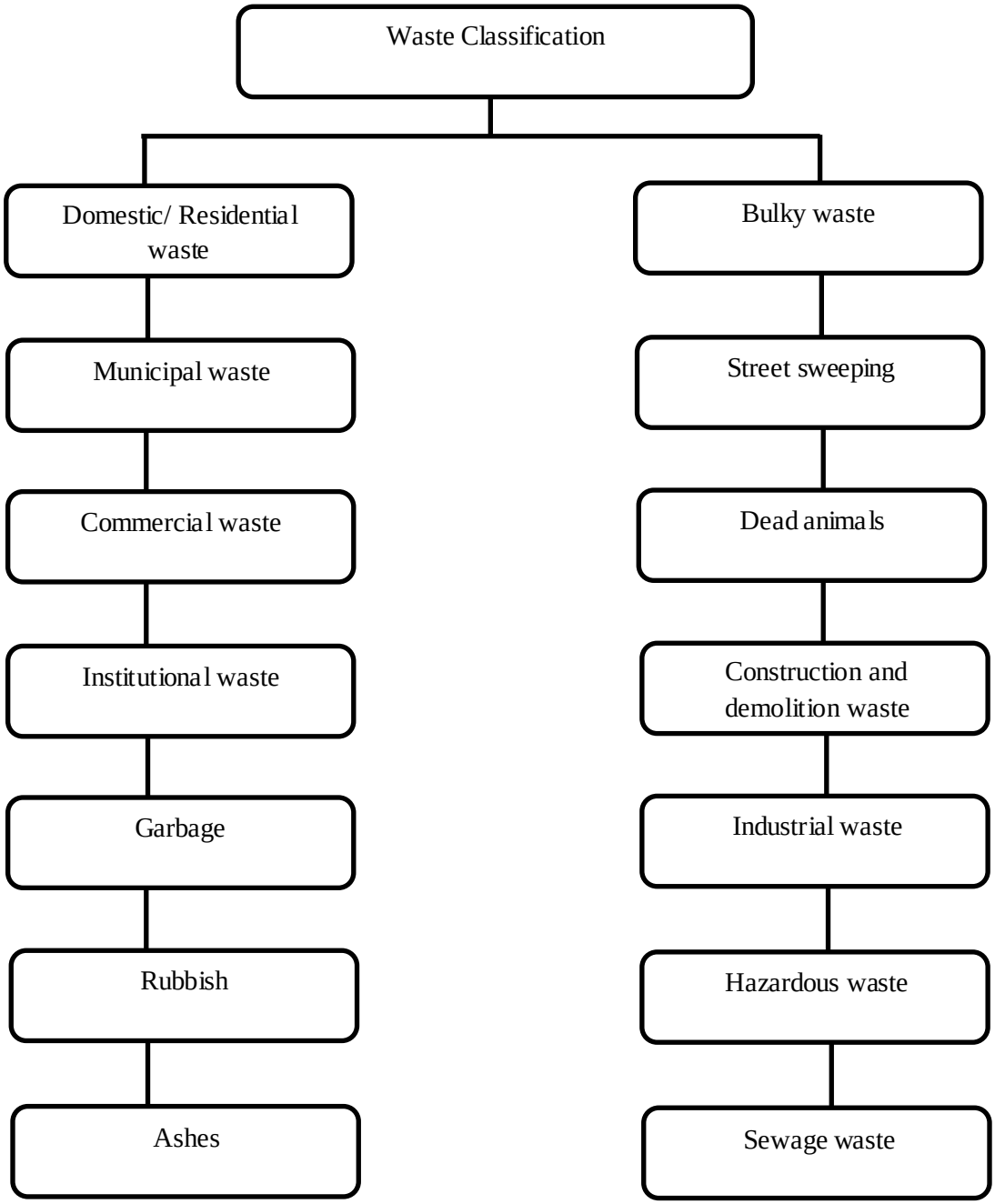


Figure 3.2: Classification of wasteadopted from MSW Manual

Source: Pictorial representation of classification of waste [65]

(xi) Construction and Demolition Wastes

(xii) Industrial Wastes

(xiii) Hazardous Wastes

(xiv) Sewage Wastes

3.3 WASTE HIERARCHY

This model was given by European Union (EU) strategy on waste [37][50]. The waste hierarchy provides order for the best environmental options which have least impact on environment, and supports sustainable waste management [51]. According to Waste not Want not [51] in their hierarchy (see Figure 3.3) they contended various methods like reuse, recycle to reduce waste. The shape of the waste hierarchy taking into account current treatment rate, such as recycling, composting, and landfill rate, seems to be the triangle shown in Figure 3.3.

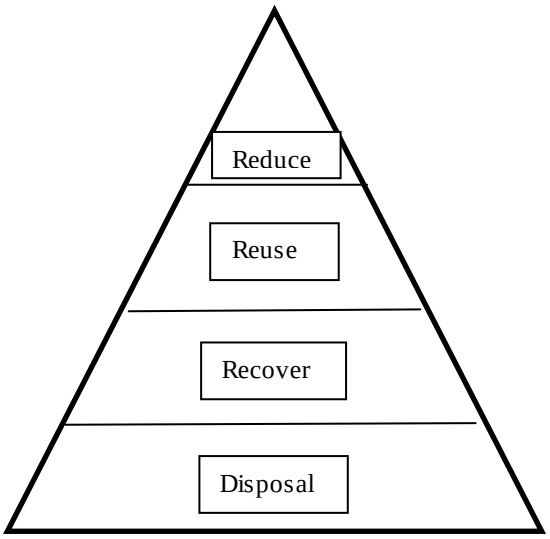


Figure 3.3: The Waste Hierarchy

Source: Waste not, wants not [51]

Waste not Want not [51] has also more detailed versions of the hierarchy. However, Department of Environment Food and Rural Affairs (DEFRA) [52] provides the waste hierarchy below as a target for waste management (See Figure 3.4).

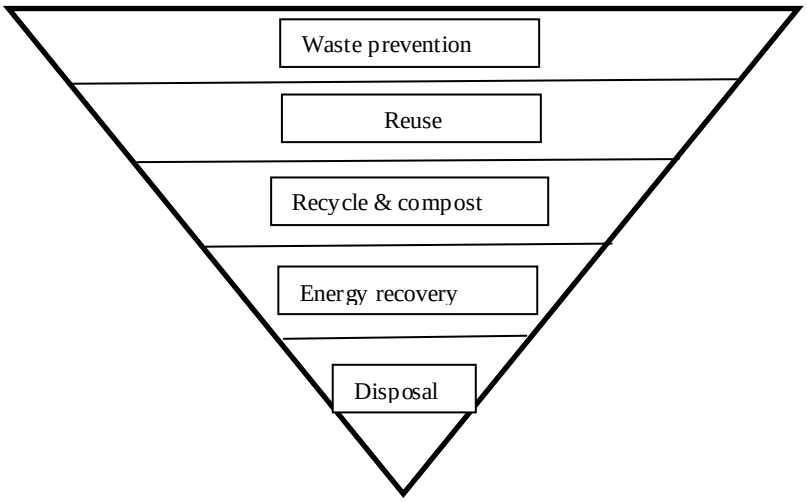


Figure 3.4: Re-define Waste Hierarchy

Source: Department of Environment Food and Rural Affairs (DEFRA) [52]

Department of Environment Food and Rural Affairs (DEFRA) [52] Figure 3.4. It was 1st introduced in 1975 and the purpose is to provide the member states with a framework for the management of the waste that they produce. It also sets out to define terms such as "waste", "recovery" and "disposal" [53].

The purpose of the waste hierarchy is to give priority to waste prevention. Failing that it aims to promote the re-use and recovery of waste. 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 landfill. The higher up the waste hierarchy a waste management strategy is, the more sustainable it is. The purpose of the waste hierarchy is to give priority to waste prevention. Failing that it aims to promote the re-use and recovery of waste. Collection of food waste and composting fits into the process of recycling. Only when all other options have been considered, should waste be disposed of, usually in the form of landfill. The higher up the waste hierarchy a waste management strategy is, the more sustainable it is.

3.3.1 WASTE PREVENTION

Waste prevention or reduction at source is viewed as the best option for waste management and can be achieved through cleaner technologies and processes by manufacturing products that are more durable. Tonglet[54] argued that the commercial and industrial sector have received better attention than the municipal sector especially householders and they further stated that it could be as a result of the emphasis being placed on recycling by waste management strategies.At the household level, waste aware shopping is vital as the [55][56].

3.3.2 REUSE

Reuse is the process when an item can be used over and over again for the same purpose.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" [57].The reuse or materials have been known to provide social, economic and environmental benefits especially in the voluntary and community waste sector which pioneered the reuse of furniture and white goods [58].

3.3.3 RECYCLING AND COMPOSTING

Waste recycling and composting is very beneficial in terms of energy savings and reduction of pressure on natural resources and emissions from landfill [59]. In a study carried out byWrap [60] on the benefits of recycling in the UK at that time 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 it environmental benefits.

Recycled materials needs 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 CO2 emissions [59]. 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 fertilizer and soil conditioner. 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 boast the market for compost products [61].

3.3.4 ENERGY RECOVERY

Recovery which is usually a process of energy from waste (EFW[2]) or burning of landfill gas is also an option in the waste hierarchy and the energy recovered can be used for heating and electricity generation and producing energy with combined heat and power (CHP) as this enables maximum recovery of energy. Other energy from waste technologies include anaerobic digestion which produces methane that can be burnt to generate electricity, direct combustion[3] or incineration, secondary derived fuel (SDF) which is output from mechanical and biological treatment, pyrolosis[4], gasification[5] and plasma arc heating [62].

3.3.5 DISPOSAL

Final disposal is the last hierarchy of model, which is the least preferred method because of the negatively environmental impacts such as release of methane and carbon dioxide from the breakdown of materials contributing to climate change, production of leachate which is a source of groundwater pollution and a loss of natural resources associated with landfill[6][63]. With the landfill directive, volume of waste landfill has reduced. Further because landfill cannot be totally avoided as a result of the production of some hazardous and clinical waste which cannot be reused, recycled or incinerated, stringent operation laws have been imposed to ensure then humans and the environment is not endangered.

3.4 WASTE POLICIES AND LAWS IN INDIA

In India there are some plocies on waste management along with historic judgements related to waste cases [64].

3.4.1 POLICIES AND RULES

Policy is the path along which the government is thinking, and reflects its priorities. Indian Policy clearly recognizes the informal recycling sector through as follows [64]:

The National Action Plan for Climate Change, 2009: The National Action Plan for Climate Change, 2009, which aims at finding ways to handle climate change within India. It states, "While the informal sector is the backbone of India'shighly successful recycling system, unfortunately a number of municipal regulations impede the operation of the recyclers, owing to which they remain at a tiny scale without access to finance or improved recycling technologies" This is part of the Mission on Urban Sustainability.

The National Environment Policy, 2006: The National Environment Policy, 2006, which states "Give legal recognition to, and strengthen the informal sector systems of collection and recycling of various materials. In particular enhance their access to institutional finance and relevant technologies" (Section 5.2.8, point (e), Pg. 36).

3.4.2 REPORTS

Indian history has got some great reports related to implementation of waste effective management [64]:

The CAG Audit on Municipal Solid Waste in India (December 2008): The CAG Audit on Municipal Solid Waste in India (December 2008) also recommends (Chapter 3, Section 3.5) that "MOEF/states should consider providing legal recognition to rag pickers so that recycling work becomes more organized and also ensure better working conditions for them."

The Supreme Court recommendations report in 1999:this reports relate to upgrading rag pickers.

3.4.3 NATIONAL COMMITTEES

There have been several committees in the last 16 years that have recognized the importance of including the informal waste recycling sector into mainstream activities [64].

AsimBurman Committee, 1999, **Bajaj Committee**

3.4.4 REGIONAL LEGISLATION

There have been many instances of progressive legislation from different states [64] like **Madhya Pradesh**, **Ahmedabad** and **Maharashtra.**

3.4.5 THE MUNICIPAL SOLID WASTE (MANAGEMENT AND HANDLING) RULES, 2000 MANUAL

This manual directs storage, waste, segregation and transportation of all municipal wastes. [65].The over-all responsibilities for the enforcement of the provisions of these rules in metropolitan cities have been given to the Secretary-incharge of the Department of Urban Development of the State/Union Territory. Further, the District Magistrate/Deputy Commissioner of the concerned district shall have the overall responsibility for the enforcement of these rules within their area of jurisdiction.

1. Collection on municipal solid waste
2. Segregation of municipal solid wastes
3. Storage of municipal solid wastes
4. Transportation of municipal solid wastes
5. Processing of municipal solid waste (Biodegradable[7])
6. Disposal of municipal solid wastes (Non-biodegradable[8])

3.5 WASTE PROCESSING TECHNIQUES/ TREATMENT

Processing techniques are used in Solid Waste Management system to improve the efficiency of Solid waste disposal system, to recover resources (usable materials), to recover conversion products and energy [66].

3.5.1 RECYCLING

It is process of converting waste material into other useful matter that can be used further [66]. There are three main methods that can be used to recover recyclable materials from municipal solid waste management.

1. Collection of source–separated recyclable materials by either the generator or the collector, with and without subsequent processing.
2. Commingled recyclables collection with processing at centralized materials recovery facilities (MRFs).
3. Mixed Municipal Solid Waste (MSW) collection with processing for recovery of the recyclable materials from the waste stream at mixed- waste processing or front-end processing facilities.

Collection of source-separated materials

The separation of recyclable materials into individual components, either by the generator or at curb side by the collector, is known as source separation. The separated materials can be collected individually in single – compartment trucks, or more commonly, they are collected at the same time in a specially designed multi compartment recycling vehicle. The segregated components are then transported to a consolidation site for further processing and subsequent shipment to markets.

Collection of commingled recyclable materials

Recyclable materials set out at curb side for commingled collection. The generator only needs to separate recyclable materials from non-recyclables. The recyclable materials are transported to an MRF[9] (Material recovery facilities) where they are segregated into each recyclable component.Processing operations at MRFs can vary from facilities with relatively mechanization, depending primarily on the sorting of waste materials, to highly mechanized automated sorting processes.

Collection of mixed MSW[10]

The third approach to recycling; there is no segregation of recyclables from other waste materials. Mixed wastes (including recyclables) are set out at curb side, as would be done for land filling or incineration. The mixed waste then transported to a central processing facility, which employs a high degree of mechanization, including separation equipment such

asshredders, trammels, magnets and air classifiers to recover the recyclables. Mixed waste processing of recyclables is also known as front-end processing or refuse-derived fuel (RDF) processing of MSW.

3.5.2 COMPOSTING

Composting is a controlled process by which, Biodegradable wastes (organic composition) gets decomposed through micro-organisms. Therefore only bio-degradable wastes can be composted, like vegetable wastes, green wastes, agricultural leaves etc. Decomposition of the organic solid waste may be done either aerobically or an aerobically. Aerobic includes even vermicomposting where earthworms are used to digest the wastes. Composting can be carried out at the local level, though compost pits and heaps and at the central level through composting plants. Compost is humus like materials that results from microbial action and degradable fraction of solid waste. The process of compositing can be either aerobic or anaerobic.

3.5.3 VERMICOMPOSTING

Vermicomposting is a process of degradation of organic matter by microbes and consumption of organic material by earthworms. Only selected species of earthworms like Eiseniafoetida, Eudriluseligeniae, Perionyx excavates, Lampitomaturi, etc., are suitable for vermicomposting process. These earthworm acts as crusher and aerator during the process. The microbe's capacity associated and makes the final product odourless. Vermicompost can be used as good fertilizer. The concentration of macronutrients was increased after vermicomposting [67].

3.5.4 AEROBIC DIGESTION

Mainly aerobic processes are used to convert bio waste into compost. In these conditions, the bio waste is aerated during several weeks up to several months by forced suction or blowing, in order to remove moisture and heat and to create an optimal environment for the aerobic merophilic and thermophiles' micro-organisms performing the biodegradation [68].

3.5.5 INCINERATION

Incineration is a technology where waste is burned in specially engineered machines. It is popularly linked primarily with hospital waste, because the use of incinerator is crucial need for the disposal of the pathological stream of Bio-medical wastes which includes body parts etc.Incineration is a process of controlled combustion for burning solid, liquid and gaseous combustible wastes to gases and residue containing non-combustible material. Heat can be recovered by incineration, which can be used for heating water and generating electricity [69]. Though incineration is not a complete method of disposal, its main advantage is thatproduces a residue that is substantially reduced in volume and may be relatively inert [70].

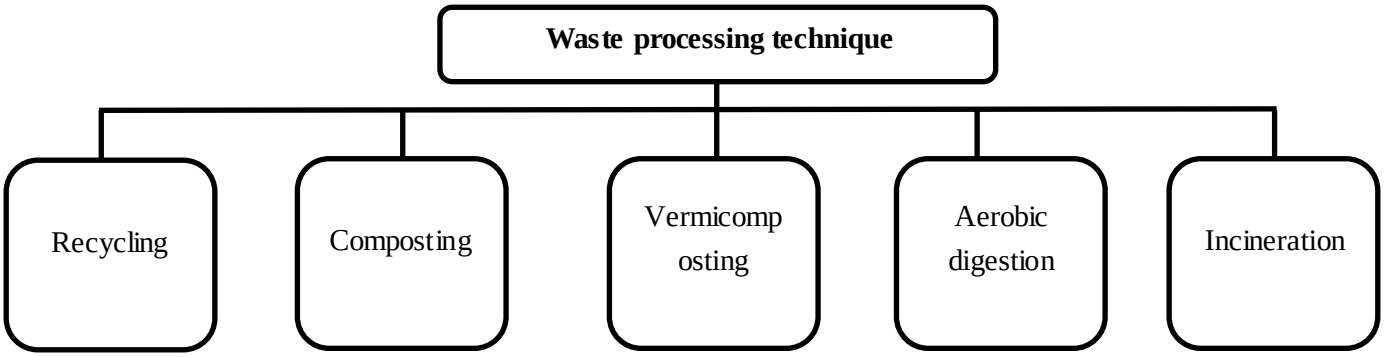


Figure 3.5: Waste processing techniques

Source: Pictorial representation of waste processing techniques [65]

CHAPTER 4

LITERATURE REVIEW

4.1 INTRODUCTION

The purpose of the study is to develop a framework for effective and efficient waste management practices for hotel industry. In line with the purpose, the literature review in this chapter has been presented in five areas:

1) Present situation of waste management in India.

2) Impact of waste generation on environment.

3) Emission of greenhouse gases (GHG) from waste generation.

4) Currently waste management practices in hotel industry.

5) Audit process for waste minimization.

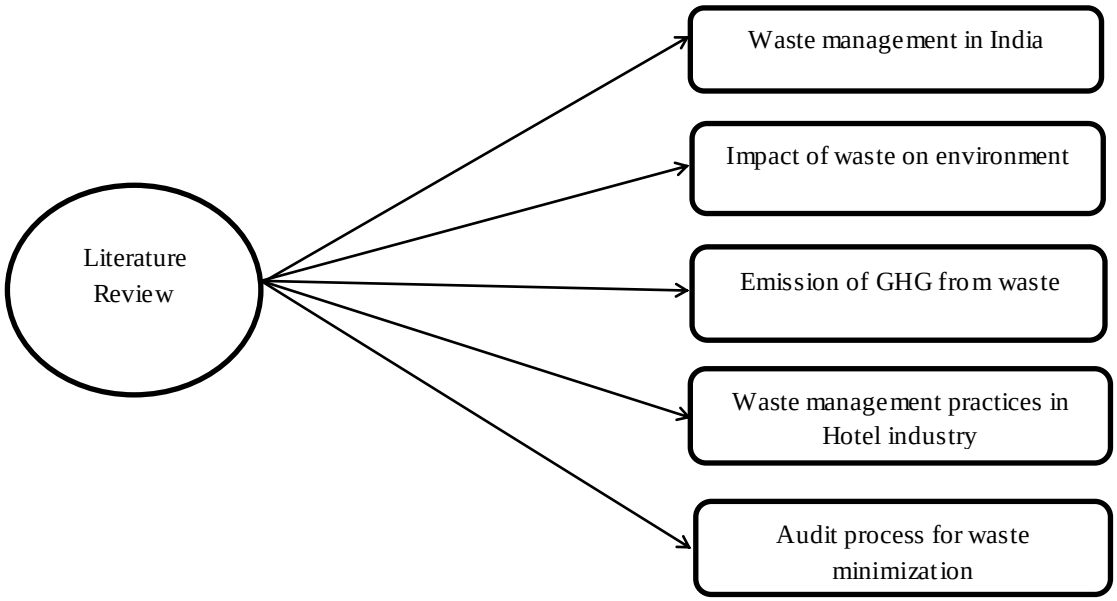


Figure 4.1: Structure of literature review

Source: Pictorial representation of literature review

4.2 PRESENT SITUATION OF WASTE MANAGEMENT IN INDIA

In the ages of modernization and industrialization there is a most common problem in today's environment [71] [72]. Pollution means change in various intrinsic properties [73] [74] and is caused mainly by human [75] [76].

One of the underlying reason for environment degradation I pollution and there could be several reasons behind [77]. These reasons could be population increase, industry growth, degradation of forest, unhygienic conditions etc. [78]. This leads to imbalance in whole ecosystem [79]. Problems such as water pollution, drainage system, waste dumping could arise out of it[80].

Waste management is one of the complex problems for entire nation [81]. Portion of organic waste is always higher in fraction that leads to problem of human and environment [82] [83]. Road side garbage from houses remains unclear because its volume is more than what the corporation can handle. Some of the useful items were taken out by Rag pickers[11][84]. The volume of waste included colonies, outlets, markets of fruits vegetables etc. (refer table 4.1).

Table 4.1: Sources and Types of Municipal Solid Waste

Sources	**Typical waste generators**	**Components of solid waste**
Residential	Single and multifamily dwellings	Food wastes, paper, cardboard, plastics, textiles, glass, metals, ashes, special wastes (bulky items, consumer electronics, batteries, oil, tires) and household hazardous wastes
Commercial	Stores, hotels, restaurants, markets, office buildings	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes
Institutional	Schools, government center, hospitals, prisons	Paper, cardboard, plastics, wood, food wastes, glass, metals, special wastes, hazardous wastes
Municipal services	Street cleaning, landscaping, parks, beaches, recreational areas	Street sweepings, landscape and tree trimmings, general wastes from parks, beaches, and other recreational areas

Source: Adopted from United Nations Environment Programme [83] [85]

Viswanathan [85] argues that waste is increasingly becoming more problematic in nature. Most of cities and towns of any nation is highly crowded and facing problem of inadequate supply of water, solid waste and disposal area[86][87].Leachate[12]formed due to pollution causes water contamination [88 [89]. Today solid wastes are considered as one of the major

sources for pollution in the human environment. Various types of pollution are spreading all over the world, posing wide variety of health and environmental threats. The solid waste generated due to the human activities causes enormous environmental damages to the soil and water sources. Improper management of waste further creates a risk to environment and human health because of insanitary conditions. [90] [91].

India generated 229 MT of solid waste in 2001 with per capita generation of 100-500 grams [94]. The Energy and Resources Institute (TERI) says there will be growth in waste generation in India from 1-1.33% by 2047 [95].

There is 45-75% organic waste in overall production of waste. It is estimated that per capital waste from major metro rage from 0.45 – 0.6 kg per day per person [96] [97]. In a high technology industrial world, garbage is an unavoidable consequence of prosperous [98]. In terms of house hold waste can be classified as vegetables, fruits, shells, metal, plastic etc. [99]. These waste generations poses problem of contamination ground water, fire, explosion in land-fill sites[100].This turns worse when Garbage left unattended [101]. This garbage also poses problem for cities, towns due to its undesirable effect [102]. Chunk of waste disturbs ecological balance of environment as well as limited the land area of residential and other useful purposes which is required in urban area [103].

In some developed countries, recycling process is used at initial level of waste source. Later on waste vendor collects waste and returns salvage value of it [104] [105]. In India up to thrre quarter waste remains collected but there are some process like recycling, composting, to utilize that source. Memon [106] discusses the concept of ISWM and its arguments. There are some stages of the ISWM chain which include source separation, collection and transportation, transfer stations and material recovery, treatment and resource recovery and final disposal. It is suggested that 3R is integrated within ISWM. This Paper also highlights the process of developing and implementing ISWM in cities/towns. This process includes waste data and assessment of current waste management systems and development of an ISWM plan with its implementation strategy. If this process is managed separately, then it would be a costly business. Hence, joint efforts under ISWM could be efficient and effective. This is a major challenge for all cities. Implementation of ISWM is straightforward because local capacity supported by national and international initiatives, can lead to all the actions

being undertaken locally, including waste characterization and quantification, assessment of the current waste management system, targets for ISWM, identification of stakeholders and development of an ISWM plan and implementation strategy for ISWM [106].

Baldisimo [107] study of Bangkok, Jakarta and Manila, while analysing scavenging of municipal solid waste in, observed that the quantities and characteristics of solid waste produced vary from country to country and identifies the factors that influence it as the average level of income, the sources, population, social behaviour, climate, industrial production and the market for the waste materials.

Jenkins & Robin [108] in their study on American municipalities found that waste generation increased with increase in the percentage of population in the age group between 18 and 49. She also developed a model where households maximize utility, which positively depends on the consumption of goods and negatively on the quantity of recycling. The budget constraint included a disposal charge for municipal solid waste collection. The quantity of municipal solid waste generated was found to be sensitive to the price of municipal solid waste collection. Analysing data for in American municipalities, she found that a $1.00 dollar fee per 32-gallon trash bag would reduce waste generation by 15 per cent. She estimated that such a pricing system would improve social welfare by $650 million per year i.e. around $3 per person per year. The average price elasticity for municipal solid waste collection was -0.12.

Mclain[109] says that change in life-style is major contributors in generation of waste in USA. In his study, it is found that one third of waste is in form of packaging and container material. Koning[110] surveyedon countries like Brazil and Mexico had high rates of over 0.3tons/person/year and countries like Bolivia and Equador had lower rates of less than 0.1tons/person/year.

Bhattarai [111]analysed the household behaviourpattern on solid waste management in Kathmandu metropolitan city and found household size and income as the major determining factors for the total quantity of wastes generated. Salhofer [112] dealt with four different approaches to analyse waste generation rates: i) Input–output models: In these models, input of the waste generator is assessed by using production, trade and consumption data about products related to the specific waste stream; ii) Factor models: These models consider

analysing factors like income, housing types etc. 28 which describe the processes of waste generation; iii) Region specific classification iv) Single point of generation based classification and v) Macro level classification.

Ambat [113]identified the types and estimated the quantities of waste generated in each ward of Thiruvananthapuram City Corporation. It was estimated that a total of 290-300 tons of solid waste were generated in the city. The contribution of the households was 181 tons followed by markets (40 tons) and hotels and restaurants (30 tons).The medical waste was about 13 tons. The non-degradable waste like plastics, paper, metals and glasses were collected from the source or from the disposal sites by a group of rag pickers. They sell these wastes to the wholesale dealers who will transport these wastes to Salem and Coimbatore for recycling. The technology optimization study considered composting as the best method for disposing waste in Trivandrum since the degradable waste content (50%) is high in the solid waste stream. Bio-methanation was suggested for institutions, hotels and marriage halls. The important aspects of the solid waste management action plan included; a) segregation and characterization of the wastes at the source itself ; b) decentralized collection from the primary source and centralized collection from secondary sources; c) strengthening the existing informal waste collection sector d) detailed transportation network planning.

Ray [114] examined the present solid waste management scenario in the city of Ahmedabad and identified the problems of the existing systems and analysed the steps taken by the city corporation to rectify the problems.

Ambat[115] analysed the current practices of solid waste storage, the present waste management practices, the communities' perception on the existing collection and management system in Thiruvananthapuram city. The study also examined the changed attitude of the community, people's preference and willingness to cooperate and pay for an improved solid waste management practice and also identified the new initiatives at the local level for waste management. Lack of space and practice are considered to be the main reasons why wastes are not segregated and thrown on the road side. People are not willing to do any segregation of waste except the newspapers. Majority of the hospitals dump the waste in the dumper placer containers or burn it in the hospital premises. It was found that 55% of the households reduce, reuse and recycle the waste materials. Majority of the low-income and

middle income houses burn 60% of the waste generated and sell the rest for a nominal rate. 88% of the people feel that they have a role to play in solid waste management showing the change in the attitude of the people towards solid waste management.

Mathew [116] examined the quantity and quality of the solid waste generated in Kottayam town. Random and cluster sampling methods were 39 used for selecting the households. The total waste generated per day was about 52.3 tons and the per capita generation was 0.62 kg/per day. It was found that the storage capacity of the community bins being inadequate. Vermicomposting was considered as the most effective method for organic wastes.

Sekher [117]analysed the process of municipal waste management in the city of Bangalore while focusing on the situation in Karnataka state. The paper considers the characteristics of municipal waste generated, the management practices involved and the role of the stakeholders in the overall process. Inadequate municipal service, unscientific disposal system, lack of civic awareness in waste management lack of a proper market for recycled waste products .etc. are found as the most important deficiencies in the waste management system.

Study on Thailand city, Chiemchaisri[118] articulates that the amount of waste generated is on basis of economic development, population and technical efficiency of recycling. It is calculated that institutional and business area can generate 67% while rest 33% from hospitality waste. The total Municipal Solid Waste (MSW) generation in Thailand increased from 11.2 million tons in 1993 to 14.3 million tons in 2002 (Fig 4.1). Moreover, the average per capita generation rate increased from 0.53 kg/capita/day in 1993 to 0.62 kg/capita/day in 2002. This clearly indicates that the quantity of the generated MSW in Thailand and the per capita generation rate are both increasing with time, pointing to the need for a sustainable approach to disposal and management [118].

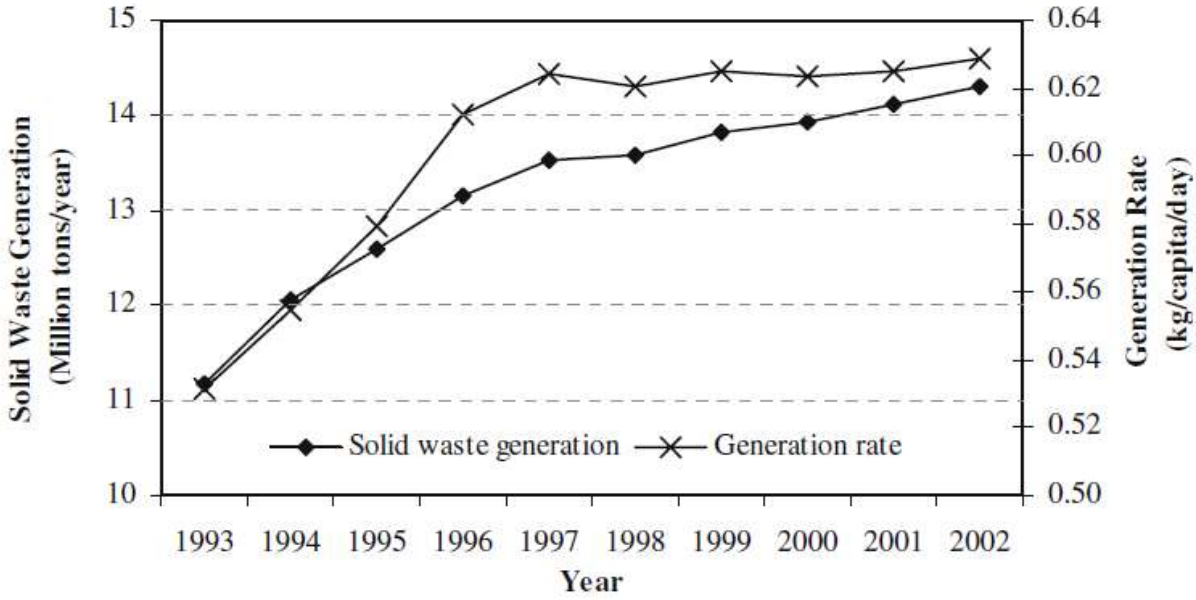


Figure 4.2: Solid waste generation and per capita waste generation

Source: Chiemchaisri et.al [118]

Bhuiyan [119] daily estimation in Dhaka is around is 3,500 tons. Out of it 400 tonnes of recyclable waste is only from informal sector. However, in one of the rigorous study conducted by JICA report [120] demonstrated that waste from domestic area is 1950 tons per day with 0.34 kg/person/day. It is projected to increase 2382 ton/day and 2817 per day in 2010-15 [120].

Growth of growth and increasing urbanization means bigger and denser cities and increased Municipal Solid Waste (MSW) generation in each city. India was generating 31.6 million tons of waste in 2001 and is currently generating 47.3 million tons, a 50% increase in one decade. It is estimated that these 366 cities will generate 161 million tons of MSW in 2041, a five-fold increase in four decades. At this rate the total urban MSW generated in 2041 would be 230 million TPY (630,000 TPD) [121].

Table 4.2: Population growth, urban waste generation and future predictions

Year	Population (Millions)	Per Capita	Total Waste generation Thousand Tons/year
2001	197.3	0.439	31.63
2011	260.1	0.498	47.30

2021	342.8	0.569	71.15
2031	451.8	0.649	107.01
2036	518.6	0.693	131.24
2041	595.4	0.741	160.96

Source: Adopted from Annepu, R.K [121]

MSW Rules 2000 mandate "landfills should always be located away from habitation clusters and other places of social, economic or environmental importance", which implies lands outside the city. Therefore, increase in MSW will have significant impacts in terms of land required for disposing the waste as it gets more difficult to site landfills [122].

Table 4.3: Area of land required for unsanitary disposal of MSW

Year	**Area of Land Occupied/Required for MSW Disposal (sq.km)**	**City Equivalents**
1947 - 2001	240	50% of Mumbai
1947 - 2011	380	90% of Chennai
1947 - 2021	590	Hyderabad
2009 - 2047	1,400	Hyderabad + Mumbai + Chennai

Source: Adopted from Annepu, R.K [121]

Study by TERI (The Energy Resources Institute, earlier Tata Energy Research Institute) in 1998, titled 'Solid Waste Management in India: options and opportunities' calculated the amount of land that was occupied by waste disposed for time period between 1947 to 1997. The study compared the waste disposal land occupied in India was in multiples of the size of a football field. Study arrived at conclusion that this land is equivalent to 71,000 football fields of solid waste, stacking up to 9 meters of height. Based on business as usual (BAU) scenario of 91% landfilling, the study estimates that waste generated in country by 2001 would have occupied 240 sq.km or an area half the size of Mumbai; waste generated by 2011 would have occupied 380 sq.km or about 220,000 football fields or 90% of Chennai [123] and [124].

There are many innovative approaches that can be used for sustainable solid waste management; especially the ones whichthe participation of public-private partnership for collection, treatment and disposal of waste [125].

4.3 IMPACT OF WASTE GENERATION ON ENVIRONMENT

The literature on environmental issues are immense, but dispersed and often concentrated on very specific problems and sometimes highly technical in nature. There are many important literatures available on environmental concern and problem [126]. 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 [127].

Natural resources are sparse and their consumption is high [128] [129]. Manivasakam commended that pollution is like a tiger lurking in the bush, ready to pounce upon us at any time leading to total destruction.

Macniell[130] said that developed countries are over exploiting natural resources so for long run these resources will become limited. Therefore renewable resources should be preferred in usage. The same study also done by Roy [130][131].Donella Meadows explained the obvious causes of ecological degradation with the help of a formula known as PAT formula [132]. The formula denoted that:

$$I = P * A * T$$

Here, I is environmental impact, P is population, A is material throughput associated with Affluence, T is technology

The formula represent degradation of environment with reason of increasing population and economic growth [132]. Rapid economic growth and population boom are considered as the reasons behind environmental degradation by William Barron, he said,

"It is the only high Income place in the world that is acquiring a third world environment"[133].

Lahiry[134]revealed that globalization and industrialization are responsibe for growth of economy as well as environment degradation[134]. Varshney [135] said that population and material growth result in global warming. It is also responsible for ozone depletion and loss of biodiversity. John Bellamy foster [136] said that there are some other sources like energy,urbanization, population etc. are responsible for increasing carbon footprint

One important problem that required specific mention among environment issues is the degrading urban environment. Kamath[137]commended urbanisation is growing at a tremendous pace leading to "a world of agglomerations, megapolis piled on megapolis". He also extend that as the urban man satisfies his needs and desires, he spoils the environment. So urbanisation is considered as a menace to the survival of homosapiens and a crime against humanity.

Angoni[138] and [139] gave same result that pollution of air, generation of waste, noise pollution, and contaminated land are seen in developed nations. Serageldin and John Martin Brown [140] talked about above factors are responsible for waste generation.

Trivedi and Gurdeep Raj said that in urban areas shops, factories and institutions can generate high amount of waste that disturb the urban life [141][142]. Raghupathi[143] classified overall urban environmental problem in three like micro level, meso level and macro level.

The main concerns in urban city are degrading environment condition because of open dumping, run off ground water etc. [143].According to Benjamin [144] from past year only life style is responsible in village as well as in city. But in recent decade various industrialization make solid waste one of the challenging problems.

Venketaswaran[145] established relationship between problem of waste and urbanization; she said that development of human life from cave to community is only with help of urbanization. This development also supports waste generation. McCarthy [146] found that this local concern is becoming global with increase in its intensity. Mills [147] classified problem of waste in two forms: first is improper diseconomy and second issue is local inefficiency.

Nath and Hens [148]said that environmental pollution is from all three sources air water and land. Also suggest that managing solid waste can also control the pollution of above areas.

Generation of solid waste and related services like collection, transportation, processing and final disposal of waste are important both in terms of health of the public and environment [149]. Solid waste is a complex mixture of different substances. The potential health effects of such solid waste are a subject of research [150]. 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.

Extensive literature shows the adverse ill effect of waste on environment and human health provided by National Solid Waste Association of India (NSWAI) in table below 4.4.

Table 4.4: Adverse effects of wastes reach landfill and open dump sites

Broad categories of Environmental or health hazard	**Specific deleterious affect**
Environmental pollution	Air quality, water quality, land use.
Spread of Communicable diseases	Diarrhoea, gastro- intestinal diseases, respiratory infection, skin diseases, Jaundice, trachoma, Eosinophilia, etc.
Occurrence of Non communicable diseases	Poisoning, hearing defects, dust allergies.
Possibility of Injury	Occupational injury by sharps, needles, glasses, metals, wood, violence etc.
Disturbance to aesthetics	Odour, visibility, dust etc.
Birth defects and reproductive disorder	Low birth rate, congenital malformations
Effects on community due to MSW solid waste incineration	Release of toxic, carcinogenic and mutagenic substances, increase in incidence of laryngeal, liver, lung cancers.
Potential risk to workers population	Risk of musculoskeletal problems, exposure to bio-aerosols and volatile compound resulting in respiratory, gastrointestinal and skin problems.

Increase in vector population	Putrefying waste is the breeding ground for rodents, insects and mosquitoes. Which are the vectors/career of many diseases such as malaria, dengue etc.

Source: Municipal solid waste (MSW) Manual [65] and Rushton [17]

There are many illustrations that shows the reality of impact of waste on human health and environment like examples of staff and community engaged in waste handling, waste dumping nearby village etc.

Illustration 4.3.1: Health Status of staff and community associated with MSW Management in Kolkata [150]

A study was conducted with a sample size of 732 adult individuals (male 466, female 266), recording the health of rag pickers, staff and community associated with waste dealing by qualified medical practitioners at the site of garbage dump, landfill or at the nearest office of the Kolkata Municipal cooperation (KMC). Questionnaire was developed containing habit, economic condition, family size, duration of work etc. On the basis of respiratory symptoms and illness determination broadly two groups are categorized:

- Upper respiratory symptoms (URS) including sinusitis, running or stuffy nose, sore throat, common cold and fever.
- Lower respiratory symptoms (LRS) including dry cough, cough with phlegm, wheezing, chest discomfort or pain.

Analysis of result shows that UR symptoms were found around 82% in worker and around 93% I rag pickers. Similarly fraction of LR symptom was much higher in conservancy staff and rag pickers. Impairment of lung function was found in 71% of the conservancy workers and 84% of rag pickers in contrast to 57% in control population. Thus the case study concludes that there is a direct correlation between the health of workers/rag pickers and their exposure to solid waste.

Illustration 4.3.2: Municipal solid waste management in cities - issues of basic rights of people of surrounding a village and alternatives, Villappilsala, Thriuvananthapuram City [151]

Villappilsala is a place with natural beauty but due to commencement of waste disposal plant for treating the municipal solid waste, the environment is polluted due to the arrival of garbage from the city and fresh water aquifers are contaminated due to dumping of inorganic waste which cannot be treated using the technology available. When the factory started functioning, there have been reports that it has been causing environmental and health problems to the local community likes Water contamination, health issues of clean air to breathe, Problem of insect vectors and other litters or sanitation problems.

Illustration 4.3.3: Case study on Health Hazard associated with waste [152]

Elliott [152] has reported the health impact of solid waste inUnited Kingdom. They observed that significantly elevated risks and several defects, including neural tube defects, hypospadias and epispadias, abdominal wall defects and surgical correction of gastroschisis and exomphalos in those people that reside in the vicinity of landfill site, usage of incinerator in "waste to energy" approach is suspected to cause cancer problems like laryngeal, lung cancers, childhood cancers, leukaemias, soft-tissue sarcoma and non-Hodgkin's lymphoma.

Vasanthi [153] found that disposal of solid waste likely to contaminate ground water. Waste that is dumped without any treatment contaminates portable water. Leachate from these wastes contain in form of Nitrogen, potassium, calcium, iron etc. when the leachate mix with water it affect whole community.

In India, there arenumber of reports about leachate problem. In one study in Chennai shows that 4,800 tons of waste generate and reached at 6,000 tons by the year 2010 [153].

Once the waste prevention program executed further it is converted to integrated waste management that is feasible for large amount of waste material. The sanitary landfill is alos play important role for waste storage.

Direct dumping of untreated waste in rivers, seas, and lakes result in the accumulation of toxic substances. These substances thenenter in the food chain through the plants and animals that feed on it. In addition, improper disposal of solid waste may produce bad odours weaning away beauty of nearby areas.

4.4 EMISSION OF GREENHOUSE GASES (GHG) FROM WASTE GENERATION

For last few years importance of global warming increases day by day that contains high amount of hazardous gases that resulting increase in temperature. IPCC [154] reports reveals that Methane[13] is important and hazardous gas in GHG. It is also estimated that it is twenty time dangerous than carbon dioxide [154]. Overall Methane emission accounts 3-19% all over the world only from landfill site [154]. The estimation has been made from mere calculation using national statistics on waste generation. In many countries, especially the developing economies of the world, the available data on waste generation are not consistent, leading to a large uncertainty in the estimates.

Nowadays, global warming and Ozone depletion is main issue for international level. Most of reports like intergovernmental Panel on Climate Change (IPCC) expected that it would increase from 1– 6 degree centigrade [155]. Between the year 1984 and 2004, CO2 increases by 43% with annual increase of 1.8% [156]. In Hong Kong, the total amount of GHG emissions in 2007 was about 46,700 kilotons of CO2-equivalent (CO2-e), or 6.7 tonnes per capita [157], which is comparable to the statistic (6.26 tonnes per capita) announced by the International Energy Agency [158]. Though being lower than those recorded in developed countries such as the United States (19.1), Australia (18.75), Singapore (9.8), Japan (9.68) and the United Kingdom (8.6), this level was still higher than that of the whole world (4.38).

In India, most of the solid wastes are disposed of by landfilling in low-lying areas located in and around the urban centres. The total methane emissions from Indian landfills carried out by National Environmental Engineering Research Institute (NEERI), worked out to be 0.334 (Tera-gram) Tg year during 1990–1991 [159]. The present paper, therefore, makes an attempt to estimate the realistic values of methane emission from municipal solid waste (MSW) landfills, by carrying out extensive investigations both from field and available national statistics.

Landfill gases are created from anaerobic decomposition of waste like methane and carbon dioxide. A wide range of gas production rate is estimated between 0.187 and 0.424 m^3 kg wet wastes or between 0.009 and 0.02 m^3kg [160]. Gases produced are not managed properly and

affect negative on human health and environment. Amount of land fill gas is based on waste type, region, and local factors. Apart from this, other conditions like moisture content, PH value [161] [162]. Municipal solid wastes in developed and developing countries have common of food waste. Here summer and winter season also affect land fill gases.

The estimation of methane gas emission from landfills has been consistently investigated by various researchers across the globe. Mostly, attempts were directed to estimate the landfill gas (LFG) for its extraction and utilisation as a renewable source of energy. These methodologies could be very well explored for their use in the estimation of GHG emissions. It could be seen that there is a need for reliable and consistent data on MSW for estimation of LFG when solid waste is disposed of in a controlled manner. In India, where such conditions do not prevail, it may be necessary to adopt empirical relationship coupled with scientific logic. The LFG could be better estimated by using the first-order decay (FOD) in two phases. In the first phase, the rate of generation keeps on increasing till the peak is reached; thereafter, it keeps on declining till the material is stabilised [164].

As a case study of urban areas in Southeast Asian countries, methane emissions from the waste landfill sites in Hanoi, Vietnam, were investigated based on a document survey and field measurements with the study aimed at being applicable to other Asian countries [165]. To estimate methane emissions from waste landfills, the streams of organic waste before landfilling were estimated in Hanoi from a document search, exploratory investigations, and interviews with persons in charge. Furthermore, to obtain the regional-specific behaviour of methane emission from waste landfills, field measurements were executed in both operating and closed waste landfills in Hanoi [165].The methane emission potential, E, from degradable organic carbon (DOC, tons) was estimated using the following equation:

$$E = MCF \cdot DOC \cdot DOC \cdot F \cdot F\ 16/12$$

Where:MCF- is the methane correction factor, 1.0; DOCF- is the dissimilated DOC content, 0.5; F- Is the methane content in landfill gas (LFG)

Furthermore, the annual change in the methane emission from the waste landfill was assumed to decrease with first-order decay (FOD) method [165]. IPCC suggest that construction of

building also helps in emission reduction [166]. Carbon audit is one of the main sources of GHGand it is reduced for construction of building [167]. There are many guidelines for carbon audit having different base and methodologies. There are many examples of calculating carbon emission like modelling approach that is sued for planning of energy and reducing carbon footprint. Most of studies estimate this emission on basis of depth field data [168] [169][170].

In tourist destinations like Singapore and Hong Kong in which hotels are energy efficient buildings [171] [172] [173] that predicts amount of emission reduces with help of construction of building[174].Emissions are major problems in India have grown steadily over time. There was a time when it was not such a big problem though today it is huge in intensity. The waste sector includes solid, biological, incineration and open waste along with andwas responsible for roughly 124 million TCO2e of emissions in 2005, or 6.7% of total Indian emissions. The average contribution of the waste sector in Asia is high than the world average. Indian emissions from waste are not very high and lower compared to many other countries. The rate in waste over last decade was 1.8% which represents 31% overall growth from the waste sector [175] and is increasing at fast pace.

Table 4.5: Growth in GHG emission from waste

Country	**1990**	**2005**	**Change**	**Avg. Annual growth**	**Total growth**
Canada	20.2	27.2	7	2.00%	34.60%
India	94.4	123.8	29.4	1.80%	31.10%
Indonesia	27.9	34.5	6.6	1.40%	23.50%
Brazil	34.6	42.8	8.1	1.40%	23.40%
Australia	10.3	12	1.7	1.00%	16.70%

* CH4 (MtCO2e)

Source: Climate analysis indicator tool (CAIT), version 6.0, Washington D.C [175]

In contrast, during the same period, many developed countries greatly reduced emissions from waste, largely due to improved landfill gas recovery technologies, recycling programs, and integrated waste management practices at the municipal level. For example, the U.S. reduced emissions from the waste sector by 0.9% annually, for an overall reduction of 13.1%.

European nations saw even greater reductions. In Germany for example emissions from waste decreased by 64.4% over the last 15 years [175].

Most of researched on issue of estimation of emission for different years [176], [177],[178], [179], [180], [181],[182], [183],[184] and [185]. India has submitted the Initial National Communication (INC) to UNFCCC in June 2004 including inventory of CO2, methane and N2O using many domestic emission factors [186]. The reporting year is 1994 and this inventory is used as a benchmark for greenhouse gases (GHGs) for the current study.

Above research estimates that emission for years 1985–2005. The report covered main GHGs gases like carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), perfluorocarbons (PFCs), hydrofluorocarbons (HFCs) and sulphur hexafluoride (SF6). In 2007 recorded GHG quantity of 1727.71 MT of CO2 equivalents consisting of 1221.76 MT of CO2 release along with 20.56 MT of CH4 and 0.24 MT of N2O [187].

Another study by Garg [188]found 10% methane from all sectors. They estimated that CO2, CH4 AND N2O was 778.00, 18.00, and 0.30Tg (Teragram; 1 Tg ¼ 1 million tonnes) respectively. In India these are growing at 6.3% (CO2), 1.2% (CH4), and 3.3% (N2O), respectively. This is based upon real data depicting current status. Other report [189] depicts trend in GHG in India for 1985–2005. Details of the findings of the study are illustrated in figure below:

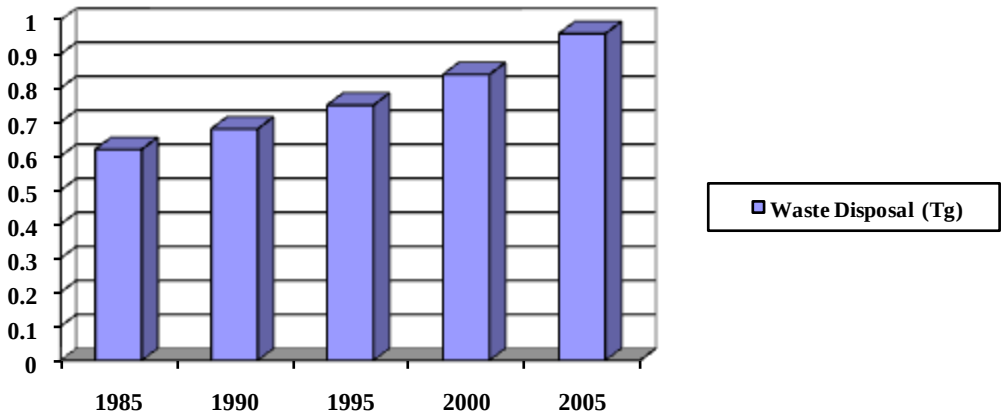


Figure 4.3: Methane (CH4) emissions from various sources in Tg-CH4

Source: Adapted from Garg. A. et al. [189]

According to author [188], methane and nitrous oxide are the two main gases which emit from waste. From table 4.3, the methane (CH4) emission rate was 0.62 Tg in 1985 and after 20 year in 2005 it reached 0.96 Tg means increase at 2.2 percent compound annual growth rate (CAGR).

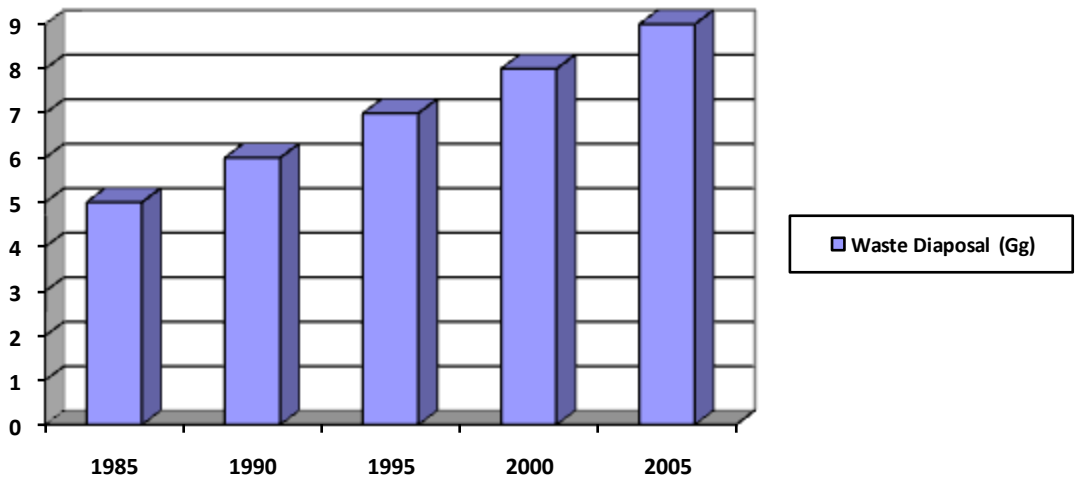


Figure 4.4: Nitrous oxide (N2O) emissions from various sources in Gg-N2O

Source: Adapted from Garg. A. et al. [189]

In the same manner the rate of nitrous oxide (N2O) was 5 Gg in 1985 and it increased to 9 Gg in 2005 with growth rate of 2.8 percent CAGR. Thus it can be said that this growth trend needs to be checked before it creates major imbalance in the environment, causing health related problems to human being.

Report by INCCA[190]compared the trend values between the dominant sectors of societies. The GHG emission from 4 major sectors for year 1994-2007 showed that tremendous changes in their compound annual growth rate as mentioned in table 4.6 [190].

Table 4.6: Comparison of GHG emissions by different sectors

Sector	**Year 1994**	**Year 2007**	**CAGR (%)**
Electricity	355.03(28.4%)	719.30(37.8%)	5.6
Transport	80.28 (6.4%)	142.04(7.5%)	4.5

Agriculture	344.48(27.6%)	334.41(17.6%)	-0.2
Waste	23.23(1.9%)	57.73(3.0%)	7.3

Source: Adapted from INCCA, India: Greenhouse Gas Emissions [190]

The estimation of greenhouse gases (GHG) is based on the first order decay model which is an improvement over the mass balance approach used in earlier reports, and is based on an exponential factor that describes the fraction of degradable material which degrades into CH4 each year. One key input in the model is the amount of degradable organic matter (DDOCm) in waste [190]. It is represented as:

$$DDOCm = W * DOC * DOCf * MCF$$

Here DDOCm= is decomposed mass in mGg
W = deposited waste inGg
DOC = degradable organic carbon in the year of deposition, fraction, Gg C/Gg waste
DOCt = fraction of DOC that can decompose (fraction)
MCF = CH4 correction factor for aerobic decomposition in the year of deposition (fraction)

CH4 generated in a year is estimated by amount and decomposition [190]. Thus methane generated in a year can be calculated as:

Methane generated in year T

$$CH4 = DDOCmdecopomT * F * 16/12$$

Where,
F = Fraction of CH4 by volume
16/12 = molecular weight ratio, CH4/C

$$CH4\ Emitted\ T = (\Sigma\ CH4\ generated\ X, T - RT) \times (1 - OXT)$$

Where,
RT = recovered CH4 in year T, Gg

OXT = oxidation factor in year T, (fraction)

On an average for all cities waste generation rate is 0.55

A study byHoornweg [191] estimates emission of CH4 for year 1995 – 2025 that shows emission in India increases at least 6 times for past 1995 year. It shows that India is 2nd highest emitter of methane.

Table 4.7: Waste generation and methane emissions from waste disposal sites (1995-2025)

	1995 Data			**2025 Projection**		
Country	**Urban MSW generation rate (kg/cap/day)**	**Methane Emission (kg/year)**	**Methane Emission (kg/cap/year)**	**Urban MSW generation rate (kg/cap/day)**	**Methane Emission (kg/year)**	**Methane Emission (kg/cap/year)**
China	0.79	898.52	2.35	0.9	4075.12	4.93
India	0.46	474.55	1.92	0.7	2774.92	5.37
Indonesia	0.76	457.49	6.52	1	1581.74	9.05
Thailand	1.1	165.33	9.44	1.5	424.39	13.58
Malaysia	0.81	68.91	6.08	1.4	281.11	11.09
Bangladesh	0.49	38.66	1.46	0.6	243.69	3.29
Vietnam	0.55	31.76	1.96	0.7	189.87	4.6
Myanmar	0.45	18.46	1.61	0.6	106.41	3.94
Cambodia	0.69	2.67	1.64	0.8	25.5	3.5

Source: Urban MSW generation rate as cited by Hoornweg et al. [191]

According to the Wilco[192], hotel industry consumes large amount of energy resources so recommendation is to adopt energy efficient practices. Cheung [193] shows that in Langham Place Hotel, Mongkok, Hong Kong effectively reduce carbon footprint by designing energy efficient building.They reduce about 1900 ton of waste by using various green practices. In another study, Gossling [194]said that consumption pattern is changed due to tourism industry that affect food as well as drink industry. To reduce volume of waste, Kirk [195]suggest that green purchasing policy, minimizes waste, proper waste disposal are three main strategies of waste management. Bohdanowicz[196]said that Hilton hotel in Europe changes varous

operational activity and training to staff help to manage their waste. Similarly, Liqin[197] in his paper "Relative analysis of the carbon footprint of the high-stared hotels during operation" assessed 6 hotels and suggested some strategies to reduce emission. For example use of mixed grain, new vegetable and cooked food in their kitchen along with saving energy by adopting low carbon consumption equipment.

Rossello[198]studied area in Balearic Islands. He found that for last 50 years energy is used highly as most of hotel arras consumes high electricity. This results heavy cost which can be reduced to gain monetary value [199]. Another study byHorobin[200]suggests that implementing environment strategies along with awareness of environment motivate staff and their worker.

Methane is produced in large quantity in landfills, as a consequence of the degradation of organic matter under anaerobic conditions [201]. Landfills often accept waste over a 20 - 30 years period, so waste in a landfill may be undergoing several phases of decomposition. This means that older waste in one area might be in a different phase of decomposition than more recently buried waste in another area [202].

The GHG emission from landfill areas in India has come into focus in last ten to twelve years and there is more number of studies on methane emission from landfill areas. In one of the study an attempt has been made to calculate the methane flux from three landfill areas of Delhi i.e., Gazipur landfill area (GLA), Okhla Landfill area (OLA) and Bhalswa landfill area (BLA), which is one of the highly populated city in India. This study has also reviewed the research work done on GHG emission from landfill areas in India.

Table 4.8: Present scenario of landfill sites in Delhi

Name	Location	Area (hectares)	Start year	Waste received (Tpd)	Zones supplying waste
Bhalswa	North Delhi	21.06	1993	2200	Civil Lines, Karol Bagh, Rohini, Narela, Najafgarh and West
Gazipur	East Delhi	29.16	1984	2000	Shahdara (South), Shahdara (North),

					City, SadarPaharganj, and NDMC
Okhla	South Delhi	16.2	1994	1200	Central, Najafgarh, South and Cantonment Board

Source: Adopted from ManjuRawat, AL. Ramanathan [203]

The total methane flux calculated for three landfill areas of Delhi (Gazipur, Bhalswa and Okhla) is as 0.54 Gg/year, which is relatively in higher side as compare to the total methane emission estimated from MSW landfill sites in India i.e., from 0.30 - 1.8 Tg per year. This could be that Delhi's MSW generation is higher than the other cities [203].

4.5 CURRENT STATUS OF WASTE MANAGEMENT PRACTICES IN HOTEL INDUSTRY

There are many research papers and report that articulate the importance of waste management in hotel industry for environment concern. Hotel industries consist of restaurant, bars etc. made up of large number of small operation and in each operation consumes relatively small amount of energy, water, food, paper and other resources but with the consumption of energy it add a small amount of pollution too in terms of smoke, smell, noise and chemical pollutants [204]. However, the impact of these operations together has a significance effect on global resources. Kirk [204] reviewed some of the development within the industry of responsible environment management and investigate attitude of manager in hotel industry in Edinburg. Author suggests that there is a need for global policy making and target setting for CFC (chlorofluorocarbons) emission and the adaptation of environmental policies must come from Top. Without a commitment at the highest level of the company, it is unlikely that ideas developed throughout the organization will flourish. He said that environmental management is also important to the individual company not only on their financial performance but also on their responsibility towards the environment. One of the main objectives of the author is to find "Do guest want green hotels?" and for this there has been many survey in USA suggest positive consumer attitude towards environment [204].

Waste management and its disposal is main concern today. Various authors suggest that proper hierarchy of source to destination [204].Authors believe that tourism is one of the main factors that affect the environment with the help of hotel industry [205[206] [207][208] A complication is found in the tourism industry that it can affect current market image of hotel industry. Attractive sides are facing these problems of waste generation that create worse scenario [209] [210] [211].

Hotel industry in a sense of protecting environment acts as a tool. Todaythere is competition in hotel industry regarding growth and sustainability [212] [213]. In competitive scenario advantage like waste management is a most important tool for sustainability [214] [215]. Hutchinson [216]tried to link environmental commitment to their actual performance.

Small hotel are focussed on customer preference but neglect environment management that further affect in negative term [217] [218] [219]. With recycling pollution can be controlled along with cost and increase overall profit [220] [221] [222] [223]. Eco-efficient products also help to reduce negative effect and create positive impact on consumption [224] [225]. Waste management is win-win situation for company and stakeholders [226].

Cortes [227] in his paper examined the implementation of environment management as a competitive tool.

An increasing number of international hotel brands are reporting their sustainability activities. Some global hotel chains have begun to provide reports using such measurements as carbon, energy, water, and waste. The companies issuing such reports include Accor, Hyatt, IHG, Marriott, Starwood, and Wyndham. Among other firms, Goldman Sachs has noted these reports and has provided sustainability ratings for hotel brands [228]. The City of New York has also created a database of hotels' reports of water use, Energy Star scores, and greenhouse gas emissions. In short, the more comparable the reports, the stronger the competitive factor will be among hotels, particularly given the interest from customers, such as groups and meeting organizers, who want to use the hotels' reports to calculate their own carbon footprint [228]. Measuring sustainability continues to be a challenge, since there are so many variables in hotel operation, even with such standards as Energy Star and ISO 14001. More to the point, given themany certifications, one question is whether guests even pay attention to

certifications. Research has found benefits for hotels certified with ISO 14001, but there remains a research gap linking that certification with client's evaluations [228].

Many small and large hotels have low intrest in recycling because they think its expensive and time consuming [229]. In 2002, the Welsh Assembly Government (WAG) [230] developed model for England to consider recycling and composting in their waste stream [231] [232]. Cummings [233] developed a model for hotel industry that includes commitment of waste minimization, eco policy, reuse-recycle for overall solid waste management [233] [234]. Hayward [235]identified customers' attitudes towards hotel and environment has positively changedon basis of waste management.

Taleb[236] gave a model hotel in Egypt helping them to use recycling for various benefits. Many countries use principle of "pay as you throw" to reduce waste [237]. In US authorities are strict to implement laws for business activities [238] [239]. Apotheker[238]showed 13 methods for dealing with recycling with help of local government [240] [241] [242] [243].

Maineri[244]shows that customers are not interested in green practices found that customers so this cost will bear by hotels. Maclaren[241] and Horobin[242] told impediments for recycling in hotels. Most literature showed that food waste are sent o piggeries farm for feeding but can be easily compostable [245] [246] [247].

There are various cases in literature talk about SWM model in hotel industry. (see Figure 4.4). The model considers four main steps to reach zero waste [248].

Step 1: Gain hotel commitment to solid waste management (SWM)

Step 2: Select a waste carrier

Step 3: Undertake a waste audit

Step 4: Implement an SWM programme based on the waste hierarchy

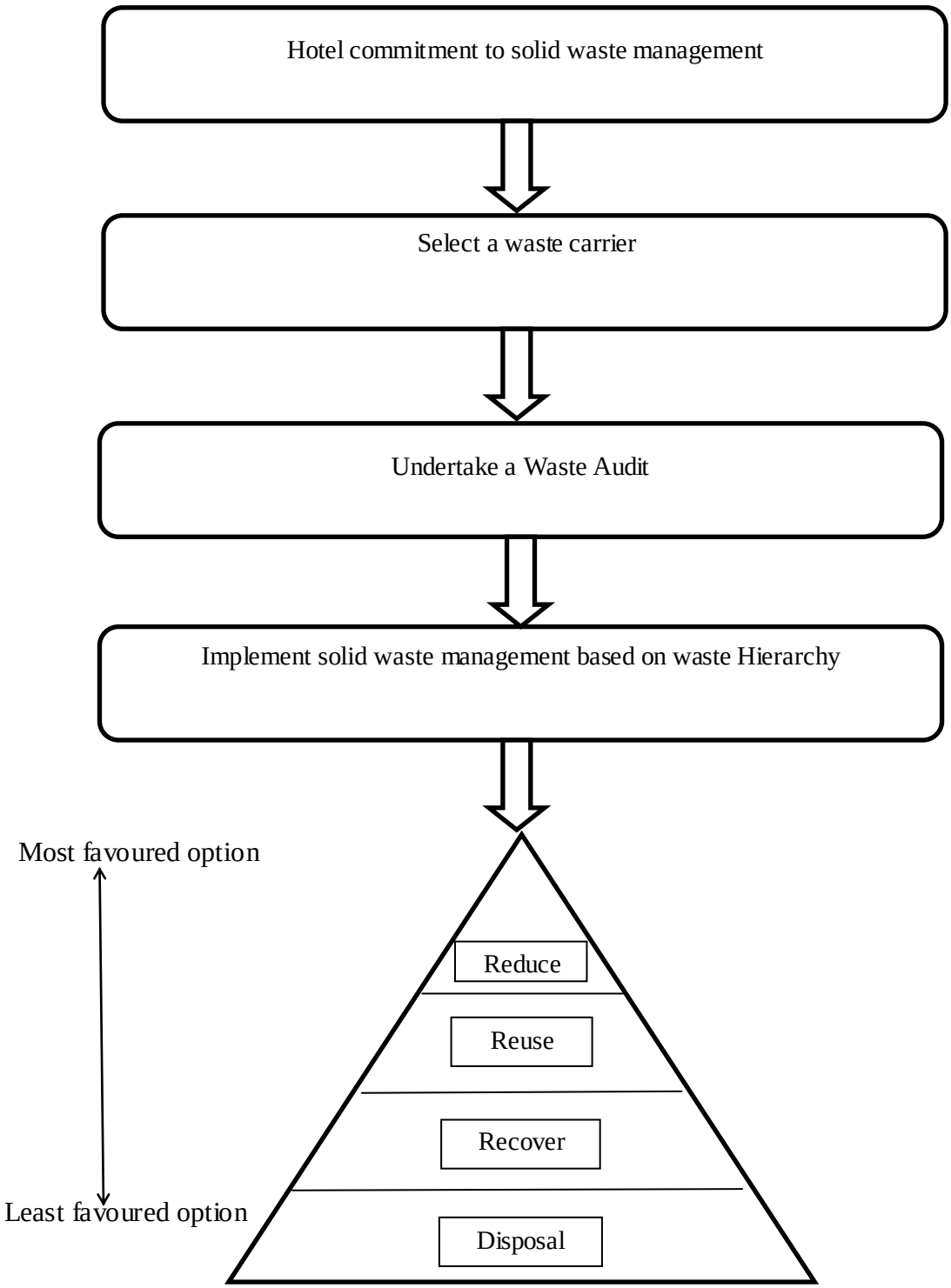


Figure 4.5: Best practice model of SWM in small hotels

Source: Adapted from Radwan., H.R.I et al. [248]

Steger [249] defined an Environment Management System must be implemented in order to protect environment Almost all hotels have implemented their in-house EMS or used efforts on protecting the environment in hotels with varying degrees of intensity in the past few decades [250]. Environment Management Act (EMA) like ISO 14000 that supports auditing program to know type of waste generated [251]. Companies must be certified with ISO 14001 to show environment credentials [252] [253]. With help of environment strategy it increase market value of hotels along with increasing efficiency [254] [255] [256].

Many negative impact are associate with hotel industry causing pollution of air, water and land [257] [258] [259][260][261] [262]. Environmental management is referred to as “the processes and practices introduced by an organization for reducing, eliminating and ideally, preventing negative environmental impacts arising from its undertaking [260][261] [263].

In one of the pioneering study by Penny [264] suggest that environment management is facilitating Tool in Macao, China. The Environmental Technology Best Practice Programme (ETBPP) defines wastes minimisation as using ``management methods for systematically reducing emissions to land, water and air" [265]. The concept is a relatively straightforward one; by using materials carefully so as to reduce the generation of wastes, pollution is reduced, resources are conserved and hence charges for disposal are minimised [266]. A wastes minimisation programme for a given company would cover; raw material and ingredient use, product loss, water consumption and effluent generation, paper and packaging, factory and office consumables, energy consumption, all other solid, liquid and gaseous wastes, and wasted effort [265].

Waste minimisation is recognised by the UK Government as the best way to minimize the adverse effect of wastes on the environment [267] [268]. It is also clear that in the industrial and commercial sectors businesses must face the full cost implications of the wastes they produce in order to encourage them to reduce waste production [267]. Certain sections of the food and drink industry have well established waste minimisation programmes. In a cross industry survey [268], it was found that 95% of the brewing industry operated wastes minimisation programmes (95% also operated recycling programmes) compared with only around 25% of the food and retailing sector.

In April 1996, the ETBPP established a distinct programme for the hotel and restaurants having fooding and drinking facilities to stimulate the uptake of wastes minimisation, as it was perceived to be too slow in this sector. There is a range of benefits for a company that operates a wastes minimisation programme, these include environmental and legal, as well as financial. One of the major factor is financial that influences the implementation of a wastes minimisation programme [269].

Research within the industry should be intensified to ratify the efficiency in the treatment of waste and to minimise waste in operational activities. This will decrease environmental loadings as a consequence of better integrated waste management [270]. It is necessary to segregate the solid waste from the liquid waste for potential reuse of both fractions [271]. Merely disposing of wastes lost useful substances and these residual products can be transferred into business products [272]. An integrated approach to wastes minimisation can take many forms, for example the proper design and application of process controllers is essential for minimising both operating costs and out-of-specification waste products [273] [274].

.

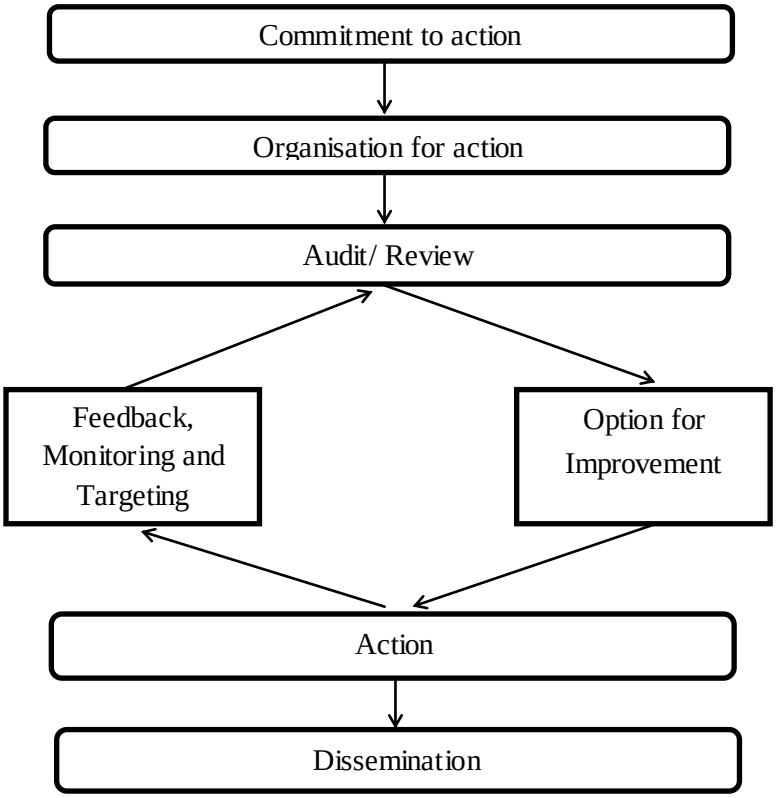


Figure 4.6: Wastes minimisation programme/methodology

Source: Adopted from Bates et.al [274]

Author think that change in waste handling technologies and methodologies has led to many industrial food processing wastes that were once considered as having no economic value, now being reused and recycled [274].

4.6 AUDIT PROCESS FOR WASTE MINIMIZATION

The growing importance of environmental awareness among people regarding limited natural resources. Many useful researches reviewed the typical types of waste produced by hotel industry. For example, [275] [276] [277] indicated that entire hotel can generated glass, paper, steal, cardboard, food etc. According toSherman [278] and Ibrahim [279] food waste negatively affect the environment in many ways.
Earlier Axler[275] researched the estimation of the volume of waste in hotel industry [280]. Potts [281] observed that large property could accumulate eight tons of waste per day and approximately 60 per cent of the waste is recyclable in nature [282] [280].

Hotel owner can playing an important role in reducing wastage of plastic, paper, bottles, batteries, bathroom amenities etc. [283]. Execution of government legislation indicated by Hasek[284], for waste reduction in hotel industry [285] [286]. On theother hand, [287] [288]shows that laws and regulations for hotel industry to dispose of waste materials in a scientific manner.

A waste audit is most structured process to quantify the amount of waste generation along with its categorization. Waste audit comprised of systematic collection of available information.As per report of APPCB [289] waste reduction opportunity quantify the problem and suggesting it as operational level in any business.

Basically auditing of waste, conducted by APPCB [289] has classified into four steps:

Step 1: Planning and organization

Step 2: Assessment

Step 3: Feasibility analysis

Step 4: Implementation

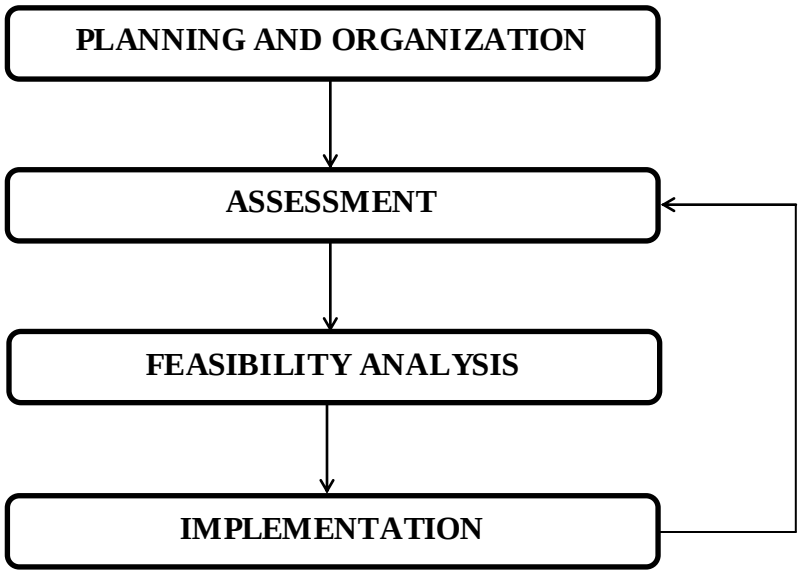


Figure 4.7: Waste audit programme- overview

Source: Andhra Pradesh Pollution Control Board (APPCB)[289]

EPA [290] inthe year 1990 suggesting that the industrial Waste Management Policy must be implemented for reduction of waste. The policy adopts the following preference of options [290]:

• Wastereduction and avoidance

• Waste recycling and reuse

• Wasteproperly treatment

• Waste disposal

There are many example of waste audit; it depends on type of waste generated and its area. For example audit sheet of school waste auditing could take following form:

Area of Auditing _____ Number of bags collected _____

Name of monitor _____

Position (e.g. pupil, teacher etc.) _____

Start date(s) of Waste Check _____ Finish Date(s) _____

Using the table below, list the items you have found, their weights and the percentage this is of the total. Remember to include any small items:

Table 4.9: Waste audit check in school

Material type	Weight	Percentage of total
Office papers		
Mixed papers		
Cardboards		
Food and drinks cans		
Plastic		
Glasses		
Organic wastage		

Source:Adopted from Antrim- Waste audit [291]

Solana Recycler[292] emphasis on compelling need for the hotel waste auditing. Indicate the example of a hotel in which recycling practices of mixed office paper, corrugated cardboard, mixed paper, green garden waste, glass etc. are implemented

Table 4.10: Waste Characterization

Waste Category	Percentage	Type of Waste	Percentage
Paper	35%	cardboards	20%
		newspapers	10%
		mixed papers	5%
Plastic	22%	PET bottle	3%
		HDPE container	5%
		Polystyrene & other	14%
Glass	1%	CA Redemption glas	1%
		other glasses	
Metal	4%	steel can	4%
		aluminum can	
		other metal	
Organics	17%	Food Waste	18%
Textiles	6%	linens, towels, etc.	7%
Other Waste	15%	All type	16%
Total			**100%**

Source:Waste characteristics adopted from Solana Recyclers [292]

4.7 CUSTOMER PREFERENCE FOR GREEN HOTEL

There are numbers of research paper enlighten the concept of waste management or green practises in hotels, it is proved by various author that green practices based hotels are highly preferred by customer. Most of the case studies on hotel like Scandic and Hyatt Regency, have shown the success of 'green' practices in hotels[328] [329]. Attitude of hotelier ion some of the studies are in positive sense [330] [331]. Choi [332] did a research on hotelier attitude regarding 'green' practices in the USA restaurant industry to know the relationship between employee and its customer [333].

Peattie[334] identify the waste management practices as a profitability tool in hotel. According to Foster [335], the hotel industry must be environment friendly for customer satisfaction. Consumers are willing to purchase various environmentally-friendly products to take participation in environment saving [336] [337] [338].

In one of the research by Manaktola[339] shows a positive relationship between the customer attitude and behaviour towards green practices in the hotel.

CHAPTER 5

RESEARCH METHDOLOGY

5.1 INTRODUCTION

Research methodology is one of the crucial decisions that have critical implications on the result of any study. In addition to being indispensable part of any research study, research methodology methods can significantly add to the effectiveness of the project. This chapter presents the detailed information about the methodology used in the study. According to aim of research, there are 3 classifications under which study can be carried out. On basis of classification given by Saunders [293], research can be classified as:

- Exploratory
- Descriptive
- Explanatory

The first kind of research i.e. exploratory is done to get more insights into the problem. There could be many possible reasons for using exploratory research though the main factor that summons this research is lack of in-depth knowledge about the phenomenon in hand. Thus exploratory research is used to develop a better understanding of the phenomenon in question [294]. There are many methods of conducting exploratory research though the most important and pertinent ones include literature review and experts' interviews etc.

Second type of research is descriptive that describes an aspect or phenomenon that a researcher is interested in. This type of research is more focussed and structured than the first type aforementioned above as the focus and clarity is quite high in descriptive than exploratory.

Third type of research is explanatory, as its name implies the focus on explaining rather than merely describing the phenomenon. The thrust of the study is on explanation of various causes that lead to a particular phenomenon to happen.

5.2 TYPE OF RESEARCH METHODS USED IN STUDY

Both exploratory and descriptive research has been used in this study in order to develop a holistic framework/ model for waste management in hotel industry.

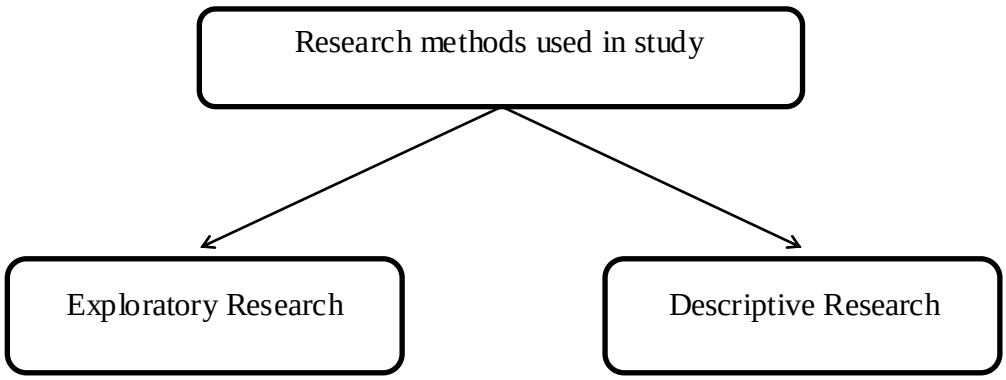


Figure 5.1: Research method used in study

Source: Pictorial representation of research method

5.2.1 Exploratory research

The research has exploratory phase to determine the different waste management dimensions and their implications related to waste management in hotel industry. This has been done in order to identify the significant/important dimensions of waste management especially from hotel industry point of view. This is done with the help of extant literature review and then discussing the relevance of the identified dimensions with domain and industry experts. Secondary data is used from various sources like government reports, published papers, case studies etc.

5.2.2Descriptive research

For descriptive phase primary data is collected through audit-form. This has been carried out with the help of exploratory research. Final model or framework is developed and at last reliability of this model has been checked by implementing the entire profitability and sustainability concept. The detail of various techniques used in descriptive research has been given in the later section of chapter.

5.3 EXPLORATORY RESEARCH

5.3.1 WASTE AUDIT

The very first step to start development of model is to understanding of content domain specification. Determining clearly what is it measure and calculate is the basic step to start with waste audit development process. For this in-depth extant literature review had been carried out with exploratory research method. Online databases like EBSCO, EMERALD and ProQuest were researched for relevant literature for comprehending the basics about the waste auditing. Various studies across the disciplines are studied to get into nuances of the concepts. Audits can be operated on all category of waste depends on the type of waste, where it is and what you want to get out of the audit. Further, interviewing some of the hotel-experts and consultants.. For starters the enhanced turbulence and dynamism mandates the rational of such audit development day distorting the environment.

5.3.2WASTE AUDIT INSTRUMENT DEVELOPMENT

After specifying the domain and defining the purpose of the research,a researcher generates a large pool of items that are candidates for eventual inclusion in the audit process. Exploratory research techniques like literature review, experts' interviews and closely following the dynamism of hotel industry through the various reports and industry-specific descriptions are used to finalize the waste audit sheet. There are some steps which help to build final audit sheet that are:

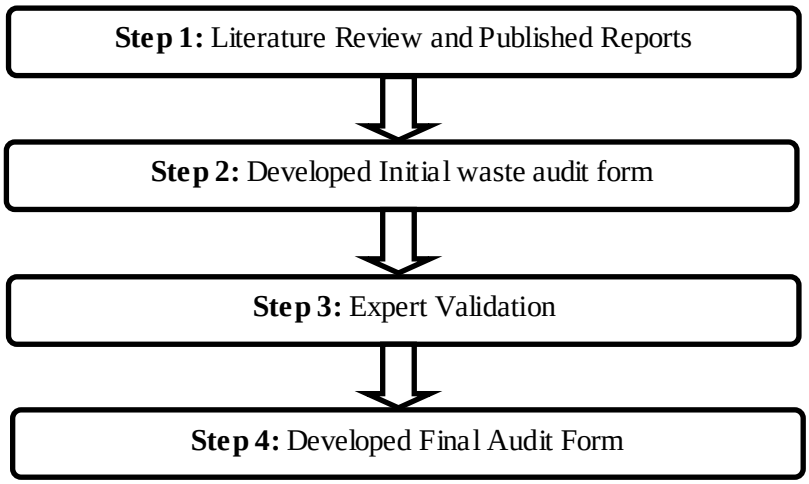


Figure 5.2: Development of waste audit instrument

Source: Pictorial representation of waste instrument development

Step 1: Literature review and published reports

There are some important research studies on types of waste produced by hotels. For example, [275], [276] and [277] indicated that hotel waste is generated in the form of glass, steel, cardboard,aluminium, plastics, and food. Each of these waste materials has different degenerate time, which is based on the composition of waste material [295].

Table 5.1: Type of waste generate and degenerate time

Type of litter	**Approximate time to degenerate**
Organic waste (vegetable and fruit peels, foodstuff)	A week or two
Papers	10-30 days
Cotton cloths	2-5 months
Woods	10-15 years
Woollen item	1 year
Tin, aluminium, and other metal items such as cans	100-500 years
Plastic bag	One million years
Glass bottles	Undetermined

Source: Adopted from R. Rajput, G.Prasad and A.K.Chopra [295]

A waste audit is most formal andwell-structured process to quantify the amountof waste generated by any organisation.

Table 5.2: Waste audit by eco-recycle

Waste Material	**Volume (m3)**	**Weight (kg)**	**% of Total Weight**
Paper			
Organic Compostable			
Other Organics			
Glass			
Plastic			
Ferrous Metals			
Non Ferrous Metals			
Prescribed Waste (optional)			
Other			
Total Quantity			

Source: Adopted from Waste audit by eco-recycle [296]

Step 2: Developed Initial waste audit form

On the basis of various literature reviews and published paper on waste audit, an initial waste audit sheet was developed based on different waste material. In this audit sheet there was a sub category of each waste material. Table 5.3 shows the categorization of different waste such as newspaper, magazine, printout, tissue paper, tetra papers, copy paper, photocopies, brochures, books etc.

Table 5.3: Categorization of paper waste

Categorization of paper waste	
Papers	Newspapers
	Magazine
	Printouts
	Tissue Papers
	Tetra Pack (Juices)
	Copy paper
	Photocopies
	Brochures
	Books
	Toilet roll cartridges
	Packaging paperboard
	Carbon paper

Source: Self collection of different paper waste from literature review, reports and experts opinion

Similarly there are many research papers on plastic waste. Different sub categories of plastic waste are shown in table 5.4.

Plastic waste is non-biodegradable because it remains in environment for several years. It is observed that due to an inefficient collection of waste, a large chunk of plastic wastes are not disposed off completely or fails to reach the recycling/reuse chains.

Table 5.4: Categorization of plastic waste

Categorization of plastic waste	
Plastic	Bottles
	Plastic Plates

	Packing Plastic and wrappers
	Mineral water bottles
	Plastic bags
	Plastic- or wax-coated paper
	Candy wrappers
	Foil gift wraps
	Shampoo bottles
	Carrier bags
	Plastic cutlery
	Toys
	Bleach & cleaners Bottles

Source: Self collection of different plastic waste from literature review, reports and experts opinion

In hotel industry most of the textile waste like pillow cover, bed cover, table cloth, cotton cloth, carpet, towel, mattress, apparel etc. are either reuse or recycle in kitchen. With the help of this process of reusing,the quantity of textile waste in hotel industry is negligible for waste dumping.All different type of textile waste generated in hotel industry is shown in table 5.5.

Table 5.5: Categorization of textile waste

Categorization of textile waste	
Textile	Pillow cover
	Bed cover
	Table cloths
	Cotton cloth
	Carpets
	Towel
	Mattress
	Apparel
	Thread Waste

Source: Self collection of different textile waste from literature review, reports and experts opinion

Leather waste and garden waste in hotel industry are also almost negligible because leather waste are either reuse or recycle whereas garden wastes are considered in composting process. Different type of leather waste and garden waste are shown in table 5.6 and 5.7 respectively.

Table 5.6: Categorization of leather waste

Categorization of Leather waste	
Leather	Rexene

	Shoes
	Bags

Source: Self collection of different leather waste from literature review, reports and experts opinion

Table 5.7: Categorization of garden waste

Categorization of Garden waste	
Garden	Leaves
	Grass clippings
	Shrubbery
	Garden wastes
	Horticulture Waste

Source: Self collection of different garden waste from literature review, reports and experts opinion

Mostly glass wastes in hotel industry are in two forms like beer bottle and wine bottle as shown in table 5.8.

Table 5.8: Categorization of glass waste

Categorization of Glass waste	
Glass	BeerBottles
	Wine Bottles

Source: Self collection of different glass waste from literature review, reports and experts opinion

Aluminiumin hotel industry are very common because of parties, conferences, function etc. these event ideally generate heavy amount of aluminium waste in the form of beer cans, broken steel plates and steel spoons as shown in table 5.9.

Table 5.9: Categorization of aluminium waste

Categorization of Glass waste	
Aluminum	Beer cans
	Steel plates
	Spoons

Source: Self collection of different glass waste from literature review, reports and experts opinion

High portion of organic waste or food waste generated from hotel industry in the form of vegetable waste, leftover food, fruit waste, egg shells, sea food and dairy products. Up to seventy per cent of total wastes are in organic form as shown in table 5.10.

Table 5.10: Categorization of food waste

Categorization of Food waste	
Food	Vegetables waste
	Leftover food
	Fruit waste
	Egg shells
	Sea food waste
	Dairy products

Source: Self collection of different food waste from literature review, reports and experts opinion

Oil from cooking food, left vegetable fried oil, lube oil used in generator are very common in nature to generate oil waste but most of the waste are used to produce soap for washing hand etc., that's why the composition of this waste is low in overall waste generation. Detail of oil waste shown in table 5.11 below.

Table 5.11: Categorization of oil waste

Categorization of Oil waste	
Oil	Vegetables oil
	Lube oil

Source: Self collection of different oil waste from literature review, reports and experts opinion

On the basis of entire sub category of each waste material an audit sheet is developed which combine all waste material with its sub category, that is easy to analyse which waste material has high portion in overall waste generation. There is a seasonal variation of waste generation shown in many literature reviews, so in the initial audit sheet, entire waste can be categorized into two season peak season and lean season. It was decided to conduct an audit five times in each season every month to avoid the biasness of calculation of waste amount (refer table 5.12). The detail representation of this form is shown in Appendix A.

Table 5.12: Initial hotel waste audit form

Hotel Waste Audit Form										
List of Waste Items	**PEAK SEASON (Average per month)**					**LEAN SEASON (Average per month)**				
	1st Month	**2nd Month**	**3rd Month**	**4th Month**	**5th Month**	**1st Month**	**2nd Month**	**3rd Month**	**4th Month**	**5th Month**
Papers:										
Newspapers										
Magazine										
Printouts										
Tissue Papers										
Tetra Pack										
Copy paper										
Photocopies										
Brochures										
Books										
Toilet roll cart.										
Packaging paperboard										
Carbon paper										
Plastics:										
Bottles										
Plastic Plates										
Packing wrappers										
Mineral water bottles										
Plastic bags										
Plastic coated paper										
Candy wrappers										
Foil gift wraps										
Shampoo bottles										
Carrier bags										
Plastic cutlery										
Toys										
Bleach cleaners Bottles										
Textiles:										
Pillow cover										
Bed cover										

Table cloths										
Cotton cloth										
Carpets										
Towel										
Mattress										
Apparel										
Thread Waste										
Leather:										
Rexene										
Shoes										
Bags										
Garden wastes:										
Leaves										
Grass clippings										
Shrubbery										
Garden wastes										
Horticulture Waste										
Glass:										
Beer Bottles										
Wine Bottles										
Aluminium:										
Beer cans										
Steel plates										
Spoons										
Food wastes:										
Vegetables waste										
Leftover food										
Fruit waste										
Egg shells										
Sea food waste										
Dairy products										
Oil waste:										
Vegetables oil										
Lube oil										

Other waste material:										

Date of assessment:

Source: Developed initial waste audit form from literature review, reports and experts opinion

Step 3: Expert Validation

After developing waste audit sheet it was tested to one of the hotel but results were not satisfactory because in India especially in hotel industry there is no provision of waste segregation and with the lack of proper waste segregation, the audit sheet is not filled well, hoteliers don't have any proper detail of each waste material. Then with the help of hotel industry experts, audit sheet was validated. As recommended by Hardesty & Bearden [297], audit sheet was again reviewed by the judges; persons that are expert in that specific domain area.

Table 5.13: Details of panel of experts

Panel of Experts		
Name of the Expert	**Organization**	**Designation**
Ashish Jain	Indian pollution control association (IPCA)	Director
Ajay Garg	Indian pollution control association (IPCA)	Manager (Compost & Recycling)
Dr. B.C. Sabat	Department of Environment, Govt. of Delhi	Head - Ozone Cell
AshieshBroota	Jaypee Greens Golf and Spa Resort	KST Manager
David Cranage	School of hospitality and management, PSU	Professor
VivekTyagi	Shangri-La's - Eros hotel	F & B Manager
Shamsher S. Mann	Hospitality Valuation Services (HVS)	Associate Director
Ajay Verma	Hilton Hotel	F & B Manager

Table 5.14: Details of waste vendor and contractor

Vendor/ contractor		
Vinay	Entrepreneur	Contractor/Vendor - Radison and Country Inn
Rajesh Yadav	Entrepreneur	Contractor/Vendor - JaypeeSiddhart and Sangri-La's

Step 4: Developed Final Audit Form

After completing expert validation, a final and more systematic audit form is developed after some changes. In the final audit form the first column shows the category of type of waste material i.e. recyclable, compostable or direct landfilling. Each hotel can audited 5 times a day with particular dates.

Second column shows the name of the hotel, date, day and waste detail. Second last column was used to calculate the average of all 5 day auditing. And last column shows the percentage of each waste material in a particular hotel per day. As shown in table 5.15.

Table 5.15: Final hotel waste audit form

HOTEL WASTE AUDIT FORM								
Type of waste material	**NAME OF THE HOTEL**							
	DATE						**AVERAGE (Kg)**	**PERCENT**
	DAY (Kg)							
Recyclable Material	**PLASTIC PET BOTTLE**							
	MIXED PLASTIC							
	TETRA PAK (Laminated Paper)							
	ALUMINIUM							
	GLASS							
	NEWSPAPER							
	MIXED OFFICE PAPER							
	CARDBOARD							
Compostable	**COMPOST/WET WASTE**							
Inert (Direct Landfill)	**TRASH (Laminated Plastic)**							
TOTAL								

Source: Developed Final waste audit form from various literature review, reports and experts opinion

Pilot study: Customer preferences for green hotels

Before going to the depth of research a pilot study has been conducted. In pilot study, customer survey is used to know whether the customers are interested to stay in green practices based hotel or not. Also it is used to know the most prominent factor for implementing green practices in any hotel. After specifying and defining the domain the objective of the study is to generate a large pool of items through various techniques like literature review, experts' feedback, various reports and industry-specific descriptions are used to generate the list of items.

These items can be classified under two heads on the basis of their generation criterion. Some of the items trace their root to literature while some draws upon the hotel-experts feedback. Factor analysis is used for data reduction and summarization. SPSS version 16.0 software has been used for conducting factor analysis. This pilot study was validated by literature review and hotel industry experts.Detail result of pilot study is shown in appendix F.

5.4SAMPLING AND DATA COLLECTION

This phase of research methodology is focussed upon sampling and data collection. The proposed format of measurement that has been approved by the experts has been used to record the responses. The target of this phase now shifts from theoretical underpinnings to field work.

5.4.1 SAMPLING PLAN

Due to various constraints like budget, time availability and population size, census method had been ruled out for carrying out the study; thereby paving way for sampling method in order to proceed with study. Sampling process is aimed at obtaining a representative portion of some whole in order to afford valid inferences and generalizations to it [298]. Sampling design process as given by Malhotra and Dash [299] consists of following sequentially arranged steps as shown in figure 5.3 given below.

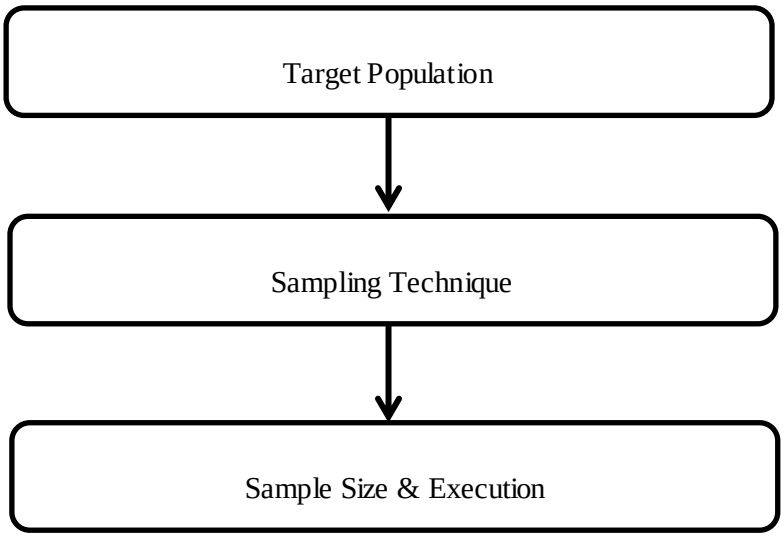


Figure 5.3: Sampling design

Source: Adapted from Malhotra& Dash [299]

Geographic Domain for study

New Delhi, Noida, Greater Noida, Ghaziabad and Gurgaon.

Target Population

Target population must have the information about the element, sampling unit and plan of geographical area in which sampling will take place. Element in target population are the respondents from whom information is sought. Sampling unit also contains the elements and at times is same as of elements. For our study target population is hotelier, KST managers, F&B managers, waste supervisor and individual self-estimation.

Sampling Technique

Non-probability sampling technique has been used in study. Under non-probability technique, judgemental and convenience sampling has been used for research.

Sample Size

Sample size for the model is 40 audits. Eight star rated hotels are selected randomly for auditing and each hotel audited at least 5 times to avoid the biasness of its average waste generation. See table 5.16 below.

Table 5.16: Hotel selected for auditing process

Type of hotel	No of hotels
5 star Deluxe hotels	2
5 star hotels	3
4 star hotels	2
3 star hotels	1
Total	**8**

Source: Selection of hotel is based on prior permission and expert opinion

Instrument used for collecting data is structured audit form consisting of 10 different waste materials generated in hotels. Further it is extrapolated on Delhi NCR star rated hotels. Table 5.17 shows the name of hotel selected for waste auditing.

Table 5.17: Name of the hotel for waste auditing

S.NO	Hotel selected for Auditing
1	La-Shangri-la Hotel
2	Hilton Hotel
3	Country INN
4	Park Plaza
5	Jaypee Vasant Continental
6	Jaypee Greens Golf & Spa Resort
7	JaypeeSiddharth
8	Lemon Tree hotel

Source: Selection of hotel is based on prior permission and expert opinion

Following table below has the details of sample that are used in development of hotel waste model. As shown in table 5.18.

Table 5.18: Sample size

8 Hotel (5 audit per hotel)			
S.NO	**Hotel's Name**	**Region**	**No of Audit**
1	La-Shangri-la Hotel	Delhi	5 audit
2	Hilton Hotel	Delhi	5 audit
3	Country INN	Ghaziabad	5 audit
4	Park Plaza	Noida	5 audit

5	Jaypee Vasant Continental	Delhi	5 audit
6	Jaypee Greens Golf & Spa Resort	Greater Noida	5 audit
7	JaypeeSiddharth	Delhi	5 audit
8	Lemon Tree hotel	Gurgaon	5 audit

Source: Selection of hotel is based on region, prior permission and expert opinion

5.5 DATA ANALYSIS TECHNIQUES

Data analysis technique is the bridge between the objective of the study and its achievement. It helps to define the suitable path to reach objectives. For the achievement of the objective of the study, that is the development of a model for hotel industry to manage their waste effectively and efficiently and it can be only possible by using appropriate five major tool or techniques, which is already pre tested by United State Environment Protection Agency (USEPA) in some other sector like household, industry etc. These tools are:

- Audit form
- WARM Model
- Equivalency Calculator
- Cost benefit analysis

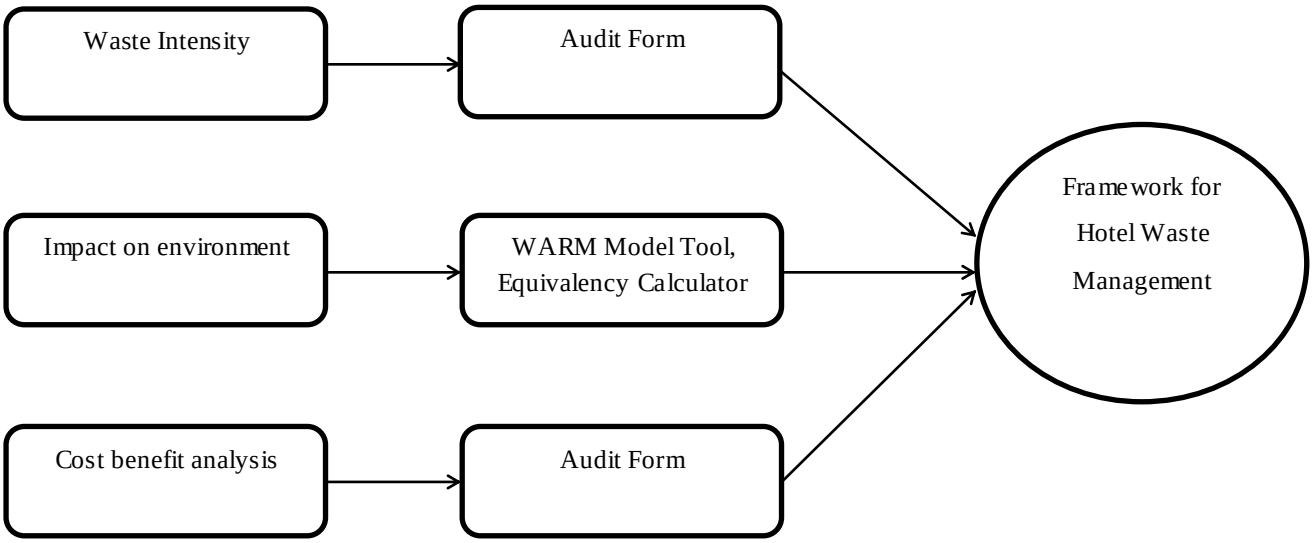


Figure 5.4: Objective wisedata analysis techniques

Source: Pictorial representation of analysis technique

Audit Form

It is used to know the intensity of waste generated from hotel industry. Auditing computes accurate value in different categories of waste material. Audit was conducted randomly, without any prior notification of visit to ensure unbiased audits and avoid any deliberate action by hotel to manipulate their recycling status. The data was collected using 'Waste audit form'. Same process for auditing has been employed in all selected hotels on 5 day audit per hotel to avoid the biasness of weight on a particular day. Further it is used to extrapolate on Delhi NCR hotel.

WARM Model

The Waste Reduction Model (WARM) was developed by the United States Environmental Protection Agency (USEPA) for waste and to estimate the reduction of greenhouse gas (GHG). It is a decision-making tool, intended to be used to estimate the benefits associated with different waste management decisions. It's a tool to quantify the linkages between waste management practices and greenhouse gas (GHG) emission reductions.

This model calculates the GHG emissions for two scenario i.e. baseline and alternative including the practices of source reduction, combustion, composting,recycling and land filling. WARM calculates emissions in metric tons of carbon dioxide.

Equivalency Calculator

Equivalency calculator is used to represent the utilization of emission generated from hotel waste to other sectors like household, vehicles, electricity, energy, coal power plant etc. Equivalency calculator is used to convert results of WARM output in metric tons of carbon dioxide equivalent for the easy understanding among people because in the climate change world, people speak and compare value in terms of carbon dioxide equivalents.

Cost benefit analysis

Cost benefit analysis is the key objective of the study. It shows the potential of waste management and its positive implementation to them as well as to the environment. The data gathered from waste audit was used for analysing the cost benefit associated with implementing cost versus benefits of implementing the green practices in hotel.

CHAPTER 6

DATA ANALYSIS

6.1 INTRODUCTION

For achieving the objective of the research, four major tools have been used i.e. waste audit, WARM Model (Waste Reduction Model), Equivalency calculator and cost benefit analysis.Waste audit calculate the amount of waste generated from hotel industry on per day basis or yearly basis. Whereas WARM model calculate the rate of emission generated from hotel waste in a year. Further equivalency calculator use to calculate usable emission generated from waste to other sector. At last cost benefit analysis use to calculate the cost of implementation of green practices and its monetary and nonmonetary benefit. On the basis of entire data analysis technique,a model has been developed for the hotel industry to effectively manage their waste.

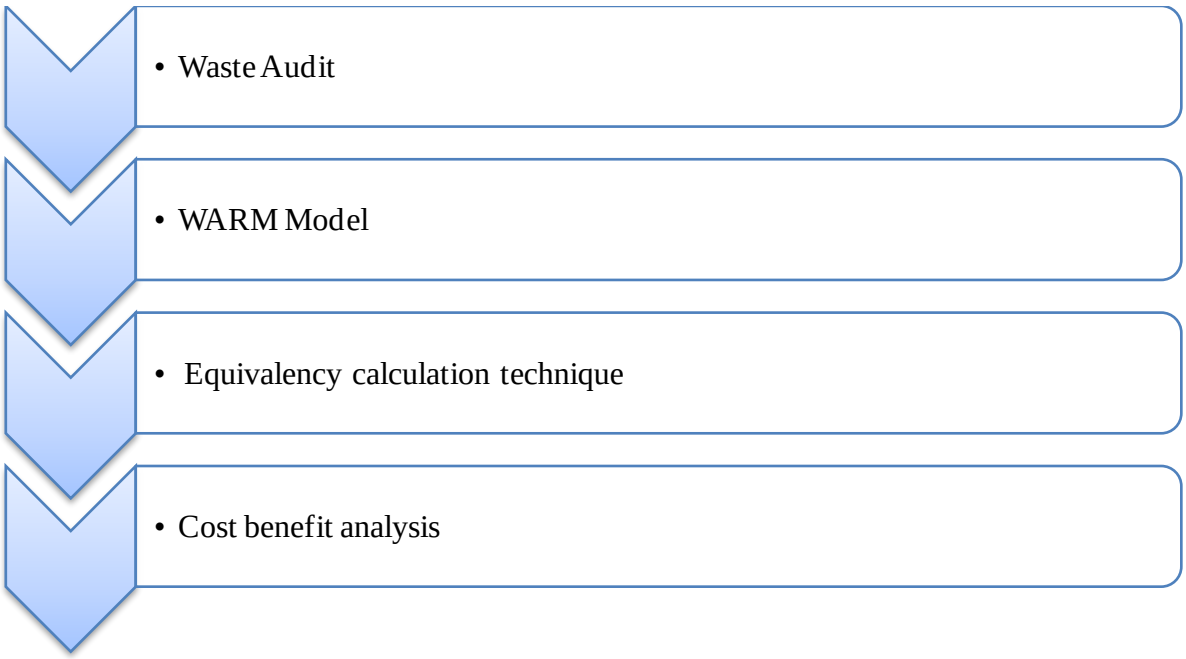


Figure 6.1 : Data analysis

Source: Pictorial representation of data analysis

6.2 WASTE AUDIT

Hotel industry is the main source of waste generation, which is directly sent to the landfill sites without any proper treatment [300]. Hotels in India contribute to the generation of overall waste. As the study suggested byWagh [301] that hotel industry up to thirty per cent of the total waste generated.

Thus the primarily focused of the study is on hotel waste management because it has a deep impact on environment. Hotel waste can be broadly classified as organic waste and recyclable waste.

On the basis of waste classification in hotel industry, waste audit sheet was developed to calculate the actual waste generated from hotel industry.In audit sheet waste is already classify into three parts i.e. recyclable, compostable and inert waste. Recyclable wastes are those wastes, which can be processed by alternative techniques or procedure to convert into by-products or any useful material. For example paper are recycle to convert paperboard products, plastics are recycle to convert small bottles and jar, broken glasses or crockery are convert into glasses etc.

Compostable waste like food waste, leftover foods, kitchen waste etc. are recycle in the form of composting to convert valuable manure, a perfect soil conditioner. With the help of bio digester, biogas can be produced. Third category of waste is inert waste like laminated plastic products or mixed waste that are not in the position to process to convert any valuable item that's why these wastes are directly sent to the landfills?Audit sheet below in table 6.1 used to calculate the waste from a particular hotel. In this sheet ten different waste can be measure like plastic pet bottles, mixed plastic, tetra pack, aluminium, glass, newspaper, mixed office paper, cardboard, compost or wet waste and inert waste. See Appendix B for more detail of final audit sheet.

Table 6.1: Audit form

HOTEL WASTE AUDIT FORM								
Type of waste material	**NAME OF THE HOTEL**							
	DATE						**AVERAGE (Kg)**	**PERCENT**
	DAY (Kg)							
Recyclable	**PLASTIC PET**							

Material	**BOTTLE**							
	MIXED PLASTIC							
	TETRA PAK (Laminated Paper)							
	ALUMINIUM							
	GLASS							
	NEWSPAPER							
	MIXED OFFICE PAPER							
	CARDBOARD							
Compostable	**COMPOST/WET WASTE**							
Inert (Direct Landfill)	**TRASH (Laminated Plastic)**							
TOTAL								

Source: Final waste audit form

Waste audit was conducted at eight different hotels in Delhi-NCR to find out the content of trash in their dumpster. These eight hotels were selected based on their consent/ approval to participate in audit. Audit was conducted randomly, without any prior notification given to these hotels to ensure unbiased audits and avoid any deliberate action by hotels to manipulate their recycling status. At each site, auditor randomly selected trash bags from each dumpster, approximately 10% of total trash by weight. Collected data feed into developed audit sheet below.

6.2.1 AUDIT IN LA-SHANGRI-LA HOTEL

First auditing is in La-Shangri-La hotel in Delhi, Which is centrally located in Delhi. Five audits have been done here in different dates as per the approval or permission from hotel authority. The method of waste auditing was already mentioned above.

Audited have been done on five different days to know the exact average value of each waste material. Here plastic pet bottle are very common in hotel industry and have different weight in all five days, on 1st day it was 7.80 kg whereas on 2nd audit it was increases to 8.20 kg, reason may be party, conferences etc. In 3rd audit, again the weight of plastic pet bottles

became 5.20 kg and on 4th audit it was 3.48 kg. Variation in plastic pet bottles shows that there were some days on which guest may be increased or decreased. In last audit weight of pet bottles was 4.80 kg, after completing the audit of pet bottles, took the average of it to know the average waste generated in one day that is 5.90 kg, if we consider these weight on yearly basis, it would become 2152.04 kg and the percentage of plastic pet bottles was 0.28%. Similarly other mixed plastic like plastic plates, packing wrappers, mineral water bottles, plastic bags, plastic coated paper, candy wrappers, foil gift wraps, shampoo bottles, carrier bags, plastic cutlery, toys, bleach cleaners bottles waste have high portion of waste compare to pet plastic bottle. On 1st audit it was 10 kg, in 2nd audit it was 6.50 kg, in 3rd audit it was 9.20 kg and in 4th and 5th audit it was 8.0 kg and 5.40 kg respectively. The average of mixed plastic waste was around 7.82 kg, which is 0.37% of the total waste and yearly it would become 2854.30 kg. Tetra pak are laminated plastic waste in the form of juice packets, lamination papers, kitchen spice packets etc. They were 8 kg, 4.20 kg, 6.30 kg, 5.50 kg, and 3 kg on 1,2,3,4 and 5th audit respectively. Below table 6.2 of audit summary of La-Shangri-la hotel shows the date in detail format.

Aluminium waste like beer cans have comparatively minimum waste in hotel industry, in 1st audit it was only 3.30 kg, in 2nd audit it was 3.50 kg which is almost similar to 1st audit. In 3rd audit it was 2.30 kg, in 4th audit it was 1.75 kg and in 5th audit it was 2.25 kg respectively. The overall portion of this waste is only 0.12% and average weight of aluminium waste is approximately 2.62 kg and if we consider the same pattern of waste generation it would become 956.30 kg yearly.

Table 6.2: Audit in La-Shangri-La hotel

NAME OF THE HOTEL	**La-Shangri-la Hotel**							
DATE	5th Jan 13	10th Jan 13	16th Jan 13	20th Jan 13	26th Jan 13	Average (Kg/day)	Percent (%)	Total waste (Kg/year)
DAY	Sat	Thurs	Wed	Wed	Wed			
PLASTIC PET BOTTLE	7.80	8.20	5.20	3.48	4.80	5.90	0.28%	2152.04
OTHER/MIXED PLASTIC	10.00	6.50	9.20	8.00	5.40	7.82	0.37%	2854.30
TETRA PAK (Laminated Paper)	8.00	4.20	6.30	5.50	3.00	5.40	0.25%	1971.00

ALUMINIUM	3.30	3.50	2.30	1.75	2.25	2.62	0.12%	956.30
GLASS	280.00	202.40	200.80	92.00	195.80	194.20	9.17%	70883.00
NEWSPAPER	80.00	80.00	80.00	80.00	80.00	80.00	3.78%	29200.00
MIXED OFFICE PAPER	11.00	13.80	9.30	7.30	12.50	10.78	0.51%	3934.70
CARDBOARD	260.80	203.70	256.10	325.00	203.90	249.90	11.80%	91213.50
COMPOST/WET WASTE	1623.10	1806.40	1356.70	1202.80	1806.80	1559.16	73.61%	569093.40
TRASH (Laminated Plastic)	3.50	1.80	3.10	2.30	0.50	2.24	0.11%	817.60
TOTAL	**2287.50**	**2330.50**	**1929.00**	**1728.13**	**2314.95**	**2118.02**	**100.00 %**	**773075.84**

All waste in Kilogram (kg)

Source: Manually calculation of waste

Glass waste like broken glasses, beer bottles, wine bottles etc. were one of the main compositions of overall waste having high portion because of its weight. On 1st audit it was 280 kg, reasons may be party, conference, marriage function etc. but on the 2nd audit it was 202.40 kg, in 3rd audit it was 200.80 kg, in 4th audit the weight of glasses were only 92 kg because of neither any function nor any parties. In 5th audit it was again almost 195.80 kg, the overall average of glass waste was 194.20 kg, which is 9.17% of total waste and yearly it would become 70883 kg.

Newspaper waste was almost similar in all audits because newspaper was daily countable items according to numbers of room in hotel. So in all audit it was 80 kg, which is 3.78% of total waste material generated from hotel industry and yearly it would be 29200 kg of weight. Mixed office paper like magazine, printouts, tissue papers, copy paper, photocopies, brochures, books, toilet roll cartridges, packaging paperboard, carbon paper etc. in 1st audit it was 11 kg, in 2nd audit it was 13.80 kg, in 3rd audit it was 9.30 kg, in 4th audit it was 7.30 kg and in 5th audit it was 12.50 kg, on an average it was approximately only 10.78 kg of waste, which is 0.51% of total waste and yearly it would become 3934.70 kg. Cardboard are the packaging items, the portion of this material always higher compare to other waste. In 1st audit it was 260.80 kg, in 2nd audit it was 203.70 kg, in 3rd audit it was 256.10 kg, in 4th audit it was 325 kg and in 5th audit it was 203.90 kg of waste respectively. On an average it

was 250 kg of waste daily generated, which is 11.80% of total waste generated. If we considered the same pattern it would become 91213.50 kg of waste on yearly basis.

Organic waste or compostable waste like Vegetables waste leftover food, fruit waste, egg shells, sea food waste, dairy products etc. There are many literature reviews, reports; published paper already proved that the portion of organic waste in hotel industry is almost 60% to 70% of the total waste. In this audit on 1st day the organic waste was 1623.10 kg on only one day, in 2ndaudit it was increased to 1806.40 kg, in 3rd day it was 1356.70 kg of waste, in 4th audit it was 1202.80 kg of waste and in last audit it was 1806.80 kg of waste. On an average this hotel generate 1559.16 kg of waste daily, which is 73.61% of the total waste generated and if we consider the same pattern, further the intensity of waste would become 569093.04 kg on yearly basis. The last type of waste is trash means non process able waste in nature because of mixed with other waste. In hotel industry trash are almost negligible but due to non-segregated waste it mixed with other recyclable material and sent directly to the landfill site for dumping. In 1st audit trash was only 3.50 kg, in 2nd audit it was 1.80 kg of waste, in 3rd audit it was 3.10 kg of waste, in 4th audit it was 2.30 kg and in 5th audit it was 0.50 kg of waste respectively. On an average it was only 2.24 kg of waste daily, which is 0.11% of the total waste and yearly it would become only 817.60 kg of waste.

Total waste generated on 1st audit of all waste material was 2287.50 kg, in 2nd audit all waste was around 2330.50 kg of waste, in 3rd audit it was 1929 kg, in 4th audit it was 1728.13 kg of all waste material and in 5th audit it was 2314.95 kg of waste. On an average the entire waste from one hotel in a day was 2118.02 kg of waste. If the pace of waste increases in the same way in a year it would become approximately 773075.84 kg of all waste. See table 6.2 for detail.

6.2.2 AUDIT IN HILTON HOTEL

Audited have been done on five different days to know the exact average value of each waste material. Here plastic pet bottle are very common in hotel industry and have different weight in all five days, on 1st day it was 8.17 kg whereas on 2nd audit it was increases to 6.33 kg, reason may be party, conferences etc. In 3rd audit, again the weight of plastic pet bottles became 5.30 kg and on 4th audit it was 10.30 kg. Variation in plastic pet bottles shows that there were some days on which guest may be increased or decreased. In last audit weight of pet bottles was 7.80 kg, after completing the audit of pet bottles, took the average of it to

know the average waste generated in one day that is 7.58 kg, if we consider these weight on yearly basis, it would become 2766.7 kg and the percentage of plastic pet bottles was 1.18%. Similarly other mixed plastic like plastic plates, packing wrappers, mineral water bottles, plastic bags, plastic coated paper, candy wrappers, foil gift wraps, shampoo bottles, carrier bags, plastic cutlery, toys, bleach cleaners bottles waste have high portion of waste compare to pet plastic bottle. On 1st audit it was 5.62 kg, in 2nd audit it was 4.60 kg, in 3rd audit it was 5.45 kg and in 4th and 5th audit it was 9.30 kg and 8.20 kg respectively. The average of mixed plastic waste was around 6.63 kg, which is 1.03% of the total waste and yearly it would become 2421.41 kg. Tetra pak are laminated plastic waste in the form of juice packets, lamination papers, kitchen spice packets etc. They were 5.80 kg, 4.50 kg, 3.80 kg, 6 kg, and 4.90 kg 1,2,3,4 and 5th audit respectively, which is 0.78% of total waste and yearly it would increase to 1825 kg of waste. Refer table 6.3 for detail explanation.

Aluminium waste like beer cans have comparatively minimum waste in hotel industry, in 1st audit it was only 2.70 kg, in 2nd audit it was 3.10 kg which is almost similar to 1st audit. In 3rd audit it was 3.40 kg, in 4th audit it was 8.10 kg and in 5th audit it was 5.10 kg respectively. The overall portion of this waste is only 0.70% and average weight of aluminium waste is approximately 4.48 kg and if we consider the same pattern of waste generation it would become 1635 kg yearly.

Table 6.3: Audit in Hilton hotel

NAME OF THE HOTEL	**Hilton Hotel, Delhi**							
DATE	2nd Feb 13	7th Feb 13	13th Feb 13	20th Feb 13	28th Feb 13	Average (Kg/day)	Percent (%)	Total waste (Kg/year)
DAY	Sat	Thurs	Wed	Wed	Thurs			
PLASTIC PET BOTTLE	8.17	6.33	5.30	10.30	7.80	7.58	1.18%	2766.7
OTHER/MIXED PLASTIC	5.62	4.60	5.45	9.30	8.20	6.63	1.03%	2421.41
TETRA PAK (Laminated Paper)	5.80	4.50	3.80	6.00	4.90	5.00	0.78%	1825
ALUMINIUM	2.70	3.10	3.40	8.10	5.10	4.48	0.70%	1635.2
GLASS	160.00	139.80	86.90	155.00	98.00	127.94	19.88%	46698.1
NEWSPAPER	60.00	60.00	60.00	60.00	60.00	60.00	9.32%	21900

MIXED OFFICE PAPER	4.30	2.80	3.00	4.80	5.80	4.14	0.64%	1511.1
CARDBOARD	100.00	89.90	155.00	195.80	128.80	133.90	20.81%	48873.5
COMPOST/WET WASTE	298.90	281.90	273.50	335.00	265.70	291.00	45.22%	106215
TRASH (Laminated Plastic)	2.40	3.30	1.30	4.10	2.80	2.78	0.43%	1014.7
TOTAL	**647.89**	**596.23**	**597.65**	**788.40**	**587.10**	**643.45**	**100.00 %**	**234860.7 1**

All waste in Kilogram (kg)

Source: Manually calculation of waste

Glass waste like broken glasses, beer bottles, wine bottles etc. were one of the main compositions of overall waste having high portion because of its weight. On 1st audit it was 160 kg, reasons may be party, conference, marriage function etc. but on the 2nd audit it was 139.80 kg, in 3rd audit it was 86.90 kg, in 4th audit the weight of glasses were 155 kg. In 5th audit it was again almost 98 kg, the overall average of glass waste was 127.94 kg, which is 19.88% of total waste. Yearly the glass waste would become 46698.1 kg.

Newspaper waste was almost similar in all audits because newspaper was daily countable items according to numbers of room in hotel. So in all audit it was 60 kg, which is 9.32% of total waste material generated from hotel industry and yearly it would be 21900 kg of weight. Mixed office paper like magazine, printouts, tissue papers, copy paper, photocopies, brochures, books, toilet roll cartridges, packaging paperboard, carbon paper etc. in 1st audit it was 4.30 kg, in 2nd audit it was 2.80 kg, in 3rd audit it was 3 kg, in 4th audit it was 4.80 kg and in 5th audit it was 5.80 kg, on an average it was approximately only 4.14 kg of waste, which is 0.64% of total waste and yearly it would become 1511.1 kg. Cardboard are the packaging items, the portion of this material always higher compare to other waste. In 1st audit it was 100 kg, in 2nd audit it was 89.90 kg, in 3rd audit it was 155 kg, in 4th audit it was 195.80 kg and in 5th audit it was 128.80 kg of waste respectively. On an average it was 133.90 kg of waste daily generated, which is 20.81% of total waste generated. If we considered the same pattern it would become 48873.5 kg of waste on yearly basis.

Organic waste or compostable waste like Vegetables waste leftover food, fruit waste, egg shells, sea food waste, dairy products etc. There are many literature reviews, reports;

published paper already proved that the portion of organic waste in hotel industry is almost 60% to 70% of the total waste. In this audit on 1st day the organic waste was 298.90 kg on only one day, in 2nd audit it was increased to 281.90 kg, in 3rd day it was 273.50 kg of waste, in 4th audit it was 335 kg of waste and in last audit it was 265.70 kg of waste. On an average this hotel generate 291 kg of waste daily, which is 45.22% of the total waste generated and if we consider the same pattern, further the intensity of waste would become 106215 kg on yearly basis. The last type of waste is trash means non process able waste in nature because of mixed with other waste. In hotel industry trash are almost negligible but due to non-segregated waste it mixed with other recyclable material and sent directly to the landfill site for dumping. In 1st audit trash was only 2.40 kg, in 2nd audit it was 3.30 kg of waste, in 3rd audit it was 1.30 kg of waste, in 4th audit it was 4.10 kg and in 5th audit it was 2.80 kg of waste respectively. On an average it was only 2.78 kg of waste daily, which is 0.43% of the total waste and yearly it would become only 1014.7 kg of waste.

Total waste generated on 1st audit of all waste material was 647.89 kg, in 2nd audit all waste was around 596.23 kg of waste, in 3rd audit it was 597.65, in 4th audit it was 788.40 kg of all waste material and in 5th audit it was 587.10 kg of waste. On an average the entire waste from one hotel in a day was 643.45 kg of waste. If the pace of waste increases in the same way in a year it would become approximately 234860.71 kg of all waste.

6.2.3 AUDIT IN COUNTRY INN HOTEL

Audited have been done on five different days to know the exact average value of each waste material. Here plastic pet bottle are very common in hotel industry and have different weight in all five days, on 1st day it was 10.84 kg whereas on 2nd audit it was increases to 6.30 kg, reason may be party, conferences etc. In 3rd audit, again the weight of plastic pet bottles became 5.30 kg and on 4th audit it was 8.34 kg. Variation in plastic pet bottles shows that there were some days on which guest may be increased or decreased. In last audit weight of pet bottles was 3 kg, after completing the audit of pet bottles, took the average of it to know the average waste generated in one day that is 6.76 kg, if we consider these weight on yearly basis, it would become 2465.94 kg and the percentage of plastic pet bottles was 0.51%. Similarly other mixed plastic like plastic plates, packing wrappers, mineral water bottles, plastic bags, plastic coated paper, candy wrappers, foil gift wraps, shampoo bottles, carrier

bags, plastic cutlery, toys, bleach cleaners bottles waste have high portion of waste compare to pet plastic bottle. On 1st audit it was 8.50 kg, in 2nd audit it was 9 kg, in 3rd audit it was 6.50 kg and in 4th and 5th audit it was 4 kg and 5.50 kg respectively. The average of mixed plastic waste was around 6.70 kg, which is 0.51% of the total waste and yearly it would become 2445.5 kg. Tetra pak are laminated plastic waste in the form of juice packets, lamination papers, kitchen spice packets etc. They were 7.50 kg, 2 kg, 6.80 kg, 3 kg, and 4.20 kg on 1,2,3,4 and 5th audit respectively, which is 0.36% of total waste and yearly it, would increase to 1715.5 kg of waste. See table 6.4 below.

Table 6.4: Audit in Country INN hotel

NAME OF THE HOTEL	**Country INN, Ghaziabad**							
DATE	5th March 13	11th March 13	17th March 13	23rd March 13	31st March 13	Average (Kg/day)	Percent (%)	Total waste (Kg/year)
DAY	Tue	Mon	Sun	Sat	Sun			
PLASTIC PET BOTTLE	10.84	6.30	5.30	8.34	3.00	6.76	0.51%	2465.94
OTHER/MIXED PLASTIC	8.50	9.00	6.50	4.00	5.50	6.70	0.51%	2445.5
TETRA PAK (Laminated Paper)	7.50	2.00	6.80	3.00	4.20	4.70	0.36%	1715.5
ALUMINIUM	3.80	2.10	2.30	3.40	2.90	2.90	0.22%	1058.5
GLASS	200.00	110.50	75.10	85.50	185.00	131.22	9.98%	47895.3
NEWSPAPER	65.00	65.00	65.00	65.00	65.00	65.00	4.94%	23725
MIXED OFFICE PAPER	7.50	5.00	2.10	6.40	5.50	5.30	0.40%	1934.5
CARDBOARD	215.00	180.00	203.00	180.00	175.50	190.70	14.50%	69605.5
COMPOST/WET WASTE	1200.00	750.00	1000.00	850.00	700.00	900.00	68.45%	328500
TRASH (Laminated Plastic)	2.80	2.10	0.80	1.50	1.00	1.64	0.12%	598.6
TOTAL	**1720.94**	**1132.00**	**1366.90**	**1207.14**	**1147.60**	**1314.92**	**100.00%**	**479944.34**

All waste in Kilogram (kg)

Source: Manually calculation of waste

Aluminium waste like beer cans have comparatively minimum waste in hotel industry, in 1st audit it was only 3.80 kg, in 2nd audit it was 2.10 kg which is almost similar to 1st audit. In 3rd audit it was 2.30 kg, in 4th audit it was 3.40 kg and in 5th audit it was 2.90 kg respectively. The overall portion of this waste is only 0.22% and average weight of aluminium waste is approximately 2.90 kg and if we consider the same pattern of waste generation it would become 1058.5 kg yearly. Glass waste like broken glasses, beer bottles, wine bottles etc. were one of the main compositions of overall waste having high portion because of its weight. On 1st audit it was 200 kg, reasons may be party, conference, marriage function etc. but on the 2nd audit it was 110.50 kg, in 3rd audit it was 75.10 kg, in 4th audit the weight of glasses were 85.50 kg. In 5th audit it was again almost 185 kg, the overall average of glass waste was 131.22 kg, which is 9.98% of total waste. Yearly the glass waste would become 47895.3 kg.

Newspaper waste was almost similar in all audits because newspaper was daily countable items according to numbers of room in hotel. So in all audit it was 65 kg, which is 4.94% of total waste material generated from hotel industry and yearly it would be 23725 kg of weight. Mixed office paper like magazine, printouts, tissue papers, copy paper, photocopies, brochures, books, toilet roll cartridges, packaging paperboard, carbon paper etc. in 1st audit it was 7.50 kg, in 2nd audit it was 5 kg, in 3rd audit it was 2.10 kg, in 4th audit it was 6.40 kg and in 5th audit it was 5.50 kg, on an average it was approximately only 5.30 kg of waste, which is 0.40% of total waste and yearly it would become 1934.5 kg. Cardboard are the packaging items, the portion of this material always higher compare to other waste. In 1st audit it was 215 kg, in 2nd audit it was 180 kg, in 3rd audit it was 203 kg, in 4th audit it was 180 kg and in 5th audit it was 175 kg of waste respectively. On an average it was 190.70 kg of waste daily generated, which is 14.50% of total waste generated. If we considered the same pattern it would become 69605.5 kg of waste on yearly basis.

Organic waste or compostable waste like Vegetables waste leftover food, fruit waste, egg shells, sea food waste, dairy products etc. There are many literature reviews, reports; published paper already proved that the portion of organic waste in hotel industry is almost 60% to 70% of the total waste. In this audit on 1st day the organic waste was 1200 kg on only one day, in 2nd audit it was increased to 750 kg, in 3rd day it was 1000 kg of waste, in 4th audit it was 850 kg of waste and in last audit it was 700 kg of waste. On an average this hotel

generate 900 kg of waste daily, which is 68.45% of the total waste generated and if we consider the same pattern, further the intensity of waste would become 328500 kg on yearly basis. The last type of waste is trash means non process able waste in nature because of mixed with other waste. In hotel industry trash are almost negligible but due to non-segregated waste it mixed with other recyclable material and sent directly to the landfill site for dumping. In 1st audit of trash was only 2.80 kg, in 2nd audit it was 2.10 kg of waste, in 3rd audit it was 0.80 kg of waste, in 4th audit it was 1.50 kg and in 5th audit it was 1 kg of waste respectively. On an average it was only 1.64 kg of waste daily, which is 0.12% of the total waste and yearly it would become only 598.6 kg of waste.Total waste generated on 1st audit of all waste material was 1720.94 kg, in 2nd audit all waste was around 1132 kg of waste, in 3rd audit it was 1366.90, in 4th audit it was 1207.14 kg of all waste material and in 5th audit it was 1147.60 kg of waste. On an average the entire waste from one hotel in a day was 1314.92 kg of waste. If the pace of waste increases in the same way in a year it would become approximately 479944.34 kg of all waste.

6.2.4 AUDIT IN PARK PLAZA HOTEL

Audited have been done on five different days to know the exact average value of each waste material. Here plastic pet bottle are very common in hotel industry and have different weight in all five days, on 1st day it was 7 kg whereas on 2nd audit it was increases to 5.50 kg, reason may be party, conferences etc. In 3rd audit, again the weight of plastic pet bottles became 8 kg and on 4th audit it was 6.40 kg. Variation in plastic pet bottles shows that there were some days on which guest may be increased or decreased. In last audit weight of pet bottles was 6 kg, after completing the audit of pet bottles, took the average of it to know the average waste generated in one day that is 6.58 kg, if we consider these weight on yearly basis, it would become 2401.7 kg and the percentage of plastic pet bottles was 2.06%. Similarly other mixed plastic like plastic plates, packing wrappers, mineral water bottles, plastic bags, plastic coated paper, candy wrappers, foil gift wraps, shampoo bottles, carrier bags, plastic cutlery, toys, bleach cleaners bottles waste have high portion of waste compare to pet plastic bottle. On 1st audit it was 8.50 kg, in 2nd audit it was 10 kg, in 3rd audit it was 5.50 kg and in 4th and 5th audit it was 4.80 kg and 5 kg respectively. The average of mixed

plastic waste was around 6.76 kg, which is 2.11% of the total waste and yearly it would become 2467.4 kg. See table 6.5 below.

Table 6.5: Audit in Park Plaza hotel

NAME OF THE HOTEL	Park Plaza, Noida							
DATE	6th April 13	12th April 13	18th April 13	24th April 13	30th April 13	Average (Kg/day)	Percent (%)	Total waste (Kg/year)
DAY	Sat	Fri	Thurs	Wed	Tue			
PLASTIC PET BOTTLE	7.00	5.50	8.00	6.40	6.00	6.58	2.06%	2401.7
OTHER/MIXED PLASTIC	8.50	10.00	5.50	4.80	5.00	6.76	2.11%	2467.4
TETRA PAK (Laminated Paper)	4.80	5.10	5.00	3.50	4.50	4.58	1.43%	1671.7
ALUMINIUM	3.20	2.80	4.10	3.90	4.20	3.64	1.14%	1328.6
GLASS	79.00	140.00	165.00	65.00	120.00	113.80	35.59%	41537
NEWSPAPER	20.00	20.00	20.00	20.00	20.00	20.00	6.25%	7300
MIXED OFFICE PAPER	3.00	5.00	4.80	3.20	2.80	3.76	1.18%	1372.4
CARDBOARD	29.00	35.90	50.00	45.50	28.80	37.84	11.83%	13811.6
COMPOST/WET WASTE	95.00	120.00	170.00	85.00	135.00	121.00	37.84%	44165
TRASH (Laminated Plastic)	0.80	1.20	2.30	1.90	2.80	1.80	0.56%	657
TOTAL	**250.30**	**345.50**	**434.70**	**239.20**	**329.10**	**319.76**	**100.00%**	**116712.4**

All waste in Kilogram (kg)

Source: Manually calculation of waste

Tetra pak are laminated plastic waste in the form of juice packets, lamination papers, kitchen spice packets etc. They were 4.80 kg, 5.10 kg, 5 kg, 3.50 kg, and 4.50 kg on 1,2,3,4 and 5th audit respectively, which is 1.43% of total waste and yearly it, would increase to 1671.7 kg of waste.

Aluminium waste like beer cans have comparatively minimum waste in hotel industry, in 1st audit it was only 3.20 kg, in 2nd audit it was 2.80 kg which is almost similar to 1st audit. In

3rd audit it was 4.10 kg, in 4th audit it was 3.90 kg and in 5th audit it was 4.20 kg respectively. The overall portion of this waste is only 1.14% and average weight of aluminium waste is approximately 3.64 kg and if we consider the same pattern of waste generation it would become 1328.6 kg yearly. Glass waste like broken glasses, beer bottles, wine bottles etc. were one of the main compositions of overall waste having high portion because of its weight. On 1st audit it was 79 kg, reasons may be party, conference, marriage function etc. but on the 2nd audit it was 140 kg, in 3rd audit it was 165 kg, in 4th audit the weight of glasses were 65 kg. In 5th audit it was again almost 120 kg, the overall average of glass waste was 113.80 kg, which is 35.59% of total waste. Yearly the glass waste would become 41537 kg.

Newspaper waste was almost similar in all audits because newspaper was daily countable items according to numbers of room in hotel. So in all audit it was 20 kg, which is 6.25% of total waste material generated from hotel industry and yearly it would be 7300 kg of weight. Mixed office paper like magazine, printouts, tissue papers, copy paper, photocopies, brochures, books, toilet roll cartridges, packaging paperboard, carbon paper etc. in 1st audit it was 3 kg, in 2nd audit it was 5 kg, in 3rd audit it was 4.80 kg, in 4th audit it was 3.20 kg and in 5th audit it was 2.80 kg, on an average it was approximately only 3.76 kg of waste, which is 1.18% of total waste and yearly it would become 1372.4 kg. Cardboard are the packaging items, the portion of this material always higher compare to other waste. In 1st audit it was 29 kg, in 2nd audit it was 35.90 kg, in 3rd audit it was 50 kg, in 4th audit it was 45.50 kg and in 5th audit it was 28.80 kg of waste respectively. On an average it was 37.84 kg of waste daily generated, which is 11.83% of total waste generated. If we considered the same pattern it would become 13811.6 kg of waste on yearly basis.

Organic waste or compostable waste like Vegetables waste leftover food, fruit waste, egg shells, sea food waste, dairy products etc. There are many literature reviews, reports; published paper already proved that the portion of organic waste in hotel industry is almost 60% to 70% of the total waste. In this audit on 1st day the organic waste was 95 kg on only one day, in 2nd audit it was increased to 120 kg, in 3rd day it was 170 kg of waste, in 4th audit it was 85 kg of waste and in last audit it was 135 kg of waste. On an average this hotel generate 121 kg of waste daily, which is 37.84% of the total waste generated and if we consider the same pattern, further the intensity of waste would become 44165 kg on yearly basis. The last type of waste is trash means non process able waste in nature because of mixed

with other waste. In hotel industry trash are almost negligible but due to non-segregated waste it mixed with other recyclable material and sent directly to the landfill site for dumping. In 1st audit of trash was only 0.80 kg, in 2nd audit it was 1.20 kg of waste, in 3rd audit it was 2.30 kg of waste, in 4th audit it was 1.90 kg and in 5th audit it was 2.80 kg of waste respectively. On an average it was only 1.80 kg of waste daily, which is 0.56% of the total waste and yearly it would become only 657 kg of waste.

Total waste generated on 1st audit of all waste material was 250.30 kg, in 2nd audit all waste was around 345.50 kg of waste, in 3rd audit it was 434.70, in 4th audit it was 239.20 kg of all waste material and in 5th audit it was 329.10 kg of waste. On an average the entire waste from one hotel in a day was 319.76 kg of waste. If the pace of waste increases in the same way in a year it would become approximately 116712.4 kg of all waste.

6.2.5 AUDIT IN JAYPEE VASANT CONTINENTAL HOTEL

Audited have been done on five different days to know the exact average value of each waste material. Here plastic pet bottle are very common in hotel industry and have different weight in all five days, on 1st day it was 5 kg whereas on 2nd audit it was increases to 8 kg, reason may be party, conferences etc. In 3rd audit, again the weight of plastic pet bottles became 2 kg and on 4th audit it was 7 kg. Variation in plastic pet bottles shows that there were some days on which guest may be increased or decreased. In last audit weight of pet bottles was 8 kg, after completing the audit of pet bottles, took the average of it to know the average waste generated in one day that is 6 kg, if we consider these weight on yearly basis, it would become 2190 kg and the percentage of plastic pet bottles was 0.84%. Refer table 6.6 below.

Table 6.6: Audit in Jaypee Vasant Continental hotel

NAME OF THE HOTEL	**Jaypee Vasant Continental,**							
DATE	5th May 13	11th May 13	17th May 13	25th May 13	31st May 13	Average (Kg/day)	Percent (%)	Total waste (Kg/year)
DAY	Sun	Sat	Fri	Sat	Fri			
PLASTIC PET BOTTLE	5.00	8.00	2.00	7.00	8.00	6.00	0.84%	2190
OTHER/MIXED PLASTIC	30.00	20.00	25.00	32.00	24.00	26.20	3.66%	9563

TETRA PAK (Laminated Paper)	2.50	2.00	1.50	3.50	1.00	2.10	0.29%	766.5
ALUMINIUM	2.00	3.50	4.00	5.00	2.00	3.30	0.46%	1204.5
GLASS	62.30	50.40	62.00	75.30	57.80	61.56	8.60%	22469.4
NEWSPAPER	60.00	60.00	60.00	60.00	60.00	60.00	8.38%	21900
MIXED OFFICE PAPER	10.00	8.50	7.00	12.00	9.50	9.40	1.31%	3431
CARDBOARD	65.00	55.00	30.00	72.00	45.00	53.40	7.46%	19491
COMPOST/WET WASTE	535.00	450.00	400.00	580.00	500.00	493.00	68.88%	179945
TRASH (Laminated Plastic)	0.50	1.00	0.30	1.50	0.80	0.82	0.11%	299.3
TOTAL	**772.30**	**658.40**	**591.80**	**848.30**	**708.10**	**715.78**	**100.00%**	**261259.7**

All waste in Kilogram (kg)

Source: Manually calculation of waste

Similarly other mixed plastic like plastic plates, packing wrappers, mineral water bottles, plastic bags, plastic coated paper, candy wrappers, foil gift wraps, shampoo bottles, carrier bags, plastic cutlery, toys, bleach cleaners bottles waste have high portion of waste compare to pet plastic bottle. On 1st audit it was 30 kg, in 2nd audit it was 20 kg, in 3rd audit it was 25 kg and in 4th and 5th audit it was 32 kg and 24 kg respectively. The average of mixed plastic waste was around 26.20 kg, which is 3.66% of the total waste and yearly it would become 9563 kg. Tetra pak are laminated plastic waste in the form of juice packets, lamination papers, kitchen spice packets etc. They were 2.50 kg, 2 kg, 1.50 kg, 3.50 kg, and 1 kg on 1,2,3,4 and 5th audit respectively, which is 0.29% of total waste and yearly it, would increase to 766.5 kg of waste.

Aluminium waste like beer cans have comparatively minimum waste in hotel industry, in 1st audit it was only 2 kg, in 2nd audit it was 3.50 kg which is almost similar to 1st audit. In 3rd audit it was 4 kg, in 4th audit it was 5 kg and in 5th audit it was 2 kg respectively. The overall portion of this waste is only 0.46% and average weight of aluminium waste is approximately 3.30 kg and if we consider the same pattern of waste generation it would become 1204.5 kg yearly. Glass waste like broken glasses, beer bottles, wine bottles etc. were one of the main compositions of overall waste having high portion because of its weight. On 1st audit it was 62.30 kg, reasons may be party, conference, marriage function etc. but on the 2nd audit it was 50.40 kg, in 3rd audit it was 62 kg, in 4th audit the weight of glasses were 75.30 kg. In 5th

audit it was again almost 57.80 kg, the overall average of glass waste was 61.56 kg, which is 8.60% of total waste. Yearly the glass waste would become 21900 kg.

Organic waste or compostable waste like Vegetables waste leftover food, fruit waste, egg shells, sea food waste, dairy products etc. There are many literature reviews, reports; published paper already proved that the portion of organic waste in hotel industry is almost 60% to 70% of the total waste. In this audit on 1st day the organic waste was 535 kg on only one day, in 2nd audit it was increased to 450 kg, in 3rd day it was 400 kg of waste, in 4th audit it was 580 kg of waste and in last audit it was 500 kg of waste. On an average this hotel generate 493 kg of waste daily, which is 68.88% of the total waste generated and if we consider the same pattern, further the intensity of waste would become 179945 kg on yearly basis. Total waste generated on 1st audit of all waste material was 772.30 kg, in 2nd audit all waste was around 658.40 kg of waste, in 3rd audit it was 591.80, in 4th audit it was 848.30 kg of all waste material and in 5th audit it was 708.10 kg of waste. On an average the entire waste from one hotel in a day was 715.78 kg of waste. If the pace of waste increases in the same way in a year it would become approximately 261259.7 kg of all waste.

6.2.6 AUDIT IN JAYPEE GREENS GOLF & SPA RESORT

Auditing has been done on five different days to know the exact average value of each waste material. Here plastic pet bottle are very common in hotel industry and have different weight in all five days, on 1st day it was 7.50 kg whereas on 2nd audit it was increases to 8 kg, reason may be party, conferences etc. In 3rd audit, again the weight of plastic pet bottles became 4.50 kg and on 4th audit it was 6 kg. Variation in plastic pet bottles shows that there were some days on which guest may be increased or decreased. In last audit weight of pet bottles was 3.20 kg, after completing the audit of pet bottles, took the average of it to know the average waste generated in one day that is 5.84 kg, if we consider these weight on yearly basis, it would become 2131.6 kg and the percentage of plastic pet bottles was 2.40%. Similarly other mixed plastic like plastic plates, packing wrappers, mineral water bottles, plastic bags, plastic coated paper, candy wrappers, foil gift wraps, shampoo bottles, carrier bags, plastic cutlery, toys, bleach cleaners bottles waste have high portion of waste compare to pet plastic bottle. On 1st audit it was 3.90 kg, in 2nd audit it was 5.80 kg, in 3rd audit it was 4.10 kg and in 4th and 5th audit it was 3.10 kg and 3.80 kg respectively. The average of

mixed plastic waste was around 4.14 kg, which is 1.70% of the total waste and yearly it would become 1511.1 kg. Aluminium waste like beer cans have comparatively minimum waste in hotel industry, in 1st audit it was only 4 kg, in 2nd audit it was 10.80 kg which is almost similar to 1st audit. In 3rd audit it was 5 kg, in 4th audit it was 6 kg and in 5th audit it was 2.10 kg respectively. The overall portion of this waste is only 2.29% and average weight of aluminium waste is approximately 5.58 kg and if we consider the same pattern of waste generation it would become 2036.7 kg yearly. Glass waste like broken glasses, beer bottles, wine bottles etc. were one of the main compositions of overall waste having high portion because of its weight. On 1st audit it was 73.50 kg, reasons may be party, conference, marriage function etc. but on the 2nd audit it was 80.10 kg, in 3rd audit it was 40.30 kg, in 4th audit the weight of glasses were 66 kg. In 5th audit it was again almost 24 kg, the overall average of glass waste was 56.78 kg, which is 23.31% of total waste. Yearly the glass waste would become 20724.7 kg.

Table 6.7: Audit in Jaypee Greens Golf & Spa Resort

NAME OF THE HOTEL	**Jaypee Greens Golf & Spa Resort**							
DATE	2nd June 13	8th June 13	13th June 13	21st June 13	25th June 13	Average (Kg/day)	Percent (%)	Total waste (Kg/year)
DAY	Sun	Sat	Thurs	Fri	Tue			
PLASTIC PET BOTTLE	7.50	8.00	4.50	6.00	3.20	5.84	2.40%	2131.6
OTHER/MIXED PLASTIC	3.90	5.80	4.10	3.10	3.80	4.14	1.70%	1511.1
TETRA PAK (Laminated Paper)	2.00	3.00	1.50	2.20	1.50	2.04	0.84%	744.6
ALUMINIUM	4.00	10.80	5.00	6.00	2.10	5.58	2.29%	2036.7
GLASS	73.50	80.10	40.30	66.00	24.00	56.78	23.31%	20724.7
NEWSPAPER	20.00	20.00	20.00	20.00	20.00	20.00	8.21%	7300
MIXED OFFICE PAPER	5.00	5.50	4.10	3.20	8.00	5.16	2.12%	1883.4
CARDBOARD	20.00	50.00	30.80	15.00	12.80	25.72	10.56%	9387.8
COMPOST/WET WASTE	130.00	165.00	110.00	85.00	98.00	117.60	48.27%	42924
TRASH (Laminated Plastic)	0.50	1.20	0.70	0.90	0.50	0.76	0.31%	277.4
TOTAL	**266.40**	**349.40**	**221.00**	**207.40**	**173.90**	**243.62**	**100.00%**	**88921.3**

All waste in Kilogram (kg)

Source: Manually calculation of waste

Organic waste or compostable waste like Vegetables waste leftover food, fruit waste, egg shells, sea food waste, dairy products etc. There are many literature reviews, reports; published paper already proved that the portion of organic waste in hotel industry is almost 60% to 70% of the total waste. In this audit on 1st day the organic waste was 130 kg on only one day, in 2nd audit it was increased to 165 kg, in 3rd day it was 110 kg of waste, in 4th audit it was 85 kg of waste and in last audit it was 98 kg of waste. On an average this hotel generate 117.60 kg of waste daily, which is 48.27% of the total waste generated and if we consider the same pattern, the intensity of waste would become 42924 kg on yearly basis.

6.2.7 AUDIT IN JAYPEE SIDDHARTH HOTEL

Audited have been done on five different days to know the exact average value of each waste material. Here plastic pet bottle are very common in hotel industry and have different weight in all five days, on 1st day it was 6 kg whereas on 2ndaudit it was increases to 7.50 kg, reason may be party, conferences etc. In 3rdaudit it was 5 kg and on 4th audit it was 5.80 kg. Variation in plastic pet bottles shows that there were some days on which guest may be increased or decreased. In last audit weight of pet bottles was 7 kg, after completing the audit of pet bottles, took the average of it to know the average waste generated in one day that is 6.26 kg, if we consider these weight on yearly basis, it would become 2284 kg and the percentage of plastic pet bottles was 2.15%. Similarly other mixed plastic like plastic plates, packing wrappers, mineral water bottles, plastic bags, plastic coated paper, candy wrappers, foil gift wraps, shampoo bottles, carrier bags, plastic cutlery, toys, bleach cleaners bottles waste have high portion of waste compare to pet plastic bottle. On 1st audit it was 8.90 kg, in 2nd audit it was 10 kg, in 3rd audit it was 4.30 kg and in 4th and 5th audit it was 6 kg and 7.30 kg respectively. The average of mixed plastic waste was around 7.30 kg, which is 2.50% of the total waste and yearly it would become 2664.5 kg. See table 6.8 below.

Table 6.8: Audit in JaypeeSiddharth hotel

NAME OF THE HOTEL	**JaypeeSiddharth**							
DATE	4th August 13	10th August 13	17th August 13	24th August 13	31th August 13	Average (Kg/day)	Percent (%)	Total waste (Kg/year)
DAY	Sun	Sat	Sat	Sat	Sat			

PLASTIC PET BOTTLE	6.00	7.50	5.00	5.80	7.00	6.26	2.15%	2284.9
OTHER/MIXED PLASTIC	8.90	10.00	4.30	6.00	7.30	7.30	2.50%	2664.5
TETRA PAK (Laminated Paper)	3.00	5.50	2.00	3.00	3.80	3.46	1.19%	1262.9
ALUMINIUM	2.00	4.90	3.00	3.50	5.00	3.68	1.26%	1343.2
GLASS	70.00	135.00	65.00	110.00	80.00	92.00	31.57%	33580
NEWSPAPER	35.00	35.00	35.00	35.00	35.00	35.00	12.01%	12775
MIXED OFFICE PAPER	2.40	3.80	4.00	3.00	4.80	3.60	1.24%	1314
CARDBOARD	20.80	30.00	20.00	25.20	35.00	26.20	8.99%	9563
COMPOST/WET WASTE	120.00	130.00	100.00	95.00	118.00	112.60	38.64%	41099
TRASH (Laminated Plastic)	1.30	2.00	0.07	1.50	1.80	1.33	0.46%	486.91
TOTAL	**269.40**	**363.70**	**238.37**	**288.00**	**297.70**	**291.43**	**100.00%**	**106373.41**

All waste in Kilogram (kg)

Source: Manually calculation of waste

Aluminium waste like beer cans have comparatively minimum waste in hotel industry, in 1st audit it was only 2 kg, in 2nd audit it was 4.90 kg which is almost similar to 1st audit. In 3rd audit it was 3 kg, in 4th audit it was 3.50 kg and in 5th audit it was 5 kg respectively. The overall portion of this waste is only 1.26% and average weight of aluminium waste is approximately 3.68 kg and if we consider the same pattern of waste generation it would become 1343.2 kg yearly. Glass waste like broken glasses, beer bottles, wine bottles etc. were one of the main compositions of overall waste having high portion because of its weight. On 1st audit it was 70 kg, reasons may be party, conference, marriage function etc. but on the 2nd audit it was 135 kg, in 3rd audit it was 65 kg, in 4th audit the weight of glasses were 110 kg. In 5th audit it was again almost 80 kg, the overall average of glass waste was 92 kg, which is 31.57% of total waste. Yearly the glass waste would become 33580 kg.

Organic waste or compostable waste like Vegetables waste leftover food, fruit waste, egg shells, sea food waste, dairy products etc. There are many literature reviews, reports; published paper already proved that the portion of organic waste in hotel industry is almost 60% to 70% of the total waste. In this audit on 1st day the organic waste was 120 kg on only

one day, in 2nd audit it was increased to 130 kg, in 3rd day it was 100 kg of waste, in 4th audit it was 95 kg of waste and in last audit it was 118 kg of waste. On an average this hotel generate 112.60 kg of waste daily, which is 38.64% of the total waste generated and if we consider the same pattern, the intensity of waste would become 41099 kg on yearly basis.

Total waste generated on 1st audit of all waste material was 269.90 kg, in 2nd audit all waste was around 363.70 kg of waste, in 3rd audit it was 238.37, in 4th audit it was 288 kg of all waste material and in 5th audit it was 297.70 kg of waste. On an average the entire waste from one hotel in a day was 291.43 kg of waste. If the pace of waste increases in the same way in a year it would become approximately 106373.41 kg of all waste.

6.2.8 AUDIT IN LEMON TREE HOTEL

Audited have been done on five different days to know the exact average value of each waste material. Here plastic pet bottle are very common in hotel industry and have different weight in all five days, on 1st day it was 5.88 kg whereas on 2nd audit it was increases to 6.50 kg, reason may be party, conferences etc. In 3rd audit it was 9.80 kg and on 4th audit it was 7.60 kg. Variation in plastic pet bottles shows that there were some days on which guest may be increased or decreased. In last audit weight of pet bottles was 6 kg, after completing the audit of pet bottles, took the average of it to know the average waste generated in one day that is 7.16 kg, if we consider these weight on yearly basis, it would become 2611.94 kg and the percentage of plastic pet bottles was 1.20%. Similarly other mixed plastic like plastic plates, packing wrappers, mineral water bottles, plastic bags, plastic coated paper, candy wrappers, foil gift wraps, shampoo bottles, carrier bags, plastic cutlery, toys, bleach cleaners bottles waste have high portion of waste compare to pet plastic bottle. On 1st audit it was 4 kg, in 2nd audit it was 7.20 kg, in 3rd audit it was 8.20 kg and in 4th and 5th audit it was 6 kg and 6.30 kg respectively. The average of mixed plastic waste was around 6.34 kg, which is 1.07% of the total waste and yearly it would become 2314.1 kg.

Aluminium waste like beer cans have comparatively minimum waste in hotel industry, in 1st audit it was only 3.80 kg, in 2nd audit it was 2.90 kg which is almost similar to 1st audit. In 3rd audit it was 4 kg, in 4th audit it was 3 kg and in 5th audit it was 2.80 kg respectively. The overall portion of this waste is only 0.56% and average weight of aluminium waste is

approximately 3.30 kg and if we consider the same pattern of waste generation it would become 1204.5 kg yearly. Glass waste like broken glasses, beer bottles, wine bottles etc. were one of the main compositions of overall waste having high portion because of its weight. On 1st audit it was 160 kg, reasons may be party, conference, marriage function etc. but on the 2nd audit it was 155 kg, in 3rd audit it was 190 kg, in 4th audit the weight of glasses were 130 kg. In 5th audit it was again almost 100 kg, the overall average of glass waste was 147 kg, which is 24.74% of total waste. Yearly the glass waste would become 53655 kg. See table 6.9 below.

Cardboard are the packaging items, the portion of this material always higher compare to other waste. In 1st audit it was 165 kg, in 2nd audit it was 155 kg, in 3rd audit it was 195 kg, in 4th audit it was 115 kg and in 5th audit it was 85 kg of waste respectively. On an average it was 143 kg of waste daily generated, which is 24.06% of total waste generated. If we considered the same pattern it would become 52195 kg of waste on yearly basis. Organic waste or compostable waste like Vegetables waste leftover food, fruit waste, egg shells, sea food waste, dairy products etc. There are many literature reviews, reports; published paper already proved that the portion of organic waste in hotel industry is almost 60% to 70% of the total waste. In this audit on 1st day the organic waste was 250 kg on only one day, in 2nd audit it was increased to 260 kg, in 3rd day it was 280 kg of waste, in 4th audit it was 175 kg of waste and in last audit it was 190 kg of waste. On an average this hotel generate 231 kg of waste daily, which is 38.87% of the total waste generated and if we consider the same pattern, further the intensity of waste would become 84315 kg on yearly basis. See table 6.9 below.

Table 6.9: Audit in Lemon tree hotel

NAME OF THE HOTEL	**Lemon Tree hotel**							
DATE	1st Sept 13	7th Sept 13	13th Sept 13	21st Sept 13	29th Sept 13	Average (Kg/day)	Percent (%)	Total waste (Kg/year)
DAY	Sun	Sat	Fri	Sat	Sun			
PLASTIC PET BOTTLE	5.88	6.50	9.80	7.60	6.00	7.16	1.20%	2611.94
OTHER/MIXED PLASTIC	4.00	7.20	8.20	6.00	6.30	6.34	1.07%	2314.1
TETRA PAK (Laminated Paper)	3.50	6.20	6.50	4.00	5.50	5.14	0.86%	1876.1
ALUMINIUM	3.80	2.90	4.00	3.00	2.80	3.30	0.56%	1204.5

GLASS	160.00	155.00	190.00	130.00	100.00	147.00	24.74%	53655
NEWSPAPER	45.00	45.00	45.00	45.00	45.00	45.00	7.57%	16425
MIXED OFFICE PAPER	3.00	4.20	5.30	3.80	4.80	4.22	0.71%	1540.3
CARDBOARD	165.00	155.00	195.00	115.00	85.00	143.00	24.06%	52195
COMPOST/WET WASTE	250.00	260.00	280.00	175.00	190.00	231.00	38.87%	84315
TRASH (Laminated Plastic)	2.00	1.80	2.90	1.70	2.30	2.14	0.36%	781.1
TOTAL	**642.18**	**643.80**	**746.70**	**491.10**	**447.70**	**594.30**	**100.00%**	**216918.04**

All waste in Kilogram (kg)

Source: Manually calculation of waste

Total waste generated on 1st audit of all waste material was 642.18 kg, in 2nd audit all waste was around 643.80 kg of waste, in 3rd audit it was 746.70, in 4th audit it was 491.10 kg of all waste material and in 5th audit it was 447.70 kg of waste. On an average the entire waste fromone hotel in a day was 594.30 kg of waste. If the pace of waste increases in the same way in a year it would become approximately 216918.04 kg of all waste.

6.2.9 AVERAGE WASTE GENERATED ACROSS EIGHT HOTELS

After completing the entire waste audit process the next logical step is to take the average of all audited hotel to know the volume of waste generated from hotel.The average generation of plastic pet bottles from audited hotel is approximately 6.51 kg per day and yearly it was 2343.06 kg. Similarly averages of other mixed plastic waste material from all hotels were 8.99 kg per day and 3235.23 kg on yearly basic. Tetra pak from the entire hotel was approximately 4.05 kg per day whereas 1458.9 kg in a year. The averages of aluminium that is 3.69 kg would become 1327.5 kg in a year. The fraction of Glass wastes is higher in total waste and average waste generation from hotel is 115.56 kg in a day. This shows that this waste has large chunk of waste. While considering yearly basis it would become 41602.5 kg. There is a variation in a hotel regarding newspaper because it is mostly depend on the number of rooms available in a particular hotel. Approximately in a day a hotel generate 48.13 kg of waste per day and yearly it would be 17325 kg. Mixed office paper is estimated as 5.80 kg per day and it would become 2086.2 kg per year. Cardboard are also one of the major portion of overall

waste. On an average it generates 107.58 kg per day and in a year it would be approximately 38729.7 kg.

Food waste is one of the high portions of waste because of consumption pattern, habit and restaurants in hotels. On an average it is 478.17 kg of waste per day and yearly it would increase and become 172141.2 kg. Trash material is very less in nature but unfortunately mixed with other material and sent to landfill sites. Currently only 1.69 kg of waste generated in a day and yearly it is only 608.13 kg of waste.

Table 6.10: Average waste generated from all eight hotels

Material	Shangri-la Hotel	Hilton Hotel	Jaypee Vasant Continental	Country INN	Park Plaza	Jaypee Greens Golf & Spa Resort	Jaypee Sidharth	Lemon Tree	Avg/day (Kg)	Avg/Yr (Kg)
PLASTIC PET BOTTLE	5.90	7.58	6	6.76	6.58	5.84	6.26	7.16	6.51	2343.06
OTHER/MIXED PLASTIC	7.82	6.63	26.2	6.7	6.76	4.14	7.3	6.34	8.99	3235.23
TETRA PAK (Laminated Paper)	5.4	5	2.1	4.7	4.58	2.04	3.46	5.14	4.05	1458.9
ALUMINIUM	2.62	4.48	3.3	2.9	3.64	5.58	3.68	3.30	3.69	1327.5
GLASS	194.2	127.94	61.56	131.22	113.8	56.78	92	147.00	115.56	41602.5
NEWSPAPER	80	60	60	65	20	20	35	45.00	48.13	17325
MIXED OFFICE PAPER	10.78	4.14	9.4	5.3	3.76	5.16	3.6	4.22	5.80	2086.2
CARDBOARD	249.9	133.9	53.4	190.7	37.84	25.72	26.2	143.00	107.58	38729.7
FOOD/WET WASTE	1559.16	291	493	900	121	117.6	112.6	231.00	478.17	172141.2
TRASH (Laminated Plastic)	2.24	2.78	0.82	1.64	1.8	0.76	1.334	2.14	1.69	608.13
Total	**2118.02**	**643.45**	**715.78**	**1314.92**	**319.76**	**243.62**	**291.43**	**594.30**	**780.16**	**2,80,857.42**

All waste in Kilogram (kg)

Source: Manually calculation of the averages of all hotel waste

These eight hotels selected as a sample from all types of star rated hotels. Because the category of star rated hotel is almost same in anywhere in India. Now these wastes are

extrapolated on all Delhi-NCR hotels to know the intensity or volume of waste generated in this geographical region.

Table 6.11: Number of star rated hotels in Delhi-NCR

Type of hotel	**Year 2014**
5 star Deluxe hotels	26
5 star hotels	13
4 star hotels	15
3 star hotels	40
Total	**94**

Source: Ministry of tourism [35]

With the help of audited hotel waste, we are able to find the waste generation ratio from a single hotel and can extrapolate it to the Delhi NCR hotel to know the approximately waste amount generated in this region. A single hotel can generate approximately 280.86 ton of waste per year. This is the huge amount of waste only from a single metro city of a single hotel. But if consider the entire hotel of Delhi-NCR the amount of waste increased to 26400.60 ton of waste per year.

This is an unexpected figure came out from a single service sector. As there are many literature articulate that there is a scarcity of land. In this scenario we can't expect more or more landfill sites for waste dumping. In metro cities there are some other sources also that generate same amount of waste daily. In Delhi there are few landfill sites like Okhla, Bhalaswa and Ghazipur sites, which are almost full. So the best option to get rid of this problem is to solve it. Table 6.12 below shows the detail of waste generation.

Table 6.12: Waste generate in Delhi-NCR

Waste generate in Delhi NCR hotels		
Material	**Waste generated from one hotel/year (Tons)**	**Total waste generated from Delhi NCR hotels (tons/year)**
PLASTIC PET BOTTLE	2.34	220.25
OTHER/MIXED PLASTIC	3.24	304.11
TETRA PAK (Laminated Paper)	1.46	137.14
ALUMINIUM	1.33	124.79
GLASS	41.60	3910.64
NEWSPAPER	17.33	1628.55
MIXED OFFICE PAPER	2.09	196.10
CARDBOARD	38.73	3640.59

COMPOST/WET WASTE	172.14	16181.27
TRASH (Laminated Plastic)	0.61	57.16
Total	**280.86**	**26,400.60**

All waste in Tons

Source: Extrapolation of hotel waste

6.3 WARM MODEL

There are many research papers on the basic of characterization of waste,status of landfill, various environmental policies and technique to resolve the volume of waste in hotel industry. This is one of the main purposes of the author to identify the emission rate from waste in hotel industry. This study willrecommend various practices to reduce or utilize waste as a resource through WARM model.

In this studyauthor wants to develop a holistic model that show the relationship between emission of waste from hotel and its pace of volume along with environment impact. Carbon emission rate was estimated from hotel industry. WARM is a decision-making tool, intended to be used to quantify the benefits associated with different waste management decisions. It's a tool to quantify the linkages between waste management practices and greenhouse gas (GHG) emission reductions.

The benefits estimates by recycling and composting hotel waste were calculated using the Waste Reduction Model - *version 12*. In model fourty six type of different waste material have been used for calculation.

The total waste collected from hotel bins and collection points has been classified into different types of waste according to WARM categorization like aluminium cans, food scraps, paper waste and plastic etc. The material wise data collected was used to analyse Metric Tons of Carbon Dioxide (MTCO2E) equivalent using WARM Model. The analysis involves using WARM to differentiate between baseline scenario and alternate scenario. Baseline scenario determines the amount of waste that goes into landfills or combusted.On the other hand waste arerecycled in the alternate scenario.

Table 6.13: Type of waste generation in hotel industry

Category of waste	**Waste Reduction by**	**Category of waste**	**Waste Reduction by**
Aluminium Cans	Recycle	Grass	Composting
Aluminium Ingot	Recycle	Leaves	Composting
Steel Cans	Recycle	Branches	Composting
Copper Wire	Recycle	Mixed Paper (general)	Recycle
Glass	Recycle	Mixed Paper (primarily residential)	Recycle
HDPE	Recycle	Mixed Paper (primarily from offices)	Recycle
LDPE	combustion	Mixed Metal	Recycle
PET	Recycle	Mixed Plasticises	Recycle
LLDPE	Recycle	Mixed Recyclables	Recycle
PP	Recycle	Mixed Organics	Composting
PS	Recycle	Mixed MSW	Combustion
PVC	Recycle	Carpet	Recycle
PLA	Recycle	Personal Computers	Recycle
Corrugated Containers	Recycle	Clay Bricks	Recycle
Magazines/Third-class Mail	Recycle	Concrete	Recycle
Newspaper	Recycle	Fly Ash	Recycle
Office Paper	Recycle	Tires	Recycle
Phonebooks	Recycle	Asphalt Concrete	Recycle
Textbooks	Recycle	Asphalt Shingles	Recycle
Dimensional Lumber	Recycle	Drywall	Recycle
Medium-density Fibre board	Recycle	Fibre glass Insulation	Recycle
Food Scraps	Composting	Vinyl Flooring	Recycle
Yard Trimmings	Composting	Wood Flooring	Recycle

Source: Adopted from United States Environmental Protection Agency (USEPA) (WARM Model) [302]

The average waste generated per hotel is derived on daily basis by Auditing in Kilograms (kg). further it is multiplied by 365 days to calculate average number of waste generated from a single star rated.Finally, value divided by 1000 to convert it to tons. This will show the emission generation ratio from a single star rated hotel. Thus, the entire weight of all waste material is received in terms of yearly basis. Similarly to calculate the emission from all-star rated hotel in Delhi-NCR, all extrapolated data from audit sheet, which later on multiplied by

365 days to the 94 star rated hotel, and at last divided by 1000 to convert in tons.In WARM model there are two type of scenario i.e. baseline and alternate scenario:

Baseline scenario

In WARM model the first step is to calculate baseline scenario. It is used to estimate the present rate of emission in form of MTCO2E, from the wastes, which is generated and disposed by hotels. As per the data collected from waste auditing there are 10 different categories of materials. On the basis of current practices like recycling, composting, combustion and landfill, they are placed in the baseline table for calculation. Basically baseline scenario talk about that all waste generated from hotel industry are neither recycle nor compostable. All waste is directly sent to the landfill sites without any proper treatment.

Alternate scenario

The alternate scenario is another step in WARM model that guide to utilize of each waste material which goes to landfill and suggest converting waste into resource by recycling, composting and combustion based on the waste material category. In this scenario all waste are treated according to their nature, for example pet bottles, mixed plastic, cardboard, newspaper, glasses, tetra pack etc. are easily recycle and wet waste like food waste, kitchen waste, horticulture waste etc. are easily compostable. Overall this scenario is a key problem solver of all problem generated by waste to atmosphere and health of human beings. It will minimize transportation and collection cost of waste from source to destination. Table 6.14 shows the both scenario of waste treatment. See Appendix C for more detail.

Table 6.14: Baseline scenario and alternative scenario

	Baseline Scenario					Alternative Scenario				
Material	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Tons Generated	Tons Source Reduced	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted
Aluminum Cans				N/A	0					N/A
Steel Cans				N/A	0					N/A
Glass				N/A	0					N/A

	Baseline Scenario					Alternative Scenario				
Material	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Tons Generated	Tons Source Reduced	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted
PET				N/A	0					N/A
Newspaper				N/A	0					N/A
Office Paper				N/A	0					N/A
Food Scraps	N/A				0	N/A	N/A			
Yard Trimmings	N/A				0	N/A	N/A			
Mixed Paper (general)				N/A	0	N/A				N/A
Mixed Metals				N/A	0	N/A				N/A
Mixed Plastics				N/A	0	N/A				N/A
Mixed Organics	N/A				0	N/A	N/A			

Source: Adopted from United States Environmental Protection Agency (USEPA) (WARM Model) [302]

6.3.1 EMISSION FROM SINGLE STAR RATED HOTEL

After placing of data, which we got from auditing now put into both the scenarios, the next logical step is the landfill characteristic with five available options like national average, no Landfill gas recovery. In which, author selected no LFG recovery because in India there is no landfill gas (LFG[14]) recovery system because landfills are not scientifically designed.

Fourth step is the waste transport characteristics, which determine emission that occur during transport of all waste materials. The table 6.15 below shows the result of emission generation and reduction.

GHG Calculation

$$A = \left[\sum_{x=S}^{T-1} \left\{ W_x L'_x \left(e^{-k(T-x-1)} - e^{-k(T-x)} \right) \right\} \right]$$

Where,

A = CH4 generations (Mg/yr)

x = Year ofwaste disposed

S = Starting year of inventory calculation

T = Inventory year

Wx = the quantity of waste disposed at site (Mg)

L' = CH4 generation (Mg CH4/Mg waste)

= MCF × DOC × DOCF × F × 16 / 12 [IPCC nomenclature]

= L0 × 16/0.02367 × 10-6

L0 = CH4 generation potential (m3 CH4/Mg waste)

MCF = CH4 correction factor

DOC = degradable organic carbon fraction

DOCF = fraction of DOC decomposed fraction

F = fraction by volume of CH4 in landfill gas

k = decay rate

Table 6.15: Report generation of single hotel

GHG Emissions Analysis – Summary Report

(Version 12, 2/12)

Analysis of GHG Emissions from Waste Management for Hotel Industry (Audit Form)

Prepared by Amar Nath

Reporting Period for this Analysis is from 05/02/2013 to 30/11/2013

GHG Emissions from Baseline Waste Management Scenario (MTCO2E):	343
GHG Emissions from Alternative Waste Management Scenario (MTCO2E):	-263
Total Change in GHG Emissions: (MTCO2E):	**-606**

	Baseline Scenario					Alternative Scenario						
Material	**Tons Recycled**	**Tons Landfilled**	**Tons Combusted**	**Tons Composted**	**Total MTCO2E**	**Tons Source Reduced**	**Tons Recycled**	**Tons Landfilled**	**Tons Combusted**	**Tons Composted**	**Total MTCO2E**	**Change (Alt - Base) MTCO2E**
Aluminum Cans	0	1	0	N/A	0	0	1	0	0	N/A	-13	**-13**
Glass	0	47	0	N/A	2	0	47	0	0	N/A	-13	**-15**
PET	0	3	0	N/A	0	0	3	0	0	N/A	-3	**-3**
Corrugated Containers	0	43	0	N/A	64	0	43	0	0	N/A	-135	**-199**
Newspaper	0	19	0	N/A	-9	0	19	0	0	N/A	-54	**-45**
Office Paper	0	2	0	N/A	9	0	2	0	0	N/A	-7	**-15**
Food Scraps	N/A	192	0	0	274	0	N/A	0	0	192	-38	**-312**
Mixed Paper (general)	0	2	0	N/A	2	N/A	2	0	0	N/A	-6	**-8**
Mixed Plastics	0	4	0	N/A	0	N/A	0	0	4	N/A	5	**4**
Mixed Recyclables	0	1	0	N/A	1	N/A	0	1	0	N/A	1	**0**

Note: A negative value indicates an emission reduction; a positive value indicates an emission increase.

Source: Report generated from United States Environmental Protection Agency (USEPA) (WARM Model) [302]

Table 6.15above shows the value of both scenarios. In baseline scenario the value was 343 metric ton of CO2 equivalent when none of the any green practices were implemented and entire waste directly sent to the landfill sites. On the other side alternative scenario is the best option for waste treatment and the value is -263 metric ton of CO2 equivalent, which shows

the reduction of GHG emission from all waste. Here negative sign denote that there is saving of greenhouse gases.

The actual value between the baseline scenario and alternate scenario is -606 metric ton of CO2 equivalent. That shows how much hotel industry to save GHG emission by adopting such technique and use waste as a resource.

Table 6.16: Change in emission

Total change in GHG emission (MTCO2E)	-606

Source: Calculated from Waste Reduction Model (WARM Model) [302]

This value shows that only a single hotel can save 606 metric ton of CO2 equivalent, at present this value is negligible but further the same process use with all-star rated hotels of Delhi-NCR, this value become a meaningful interpretation.

6.3.2 EMISSION FROM ALL STAR RATED HOTELS IN DELHI- NCR

Similarly the same process mentioned like placing of data in both the scenarios. The last step is the conversion of output in metric tons of carbon dioxide equivalent (MTCO2E) for the communication for easily understand because in the climate change world, people speak and compare value in terms of carbon dioxide equivalents.Table 6.17 below shows the data of both scenarios of all hotels. In this calculation small unrated hotel, restaurants, motels, dhabas and kiosks were not considered here. Suppose if we considered the entire segment the value of both scenarios become very high.

Table 6.17: Report generation of all-star rated hotel in Delhi-NCR

GHG Emissions Analysis – Summary Report

(Version 12, 2/12)

Analysis of GHG Emissions from Waste Management for Delhi NCR Hotel

Prepared by Amar

Reporting Period for this Analysis is from 05/01/2014 to 25/04/14

GHG Emissions from Baseline Waste Management Scenario (MTCO2E):	31,748
GHG Emissions from Alternative Waste Management Scenario (MTCO2E):	-25,008
Total Change in GHG Emissions: (MTCO2E):	**-56,756**

	Baseline Scenario					Alternative Scenario						
Material	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Total MTCO2E	Tons Source Reduced	Tons Recycled	Tons Landfilled	Tons Combusted	Tons Composted	Total MTCO2E	Change (Alt - Base) MTCO2E
Aluminum Cans	0	138	0	N/A	5	0	138	0	0	N/A	-1,223	**-1,228**
Glass	0	4,311	0	N/A	167	0	4,311	0	0	N/A	-1,199	**-1,366**
PET	0	243	0	N/A	9	0	243	0	0	N/A	-269	**-279**
Corrugated Containers	0	4,013	0	N/A	5,965	0	4,013	0	0	N/A	-12,481	**-18,446**
Newspaper	0	1,795	0	N/A	-864	0	1,795	0	0	N/A	-4,993	**-4,129**
Office Paper	0	216	0	N/A	803	0	216	0	0	N/A	-617	**-1,420**
Food Scraps	N/A	17,837	0	0	25,443	0	N/A	0	0	17,837	-3,526	**-28,968**
Mixed Plastics	0	335	0	N/A	13	N/A	335	0	0	N/A	-329	**-342**
Mixed Recyclables	0	151	0	N/A	155	N/A	151	0	0	N/A	-423	**-578**
Mixed Organics	N/A	63	0	0	52	N/A	N/A	63	0	0	52	**0**

Note: A negative value indicates an emission reduction; a positive value indicates an emission increase.

Source: Report generated from United States Environmental Protection Agency (USEPA) (WARM Model) [302]

Table 6.17 above shows the value of both scenarios. In baseline scenario the value was 31, 748 metric ton of CO2 equivalent when none of the any green practices were implemented and entire waste directly sent to the landfill sites. On the other side alternative scenario is the best option for waste treatment and the value is -25,008 metric ton of CO2 equivalent, which shows the reduction of GHG emission from all waste. Here negative sign denote that there is saving of greenhouse gases. The actual value of the difference between both scenario is -56,756 metric ton of CO2 equivalent. That shows hotel industry save emission by adopting such technique and use waste as a resource.

Table 6.18: Change in emission (Delhi-NCR hotels)

Total change in GHG emission (MTCO2E)	-56,756

Source: Calculated from Waste Reduction Model (WARM Model) [302]

This value shows that the entire star rated hotel can save approximately -56,756 metric ton of CO2 equivalent, earlier we saw the a single hotel can save -606 metric ton of CO2 equivalent whereas the entire hotel save a huge amount of emission, which is really a meaningful saving the earth atmosphere. Table6.19 below shows the saving of greenhouse emission from both calculations.

Table 6.19: Saving of GHG emission

GHG emission saving (MTCO2)	
Emission from one hotel	-606 MTCO2
Total emission from all hotels in Delhi NCR	-56,756 MTCO2

Source: Report generated from United States Environmental Protection Agency (USEPA) (WARM Model) [302]

6.4 EQUIVALENCY CALCULATOR

Equivalency calculator is one of another most important tool developed by United States Environment Protection Agency (USEPA). This tool was used to show the optimum utilization of GHG emission to other sector. After calculating the emission ratio from audit form, the final step is the conversion of result. The value which derived from both scenarios is again put into WARM calculator, which calculates the equivalencies. Each equivalency represents the full benefit of hotel waste management decision. Equivalency calculator the emission analysis in other sector like passenger vehicles, gasoline consumed, oil consumed, tanker trucks' worth of gasoline, electricity use, energy use, deforestation, propane cylinders, burning railcars' worth of coal, emissions from waste sending to the landfill, emissions from coal fired power plants, etc.

6.4.1 EMISSION CONVERSION FROM ONE HOTEL

With the help of equivalency calculator all emission generated form waste utilize to the other sector it means the same amount of GHG emission can be used to other segment like -606

metric ton of carbon dioxide is equivalent to 126 passenger vehicles or 217 tons of waste send to landfill or 31.1 garbage trucks of waste recycled instead of landfilled or 67937 gallons of gasoline consumed or 650913 pounds of coal burned or 1409 barrels of oil consumed or 8 tanker trucks 'worth of gasoline or 83.4 homes of electricity consumed or 0.167 wind turbines installed or 30.3 homes of energy consumed or 15851 incandescent lamps switched to CFLs or 25250 propane cylinders for home barbeques or 2.6 burning railcars 'worth of coal or 227 tons of recycling of waste despite sending it to the landfill or 0.0002 coal fired power plants or 15538 tree seedlings grown for 10 years. See table 6.20.

Table 6.20: Utilization of emission from one hotel to other sector

Equivalent to:	Emission from one hotel
Passenger vehicles**or**	126
Tons of waste send to landfill **or**	217
Garbage trucks of waste recycled instead of landfilled**or**	31.1
Gallons of gasoline consumed **or**	67937
Pounds of coal burned**or**	650913
Oil consumed **or**	1409 barrels
Tanker trucks 'worth of gasoline **or**	8
Electricity consumed**or**	83.4 homes
Wind turbines installed**or**	0.167
Energy consumed**or**	30.3 homes
Incandescent lamps switched to CFLs**or**	15851
Propane cylinders for home barbeques **or**	25250
Burningrailcars 'worth of coal **or**	2.6
Recycling of waste instead of sending it to the landfill **or**	227 tons
Coal fired power plants **or**	0.0002
Tree seedling grown for ten years	15538

Source: Report generated from United States Environmental Protection Agency (USEPA) (EPA Calculator) [303]

6.4.2 EMISSION CONVERSION FROM ALL DELHI-NCR HOTEL

With the help of equivalency calculator all emission generated form waste utilize to the other sector it means the same amount of GHG emission can be used to other segment like -56756

metric ton of carbon dioxide is equivalent to 11949 passenger vehicles or 20343 tons of waste send to landfill or 2909 garbage trucks of waste recycled instead of landfilled or 6386407gallons of gasoline consumed or 60962406 pounds of coal burned or 131,991 barrels of oil consumed or 751 tanker trucks 'worth of gasoline or 7,807 homes of electricity consumed or 15.6 wind turbines installed or 5,178 homes of energy consumed or 1484593 incandescent lamps switched to CFLs or 2,364,833 propane cylinders for home barbeques or 304 burning railcars 'worth of coal or 2,909 tons of recycling of waste instead of sending it to the landfill or 0.015 coal fired power plants. See table 6.21.

Table 6.21: Utilization of emission from all Delhi-NCR hotels to other sector

Equivalent to:	Emission from Delhi-NCR hotels
Passenger vehicles **or**	11949
Tons of waste send to landfill **or**	20343
Garbage trucks of waste recycled instead of landfilled **or**	2909
Gallons of gasoline consumed **or**	6,386,407
Pounds of coal burned **or**	60962406
Oil consumed **or**	131,991 barrels
Tanker trucks 'worth of gasoline **or**	751
Electricity consumed **or**	7,807 homes
Wind turbines installed **or**	15.6
Energy consumed **or**	5,178 homes
Incandescent lamps switched to CFLs **or**	1484593
Propane cylinders for home barbeques **or**	2,364,833
Burningrailcars 'worth of coal **or**	304
Recycling of waste instead of sending it to the landfill **or**	2,909
Coal fired power plants **or**	0.015
Tree seedlings grown for ten years	1455282

Source: Report generated from United States Environmental Protection Agency (USEPA) (EPA Calculator) [303]

6.5 COST BENEFIT ANALYSIS

Cost benefit analysis (CBA) is the key objective of the study. It is the main gap, which needs to be bridged so that the hotel industry may be shown the potential of waste management and its positive implementation to them as well as to the environment. The data gathered from

waste audit was used for analysing the cost benefit associated with implementing cost versus benefits of implementing the green practices in hotel.

Net benefit = Benefit - Cost

Before going to the depth of calculation, first of all we need to know the various methods for waste treatment according of the nature of waste. There are two categorization of waste treatment:

- Treatment of recyclable waste
- Treatment of compostable waste

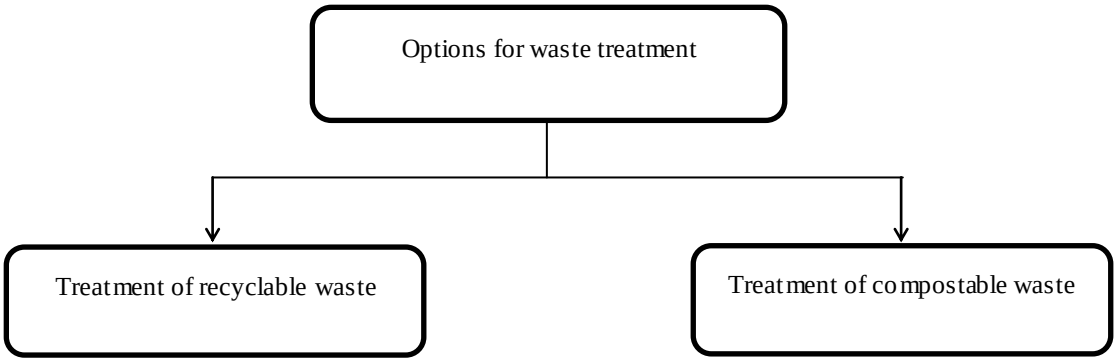


Figure 6.2: Options for waste treatment

Source: Pictorial representation of waste treatment options

6.5.1 TREATMENT OF RECYCLABLE WASTE

There are many different ways to treat waste. Paper waste like cardboard, newspaper, magazine, tissue paper, paper thermocol, paper plates, napkins, letterhead, copy paper, photocopies, colour paper, envelop, folders, file, books, broachers etc. are treated with re-pulping technique to convert paper and paperboard products.

Plastic waste like bottles, plastic Plates, packing Plastic (Chips, Biscuits, Namkeens), mineral water bottles, plastic bags, plastic- or wax-coated, paper, milk packaging plastic, candy wrappers, foil gift wraps, shampoo bottles, window and door frames, carrier bags, bin liners, microwaveable meal trays, foam hamburger boxes, egg cartons, plastic cutlery, toys, bleach

&cleaners Bottles etc. are treated with the help of Extruder Machine, Injection moulding, Blow moulding, Film blowing and depolymerisation Process (the plastic is melted and chemically broken down) and Fluidized bed reactor to convert into bottles and jar. Textiles waste like pillow cover; bed cover, table cloths, cotton cloth, carpets, towel, mattress, apparel etc. are treated with the help of Remanufacturing process, Lyocell process, Patagonia process and Textile incineration to convert into reusable cloths. Similarly glass waste like beer bottles, wine bottles, sham pane bottles etc. are treated with Cullet- Glass crusher.Metals waste like spoons, cans etc. are treated with the help of Ferrous metal shears. See table 6.22 below.

Table 6.22: Recyclable waste treatment

S.No	List of SW Categories/Items	Alternate Processes to make it usable	Output
1	Paper • Cardboard • Newspapers • Magazine • Printouts • Tissue Papers • Paper Thermocol • Tetra Pack (Juices) • Paper plates • Napkins • Letterhead • Copy paper • Photocopies • Index cards • Colour paper • Envelopes and folders • Standard business cards • Brochures • Books • Toilet roll cartridges • Packaging paperboard • Carbon paper	Re-Pulping technique	paper and paperboard products
2	Plastics • Bottles • Plastic Plates • Packing Plastic (Chips, Biscuits, Namkeens) • Mineral water bottles • Plastic bags • Plastic- or wax-coated Paper • Milk packaging plastic • Candy wrappers • Foil gift wraps • Shampoo bottles • window and door frames • Carrier bags	Extruder Machine[15], Injection moulding, Blow moulding, Film blowing and depolymerisation Process (the plastic is melted and chemically broken down) and Fluidized bed reactor. Plastic Melt Filter Press	Bottles, Jar etc.

	• Microwaveable meal trays • Foam hamburger boxes • Egg cartons • Plastic cutlery • Bleach & cleaners Bottles	Extruders (Granule)	
3	Textiles • Pillow cover • Bed cover • Table cloths • Cotton cloth • Carpets • Towel • Mattress • Apparel • Thread Waste	Remanufacturing process, Lyocell process, Patagonia process, Textile incineration.	Reuse cloths or non-recycled clothes are dumped
4	Garden wastes • Leaves • Grass clippings • Shrubbery • Garden wastes • Horticulture Waste	Composting	Manure
5	Glass • Beer/wine Bottles • Food and beverage containers	Cullet- Glass crusher	Glass
6	Metals • Spoons • Cans • Batteries • Stainless steel plates	Ferrous metal shears	Metals
7	Food wastes • Vegetables waste • Leftover food • Fruit waste • Egg shells • Sea food waste • Dairy products	Composting, Feed Animals (piggeries)	Manure

Source: Collected from various sources of literature

Garden waste like leaves, grass clippings, shrubbery, horticulture Waste etc. and food waste like vegetables waste, leftover food, fruit waste, egg shells, sea food waste, dairy products etc. are treated with the process of composting and convert manure from it.

6.5.2 TREATMENT OF COMPOSTABLE WASTE

Organic waste is not recyclable and not easily to combustible because of high moisture content in it, so the only best alternative to reduce hotel organic waste is by composting. It is a biological process of decomposition of organic wastes within certain condition like proper ventilation, temperature, moisture and carbon and nitrogen ratio [304]. Compost is useful manure and perfect soil conditioner. Composting is basically depending on the nature of

waste and its decomposition process. In the manual of municipal solid waste management (MSW manual, 2000) there are two methods of composting describes i.e., aerobic and anaerobic. Apart from that another form of composting is vermicomposting, in which various species of earthworm are used to convert organic waste into manure.

- **Aerobic composting:** This type of composting doesn't emit an unpleasant odor and, with the proper conditions, can be completed in a span of two weeks whereas anaerobic composting usually takes up to 3 months. Aerobic composting uses oxygen to biologically decompose waste materials in a controlled condition. Some factors like materials used, the temperature, moisture content and aeration are main parameters for a good composting process [305]. Compare to anaerobic method, aerobic composting enriches soil nutrient, sanitizes the MSW very effectively as well as destroy contaminating including weeds and other biological hazardous material, it's process is fast and more qualitative [306].

  Carbon and nitrogen rich organic materials are more beneficial for aerobic composting. The optimum ration is 25 or 30 parts carbon to 1 part nitrogen. Sources of carbon rich materials are leaves, wood chips, and sawdust. Similarly nitrogen rich materials are grass, food waste, and livestock manure. These materials are decomposed by organisms utilizing oxygen [307]. There are many types within aerobic waste treatment for detail refer table 6.23 below.

Table 6.23: Compostable waste treatment

Type of composting plant/bin/pit					
Method of Composting	**Dimension /size**	**Capacity**	**Material use to make bin**	**Decomposition time**	**Benefit/Remark**
VERMICOMPOSTING					
1) Pits below the ground	1 mtr deep and 1.5 mtr wide	100 kg	Pits making	3 week	length are varies as required
2) Heaping above the ground	Depend on ground size			3 week	Biomass production washigher in the heap method.
3) Tanks above the ground	1.5 m width, 4.5 m length and 0.9 m) height.		Tanks made of different materials	3 week	
4) Cement rings	90 cm in diameter and 30 cm in height		Rings made up of cement	1 month	

5) Commercial model	1.5 m width, 4.5 m length and 0.9 m height		The walls are made up of different materials rocks.	3 week	This option of technology reduces labour cost and saves water
PASSIVELY-AERATED BINS	3 feet by 3 feet by 3 feet in dimension	Each bin holds one-half cubic yard of food	Its base and walls are made from wood or recycled plastic lumber.	1 month	Its simplicity, inexpensive and need no electricity. It is best suit for small scale
AERATED CONTAINERS	40 inches wide by 44 inches long by 44 inches high	16 to 40 cubic yards of material	Containers with fans	3 week	Aerated containers rely on forced aeration from fans to supply oxygen, and remove moisture and heat.
AGITATED-AERATED CONTAINERS	The diameters at base and lid are 64 and 89 inches, respectively. The tub is 4 feet deep	Single tub holds 3 cubic yards of material.	Containers with lid	3 week	Feedstock mixtures, composts produced, are more uniform.
ROTATING DRUMS	The typical small drum is 4 or 5 feet in diameter and 8 to 16 feet in length, Drums are oriented horizontally, sometimes at a slight incline.		made up of drums	3 weeks	The key function of the rotation is to expose the material to air, add oxygen and release heat and gaseous products of decomposition.
BIODIGESTER[16]					
1) Flotting drum biodigester	Small- to middle-sized farms (digester size: 5-15m^3)		Two 50 gallon drums, 1 small drum	1 month	They provide gas at pressure, and the stored gas-volume is immediately recognizable by position of the drum.
2) Fixed dome	Minimum size of a fixed-dome plant is 5 m^3	Volumes 200 m^3		1 month	Low costs and long life-span and saves space

Source: Collected from various sources of literature

- **Anaerobic Composting:** Anaerobic composting[17] is done through fermentation with the limited or without oxygen and relies on anaerobic microbes to decompose the waste materials [307].

- **Vermicomposting:** Vermicomposting[18] is easy and simple biotechnological process of composting with the use of certain species of earthworm [308] [309]. It was found that the vermin-compost was rich in nutrients like Potassium, Nitrate, Sodium, Calcium, Magnesium, and Chloride and have the potential for improving plant growth than pit compost and garden soil [310] [311] [312].

6.5.3 CALCULATION OF SAVING FROM RECYCLABLE MATERIAL

Before going for calculation of saving, we need to know the cost associated in implementing green practices or any strategies. There are many costsassociated with implementing any green practices like labour cost, cost of extra bin, miscellaneous expenses, salvage value etc. Below the following facts and logic were made to this analysis based on the experience of the waste audit, discussions with practitioners like hotel managers, waste supervisors and NGO associated with hotel's waste dealing:

Labour cost for waste handling

As per the estimation form waste audit we are able to find that on an average a single star rated hotel can generate approximately 780 kg of waste daily. When all waste is collected from hotel industry, segregation of entire waste is most important because of its well treatment. In one of the survey [313]examined by CPCB and New Delhi Municipal Cooperation (NDMC) on waste segregation, it was found that a single labour can segregate 100 kg of waste in a day [314]. So taking it as a base for hotel industry wastes that is 780 kg, we required at least eight labour for waste segregation [315].

Table 6.24: Number of labour required for waste handling

Number of labour required		
Average waste generated from hotel (Kg/day)	**Total waste segregated (kg/Per day)**	**Labour Required**
780.16 kg	100 kg	1 labour
	800 kg	8 labour

Source: Estimated by Chintan (NGO) as per research project with CPCB and NDMC in Delhi

After identifying the number of labour required for waste handling, the next step is to know the salary or wages of the labour for their work. Apart from the facts of literature review and published reports, a separate individual interview have been conducted with three different Non-profit organisation (NGO) i.e. Indian Pollution Control Association (IPCA), Chintan and Vatavaran to know how much cost or salary they are paying to their worker for waste handling [314]. The table below 6.25 shows the cost of labour.

Table 6.25: Salary paid to labour

Cost of Labour (Salary per month)				
Price paid to worker (Rs/month)				**Average per month**
NGO 1 (IPCA)	**NGO 2 (Chintan)**	**NGO 3 (Vatavaran)**	**As per Research Paper**	
Rs7400	Rs7500	Rs7200	Rs6000	Rs7025

Source: Estimation of salary from all NGOs

Currently IPCA is paying around Rs 7400 to their labour while Chintan pay Rs 7500 and Vatavaran pay Rs 7200. In many research papers [317] on rag pickers, waste handlers, waste suppliers etc. quoted Rs 6000 as a labour cost [314] and [316] In cost benefit calculation we took the average of all four labour cost and consider Rs 7000 as labour cost per month.

Cost of dustbin

For waste storage and segregation process, some different size dustbins are required. Initially minimum 2 bins of 50 litter size are required to segregate all waste in recyclable form and compostable form at hotel dumpster. Then 8 more bins of 120 litters are required for waste segregation by eight labours. All waste audited items like paper, plastic, newspaper, cardboard, glass, trash, aluminium, tetra pak, compostable items etc. are required 10 different waste dustbins of 80 litter. Table 6.26 below represent the detail of bins.

Table 6.26: Number of bin required

Bins Required			
Bin Description	**Bins required**	**Cost of per bin (Rs)**	**Total cost of bin (Rs)**
50 Liter	2	Rs1092	Rs2184
80 Liter	10	Rs1437	Rs14370
120 Liter	8	Rs3300	Rs26400
Total Cost			**Rs42954**

Source: current market rate in Delhi

Miscellaneous expenses

During auditing, we find out some fact and figure of miscellaneous expenses that would keep in the petty cash book, officially these figure below was not disclose. In miscellaneous expenses there are some cost also include like cleaning, logistic, waste storage etc. each hotel have some amount, which they spent on waste handling. Shangri-la hotel spent approximately Rs 12000 as a miscellaneous expense whereas Hilton hotel spent Rs 10000. Country INN spent Rs 7500 and Park Plaze spent only Rs 6500 and so on. Table 6.27 below shows the expenses of all hotels. On an average hotel spent approximately Rs 7500 on their monthly expenses whereas Rs 90000 on yearly basis.

Table 6.27: Miscellaneous expenses

Miscellaneous expenses (waste storage/cleaning/transportation etc.)		
Name of the Hotel	**Miscellaneous expense/month**	**Miscellaneous expense/year**
La-Shangri-la Hotel	12000	144000
Hilton Hotel	10000	120000
Country INN	7500	90000
Park Plaza	6500	78000
JaypeeVasant Continental	6000	72000
Jaypee Greens Golf & Spa Resort	7000	84000
JaypeeSidharth	6000	72000
Lemon Tree hotel	5000	60000
Average cost	**Rs 7500**	**Rs 90000**

Source: Data collected during waste auditing

Calculation of salvage value

All waste material has some value. In generally waste is treated as useless or no value but when it processed systematically it will generate handsome amount of revenue. Here in table 6.28 below show that each waste material have value if it will resale to recycler or scrap dealer. In a small survey, resale values have been calculated from Indian Pollution Control Association (IPCA) and three different waste dealer or scrap dealer. For example the rate of plastic pet bottle is Rs 35 by IPCA, Rs 30 by recycler one and twoand Rs 25 offer by recycler three. In cost benefit analysis we took the average rate offer by all four scrap dealer i.e. Rs 30. Similarly for better result we took the average of all waste material rates for further calculation. The higher rates of any waste material leads to the increment of revenue and in coming future the resale value of each waste material become higher. See table 6.28 for detail.

Table 6.28: Salvage value

Salvage value					
Material	**Rates from Indian Pollution Control Association (IPCA)**	**Rates from recycler 1**	**Rate from recycler 2**	**Rate from recycler 3**	**Average rate (Rs/kg)**
PLASTIC PET BOTTLE	35	30	30	25	30.00
OTHER/MIXED PLASTIC	15	15	14	16	15.00
TETRA PAK (Laminated Paper)	6	4	3	3	4.00
ALUMINIUM	100	95	80	85	90.00
GLASS	2	1	1	0	1.00
NEWSPAPER	18	11	10	9	12.00
MIXED OFFICE PAPER	10	10	9.5	10.5	10.00
CARDBOARD	10	8	7.5	7	8.13
COMPOST/WET WASTE	0	0	0	0	0.00
TRASH (Laminated Plastic)	0	0	0	0	0.00
Total					**170.13**

Source: Data collected from survey

If the waste will segregated properly, it will no more a waste, we can convert waste as a resource. With the help of these analyses it can be proved that waste can also add profitability.

Calculation of saving

The average waste generation of pet plastic bottle in a month is 195.26 kg and yearly it will become 2343.06 kg, if this waste resale to scarp dealer, we will generate Rs 5857.65 per month and yearly it will become Rs 70291.8. Similarly the average salvage value of this material is Rs 15 and if it is resale, it can generate Rs 48528.45 yearly on selling of yearly waste i.e. 3235.23 kg. Refer table 6.29 for detail analysis of each waste generated monthly and yearly along with its salvage value or profit.

Table 6.29: Revenue generation from salvage value

Material	Avg waste/month (Kg)	Avg waste/yr (Kg)	Salvage value (Rs/kg)	Income from salvage (Rs/month)	Income from salvage (Rs/year)
PLASTIC PET BOTTLE	195.26	2343.06	30.00	5857.65	70291.8
OTHER/MIXED PLASTIC	269.60	3235.23	15.00	4044.04	48528.45
TETRA PAK (Laminated Paper)	121.58	1458.90	4.00	486.30	5835.6
ALUMINIUM	110.63	1327.50	90.00	9956.25	119475
GLASS	3466.88	41602.50	1.00	3466.88	41602.5
NEWSPAPER	1443.75	17325.00	12.00	17325.00	207900
MIXED OFFICE PAPER	173.85	2086.20	10.00	1738.50	20862
CARDBOARD	3227.48	38729.70	8.00	25819.80	309837.6
COMPOST/WET WASTE	14345.10	172141.20	0.00	0.00	0
TRASH (Laminated Plastic)	50.68	608.13	0.00	0.00	0
Total	**23404.79 kg**	**280857.42 kg**	**Rs 170.00**	**Rs 68694.41**	**Rs 824332.95**

Source: Calculated from survey

Aluminium is generated 1327.50 kg per year; it can generate Rs 119475 in a year. Yearly glass waste can generate Rs 41602.5 on selling of yearly waste 41602.50 kg of glass. Newspaper, which is very common in every hotel, can add approximately Rs 207900 on 17325 kg of newspaper yearly. Apart from newspaper there are some other mixed office papers generated daily, it can also generate Rs 20862 on an average generation of 2086.20 kg of waste. Cardboard are frequently used material in hotel industry because of packaging. On monthly basis it generates around 3227.48 kg of waste and in a year it becomes 38729.70 kg.

In the same manner cardboard can generate Rs 25819.80 monthly and Rs 309837.6 yearly. Wet waste or organic waste are not recyclable mean cant resale to other the only process can

do is composting. Similarly trash is a direct landfill item, that's why these materials haven't any resale value.

6.5.4 CALCULATION OF SAVING FROM COMPOSTABLE MATERIAL

There are mainly two ways of composting based on amount of waste generation and hotel premises. These two feasible solutions of organic waste are:

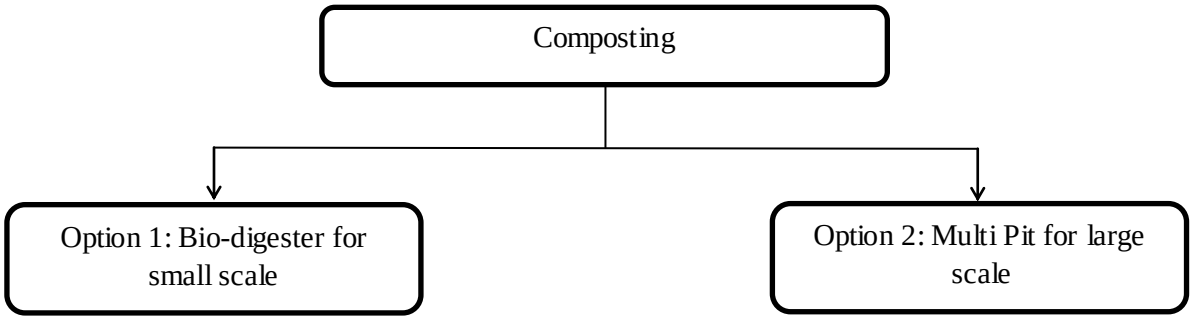


Figure 6.3: Composting options for waste treatment

Source: Pictorial representation of composting options for waste treatment

Bio-digester for small scale

Bio-digester is usually related to the reduction of waste volume that converts waste into useful gas and manure. It provides a relatively simple solution for waste management and energy production. The size, cost and output of the bio-digesters ranged from single family use, small and large scale depend upon quantity and quality of waste. In India, these bio-digesters are more popular in rural area designed for single families or small communities [318]. There are several "models" of bio-digesters used around the world, including the Canadian, the Indian, and the Chinese. India has many examples of successful small-scale bio-digesters, including the floating drum model and the fixed dome model. As a cleaner alternative to wood stoves, these bio-digesters are popular in rural India and other countries, and are typically designed for single families or small communities.As more communities are driven to investing in "greener" technologies, bio-digesters provide a relatively simple solution for waste management and energy production [318]. Even in countries like the United States, that have a climate least suited for this technology, the use of bio-digesters is growing.

Cost of implementing Bio-digester

- ✓ Daily 1 labor required for 2-3 hours for handling and loading of waste to container that cost Rs1500/month. [315] and [318]
- ✓ No additional space required, it is possible to install at backyard of hotel [318] and [319]
- ✓ It consume low amount of electricity which is adjustable to electricity bill [320]
- ✓ No transportation cost is required.
- ✓ The cost of bio-digester and its installation is Rs 10,50,000 (Current market cost of 2013)
- ✓ Average cost of LPG is Rs 70- Rs 75 per kg [320]
- ✓ Biogas generated from compostable waste is equal to:

1 m3 biogas = 0.45 kg(450 g) LPG [320]

Table 6.30: Cost of installation of bio-digester

Cost of installation of bio-digester	
Cost of Bio-digester	Rs. 10,50,000
Cost of Labour (year)	Rs. 18,000
Cost of bins (2 quantity of 32 gallon)	Rs. 4,200
Cost of Land	Included in hotel property
Cost of electricity	included in hotel electricity bill
Cost of transportation	Not required
Maintenance	Negligible
Total	**Rs 10,72,200**

Source: Calculated from survey and published paper [320]

Table 6.30 above shows the cost of bio-digester equipment i.e. Rs 1050000 as per market rate. Apart from equipment minimum one labour is required for waste churning and filtering that would be cost around Rs 18000 per year along with the cost of 2 bins having dimension 32 gallon, costing Rs 4200. As it is already explain that it is best suited for small scale so cost of land, electricity, transportation cost and maintenance cost are almost negligible.

Saving from Bio-digester

On an average a hotel generate 450 kg to 500 kg of wet waste daily and with the utilization of this material, waste can convert into biogas. In a day, bio-digester can generate 150 m3 to 180 m3 of biogas, which is equivalent to 80 kg of LPG. The cost of LPG in market is about Rs 70 to Rs 80 per kg, so with the utilization of wet waste hotel can save Rs 6000 of LPG daily. In a year a single hotel can generate approximately Rs 2190000 from all organic waste. Refer table 6.31 below for detail.

Table 6.31: Saving from bio-digester

Saving from bio-digester		
Input	450-500 kg waste daily	
Daily Biogas	Generation of biogas/day (Average)	150- 180 m3
	LPG equivalent of biogas/day (.45kg/1 m3)	80 Kg
	Saving through LPG/day @75/kg	Rs. 6000
Annual	Biogas (Rs 6000 *365 day)	Rs 2190000
Total saving		**Rs 21,90,000**

Source: Calculated from survey and published paper [320]

Multi pit for large scale

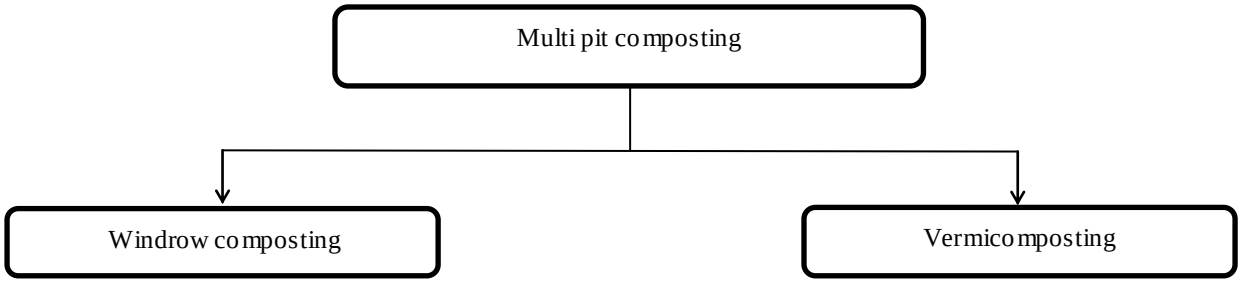


Figure 6.4: Multi pit composting options for waste treatment

Source: Pictorial representation of Multi pit composting options

- **Windrow Composting** The organic waste material in Municipal Waste can be converted by aerobic decomposition. [321].As per the data available in Bio-cycle in 1997, there are total 220 projects on composting in nationwide, out of which 204 are operating and 16 is in development. The feed-stocks for these projects are grocery stores, hotels, restaurants,

universities, correctional facilities, seafood processors and military bases. The majority of operating composting utilizes the windrow composting method [322]

- **Vermicomposting:** The term "vermicomposting" mean the use of the earthworms for composting the organic residues into manure [321]. Several authors have noted that the earthworms play a major role in affecting populations of soil organisms, especially in causing changes in the soil microbial community [308],[323] [324]. In many of the researches it is clearly mentioned that environmental degradation by rampant use of chemical fertilizers depletes the fossil fuels and generates carbon dioxide (CO_2) and also, contaminates of water resources. It even leads to loss of soil fertility due to imbalanced use of fertilizers and adversely impacts agricultural productivity, due to soil degradation [325], [326] [327].

Cost of implementing Multi pit

- ✓ For large scale composting, additional land is required; minimum area required for composting is around 100-150 square yard, costing Rs 4,00,000 (Current market cost estimated in 2013)
- ✓ One full time labor is required for churning and mixing waste at cost of Rs 7000/month [315] and [318]
- ✓ Required Rs 7,500/month as a transportation cost of loading waste food material from hotel to specific composting unit [317]
- ✓ No electricity cost is required because all work done manually [320]
- ✓ Organic waste converted into manure in 3 week [315]

Table 6.32: Cost of Multi pit composting

Cost of Multi-pit composting	
Land required	100-150 Sq Yard
Cost of Land	Rs 4,00,000
Labor cost (Rs 7000/month)	Rs 84,000/year
Cost of bins (2 quantity of 32 gallon)	Rs. 4,200
Cost of transportation (Rs 7,500/month)	Rs 90,000/year
Cost of electricity	Not required

Miscellaneous Expenses	Negligible
Total	**Rs 5,78,200**

Source: Calculated from survey and published paper [315], [317] and [318]

For multi pit based composting like windrow and vermicomposting required at least 100 sq. yard to 150 sq. yard of land, which cost around Rs 400000. One full time labour is required for waste churning. Two bins are required that would cost Rs 4200. One of the major costs is transportation cost because these type of composting are ideally centralized, the cost of transportation is Rs 90000 per year. In this composting no electricity is required so the overall cost of this type of composting is Rs 578200.

Saving from Multi pit composting

On an average 450 kg to 500 kg of wet waste generate daily. As per the estimation of solid waste manual at least three week is required for converting wet waste to compost. Currently the cost of composting is Rs 30 per kg, so for every 130 kg to 150 kg of waste can generate approximately Rs 4500. In a year there are 17 weeks and entire waste can generate Rs 76500.

Table 6.33: Saving from Multi pit composting

Saving from Multi pit composting		
Input	450-500 kg waste/day/hotel	
Manure (3 week)	130- 150 kg/Rs 30	Rs 4500
Annual Manure	(17 week * 150 kg) = 2550 kg	Rs 76,500
Total saving		**Rs 76,500**

Source: Calculated from survey and Municipal Solid Waste (MSW manual) [321]

After completing all cost and benefit calculation, a final table (Table 6.34) of cost benefit analysis has been shown below for easy understanding of interpretation. Cost benefit analysis is the key objective of the study. It is the main gap, which is bridged with the help of waste

auditing so that the hotel industry may be shown the potential of waste management and its positive implementation to them as well as to the environment.

Table 6.34: Cost Benefit Analysis

Cost Benefit Analysis									
Extra labours cost (a)	**Extra bins cost (b)**	**Miscellaneous expenses (c)**	**Salvage value (d)**	**Expense in 1st Year**	**Expense in 2nd Year**	**Earning in 3rd Year**	**Earning in 4th Year**	**Earning in 5th Year**	**Saving from Biogas/ Compost**
8 Labour * Rs 7000/month * 12	50 Liter - 2 qty 80 Liter - 10 qty 120 Liter - 8 qty	waste storage/cleaning/transportation etc- Rs 7500/month* 12	Income from salvage Rs 68694 per month* 12	Currently hotel doesn't adopt any waste management practices like segregation	Hotel adopt waste segregation practices and sell scraps to vendor. Expenses on bin also reduced	In this year only half of the labours required because 50% labor cost is reduced due to experiential learning	Again in the 4th year only 50 percent labour are required because of experiential learning	Neither extra labour cost nor any miscellaneous expenses paid because segregation at source implemented	Option 1: Through biodigester - Hotel save around Rs 21,90,000. Option 2: Through multi pit - Hotel save around Rs 76,500 by selling @ cost of Rs. 30/Kg
a= Rs 6,72,000	b= Rs 42,954	c= Rs 90,000	d= Rs 8,24,333	**a+b+c= Rs 8,04,954**	**a+c-d= Rs (+ 62,333)**	**a/2+c-d= Rs (+ 3,98,333)**	**a/2+c-d= Rs (+ 3,98,333)**	**Rs (+ 8,24,333)**	**Rs (+ 21,90,000)/ Rs (+ 76,500)**

Source: Calculated from all survey

First column of the table represent requirement and cost of extra labour for waste segregation. Here we see eight labours are required at Rs 7000 per month, so it would cost Rs 672000 per year. Second column shows the numbers of bins required and its cost i.e. Rs 42954. These costs are one-time expenses. Miscellaneous expenses are around Rs 90000 per year. Fourth column articulate the salvage value of each waste material, adding all waste material the salvage value become Rs 824333 per year.

Expense in 1st year: Hotels need to invest approximately Rs 8 lakh in very first year for implementing green practices in their premise. This includes cost of extra labour for waste segregation i.e. 1 labour segregate 100 kg of waste, so 8 labour required to segregate around 800 kg of waste per day, as per the source of Chintan (NGO) along with an working project with NDMC and CPCB. Similarly cost of bins and miscellaneous expenses also include in first year.

Expense in 2nd year: In the second year of its operation the hotel will not be paying any cost for bins again because it is onetime expense, therefore Rs 42,954 will not be added in the second year. Salvage value is deducted from overall cost i.e. Rs 824333 because it is the additional revenue generated from selling of recyclable items to scrap dealer. Thus, in the second year hotel will start earning profit of approximately Rs 62,333 per year.

Expense in 3rd and 4th year: From its 3rd and 4th year of operation the labour cost should ideally be reduced to half (50%) as already stated on basis of experience learning. So Rs 336000 is given to 4 labours per year only and the amount of salvage value Rs 824333 is deducted from overall cost. So in this year hotel will earn approximately Rs 3.98 lakh.

Expense in 5th year: From the 5th year onwards hotel will not require to spend any amount on labour or miscellaneous expenses rather they start earning Rs 8.24 lakh subsequently for each successive year only from the selling of sorted recyclable material to scrap dealer.

Revenue through composting: Revenue through composting is another option for hotel because the contribution of food waste is approximately 61.29% of total waste generated. Proper treatment of organic waste like composting can generate additional revenue by adopting one of the two options.

1st option: Bio digester is the 1st option for hotel, it required small area for establishment with on an average cost of Rs 10.7 lakhs that generate profit of approximately Rs 22 lakhs per year depend on the quality of sorted waste material for compost.

2nd option: Multi pit composting is second option, it is suitable for centralize composting of many hotels that required some amount of land, which is given on the subsidy of Government that would cost less than 4 lakh for 100- 150 sq. yard and generate Rs. 76,500 per year by selling of compost.

6.6 MODEL OR FRAMEWORK DEVELOPMENT

On the basis of waste audit, WARM model, equivalency calculator and cost benefits analysis, a holistic framework is developed for hotel industry with special focus on profitability and sustainability aspect. With the help of this framework, it has been proved that waste is revenue earning source for the hotels provided there is a well laid-out mechanism for effective waste management.

This model not only brings in revenue but also save on the cost incurred by hotels like hauling cost, transportation cost etc.Framework will create options to save the cost paid to the local vendors and save labour cost for waste handling. It meets all objectives of the study mentioned in chapter one.

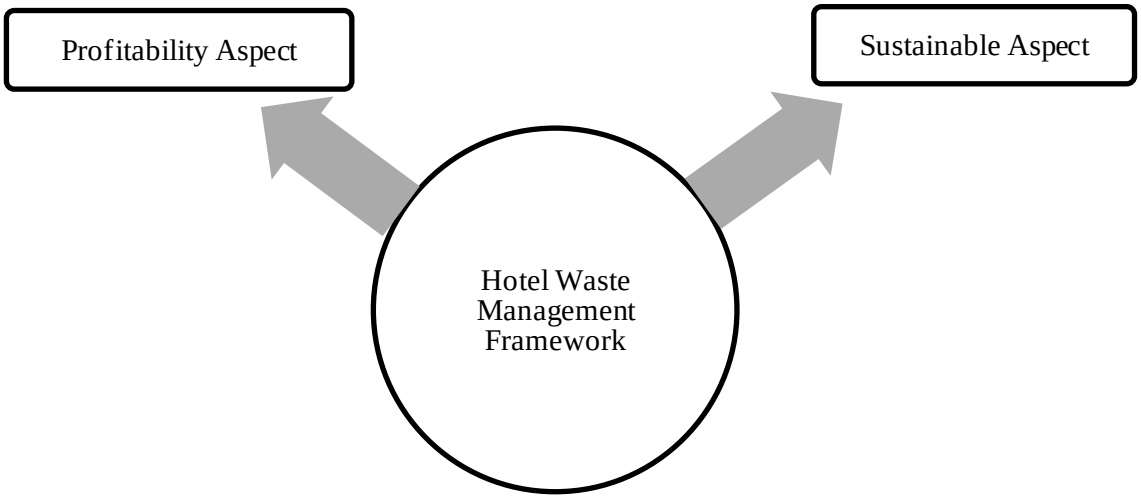


Figure 6.5: Aspects of hotel waste management Framework

Source: Pictorial representation of aspects of hotel waste management framework

6.6.1 PROFITABILITY FROM RECYCLABLE AND COMPOSTABLE WASTE

Profitability means the ability to generate profit from all the available business activities of an organization or firm.It is a return of given investment. It is a tool to boost or increase the overall profit by any systematic strategy. Here waste material work as profit enhancer. These waste items can generate some handsome amount of revenue; the two major source of profit is organic waste and recyclable waste.

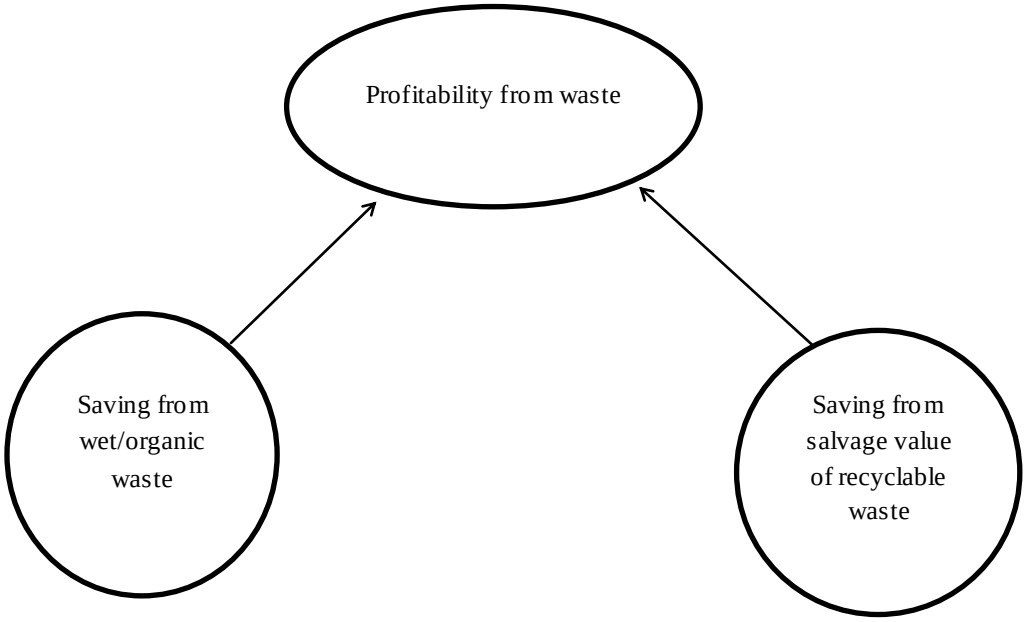


Figure 6.6: Profit generated from organic and recyclable waste

Source: Pictorial representation of profitability options

This is the first outcome phase of the model of waste management for hotel industry. With the help of various tool and technique, it is proved that waste will add profit in overall profitability. In this phase, it is shown that profit can be generated from both bio-degradable waste as well as non-biodegradable waste. Here waste material work as profit enhancer.We estimate the monetary and non-monetary value of waste. These waste items can generate some handsome amount of revenue.

All the collected waste are further segregated and categorized into three parts i.e. biodegradable waste/organic waste/wet waste or recyclable waste and inert/landfill waste. Wastes are properly treated according to the characteristic and composition. Biodegradable

waste is sorted for composting process or biogas plant. If the volume of waste and land for waste treatment is limited then the best suit option is biogas. Otherwise if the volume of waste is higher or there is availability of land than composting is appropriate for waste treatment. Similarly once the waste are sorted in the form of recyclable waste again recyclable waste are categorized into sub category like metal waste, plastic waste, paper waste etc. Now the sub categorised waste are sell to concerning recycling units or scrap dealers to get salvage value of each material.

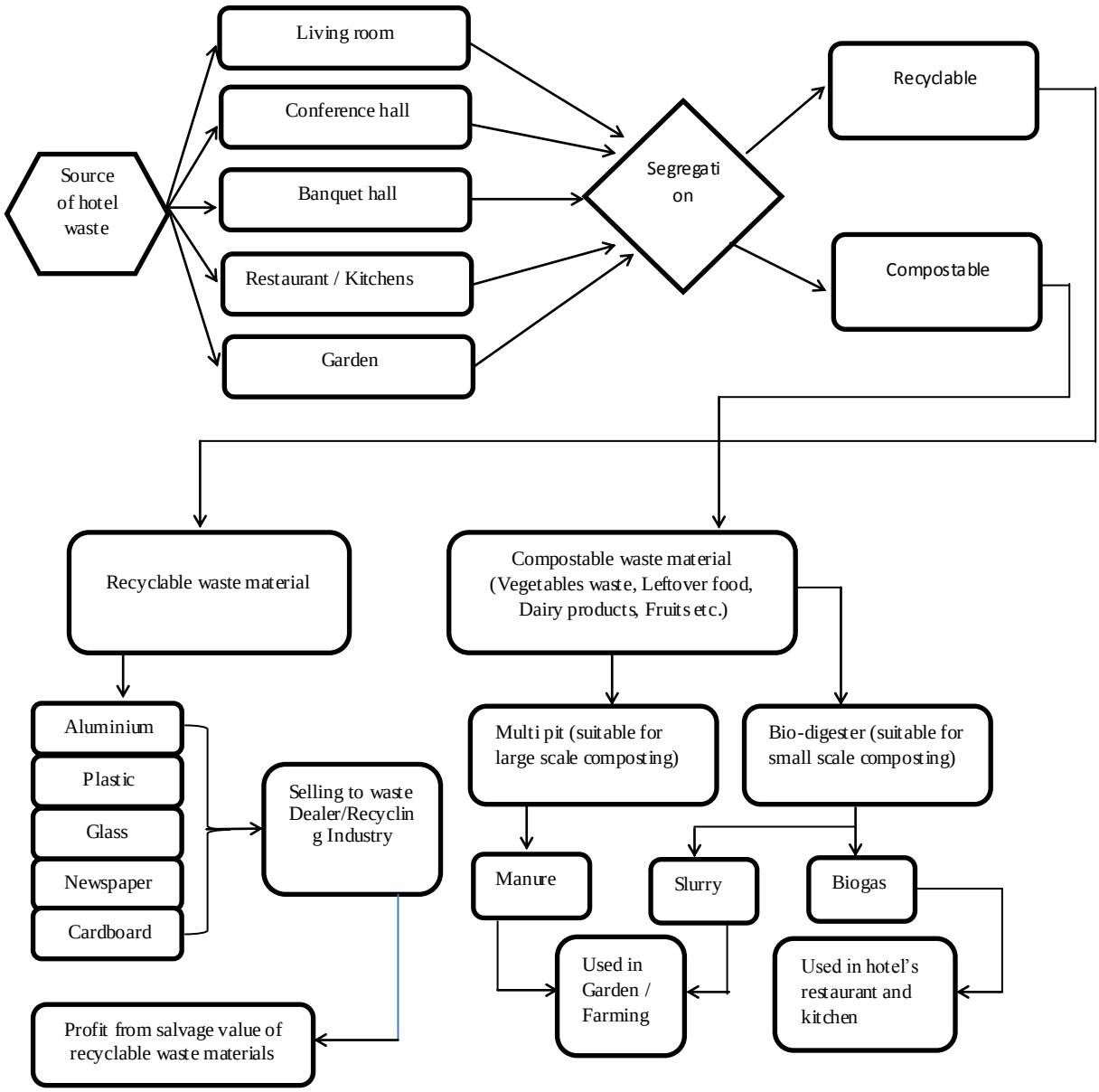


Figure 6.7: Profit generated from recyclable waste

Source: Pictorial representation of Profit generated from recyclable waste material

Profit generated from wet/organic waste: Composting help to generate more revenue because it has high fraction of overall waste i.e. 60-70%. It is well proved from auditing that hotel can generate 3/4th of compostable waste. It's depending on hotelier that which technique they adopt for processing, for a single hotel, bio-digester is the best option. Hotelier can earn approximately Rs 22 lakhs from composting activity as discussed earlier in composting cost and benefit calculation.

Profit generated from recyclable waste: Recycling practices are primarily based on segregation. The more the waste segregate, the more amounts it generate. Recycling practices add revenue to overall profit by selling each waste material to scrap dealer or recycler as a salvage value. As we see in calculation within three year, any hotel van star earning profit and at the end of 4th and 5th year they recover the entire cost of waste strategy implementation. With the help of salvage value, hotel can generate approximately Rs 8, 24,333.

6.6.2 SUSTAINABILITY FROM WASTE MANAGEMENT

Sustainability is everything that need for the existence and survival of well-being that depends, either directly or indirectly on the natural environment. It creates as well as maintains the required conditions in which humans and nature can survive in a productive manner. Sustainability consists of three major aspects that is social, economic and environmental. Any model, framework, strategy, blueprint etc. are only said to be sustainable if these three aspects are within.

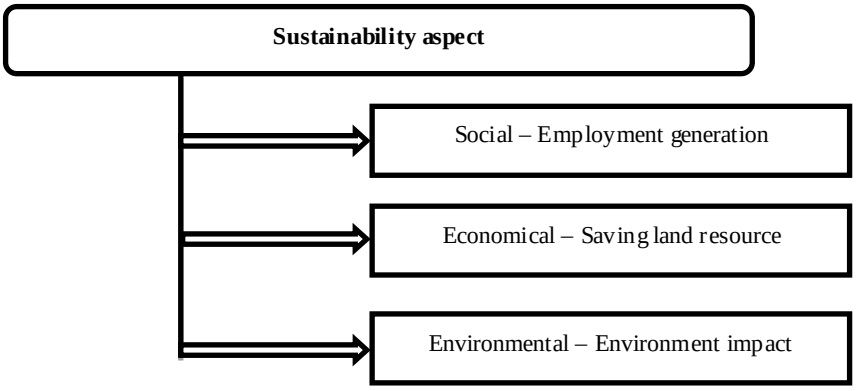


Figure 6.8: Aspect of sustainability

Source: Pictorial representation of sustainability aspect

Social Impact- Employment generation: Waste management is a labor intensive activity, it helps in employment generation. Recycling and composting practices create opportunity of employment i.e. 9 labour in one hotel and prefer to establish more recycling units.

Table 6.35: Employment generation

Employment generation		
Practices	**No of labor employed in a hotel**	**No. of labor employed in Delhi NCR hotels**
Segregation/Sorting	8	752
Composting	1	94
Total	**9**	**846**

Source: Estimation from survey

Economic Impact- Saving land resource: Waste management practices help to reduce the area of waste dumping i.e. 3960000 sq. yard approximately, which can utilize for building flats under various schemes like Rajiv AwasYojana (RAY), Indira AwasYojana (IAY) etc for weaker section of society.

Table 6.36: Saving land resources

Land required for waste dumping		
Land required for waste dumping/ton	**Total waste generated from Delhi NCR**	**Total land required for waste dumping**
100-150 sq. yard	26,400 ton	3960000 sq. yd. or 35640000 sq. ft.

Source: Calculated from survey [121]

Environmental Impact- Saving environmental degradation: Reduce GHG emission i.e. 31,748 MTCO2 helps to maintain the ecological balance and providing clean and green environment for living organism. Waste reduction help to maintain the balance of environment by providing clean and green environment for living organism.

6.6.3 FINAL FRAMEWORK OR MODEL

After completing the all phase of the research a holistic framework is developed for hotel industry with special focus on profitability and sustainability aspect.

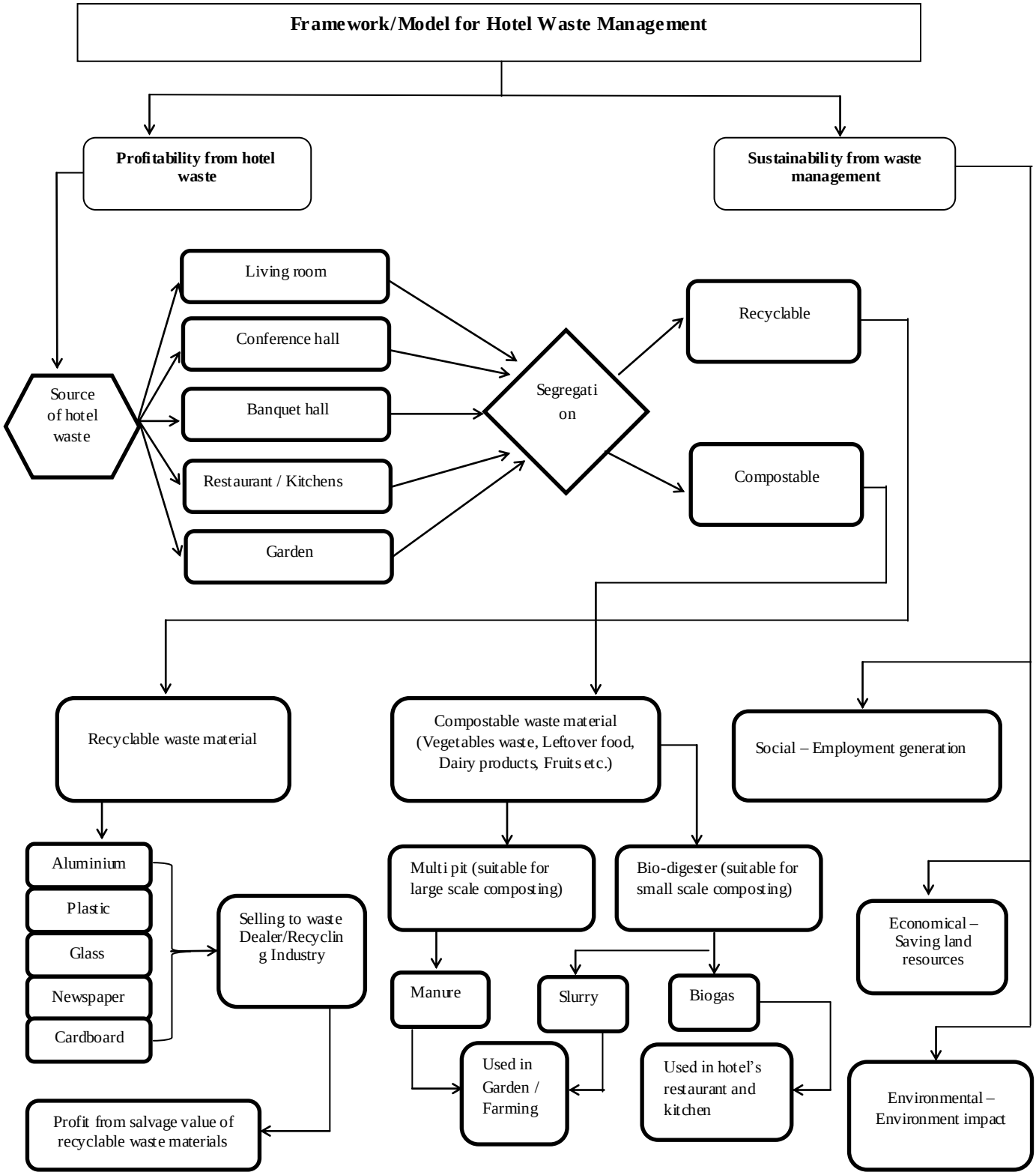


Figure 6.9: Framework or Model for hotel waste management

Source: Pictorial representation of framework

With the help of this framework or model it has been proved that waste is revenue earning source for the hotel industry. This framework shows that there are numbers of sources where waste are generated for example living room, kitchen, banquet hall, garden, conference hall etc. These wastes are segregated according to its nature like category of recyclable waste and compostable waste.

Recyclable waste like paper, plastic, aluminium, glass, cardboard, newspaper etc. are further categorized in the sense for selling to scrap dealer or recycling units. This will add profit to the overall profitability of the hotel. Similarly the compostable waste like kitchen waste, restaurants waste, garden waste, leftover food etc. are used for composting or biogas process. There are two ways in which these compostable wastes are processed. One is multi-pit which is suitable for large scale composting that generates compost, a soil conditioner. This compost is either used for horticulture in hotel or selling this compost to farmers. Second option is bio-digester; this is suitable for small scale composting, in which hotel use bio-digester to generate biogas for their kitchen uses. We know that the fuel for cooking food is going to more costly. This will save the huge amount of money invested on kitchen and restaurant for cooking food. Apart from that the remaining part of biogas generation like slurry is used as compost in garden.

This frameworkwill create options to save the cost paid to the local vendors and save labour cost for waste handling. It meets all objectives of the study mentioned in chapter one. Detail representation of the model in figure 6.7 above.

CHAPTER 7

FINDINGS

7.1 OVERVIEW OF STUDY

In today's competitive scenario, competitive advantage is indispensible for sustainability of any business. Solid waste is a key concern in the hotel industry. The major challenge in hotel service industry is their produced waste. Waste production from hotel industries is one of the major issues in India just because waste is not treated well due to non-segregation process and out-dated technologies.

This study focuses on the most complex and worst situation of improper waste management practices in hotel industry. The study develops a sustainable waste management framework for the hotel industry that shows the optimum utilization of each waste material. The framework will include current practices by hotels of different categories and feasible solutions for the waste collection, segregation, processing, and its disposal. Effective and efficient green practices are not only essential for environment protection but also add to the profitability of hotels.

This chapter is aimed to summarize the findings of the study. The chapter starts with overview of study and then focus shifts towards the findings of study according to enumerated objectives. Various techniques used in development of framework for hotel industry have also been discussed in this chapter.

Findings of study include the various results that have been obtained from the exploratory and descriptive analysis of the study. Exploratory part of study is focussed on to find important dimensions and attributes of waste management in hotel industry. A thorough literature review along with experts interviews are done to develop waste audit form for the calculation of waste volume. Then the impact of waste on environment was calculated with the help of WARM Model and equivalency calculator. After completing the estimation of waste volume and its impact the next most important analysis was cost benefit. It was used to know the cost associated with any green practices and its monetary and non-monetary benefit associated with it. At last with the help of all analysis result like waste audit, WARM, equivalency and

cost benefit, a framework or model have been developed, which explain the value of profitability and sustainability.

7.2 FINDINGS OF STUDY

The first aim of the study was to find know the intensity or volume of waste generated from hotel industry. Second objective was to identify the impact of waste on environment that would pave the way for development of holistic model. Third objective was the cost benefit analysis of implementing green practices and their monetary and non-monetary benefits. Fourth and last objective of study was to develop a holistic framework/model for waste management in hotel industry.

7.2.1 OBJECTIVE NUMBER ONE ACHIEVED

In order to achieve first objective, extensive literature review and experts interviews were conducted in order to identify important dimensions of waste management. Further the in-depth study of the importance and significance of these dimensions related to hotel industry were done. Based upon the extensive literature review, industry cum domain specific interview and various pilot surveys, a well-structured audit form was developed. With the help of this audit, waste generation ratio from a single hotel and waste volume from all Delhi-NCR hotels could be calculated.

With the help of audit sheet of hotel waste, we are able to find the waste generation ratio from a single hotel and further it was extrapolate to the Delhi NCR hotel, to know the approximately waste amount generated in this region. As we see that a single star rated hotel can generate approximately 280.86 ton of waste per year. Considering all types of waste mentioned in audit sheet. This is the huge amount of waste generated from a single hotel of a metro city like Delhi. But if consider the entire hotel industry of Delhi-NCR the amount of waste heavily increased to 26400.60 ton of waste per year.

Table 7.1: Calculation of waste volume

Waste generate in Delhi NCR hotels		
Material	**Waste generated from one hotel/yr (Tons)**	**Total waste generated from Delhi NCR hotels (tons/year)**
PLASTIC PET BOTTLE	2.34	220.25
OTHER/MIXED PLASTIC	3.24	304.11
TETRA PAK (Laminated Paper)	1.46	137.14
ALUMINIUM	1.33	124.79

GLASS	41.60	3910.64
NEWSPAPER	17.33	1628.55
MIXED OFFICE PAPER	2.09	196.10
CARDBOARD	38.73	3640.59
COMPOST/WET WASTE	172.14	16181.27
TRASH (Laminated Plastic)	0.61	57.16
Total	**280.86 tons**	**26,400.60 tons**

Source: Calculated from survey

This is an unexpected figure came out from a single service sector. As there are many literature articulate that there is a scarcity of land. In this scenario we can't expect more or more landfill sites for waste dumping. In metro cities there are some other sources like municipal, household, industry, etc. are generating same amount of waste daily. In Delhi there are few landfill sites like Okhla, Bhalaswa and Ghazipur sites, which are almost full. So the best option to get rid of this problem is to solve it. Detail is shown in above table 7.1.

7.2.2 OBJECTIVE NUMBER TWO ACHIEVED

Second objective of research was to know the impact of waste generation on environment. After getting data from audit form, it was used in Waste Reduction Model (WARM), one of the best waste management strategically tool developed by United States environmental protection agency (USEPA). In this model waste can be treated in two forms Baseline and Alternative scenario. Basically baseline scenario talk about that all waste generated from hotel industry are neither recycle nor compostable. All waste is directly sent to the landfill sites without any proper treatment. The alternate scenario is the next logical step in WARM model. It guide to utilize of each waste material which goes to landfill and suggest converting waste into resource by recycling, composting and combustion based on the waste material category. In this scenario all waste are treated according to their nature.

After entering the collected data with the help of audit sheet for WARM Model, generation of GHG emission analysis report in which emission from both scenarios is highlighted. This shows the emission impact of waste of adopting both the technique. The resultant output in (MTCO2E) for the communication. The difference of both scenarios is the actual saving of emission.

Table 7.2: Emission from a hotel

Baseline scenario	**343 MTCO2**
Alternative scenario	**-263 MTCO2**
Saving of GHG emission	**-606 MTCO2**

Source: Report generated from Waste Reduction Model (WARM Model) [302]

Table 7.2 above shows the value of both scenarios. In baseline scenario the value was 343 metric ton of CO2 equivalent when none of the any green practices were implemented and entire waste directly sent to the landfill sites. On the other side alternative scenario is the best option for waste treatment and the value is -263 metric ton of CO2 equivalent, which shows the reduction of GHG emission from all waste. Here negative sign denote that there is saving of greenhouse gases. The actual difference value from both -606 metric ton of CO2 equivalent. That shows how much hotel industry save GHG emission by adopting such technique and use waste as a resource. This value shows that only a single hotel can save 606 metric ton of CO2 equivalent, at present this value is negligible but further the same process use with all-star rated hotels of Delhi-NCR, this value become a meaningful interpretation.

Similarly while considering the Delhi-NCR hotel this figure of emission became so unexpected. Table 7.3 below shows the value of both scenarios. In baseline scenario the value was 31, 748 metric ton of CO2 equivalent when none of the any green practices were implemented and entire waste directly sent to the landfill sites. On the other side alternative scenario is the best option for waste treatment and the value is -25,008 metric ton of CO2 equivalent, which shows the reduction of GHG emission from all waste. Here negative sign denote that there is saving of greenhouse gases. The actual difference value from both scenario is-56,756 metric ton of CO2 equivalent. It indicates how much hotel industry save GHG emission by adopting such technique and use waste as a resource.

Table 7.3: Emission from Delhi-NCR hotel

Baseline scenario	**31,748 MTCO2**
Alternative scenario	**-25,008 MTCO2**
Saving of GHG emission	**-56,756 MTCO2**

Source: Report generated from United States Environment Protection Agency (USEPA) (WARM Model) [302]

This value in table 7.3 shows that the entire star rated hotel can save approximately -56,756 metric ton of CO2 equivalent, earlier we saw the a single hotel can save -606 metric ton of

CO2 equivalent whereas the entire hotel save a huge amount of emission, which is really a meaningful saving the earth atmosphere. Table 7.4 below shows detail of saving.

Table 7.4: Saving of emission

GHG emission saving (MTCO2)	
Emission from one hotel	**-606 MTCO2**
Total emission from all hotels in Delhi NCR	**-56,756 MTCO2**

Source: Report generated from United States Environment Protection Agency (USEPA) (WARM Model) [302]

With the help of equivalency calculator all emission generated form waste utilize to the other sector it means the same amount of GHG emission can be used to other segment like -606 metric ton of carbon dioxide is equivalent to 126 passenger vehicles or 217 tons of waste send to landfill or 31.1 garbage trucks of waste recycled instead of landfilled or 67937 gallons of gasoline consumed or 650913 pounds of coal burned or 1409 barrels of oil consumed or 8 tanker trucks 'worth of gasoline or 83.4 homes of electricity consumed or 0.167 wind turbines installed or 30.3 homes of energy consumed or 15851 incandescent lamps switched to CFLs or 25250 propane cylinders for home barbeques or 2.6 burning railcars 'worth of coal or 227 tons of recycling of waste despite of sending it to the landfill or 0.0002 coal fired power plants or 15538 tree seedlings grown for 10 years. See table 7.5 below.

Table 7.5: Utilization of emission to other sector

Equivalent to:	Emission from one hotel	Emission from Delhi-NCR hotels
Passenger vehicles **or**	126	11949
Tons of waste send to landfill **or**	217	20343
Garbage trucks of waste recycled instead of landfilled **or**	31.1	2909
Gallons of gasoline consumed **or**	67937	6,386,407
Pounds of coal burned **or**	650913	60962406
Oil consumed **or**	1409 barrels	131,991 barrels
Tanker trucks 'worth of gasoline **or**	8	751
Electricity consumed **or**	83.4 homes	7,807 homes
Wind turbines installed **or**	0.167	15.6
Energy consumed **or**	30.3 homes	5,178 homes
Incandescent lamps switched to CFLs **or**	15851	1484593
Propane cylinders for home barbeques **or**	25250	2,364,833
Burningrailcars 'worth of coal **or**	2.6	304
Recycling of waste instead of sending it to the landfill **or**	227 tons	2,909
Coal fired power plants **or**	0.0002	0.015
Trees seedlings grown for 10 years	15538	1455282

Source: Report generated from Environment Protection Agency (EPACalculator) [303]

Similarly emission generated from Delhi-NCR hotel can utilize to the other sector it means the same amount of GHG emission can be used to other segment like -56756 metric ton of carbon dioxide is equivalent to 11949 passenger vehicles or 20343 tons of waste send to landfill or 2909 garbage trucks of waste recycled instead of landfilled or 6386407 gallons of gasoline consumed or 60962406 pounds of coal burned or 131,991 barrels of oil consumed or 751 tanker trucks 'worth of gasoline or 7,807 homes of electricity consumed or 15.6 wind turbines installed or 5,178 homes of energy consumed or 1484593 incandescent lamps switched to CFLs or 2,364,833 propane cylinders for home barbeques or 304 burning railcars 'worth of coal or 2,909 tons of recycling of waste instead of sending it to the landfill.

7.2.3 OBJECTIVE NUMBER THREE ACHIEVED

Third objective of the study is the cost benefit analysis. It is the key objective of the study. It is the main gap, which is bridged, so that the hotel industry may be shown the potential of waste management and its positive implementation to them as well as to the environment. The data gathered from waste audit was used for analysing the cost benefit associated with implementing cost versus benefits of implementing the green practices in hotel.

Calculation of saving from recyclable material

Before going for calculation of saving, we need to know the cost associated in implementing green practices or any strategies. There are many costs like labour cost, cost of extra bin, miscellaneous expenses, salvage value etc.

Table 7.6: Calculation of total cost and benefit

Total cost	Number of labor required	8
	Total cost of Labor	Rs 672000 yearly
	Total cost of dustbin	Rs 42954
	Miscellaneous expense	Rs 90000 yearly
Total benefit	Salvage value	Rs 824332.95 yearly

Source: Summary of the calculation of total cost and benefit from recycling

Calculation of saving from compostable material

Revenue through composting is another option for hotel because the contribution of food waste is approximately 61.29% of total waste generated. Proper treatment of organic waste like composting can generate additional revenue by adopting one of the two options. There

are mainly two ways of composting based on amount of waste generation and hotel premises. These two feasible solutions of organic waste are:

Option 1: Bio-digester for small scale

Bio-digester is usually related to the reduction of waste volume that converts waste into useful gas and manure. It provides a relatively simple solution for waste management and energy production. The size, cost and output of the bio-digesters ranged from single family use, small and large scale depend upon quantity and quality of waste.

Table 7.7: Cost and saving from bio-digester

Total cost of installing bio-digester	**Rs 10,70,976**
Total saving from bio-digester	**Rs 21,90,000**

Source: Summary of the calculation of total cost and benefit from composting at small scale

Bio digester is the 1st option for hotel, it required small area for establishment with on an average cost of Rs 10.7 lakhs that generate profit of approximately Rs 22 lakhs per year depend on the quality of sorted waste material for compost.

Option 2: Multi-pit for large scale

In multi pit option there are two types of composting at large scale. One is Windrowcomposting and other is vermicomposting.

Table 7.8: Cost and saving from Multi pit

Total cost	**Rs 5,78,200**
Total saving	**Rs 76,500**

Source: Summary of the calculation of total cost and benefit from composting at large scale

Multi pit composting is second option, it is suitable for centralize composting of many hotels that required some amount of land, which is given on the subsidy of Government that would cost less than 4 lakh for 100- 150 sq. yard and generate Rs. 76,500 per year by selling of compost. After completing all cost and benefit calculation, a final table (Table 7.9) of cost benefit analysis has been shown below for easy understanding of interpretation. Cost benefit analysis is the key objective of the study. It is the main gap, which is bridged with the help of

waste auditing so that the hotel industry may be shown the potential of waste management and its positive implementation to them as well as to the environment.

Table 7.9: Detail of cost benefit analysis

Cost Benefit Analysis									
Extra labours cost (a)	**Extra bins cost (b)**	**Miscellaneous expenses (c)**	**Salvage value (d)**	**Expense in 1st Year**	**Expense in 2nd Year**	**Earning in 3rd Year**	**Earning in 4th Year**	**Earning in 5th Year**	**Saving from Biogas/ Compost**
8 Labour * Rs 7000/month * 12	50 Liter - 2 qty 80 Liter - 10 qty 120 Liter - 8 qty	waste storage/cleaning/transportation etc- Rs 7500/month* 12	Income from salvage Rs 68694 per month* 12	Currently hotel doesn't adopt any waste management practices like segregation	Hotel adopt waste segregation practices and sell scraps to vendor. Expenses on bin also reduced	In this year only half of the labours required because 50% labor cost is reduced due to experiential learning	Again in the 4th year only 50 percent labour are required because of experiential learning	Neither extra labour cost nor any miscellaneous expenses paid because segregation at source implemented	Option 1: Through biodigester - Hotel save around Rs 21,90,000. Option 2: Through multi pit - Hotel save around Rs 76,500 by selling @ cost of Rs. 30/Kg
a= Rs 6,72,000	b= Rs 42,954	c= Rs 90,000	d= Rs 8,24,333	**a+b+c= Rs 8,04,954**	**a+c-d= Rs (+ 62,333)**	**a/2+c-d= Rs (+ 3,98,333)**	**a/2+c-d= Rs (+ 3,98,333)**	**Rs (+ 8,24,333)**	**Rs (+ 21,90,000)/ Rs (+ 76,500)**

Source: Detail calculation of cost and benefit in yearly basis

Expense in 1st year: Hotels need to invest approximately Rs 8 lakh in very first year for implementing green practices in their premise. This includes cost of extra labour for waste segregation i.e. 1 labour segregate 100 kg of waste, so 8 labour required to segregate around 800 kg of waste per day, as per the source of Chintan (NGO) along with an working project with NDMC and CPCB. Similarly cost of bins and miscellaneous expenses also include in first year.

Expense in 2nd year: In the second year of its operation the hotel will not be paying any cost for bins again because it is onetime expense, therefore Rs 42,954 will not be added in the second year. Salvage value is deducted from overall cost i.e. Rs 824333 because it is the additional revenue generated from selling of recyclable items to scrap dealer. Thus, in the second year hotel will start earning profit of approximately Rs 62,333 per year.

Expense in 3rd and 4th year: From its 3rd and 4th year of operation the labour cost should ideally be reduced to half (50%) as already stated on basis of experience learning. So Rs 336000 is given to 4 labours per year only and the amount of salvage value Rs 824333 is deducted from overall cost. So in this year hotel will earn approximately Rs 3.98 lakh.

Expense in 5th year: From the 5th year onwards hotel will not require to spend any amount on labour or miscellaneous expenses rather they start earning Rs 8.24 lakh subsequently for each successive year only from the selling of sorted recyclable material to scrap dealer.

7.2.4 OBJECTIVE NUMBER FOUR ACHIEVED

Fourth objective is the whole sum or main objective of the study. On the basis of various tool and technique like waste audit, WARM model, equivalency calculator and cost benefits analysis, a holistic framework is developed for hotel industry with special focus on profitability and sustainability aspect.

With the help of this framework or model it has been proved that waste is revenue earning source for the hotels provided there is a well laid-out mechanism for effective waste management. This not only brings in revenue but also save on the cost incurred by hotels hauling cost, transportation cost etc. See Appendix D for detail explanation of profitability and sustainability.

Profitability from salvage value of recyclable waste

The two major source of profit is organic waste and recyclable waste.

Table 7.10: Profit generation

Profit through organic waste	Rs 22 lakhs
Profit through recyclable waste	Rs 8.24 lakhs

Source: Overall profit calculation

Sustainability from waste management

Sustainability consists of three major aspects that are social, economic and environmental.

- **Employment generation:** Waste management being a labor intensive activity, it helps in employment generation. Recycling and composting practices create opportunity of employment i.e. 9 labour in one hotel and prefer to establish more recycling units.

- **Saving land resource:** Waste management practices help to reduce the area of waste dumping i.e. approximately 39, 60,000 sq. yd.

- **Saving environmental degradation:** Reduce GHG emission i.e. 31,748 MTCO2 helps to maintain the ecological balance and providing clean and green environment for living organism.

CHAPTER 8

CONCLUSION AND IMPLICATIONS

8.1 CONCLUSION

Though there are number of studies that have been done on waste management in almost all other disciplines, management of hotel waste has largely been remained untouched as extant literature reveals. There is total dearth of studies that deal with hotel waste management in detail and this resulted in scant availability of knowledge related to this critical aspect. Further the underexplored nature of hotel waste management has hamstrung the prospects of its practical applications.

Waste management in hotel industry is one of the most affected areas in terms of perennial changes that keep on happening in environment on regular basis. Waste management play a vital role in cushioning the organizations against the ill-effects of this turbulence. In fact the segment chosen for study is hotel industry is one of the most affected categories in India that is at receiving end of this continuous tumult. The implications of efficient waste management practices are immense for these organizations as it can certainly help in enhancing the profitability and sustainability in these organizations.

Hotel industry is to develop responsible strategies through for competitive advantage. Business sustainability is achieved by minimizing company efforts to climate change. These strategies can generate new offers and opportunities for making profit for organization. Top hotel's strategists and marketing echelons of these organizationscan face the day-to-day changing market situations to make their hotel sustainable in competitive world. Waste management practices are one of the most appropriate optionsof utilization of existing resources instead of implementing high budgeted strategies.

Thus framework/model of hotel waste management developed in study can help the hotelier to not only diagnose weak areas of sustainability in their daily operation and then taking corrective measures at very initial level.

8.2CONTRIBUTION OF STUDY

The major contributions of the study are as follows:

- Holistic Framework/Model; an effective and efficient waste handling strategy for hotel industry has been developed. This model provides a way to hotel industry to deal any type of waste generation issue. It gives the basic idea of waste segregation and categorize each waste according to its treatment

- Framework/model has two main aspects, which is currently more important for any organization. The first one is profitability, which is basically the first motive of every organization to achieve and second is sustainability, which is the competitive advantage of the organization.

- Land is the precious resource; with the help of this model burden on landfill sites can be reduced. Saving of mother earth is a moral duty of all human being to maintain the ecological balance of environment. With the help of waste management practices we can reduce the ill effect of greenhouse gas (GHG) emission.

- Third-party service providers like vendors for waste collection & segregation may be considered as an alternative to the existing waste management system. In this way not only hotels will earn the salvage value but also help in community development through employment generation.

8.3 LIMITATIONS OF THE STUDY

In spite of being unique and first on several counts especially on aspect of model or framework development on waste management marketing for hotel industries, this study has some limitations.

First of all data has been taken only from a selected number of hotel industry especially from star rated hotels. Only a selected few hotels were being administered for survey because of time, effort and money constraint researcher has been grappled with.

Second the data is based on the waste-audit conducted on hotels in Delhi NCR region only but the hotels in other area may have a different practice for recycling which limits generalizability of this study's findings.

Third customer view point about waste management has not been included as research was focussed single-mindedly from organizations' point of view. It may be case that customers of this hotel industryhave different perspective especially on customer orientation front.

Lastly the estimation of labour cost and salvage value is a dynamic in nature which changes with time and place.

8.4 FUTURE RESEARCH

Study of waste management practices in hotel industry is the first model that creates the options of waste handling and treatment. This model could be extended to other ways too.

- This study was conducted for star rated hotels only. Future research will expand the ambit of study by including small hotels and restaurants segment.

- Customer preference towards green hotel, as examined in pilot study, will be further examined in future as it could induce the hotels to implement waste management practices in their establishments. The enhanced preference of customers towards green hotels will justify high initial cost associated while implementing SWM in hotels.

- It could be extended to household waste because the waste generation from hotel and from household are almost very similar.

- It is proposed that further research is needed to bring more clarity and strengthen the ides of recycling.

REFERENCES

[1] Vardharajan, K. and Rajan, Y.,*"Hotels in India trends and opportunities"*, HVS hospitality services report, Gurgaon, 2012

[2] Mukherjee, D.,*"Rural Tourism - Path to Economic and Regional development in India"*, Kurukshetra, Vol. 60(7), pp. 3-6, May, 2012.

[3] World Travel and Tourism Council,*http://www.wttc.org*, July 15, 2013.

[4] Middleton, V.T.C., and Clarke, J.,*"Marketing in travel and tourism"*, Butterworth Heinemann, Oxford, 2009

[5] Cooper, C., Fletcher, J., Gilbert, D. and Wanhill, S.,*"Tourism principles and practice*", Longman, London, 1996

[6] Rohweder, L.,*"Climate Change – A Business Challenge"*Haaga-Helia Discussion, Vol. 9, 2008

[7] Bacot, H., McCoy, B. and Galvan, J., *"Municipal commercial recycling: Barriers to success"*, American Review of Public Administration, Vol.32 (2), pp.145-165, 2002

[8] India Hotel Market Reports, Published by Knight Frank Research Inc., 2010

[9] Ministry of tourism, *"Manpower requirement in hotel industry, tour operators & travel sector manpower trained by different institutes & placement scenario"*Department of tourism, Government of India, February 05, 2004.

[10] CPCB, *"Annual report"*, Ministry of Environment & Forestry, Government of India, 2007.

[11] AC Nielsen Report,*"Hotel Rooms Assessment"*, Ministry of Tourism, Government of India, 2008.

[12] Sharholy, M., Ahmad, K., Mahmood, G. and Trivedi, R.C;*"Municipal solid waste management in Indian cities-A review"*, Waste Management, Vol. 28(2), pp. 459- 467, 2008.

[13] Singh, N.,Cranage, D.A. and Nath, A.,*"Estimation of GHG emission from hotel industry"*, Anatolia: An International Journal of Tourism and Hospitality Research, DOI: 10.1080/13032917.2013.822817, August 10, 2013.

[14] India is the third biggest greenhouse gas emitter,http://www.articles.timesofindia.indiatimes.com/2011-08-03/global-warming/29861707_1_mgreenhouse-gas-emitter-emissions, Government TOI report, August 03, 2011.

[15] Murali, S.,Shrivastava, R. and Saxena, M.,*"Greenhouse gas emission from open field burning of agricultural residues in India*, Journal of environmental science and engineering, Vol. 52(4),pp. 277-284, Oct 2010.

[16] Fullerton, D. and Kinnaman, T.C.,*"Household responses to pricing garbage by the bag"*. The American Economic Review, Vol. 86(4), pp. 971–984, 1996.

[17] Rushton, L.,*"Health hazards and waste management"*, British Medical Bulletin, Vol. 68, pp. 183–197, 2003.

[18] CPCB, *"Health status of conservancy staff and other community associated with municipal solid waste management in Kolkata and Chennai"*, control of urban pollution series, CUPS/62/2005-06, report by CPCB, Government of India, India, 2006.

[19] Coles, C.,"*Solving New York's garbage problems*", The Futurist, pp. 45, October 2002.

[20] Dix, C. and Baird, C.,*"Front Office Operations"*, India: Published by arrangement with Pearson, Education Limited and Anand sons, 2006.

[21] Andrews, S.,*"Hotel Housekeeping Management & Operations"*, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2008.

[22] Al-Sairafi, M., Alfanadeq, E. and Edari, M.,"*Helping you in understanding the required skills and Etekit of Successful Hotel Management"*, Hotel management Managerial Overview, Comprehensive Guide,Shaima Printing and Computer Daqhaliya.

[23] Braham,B.,*"Hotel front office*", Hutchinson Education, London, 1990.

[24] Brody,D.,*"Latest trends in hotel industry*",First edition, Global Media, Delhi, 2009.

[25] Walker, J.R.,*"Introduction to Hospitality Management",* First Indian reprint, Pearson Education, India, 2005.

[26] Batra, G.S. and Dangwal, R.C.,*"Tourism Promotion and development: new advances"*. Deep and Deep Publications Pvt. Ltd, 2001.

[27] AboRoman, A.,"*Edaratalzeyafah (Hospitality Management)",*first edition,Aman: Al-hamed for publication and distribution, 2001.

[28] Tourism and hotel industry in India, http://www.docstoc.com/search/Hotel-Industry, May 10, 2014.

[29] Devising strategy in Tourism Marketing, the existing trends and devising strategy in Tourism Marketing, http://www.ukessays.com/essays/tourism/devising-strategy-in-tourism-marketing.php#ixzz3AvjOZtDG, May 11, 2014.

[30] Kumar, L.,Singh, T.,Saigal, N. and Cebula, B; report on *"Dissecting the Indian Hospitality Industry"*, Published by Technopak perspective, Vol. 1, 2010.

[31] Federation of Hotel & Restaurant Associations of India (FHRAI),"*Indian Hotel Industry Survey 2011-2012*", 2012.

[32] Vardharajan, K. and Rajan, Y.,*"Hotels in India trends & opportunities"*, HVS Hospitality Services, DLF Cyber City, Gurgaon, India, 2012.

[33] Media Report, Ministry of Tourism, Press Releases, Department of Industrial Policy and Promotion (DIPP), http://www.ibef.org/industry/tourism-hospitality-india.aspx, May 10, 2014.

[34] Industry Insight - Indian Hotels (2011), Cygnus Research, India, http://www.researchandmarkets.com/reports/2017977/industry_insight_indian_hotels, April 10, 2013.

[35] Ministry of tourism, *"Study to Assess the Requirement of Manpower in Hospitality and Travel Trade Sector"*, Department of tourism, Government of India, January 2012.

[36] Ministry of Tourism, *"Assessment of requirement of Hotel Room / Accommodation in Metro Cities and 50 major Tourist Centres in India",* Government of India, ACNielsen ORG-MARG Pvt. Ltd, New Delhi, February 2008.

[37] Williams, P.T.,*"Waste disposal and treatment",* John Wiley, Chichester, 2005.

[38] Barrett, J.,Chambers, N.,Cherrett, N.,Jenkin, N., Lewis, K. and Vergoulas, G.,*"Material Health: an ecological footprint analysis of the NHS in England and Wales",* Best Foot Forward Ltd, Oxford, UK, 2004.

[39] Glasson, J.,Therivel, R. and Chadwick, A., *"Introduction to Environmental Impact Assessment"*, Spon Press, London, 1999.

[40] White, P.R., Franke, M. andHindle, P.,*"Integrated Solid Waste Management: A Lifecycle"* Inventory Blackie Academic and Professional, London, 1995.

[41] Pongrácz, E. and Pohjola, V.J., *"Re-defining waste, the concept of ownership and the role of waste management "* Resources, Conservation and Recycling, Vol. 40(2), pp. 141-153, 2003

[42] Lox, F., *"Waste management-Life Cycle Analysis of packaging"*, Final Report, Belgian Packaging Institute, European Commission, 1994.

[43] DEFRA (Department of Food and Rural Affairs),*"Securing the future, the UK Government Sustainable Development Strategy"*, http://www.sustainable development.gov.uk/publications/uk-strategy/uk-strategy-2005.htm,2005a, July 28, 2014.

[44] Davies, S.,*"Politics and the Markets- The case of municipal waste management"*, Cardiff University, School of Social Science, working paper no 5, Paper presented in the

panel session, Local Service Privatization international perspective at the APPAM Fall conference, Washington DC, USA, 2007.

[45] Powell, J.C.,*"Waste Management"*,The Oxford Companion to Global Change, Oxford University Press, Oxford Reference Online, Oxford University Press, University of East Anglia, http://www.oxfordreference.com/views/ENTRY.html?subview=Main&entry=t265.e238, 2009, June 07, 2014.

[46] Zerbock, O.,*"Urban Solid Waste Management: Waste Reduction in Developing Nations"*, Michigan Technological University, http://www.cee.mtu.edu/peacecorps/documents_july03/Waste_reduction_and_incineration_FINAL.pdf>, 2009, August 15, 2014.

[47] Gilmour, B. and Manns, H.,*"A practical guide to waste management for Universities and colleges"*, Environmental Association for Universities and Colleges, 2001.

[48] World Bank,*"Decision Makers' Guide to Municipal Solid Waste Incineration"*, Washington D.C, 1999.

[49] MSW Manual, *"Manual on municipal solid waste management"*, Government of India, Ministry of urban development, 2009.

[50] Gervais, C.,*"An overview of European Waste and Resource Management Policy"*. Forum for the Future, London, 2002.

[51] UK Government Strategy Unit, *"Waste Not Want Not"*, U.K, HMSO, 2002.

[52] Department of Environment Food and Rural Affairs (DEFRA), *"Introductory Guide to Options for the Diversion of Biodegradable Municipal Waste from Landfill"*, Waste Strategy for England, 2007.

[53] Waste Online, *"Legislation Affecting Waste"*,http://www.wasteonline.org.uk/resources/InformationSheets/Legislation.htm, 2005, January 14, 2014.

[54] Tonglet, M., Philips, P.S., and Read, A. D.,*"Using the theory of planned behaviour to investigate the determinants of recycling behaviour a case study from Brixworth"*, Resources, conservation and recycling, U.K, Vol. 41(3), pp. 191, 2004.

[55] Prudential Soggy lettuce Report,*"Are we a nation of wasters"*, Craigforth, United Kingdom, 2004.

[56] Barr, S.,*"What we buy, what we throw away and how we use our voice"*, Sustainable Household waste Management in the UK, Sustainable Development, Vol. 12, pp. 32-44, 2004.

[57] EEA (European Environment Agency),*"Diverting waste from landfill. Effectiveness of waste management policies in the European Union"*, EEA Report No 7, Copenhagen, Denmark, 2009.

[58] Department of Environment Food and Rural Affairs (DEFRA), "What happens to waste", http://www.defra.gov.uk/environment/waste/topics/#reuse, November 30, 2010.

[59] POSTNOTE (Parliamentary office of Science and Technology), *"Recycling household waste"*, Note number 252, 2005.

[60] WRAP,*"Improving the performance of waste diversion schemes"*, A good practice guide to monitoring and evaluation, Prepared by WRAP, 21, Horsefall, Banbury, 2006.

[61] European Union, *"Packaging and Packaging waste"*,http://europa.eu/legislation_summaries/environment/waste_management/l21207_en.htm, 2010, March 19, 2014.

[62] DEFRA (Department of Environment, Food and Rural Affairs),*"Introductory guide to options for the diversion of biodegradable municipal waste from landfill"*, http://www.defra.gov.uk/environment/waste/residual/newtech/documents/introductory-guide-2007.pdf, 2007b, March 29, 2014.

[63] DEFRA (Department of Environment, Food and Rural Affairs,*"Municipal Waste Management statistics"*, http://www.defra.gov.uk/evidence/statistics/environment/wastats/bulletin09.htm, 2009b, March 19, 2014.

[64] Chintan Report, *"waste rules in India"*, Environmental research and action group,http://www.chintan-india.org, December 19, 2013.

[65] Municipal solid waste Manual Rule 2000, *"Municipal solid waste (management and handling)",* Ministry of urban development, Government of India.

[66] Lakshminarasimaiah, N.,*"Integrated solid waste management - a case study on hosur, Tamilnadu"*, Thesis submission in faculty of civil engineering, Anna university, Chennai, 2011.

[67] Bai, L. and Vijalakshmi, G.S.,*"Vermi composting of sugar Factor Filter Press mud Using an Earthworm species EudrilusEugeniae (Kingberg) with a note on its Physico-chemical Features"*, Vol. 19(3), pp.181-483, 2000.

[68] Haug, R.T.,*"Composting process design criteria",* Biocycle, Vol. 27, pp. 53-62, 1986.

[69] Khan, R.R.,*"Environmental management of municipal solid wastes"*, Indian journal of Environmental protection, Vol. 14(1), pp.26-30, 1994.

[70] Suess, M.J.,*"Solid Wastes Management Selected Topics"*, World Health Organization Regional Office, Europe, Copenhagen, 1985.

[71] Ramjee, N.,*"Include Eco-issues in Syllabus"*, The Hindu, August 14, 2005.

[72] Sharma, M. R.,*"Pollution Research"*, Environmentmedia, India, Vol. 23(1), pp.131-134, 2004.

[73] Tripathi, B. D. and Ranigovil, S.,*"Water Pollution – An Experimental Approach"*, CBS Publishers and Distributors, New Delhi, pp. 1, 2001.

[74] Prabhakar, V. K.,*"Prevention and Control of Pollution"*, Anmol Publication Pvt. Ltd., New Delhi, pp. 78, 2001.

[75] Tripathi, G., Verma, P. and Mishra, M.,*"Aquatic Pollution and Fish",* Ecology and Conservation of lakes, Reservoirs and Rivers, ABD publishers, Jaipur, pp. 549-564, 2001.

[76] Chatterjee, S. N.,*"Water Pollution: Causes and Prevention"*, Environment and People, pp. 6-8, 2006.

[77] Mukhopadhay, K., Bera, R. and Roy, R.,*"Modern Agriculture and Environmental Pollution"*, Everyman's Science, Vol. XL (3), pp. 186, September 2005.

[78] Sunder, I., *"Environment Protection through NGOs and Local Community"*, Environment and People, Vol. 8(16),May 2002.

[79] Verma, D. K., Singh, A. and Agarwal, S. B.,*"Pollution Mitigation through Plants"*, Environment and People, pp. 29-30, September 2006.

[80] Ganesamurthy, V. S. and Paari, C. A.,*"Water Pollution and its Effects on Human Health with Special Reference to Erode Town"*, Environment and People, pp. 3-4, 2006.

[81] Lakshmanan, K.K.,*"Electronic Wastes"*, Kisan World, Vol.36(1), p. 29, 2009.

[82] Edwards, C.A. and Bater, S., *"The Use of Earthworms in Environmental Management"*, Soil Biol.Biochem, Vol. 24(12), pp. 1683-1689, 1992.

[83] Kannaiyan, S. and Lilly, S.S., *"Bio-resources Technology for Sustainable Agriculture"*, Associated Publishing Company, New Delhi, pp. 351-357, 1999.

[84] Mani, D.,*"Vermiculture: A Tool for Minimizing Solid Waste Pollution"*, Kurukshetra, Vol. 45, pp. 61-62, December 1996.

[85] Viswanathan, D.,*"Combat Environmental Degradation"*, The Hindu, October 17, 2005

[86] Petrella, R., *"Poverty, Water and Globalisation"*, Yojana, June, Vol. 49(6), pp. 18-19, June 2005.

[87] Nath, K. J.,*"Home Hygiene and Environmental Sanitation – A Country Situation Analysis for India"*, International Journal of Environmental Health Research, Taylor and Francis Publishers, Vol. 13(1), pp. 319-328, June 2003.

[88] Maheswari, M.,*"For Cleaner Lakes and Ponds"*, The Hindu, December 12, 2005.

[89] Rao, J.K.,*"Production of Urban Compost from Municipal Solid Wastes"*, Kisan World,Vol.31(3), pp. 62, March 2008.

[90] Setua, G.C. and Setua, M.,*"Serifarm Waste Compost- An Easy and Quick Method of Preparation for Efficient Use and Alternative Source of Chemical fertilizer"*, Indian Farming, Vol. 57(10),pp. 41-44,January 2008.

[91] Ramjee, N.,*"Include Eco-issues in Syllabus"*, The Hindu, August 14, 2005.

[92] Anantharaman, V. and Balaguru, K.,*"Environmental Pollution and Health Hazards of Pesticides"*, Kisan World, Vol. 35(9), pp. 58, September 2008.

[93] Malarvan.,*"Waste-to-Manure Project Planned"*, The Hindu, November 28, 2205

[94] Arrifa, B.J. and Jayalakshmi, S.,*"Solid Phase Anaerobic Digestion of Kitchen Waste"*, Proceedings of National Conference on Sustainable Development of Environment for Future Generation, p.16, 2005.

[95] Singh, K.K. and Shekhawat, M.S.,*"Organic Farming- Need of the Hour",* Environment and People, Vol. 7(1), pp. 29-31, June 2000.

[96] Manimozhi, K., Meena, M. and Kalpana, M.,*"Enhancing Environment Through Garbage Management"*, Kisan World, Vol. 33(10), pp. 24-27, October 2006.

[97] Gupta, R.D.,*"Save the Soil-Save the Nation"*, Environment and People, Vol. 8(16), May 2002.

[98] Venkataratnam, L.,*"Vermiculture for Rural Areas"*Kisan World, Vol.28(10), October 2001.

[99] Karpagam, R.,*"A Green Effort from Home Pays Off"*, The Hindu, November 4, 2005.

[100] Ramaswamy., "*Waste- Disposal, Management and Utilisation"*, Proceeding – UGC sponsored National Seminar , Department of Mechanical Engineering, Faculty of Engineering and Technology, Annamalai University, Annamalainagar, India, 2005

[101] Venkatesan,,*"Programme to Train SHG Members Youth in Solid Waste Management"*, The Hindu, 23 September, 2005.

[102] Viswanathan, S.,*"Hell to Heaven"*, Proceeding – UGC sponsored National Seminar on Waste - Disposal, Management and Utilisation, Department of Mechanical Engineering Faculty of Engineering and Technology, Annamalai University, Annamalainagar, India, P. 20, 2005.

[103] Ponniah, C.,*"For Cleaner Lakes and Ponds"*, December 12, 2005

[104] Karthikeyan, V., Meenambal, T. and Murugesan, R., *"Assessment of Municipal Solid Waste in the Salem City"*, Proceedings – Indian Environment Congress, Karpagam Arts and Science College, Coimbatore, pp. 75-81, 2003.

[105] Kumar, P. and Singh, C.P., *"Managing Solid Waste: A Case Study of Ghazipur City"*, Pollution Research, Vol. 18(3), pp. 231-234, March 1999.

[106] Memon, M.A., *"Integrated solid waste management based on the 3R approach"*Journal of Material Cycles Waste Management, DOI 10.1007/s10163-009-0274-0,February 25, 2008.

[107] Baldisimo, J.M.,*"Scavenging of Municipal Solid Waste in Bangkok, Jakarta and Manila"*,Environmental Sanitation Reviews, Vol. 26, Asian Institute of Technology, Bangkok, 1988.

[108] Jenkins and Robin, R.,*"The Economics of Solid Waste Reduction*", Burlington, Edward Elgar, 1993.

[109] Mclain, K.T.,*"Recycling Programmes in Bromley: The Handbook of Environmental Economics"*, Blackwell Publishers Ltd, U.K, 1995.

[110] Koning, D.H., Cantanhede, A. and Benevides, L., *"Hazardous Waste and Health in Latin America and the Caribbean"*, Pan American Health Organization, Environmental Series, Vol.14, pp. 1-59, 1995.

[111] Bhattarai, R.C.,*"Solid Waste Management and Economics of Recycling: A Case of Kathmandu Metro City"*, Economic Journal of Development, Vol. 1(2), pp. 9-106, 2000.

[112] Salhofer, S., *"Waste Generation -modelling the amount of waste"*, Institute of Waste Management, BOKU - University of Natural Resources and Applied Life Sciences, Vienna, 2001.

[113]Ambat, B., *"Preparation of action plan for solid waste management of Thiruvananthapuram city and establishment of an environmental information system"*, Kerala Research Programme on Local Level Development, C.D.S, Trivandrum, 2000.

[114] Ray, C.N.,*"Municipal Solid Waste Management in Ahmedabad"*, Nagarlok, Vol. 35(2), 2003.

[115] Ambat, B.,*"Study of the Attitude and Perception of Community towards Solid Waste Management-A Case Study of Thiruvananthapuram-Phase II"*, Kerala Research Programme on Local Level Development, C.D.S, Trivandrum, 2003.

[116] Mathew, V., *"Solid waste management in Kottayam town"*, KRPLLD, CDS, Trivandrum, 2003.

[117] Sekher, M., *"Keeping Our Cities Clean: Urban Solid Waste Management in Karnataka"*, Journal of Social and Economic Development, Vol. 6(2), 2004.

[118] Chiemchaisri, C., Juanga, J.P. and Visvanathan, C., *"Municipal solid waste management in Thailand and disposal emission inventory"*, Environment Monitoring Assessment, Vol. 135, pp. 13-20, DOI 10.1007/s10661-007-9707-1, May 10, 2007.

[119] Bhuiyan, M. S. H., *"Solid waste management of Dhaka city"*, Paper presented at the seminar on solid waste Management, DCC, Dhaka, Bangladesh, 1999.

[120] JICA.,*"The study on solid waste management in Dhaka city"*, Clean Dhaka Master Plan, Final Report, Japan International Cooperation Agency, Pacific Consultants International, Yachiyo Engineering Co., Ltd., 2005.

[121] Annepu, R.K.,*"Sustainable Solid Waste Management in India"*, Waste-to-Energy Research and Technology Council (WTERT), Earth Engineering centre, Columbia University, New York, 2012.

[122] Department of Economic Affairs.,*"Position Paper on the Solid Waste Management Sector in India"*, Public Private Partnerships in India, Ministry of Finance, Government of India, November 2009.

[123]. Gupta, S.,Mohan, K., Prasad, R. andKansal, A.,*"Solid Waste Management in India: Options and Opportunities"*Resources, Conservation and Recycling, Vol. 24, 1998.

[124] CityMayors., *"The Largest Cities in the World by Land Area"*, Population and Density, http://www.citymayors.com, July 15, 2013.

[125] Rampal, R.K., *"Solid Waste generation in Government Hospitals of Jammu City"*, Pollution Research, Vol. 21(1), 2000.

[126] Gopalan, U. K.,*"Environmental consciousness"*, Paper presented at the World Environment day Seminar on Development and Environment, Cochin, 1982.

[127] Wasir, H.S.,*"Environmental pollution and heart diseases"*, Article published in Yojana, 1997.

[128] Abelson, P., *"Project appraisal and valuation of the environment"*,London: Macmillan Press, 1996.

[129] Manivasakam, N., *"We breathe and drink poison"*, New Delhi, National book trust, 1995.

[130] Macniell, J., and Yskushiji, T.,*"Beyond interdependence",* New York, Oxford University Press, 1991.

[131] Roy, K.C. and Tisdel, C.A.,*"Economic development: a case study of India"*, New Delhi, Oxford university press, 1992.

[132] Meadows, D. and Renders, J.,*"Beyond the limits"*, London, Earth scan publishers, 1992.

[133] Barron, B.,*"Down to Earth"*, Vol. 8(16), 2000.

[134] Lahiry, S.C.,*"Sustainable economic development"*, Article Published in Kuruksheaa, pp. 39, 1997.

[135] Varshney, C. K.,*"Environmental challenges"*,Wiley Eastern Limited, New Delhi, 1993.

[136] Foster, J.B.,*"The vulnerable planet"*, New York: Monthly review press, 1999.

[137] Kamath, M.V.,*"Problem of Urbanisation"*, Article published in Times of India daily, June, 1976.

[138] Kasarda, J. D. and Rondnelli, D.A.,*"Mega cities, the environment and ecologically sustainable urbanisation"*, Environment impact Assessment Review, 1990.

[139] Angoni, T.,*"Metropolis"*, Planning, poverty and politics,Rutledge publishers, London, 2000.

[140] Serageldin, I. and Martin, J.B., *"The business of sustainable cities*", World bank publications, Washington, 1995.

[141] Trivedi, P.R. and Raj, G.,*"Solid waste pollution in New Delhi"*, Akashdeep publishing house, 1996.

[142] Down to Earth report, *"Why are we all falling ill in New Delhi"*, Centre for science and environment, 1998.

[143] Raghupathi, U.P., *"Environmental protection in developing countries"*, New Delhi: Oxford Press, 1993.

[144] Benjamin, K.M.S.,*"Dimensions of development"*, Chennai: Centre for human development and social change, 1982.

[145] Venketaswaran, S.,"Managing waste", Article published in EPW, pp. 5-12, 1994.

[146] McCarthy, J.E., *"Recycling and reducing packaging waste- How the United States compares to other countries"*, Resources, Conservation and Recycling, Amsterdam, Vol.8, Elsevier Science Publishers, 1993.

[147] Mills, E.S.,*"The Economics of Environmental quality"*, New York,W.W. Norton and Company, 1978.

[148] Nath, B. and Hens, L.,*"Environmental management in practice",*London, Rutledge Publishers, 1999.

[149] Rushton, L.,*"Health hazards and waste management"*, British Medical Bulletin, Vol. 68,pp. 183–197, 2003.

[150] CPCB.,*"Health status of conservancy staff and other community associated with municipal solid waste management in Kolkata and Chennai"*, control of urban pollution series, CUPS/62/2005-06, report by CPCB, Government of India, India, 2006.

[151] Shyjan, D., Mohan, R. and Surjit, V., http://mpra.ub.uni-muenchen.de/24258/1/MPRA_paper_24258.pdf, 2010, January 14, 2014.

[152] Elliott, P., Briggs, D., Morris, S., Hoogh, C.D., Hurt, C., Jensen, T.K., Maitland, I., Richardson, S., Wakefield, J. andJarup, L.,*"Risk of adverse birth outcomes in populations living near landfill sites"*, British medical journal, Vol. 323, pp. 363–368, 2011.

[153] Vasanthi, P., Kaliappan, S. and Srinivasaraghavan, R., *"Impact of poor solid waste management on ground water"*, Environment monitoring Assessment, Vol. 143, pp. 227-238, DOI 10.1007/s10661-007-9971-0, 2008.

[154] Intergovernmental Panel on Climate Change (IPCC), *"Session report"*, Report of the Twelfth Season of the Intergovernmental Panel on Climate Change, Mexico City, pp. 11–13, September 1996.

[155] Marsh, R., Larsen, V.G. and Kragh, M., *"Housing and energy in Denmark: past,present, and future challenges"*, Building Research & Information, Vol. 38(1),pp.92-106, 2010.

[156] Lombard, P. and Pout, C.,*"A review on buildings energy consumption information"*, Energy and Buildings, Vol. 40(3), pp. 394-398, 2008.

[157] Environmental Protection Department, *"Hong Kong greenhouse gas inventory for the period 1990-2007*", Environmental Protection Department, Hong Kong, 2009.

[158] International Energy Agency, *"CO2 emissions from fuel combustion"*, International Energy Agency, 2009.

[159] Bhattacharya, S. and Mitra, A.P., *"Greenhouse gas emissions in India for the base year 1990*, Scientific Report, Vol. 11, pp. 74–81, 1998.

[160] Rees, J. F., *"Landfill for treatment of solid wastes- The principles, applications, regulations of biotechnology in industry, agricultural and medicine"*, Comprehensive biotechnology, Vol.4, U.K, Pergamon Press, 1985.

[161] Kinman, R. K., Nutini, D. L.,Walsh, J. J., Vogt,W. G., Stamm, J. andRickabaugh, J.,"*Gas enhancement techniques in landfill simulators"*, Waste Management Research, Vol. 5, pp. 13–25, 1987.

[162] Lay, J. J., Li, Y. Y. andNoike, T.,*"Dynamic of methane organic activities in a landfill bioreactor treating the organic fraction ofmunicipal solid wastes"*, Water Science and Technology, Vol. 38 (2), pp. 177–184, 1998.

[163] Visvanathan, C., Trankler, J., Joseph, K., Chiemchaisri, C., Basnayake, B. F. A. andGongming, Z.,*"Municipal SolidWaste Management in Asia"*, Asian Regional ResearchProgram on Environmental Technology, Asian Institute of Technology Publications, ISBN: 974–417–258–1, 2004.

[164] Kumar, S., Gaikwad, S.A., Shekdar, A.V.,Kshirsagar, P.S. and Singh, R.N.,*"Estimation method for national methane emission from solid waste landfills"*, Atmospheric Environment, Vol. 38, pp. 3481–3487, 2004.

[165] Ishigaki, T., Chung, C.V., Otsuka, K. and Inoue, M.Y.Y.,*"Estimation and field measurement of methane emission from waste landfills in Hanoi, Vietnam"*, Journal of Material Cycles Waste Management, Vol.10, pp. 165–172, DOI 10.1007/s10163-008-0202-8, 2008.

[166] Intergovernmental Panel on Climate Change, *"Climate change 2007"*, Synthesis report, Intergovernmental Panel on Climate Change, 2007.

[167] European Commission,*"Carbon footprint – what it is and how to measure it"*, http://lct.jrc.ec.europa.eu.com, January 14, 2014.

[168] Kneifel, J.,*"Life-cycle carbon and cost analysis of energy efficiency measures in new commercial buildings"*, Energy and Buildings, Vol. 42(3), pp. 333-340, 2010.

[169] Pękala, Ł.M., Tan, R.R., Foo, D.C.Y. and JeŜowski, J.M.,*"Optimal energy planning models with carbon footprint constraints"*, Applied Energy, Vol. 87(6), pp. 1903-1910, 2010.

[170] Sovacool, B.K. and Brown, M.A.,*"Twelve metropolitan carbon footprints: Apreliminary comparative global assessment"*, Energy Policy, Vol. 38(9),pp. 4856-4869, 2010.

[171] Deng, S. and Burnett, J.,*"A study of energy performance of hotel buildings in Hong Kong"*, Energy and Buildings, Vol. 31(1), pp. 7-12, 2000.

[172] Lai, J.H.K. and Yik, F.W.H.,*"Benchmarking operation and maintenance costs of luxury hotels"*, Journal of Facilities Management, Vol. 6(4), pp. 279-289, 2008.

[173] Priyadarsini, R., Wu, X. and Lee, S.E.,*"A study on energy performance of hotelbuildings in Singapore"*, Energy and Buildings, Vol. 41(12), pp. 1319-1324, 2009.

[174] Chan, W.W. and Lam, J.C.,*"Prediction of pollutant emission through electricityconsumption by the hotel industry in Hong Kong"*, International Journal of Hospitality Management, Vol. 21(4), pp. 381-391, 2000.

[175] Chintan Report, *"Cooling Agents- an Examination of the role of the Informal Recycling Sector in Mitigating Climate Change"*, The Advocacy Project, Washington DC, 2009.

[176] Mitra, A.P., *"Greenhouse Gas Emission in India A Preliminary Report"*, CSIR, 1991.

[177] ALGAS.,*"Asia Least Cost Greenhouse Gas Abatement Strategy"*, India Country Report, Asian Development Bank, Manila, 1998.

[178] Garg, A., Bhattacharya, S., Shukla, P.R. andDadhwal, V.K., *"Regional and sectoral assessment of greenhouse gases emissions in India",* Atmospheric Environment, Vol. 35(15), pp. 2679–2695. 2001a.

[179] Garg, A., Shukla, P.R., Bhattacharya, S. and Dadhwal, V.K., *"Sub-region (district) and sector level SO2 and NOX emissions for India: assessment of inventories and mitigation flexibility"*, Atmospheric Environment, Vol. 35(4), pp. 703–713, 2001b.

[180] Reddy, M.S. and Venkataraman, C., *"Inventory of aerosol and sulphur dioxide emissions from India. Part II—biomass combustion"*, Atmospheric Environment, Vol. 36(4), pp. 699–712, 2002.

[181] Garg, A., Kapshe, M., Shukla, P.R. andGhosh, D., *"Large point source (LPS) emissions from India: regional and sectorial analysis"*, Atmospheric Environment, Vol. 36, pp. 213–224, 2002.

[182] Mitra, A.P. and Bhattacharya, S., *"Climate change and greenhouse gas inventories: projections, impacts and mitigation strategies"*, Climate Change and India: Issues, Concerns and Opportunities, Tata McGraw-Hill Publishing Company Limited, New Delhi, 2002.

[183] Garg, A., Kapshe, M., Shukla, P.R. andGhosh, D., *"Large point source (LPS) emissions from India: regional and sectoral analysis"*, Atmospheric Environment,Vol. 36, pp. 213–224, 2002.

[184] Mondal, S.K.,Gaikwad, A.N., Devotta, S.A., Singh, R.N., *"Qualitative assessment of methane emission inventory from municipal solid waste disposal sites: a case study"*, Atmospheric Environment, Vol. 38(29), pp. 4921–4929, 2004.

[185] PCRM, /http://www.osc.edu/research/pcrm/emissions/ inventory.shtml,2002, January 18, 2013.

[186] INC, *"India's Initial National Communication to the United Nations Framework Convention on Climate Change"*, Ministry of Environment and Forests, Government of India, New Delhi,http://www.natcomindia.org, 2004, March 24, 2012.

[187] INCCA, *"India: Greenhouse Gas Emissions 2007 Report"*,New Delhi, India, http://www.google.co.in/?gws_rdoutput_search&sclient_psy-ab&q_, 2007, January 14, 2014.

[188] Garg, A., Bhattacharya, S., Shukla, P. R., andDadhwal, V. K.,*"Regional and sectoral assessment of greenhouse gas emissions in India"*, Atmospheric Environment, Vol. 35, pp.2679–2695, 2001.

[189] Garg, A.,Shukla, P.R. andManmohanK., *"The sectoral trends of multigas emissions inventory of India"*, Journal of atmospheric environment, Vol. 40, pp. 4608–4620, 2006.

[190] Indian Network for Climate Change Assessment (INCCA), *"India: Greenhouse Gas Emissions"*, 2007.

[191] Hoornweg, L., and Thomas, K. V.,*"What a waste: Solid waste management in Asia"*,Washington, DC, International Bank for Reconstruction and Development/World Bank, 1999.

[192] Wilco, C.,*"Energy benchmarking in support of low carbon hotels: Developments, challenges and approaches in China"*, International Journal of Hospitality Management, Vol. 31, pp. 1130–1142, 2010.

[193] Cheung, M. and Fan, J.,*"Carbon reduction in a high-density city: A case study of Langham Place Hotel"*,Mongkok Hong Kong, Renewable Energy, Vol. 50, pp. 433–440, 2013.

[194] Gossling, S., Garrod, B., Aall, C., Hille, J.andPeeters, P.,*"Food management in tourism: Reducing tourism's carbon footprint"*,Tourism Management, Vol. 32, pp. 534–543, 2011.

[195] Kirk, D.,*"Environmental management in hotels"*, International Journal of Contemporary Hospitality Management, Vol.7, pp. 3–8, 1995.

[196] Bohdanowicz, P. andMartinac, I., *"Determinants and benchmarking of resource consumption in hotels: Case study of Hilton International and Scandic in Europe"*, Energy and Buildings, Vol. 39, pp. 82–95, 2007.

[197] Liqin, Y.,*"The analysis on carbon footprint of catering products in high-star hotels during operation: Based on investigation conducted in parts of high-star hotels"*, Energy Procedia, Vol. 5, pp. 890–894, 2011.

[198] Rossello´-Batle, B., Moia, A., Cladera, A. and Martınez, V.,*"Energy use, CO2 emissions and waste throughout the life cycle of a sample of hotels in the Balearic Islands"*, Energy and Buildings, Vol. 42, pp. 547–558, 2010.

[199] Goodall, B.,*"Environmental auditing: A tool for assessing the environmental performance of tourism firms"*, The Geographical Journal, Vol. 161, pp. 29–37, 1995.

[200] Horobin, H. and Long, J.,*"Sustainable tourism: The role of the small firm"*, International Journal of Contemporary Hospitality Management, Vol. 8, pp. 15–19, 1996.

[201] Rawat, M., Singh, U.K., Mishra, A.K. and Subramanian, V., *"Methane Emission from Landfill Areas of India"*, Environmental Monitoring and Assessment, Vol. 137(1-3), pp. 67-74,DOI: 10.1007/s10661-007-9729-8, 2008.

[202] Chan, Y.S.,*"Evaluation of Leachate Recirculation on Nitrous Oxide Production in the Likang Landfill, China"*, Journal of Environmental Quality, Vol. 31(5),pp. 1502-1508, doi:10.2134/jeq2002.1502, 2002.

[203] Rawat, M. and Ramanathan, A.L.*"Assessment of Methane Flux from Municipal Solid Waste (MSW) Landfill Areas of Delhi, India"*, Journal of Environmental Protection, Vol. 2, pp. 399-407, DOI: 10.4236/jep.2011.24045, 2011.

[204] Kirk, D., *"Environmental management in hotels",* International Journal of Contemporary Hospitality Management, Vol. 7(6), pp. 3-8, 1995.

[205] Holjevac, I.A.,*"A vision of tourism and the hotel industry in the 21st century"*, International Journal of Hospitality Management, Vol. 22, pp. 129–134, 2003.

[206] Archer, B. and Cooper, C.,*"The positive and negative impacts of tourism"*, W.F. Theobald, Global Tourism, Oxford Butterworth-Heinemann, pp. 73–91, 1994.

[207] Smith, C. and Jenner, P.,*"Tourism and the environment"*, Travel and Tourism Analyst, Vol. 5, pp. 68–86, 1989.

[208] Buhalis, D.,*"Tourism on the Greek islands: Issues of peripherally, competitiveness and development"*, International Journal of Tourism Research,Vol. 1(5), pp. 341–358, 1999.

[209] Tucker,H.,*"Tourist and troglodites:Negotiating for sustainability"*, Annals of Tourism Research, Vol. 28(4), pp. 868–891, 2001.

[210] Hu, W. and Wall, G.,*"Environmental management, environmental image and thecompetitive tourist attraction"*, Journal of Sustainable Tourism, Vol. 13(6), pp. 617–635, 2005.

[211] Hillery, M., Nancarrow, B., Griffin, G. and Syme, G.,*"Tourist perception of environmental impact"*, Annals of Tourism Research,Vol. 28(4), pp. 853–867, 2001.

[212] Poon, A.,*"Tourism, Technology and Competitive Strategies"*, Wallingford: CAB International, 1993.

[213] Pyo, S., Uysal, M. and Chang, H.,*"Knowledge discovery in database for touristdestinations"*, Journal of Travel Research, Vol. 40(4), pp. 396–403, 2002.

[214] Jennings, S.,*"Coastal tourism and shorelinemanagement"*, Annals of Tourism Research, Vol. 31(4), pp. 899–922, 2003.

[215] WTO (World Tourism Organization),*"What Tourism Managers Need to Know"*, A Practical Guide to the Development and Use of Sustainable Tourism, Madrid:WTO, 1995.

[216] Hutchinson, C.,*"Integrating environmental policy with business strategy"*, Long Range Planning, Vol. 29(1), pp. 11–23, 1996.

[217] Miller, G.A.,*"Consumerism in sustainable tourism"*, A survey of UK consumers, Journal of Sustainable Tourism, Vol. 11(1), pp. 17–39, 2003.

[218] Guthunz, U. and Krosigk, F.,*"Tourism development in small island states"*, Sustainable Tourism in Islands and Small States, Issues and Policies,pp. 18–35, London: Cassel, 1993.

[219] Swarbrooke, J.,*"Sustainable Tourism Management"*, Wallingford, CABI, 1998.

[220] Chan, W.W.,*"Partial analysis of the environmental costs generated by hotels in Hong Kong"*, Tourism Management,Vol. 24, pp. 517–531, 2005.

[221] Chan, W.W. and Lam, J.C.,*"Energy-saving supporting tourism sustainability: Acase of study of hotel swimming pool heat pumps"*, Journal of Sustainable Tourism,Vol. 11(1), pp.74–83, 2003.

[222] Hart, S.,*"Beyond greening: Strategies for a sustainable world"*, Harvard Business Review, Vol. 75(1), pp. 66–76, 1993.

[223] Shrivastava, P.,*"The role of corporations in achieving ecological sustainability"*, Academy of Management Review, Vol. 20, pp. 936–960, 1995a.

[224] Knight, C.,*"Pollution prevention, technology challenges, and competitive advantage in the process industries"*, Total Quality Environmental Management, Vol. 5, pp. 87–92, 1995.

[225] Starik, M. and Marcus, A., *"Introduction to the special research forum on the management of organizations in the natural environment"*, A field emerging from multiple

paths with many challenges ahead, Academy of Management Journal, Vol. 43, pp. 539–546, 2000.

[226] Porter, M. and Van der Linde, C.,*"Green and competitive: Ending the stalemate"*, Harvard Business Review,Vol. 73(5), pp. 120–134, 1995.

[227] Cortes, E.C., Azorın, J.F.M.,Moliner, J.P. and Gamero, M.D.L.,*"Environment strategies and their impact on Hotel Performance"*University of Alicante, Department of Business Management, Spain, Journal of Sustainable Tourism, Vol. 15(6),2007.

[228] Withiam, G.,*"Toward Sustainable Hotel and Restaurant Operations"*, Cornell Hospitality Research Summit in 2012, Cornell Hospitality Proceedings, Vol. 5(12), Centre for Hospitality Research, Cornell University, 2013.

[229] Chan, W.W. and Lam, J.,*"Environmental accounting of municipal solid waste originating from rooms and restaurants in the Hong Kong hotel industry"*, Journal of Hospitality and Tourism Research, Vol. 25(4), pp. 371–385, 2001.

[230] Welsh Assembly Government (WAG), "*Wise about waste: The national waste strategy for Wales (Parts One and Two)",* Cardiff, UK, 2002.

[231] DEFRA,*"Waste Strategy 2000 England and Wales"*, London, UK, The Stationery Office, 2000.

[232] WTB.,"Achieving our potential – a tourism strategy for Wales", http://www.visitpembrokeshire.com/industry/documentlibrary223Achieving%20Our%20Potential.pdf, March 19, 2014.

[233] Cummings, L.E.,*"Waste minimisation supporting urban tourism sustainability: A mega-resort case study"*, Journal of Sustainable Tourism, Vol. 5(2), pp. 93–108, 1997.

[234] Trung, D.N. and Kumar, S.,*"Resource use and waste management in Vietnam hotel industry"*, Journal of Cleaner Production, Vol. 13(2), pp. 109–116, 2005.

[235] Hayward, P., *"Disney does the environment"*, Lodging, Vol. 19(7), pp. 46–58, 1994.

[236] Taleb, A., *"A study on benefits of applying waste recycling programs in the hotel industry"*, Faculty of Tourism and Hotel Management, Helwan University, Egypt, 2005.

[237] Fullerton, D. andKinnaman, T.C.,*"Household responses to pricing garbage by the bag"*, The American Economic Review, Vol. 86(4), pp. 971–984, 1996.

[238] Apotheker, S.,*"Making the big jump in commercial recycling, one small business at a time"*, Resource Recycling, Vol. 14, pp. 16–26, 1995.

[239] Oskamp, S., Harrington, M.J., Edwards, T.C., Sherwood, D.L., Okuda, S.M. and Swanson, D.C., *"Factors influencing household recycling behaviour"*, Environment and Behaviour, Vol. 23(4), pp. 494–519, 1991.

[240] Bacot, H., McCoy, B. and Plagman-Galvin, J.,*"Municipal commercial recycling: Barriers to success"*, American Review of Public Administration, Vol. 32(2), pp. 145–165, 2002.

[241] Maclaren, V.W. and Yu, C.C.,*"Solid waste recycling behaviour of industrial-commercial institutional establishments"*, Growth and Change, Vol. 28, pp. 93–110, 1997.

[242] Horobin, H. and Long, J.,*"Sustainable tourism: The role of the small firm"*, International Journal of Contemporary Hospitality Management, Vol. 8(5), pp. 15–19, 1996.

[243] DETR (Department of the Environment, Transport and the Regions),*"A better quality of life: A strategy for sustainable development in the UK"*, London, UK, 1999.

[244] Maineri, T., Barnett, E.C., Valdero, T.R., Unipan, J.B. andOskamp, S.,*"Green buying: The influence of environmental concern on consumer behaviour"*, Journal of Social Psychology, Vol. 137, pp. 189–204, 1997.

[245] Bacot, H., McCoy, B. andPlagman-Galvin, J.,"Municipal commercial recycling: Barriers to success" American Review of Public Administration, Vol. 32(2), pp. 145–165, 2002.

[246] Farrell, M.,*"Recycling residuals into animal feed"*, BioCycle, Vol. 1, pp. 50–53, 2000.

[247] DEFRA ,"Animal by-products: Catering waste", http://www.defra.gov.uk/animalh/by-prods/wastefood/caterwaste.htm, March 19, 2014.

[248] Radwan, H.R.I.,Jones, E. and Minoli, D.,*"Managing solid waste in small hotels"*, Journal of Sustainable Tourism, Vol. 18(2), pp. 175–190, Cardiff School of Management, University of Wales Institute, Cardiff, UK, 2010.

[249] Steger, U.,*"Environmental management systems: empirical evidence and further perspectives"*, European Management Journal, Vol. 18(1), pp. 23-37, 2000.

[250] Stipanuk, D.M.,*"The US lodging industry and the environment – a historical view"*,Cornell Hotel and Restaurant Administration Quarterly, Vol. 37(5), pp. 39-45, 1996.

[251] ISO, Geneva, http://www.iso.org,March 29, 2014.

[252] ISO, the ISO Survey of Certifications,Geneva, 2005.

[253] Chan, W.W.,*"Predicting and saving the consumption of electricity in sub-tropical hotels"*, International Journal of Contemporary Hospitality Management, Vol. 17(3), pp. 228-37, 2005.

[254] Harrington, H.J. and Knight, A.,*"ISO 14000 Implementation – Upgrading Your EMS Efficiently"*, McGraw-Hill, New York, NY, 1999.

[255] Tibor, T. and Feldman, I.,*"The Development of ISO 14000: A Guide to the NewEnvironmental Management Standards"*, Irwin, Chicago, 1996.

[256] Woodside, G.,*"ISO 14001 Auditing Manual"*, McGraw-Hill, New York, NY, 2000.

[257] APAT,*"Tourists accommodation EU eco-label award scheme – Final Report"*, Italian National Agency for the Protection of the Environment and for Technical Services, Rome, 2002.

[258] IHEI,*"Challenge and Change: 1992-2000"*, International Hotels Environmental Initiatives, London, 1996.

[259] Kirk, D.,*"Attitudes to environmental management held by a group of hotel managers in Edinburgh"*, International Journal of Hospitality Management, Vol. 17, pp. 33-47, 1998.

[260] Cooper, I.,*"Emerging issues in environmental management"*, Facility Management: Theory and Practice, Spon Press, London, pp. 111-9, 1998.

[261] Mensah, I.,*"Environmental management practices among hotels in the greater Accraregion"*, International Journal of Hospitality Management, Vol. 25(3), pp. 414-31, 2006.

[262] Taylor, S.R.,*"Green management: the next competitive weapon"*, Futures, Vol. 24, pp. 669-80, 1992.

[263] Feiertag, H.,*"Boots sales with environment-driven strategy"*, Hotel and Motel Management, Vol. 209(2), p. 8, 1994.

[264] Penny, W.Y.K.,*"The use of environmental management as a facilities management tool in the Macao hotel sector"*, Vol. 25(7/8), pp. 286-295, Emerald Group Publishing Limited, 0263-2772, DOI 10.1108/02632770710753325, 2007.

[265] ETBPP,*"Saving Money through Waste Minimisation: Raw Material Use"*, Environmental Technology Best Practice Programme, 1996a.

[266] Price, P.,*"Waste Minimisation:a Cross-industry Review of Current Practices and Trends"*, Pearson Professional, Harlow, 1995.

[267] DETR,*"Less Waste More Value"*, Consultation Paper on the Waste Strategy for England and Wales, Department of the Environment, Transport and the Regions, 1998a.

[268] House of Commons,*"Sustainable Waste Management"*, Environment, Transport and Regional Affairs Committee, Sixth Report, Vol. 1, HMSO, London, 1998.

[269] Biffa.,*"Waste: a Game of Snakes and Ladders"*, Biffa Waste Services, High Wycombe, 1995.

[270] Kroyer, G.T.,"*Impact of food processing on the environment- an overview"*, Food Science and Technology, Lebensmittel - Wissenschaft andTechnologie, Vol. 28(6), pp. 547-52, 1995.

[271] Orsat, V., Raghavan, G.S.V. and Norris, E.R.,*"Food-processing waste dewatering by electro-osmosis"*, Canadian Agricultural Engineering, Vol. 38(1), pp. 63-7, 1993.

[272] Laufenberg, G., Gruss, O. and Kunz, B.,*"New concepts for the utilisation of residual products from food industry prospects for the potato starch industry"*, Starch-Starke, Vol. 48(9), pp. 315-21, 1996.

[273] Haley, T.A. and Mulvaney, S.J.,*"Advanced process control techniques for the food industry"*, Trends In Food Science & Technology, Vol. 6(4), pp. 103-10, 1995.

[274] Bates., M.P and Phillips, P.S.,*"Sustainable waste management in the food and drink industry"*, British Food Journal, Vol. 101(8), pp. 580-589, 1999.

[275] Axler , H.,*"Sanitation, Safety and Maintenance Management"*, New York: The Bobbs Merrill Company, pp. 94 – 102, 1973.

[276] Kirk , D,*"Environmental management in Hotels"*, International Journal of Contemporary Hospitality Management, Vol. 7(6), pp.3–8, 1995.

[277] Taleb, A.M.,*"A study on benefits of applying waste recycling programs in the hotel industry"*,Unpublished doctorate thesis, Faculty of Tourism and Hotel Management, Helwan University, pp. 50 – 77, 2005.

[278] Sherman, R., *"Water Quality and Waste Management"*, USA: North Carolina Cooperative Extension Service, pp. 4– 9, 1998.

[279] Ibrahim, N., *"Cleaner production new opportunities for food industry in Egypt",* The 4th International Conference and Exhibition for Environmental Technologies, Egypt, pp. 4, 2003.

[280] Bohdanowicz, P.,*"European hoteliers' environmental attitudes: Greening the business"*, Cornell Hotel and Restaurant Administration Quarterly, Vol. 46, pp. 188, 2005.

[281] Potts, D., Christenbury , H. and Wolak , J.,*"Recycling for the hospitality industry"*, Cooperative Extension Service, Clemson University, pp. 15 – 30, 2002.

[282] Snarr , J. and Pezza, K., *"Recycling Guidebook for the Hospitality and Restaurant Industry"*,Washington Council of Government , pp. 9 – 18, 2000.

[283] WWF-UK and IBLF, *"Why environmental benchmarking will help your hotel"*, A guide produced by the IBL Forum's travel and tourism program and WWF-UK., 2005.

[284] Hasek , G., *"Hotels keeping watch in waste"*, Resource Recycling, Vol. 10, pp. 56 – 60, 1991.

[285] Cartier, D., *"Mixed waste sorting in Las Vegas"*, Biocycle, Vol. 38, pp. 32 – 36, 1997.

[286] Nicholls, L. and Nystuen , C., *"Future foodservice waste management"*, Hospitality Research Journal, Vol. 17(1), pp. 234– 238, 1993.

[287] Stipanuk , D., *"The US lodging industry and the environmental historical view"*, Cornell Hotel and Restaurant Administration Quarterly, Vol. 37(5), pp. 39 – 45, 1996.

[288] Pizzolato, A. and Zeringue, C., *"Facing society's demands for environmental protection: Management in practice"*, Journal of Business Ethics, Vol. 12, pp. 441 – 447, 1993.

[289] Andhra Pradesh Pollution Control Board (APPCB), *"Waste Audit Guidelines – Overview"*, cleaner production cell, Andhra Pradesh Pollution Control Board, Hyderabad, 1998.

[290] Environment Protection Authority (EPA), *"Guidelines for Preparing Waste Assessments"*, A Practical Guide Towards Cleaner Production, ISBN 0-7306-2892-2, 1994.

[291] Antrim Waste audit, *"Operational Services—School information"*, http://antrimwasteaudit.com, March 29, 2014.

[292] Solana Recyclers, *"Hotel Waste Reduction Recommendation Report"*, Sponsored by Region IX of the US EPA, 1999.

[293] Saunders, M., Lewis, P. and Thornhill, A., *"Research Methods for Business Students"*, Fifth Edition, London: Prentice Hall, 2009.

[294] Hair, J., Money, A., Samouel, P. and Babin, B., *"Essentials of business Research"*, USA: John Wiley & Sons, Leyh Publishing, LLC, 2003.

[295] Rajput, R., Prasad G. and Chopra, A.K.,*"Scenario of solid waste management in present Indian context"*, Caspian Journal of Environmental Sciences, Vol. 7(1), pp. 45-53, 2009.

[296] Eco-recycle, *"Waste wise business- survey and audit questionnaire"*, Victoria, 2000.

[297] Hardesty, D. M. and Bearden, W.O., *"The use of expert judges in scale development: Implications for improving face validity of measures of unobservable constructs"*, Journal of Business Research, Vol. 57 (2), pp. 98-107, 2004.

[298] Dillman, D. A., Smyth, J.D. and Christian, L.M., *"Internet, mail, and mixed-mode surveys: the tailored design method"*, Third Edition, Hoboken, John Wiley & Sons, 2009.

[299] Malhotra, N.K. and Dash, S., *"Marketing Research: An applied Orientation"*, Sixth Edition, Pearson education, 2010.

[300] McCoy B., Bacot, H and Galvan, P.J., *"Municipal commercial recycling: Barriers to success"*, American Review of Public Administration, Vol.32(2), pp. 145-165, 2002.

[301] Wagh V., *"Management of Hotel Waste- Get involved in your city and locality"*, published by NGO- Karmayog, Mumbai.

[302] USEPA,*"Waste reduction Model- users guide"*, 2011 and 2013,http://www.epa.gov/warm.com, November 30, 2013.

[303] USEPA,*"Greenhouse Gas Equivalencies Calculator"*, 2011and 2013,http://www.epa.gov/cleanenergy/energy-resources/calculator.html#results.html, April 20, 2014.

[304] MSW Manual, *"Manual on municipal solid waste management"*, Government of India, Ministry of urban development, 2000.

[305] Stevens, C.V and Verhe, R.G.,*"Renewable Bioresources, Scope and Modification for Non-Food Applications"*, John Wiley and Sons Ltd, Chichester, pp. 54, 2004.

[306] Regional Centre for Urban and Environmental Studies,"*Detailed Project Report for Solid Waste Management in Lucknow"*, Uttar Pradesh.

[307] Eco evaluator, *"Anaerobic composting"*, 2012, http://www.ecoevaluator.com/lifestyle/gardening/anaerobic-composting.html, November 22, 2013.

[308] Nagavallemma, K.P., Wani, S.P., Stephane, L., Padmaja, V.V.,Vineela, C.,Rao, M.B. andSahrawat, K.L.,*"Vermicomposting: Recycling Wastes into Valuable Organic Fertilizer"*, SAT eJournal, An Open Access Journal published, ICRISAT, Vol. 2(1), 2006.

[309] Subler, S., Edwards, C.A and Metzger J., "*Comparing vermicomposts and composts",*BioCycle,Vol. 39, pp. 63–66, 1998.

[310] Khan, A. and Ishaq, F.,*"Chemical nutrient analysis of different composts (Vermicompost and Pitcompost) and their effect on the growth of a vegetative crop Pisumsativum"*, Asian Journal of Plant Science and Research, Vol. 1(1), pp. 116-130, 2011.

[311] Crescent, T.,*"Vermicomposting. Development Alternatives (DA) Sustainable Livelihoods"*, 2003, http://www.dainet.org/livelihoods/default.htm, Dec 20, 2013.

[312] Vermi Co.,*"Vermicomposting technology for waste management and agriculture: an executive summary"*, 2001, http://www.vermico.com/summary.htm, November 20, 2012.

[313] Devi, K.S., Krishna, R.H. and Swamy, A.V.V.S.,*"Studies on the Solid Waste Collection by Rag Pickers at Greater Hyderabad Municipal Corporation, India"*, International Research Journal of Environment Sciences, Vol. 3(1),pp. 13-22, ISSN 2319–1414, 2014.

[314] Nilofour, S., Swamy, A.V.V.S. and Devi, K.S.,*"Waste collection by rag pickers in the cities:A brief study"*, Indian journal of research, Vol. 2(4), ISSN - 2250-1991, 2013.

[315] Chintan Environmental Research And Action Group,*"Space for Waste Planning for the Informal Recycling Sector"*, report, Delhi, 2004.

[316] NDMC,*"PPP project for the Collection and transportation of municipal solid waste in entire NDMC area"*, proposal document, New Delhi Municipal Council, New Delhi, 2014.

[317] Papiya, S.,*"Solid Waste Management In Delhi – A Social Vulnerability Study"*, Proceedings of the Third International Conference on Environment and Health, Department of Geography, University of Madras and Faculty of Environmental Studies, Chennai.

[318] Hojnacki, A., Li, L. and Kim, N.,*"Biodigester Global Case Studies"*, D-Lab Waste, 2001.

[319] AARTI,*"ARTI Biogas Plant: A compact digester for producing biogas from food waste"*, 2008, http://www.arti-india.org/index2.php?option=com_content&do_pdf=1&id=45#Benefits, November 20, 2012.

[320] Ananthakrishnan, R., Sudhakar, K.,Goyal, A. and Sravan, S.,*"Economic feasibility of substituting LPG with Biogas for MANIT Hostels"*, International Journal of ChemTech Research, CODEN(USA), IJCRGG ISSN : 0974-4290, Vol.5(2), pp. 891-893, 2013.

[321] MSW Manual,*"Manual on municipal solid waste management- composting"*, Government of India, Ministry of urban development, 2000.

[322] Goldstein, N.,*"National trends in food residuals composting"*, biocycle, Vol. 38(7), 1997.

[323] Coleman, D. C.,*"Through a red darkly: an ecological assessment of root soil microbial faunal interactions"*, Ecological interaction in Soil, London, UK: Blackwell Scientific Publications, pp. 1-21, 1985.

[324] Parmelee, R.W., Bohlen, P.J. and Blair, J.M.,*"Earthworms and nutrient cycling processes: intergrating across the ecological hierarchy",* Earthworm Ecology,New York, USA: St Lucie Press, pp. 123-143, 1998.

[325] Jim, A.,*"Land degradation: Changing attitudes – why",* Journal of Soil Conservation, New South Wales, Vol. 44, pp. 46–51, 1988.

[326] Wani, S.P and Lee, K.K.,*"Biofertilizers role in upland crops production"*, Fertilizers, organic manures, recyclable wastes and biofertilisers, New Delhi, India: Fertilizer Development and Consultation Organisation, pp. 91-112, 1992.

[327] Wani, S.P., Rupela, O.P. and Lee, K.K.,"*Sustainable agriculture in the semi-arid tropics through biological nitrogen fixation in grain legumes*", Plant and Soil, Vol. 174, pp. 29–49, 1995.

[328] Goodman, A, *"Implementing sustainability in service operations at Scandic hotels Interfaces"*, Vol. 30 (3), pp. 202 – 214, 2000.

[329] Enz, C. A and Siguaw , A, *"Best hotel environmental practices"*, Cornell Hotel & Restaurant Administration Quarterly, Vol. 40 (5), pp. 72 – 77, 1999.

[330] Bohdanowicz, P., *"Environmental awareness and initiatives in the Swedish and Polish hotel industries – survey results"*, International Journal of Hospitality Management, Vol. 25, pp. 662 – 682, 2006.

[331] Le, Y., Harris, C., McLaughlin, A and Shook, S, *"Environmental management: A study of Vietnamese hotels"*, Annals of Tourism Research, Vol. 33(2), pp. 545 – 567, 2006.

[332] Choi, G and Parsa, H. G. *"Green practices II: Measuring restaurant managers ' psychological attributes and their willingness to charge for the ' green practices"*, Journal of Food service Business Research, Vol. 9(4), pp. 41 – 63 , 2006.

[333] Goldstein, N. J , B. and Griskevicius, V, *" Norms to motivate environmental conservation in hotels"*, Journal of Consumer Research, Vol. 35, pp. 472 – 482, 2008.

[334] Peattie, K., *"Environmental Marketing Management: Meeting the Green Challenge"*, Pitman, London, 1995.

[335] Foster, S.T., Sampson, S.E. and Dunn, S.C., *"The impact of customer contact on environmental initiatives for service firms"*, International Journal of Operations & Production Management, Vol. 20(2), pp. 187-203, 2000.

[336] E. Robinot and J.L Gianellons, *"Do Hotels' "green" attributes contribute to customer satisfaction"*, Journal of services marketing, Vol. 24, pp. 117-169, 2010.

[337] Schwartz, J., *"Earth day today"*, American Demographics, Vol. 12(4), pp. 40-1, 1990.

[338] McDaniel, S.W. and Rylander, D.H., *"Strategic green marketing"*, The Journal of Consumer Marketing, Vol. 10(3), pp. 4-11, 1993.

[339] Manaktola, K and Johri.V, *"Exploring consumer attitude and behaviour towards green practices in the lodging industry in India"*, International Journal of Contemporary Hospitality Management, Vol. 19(5), pp. 364-377, 2007.

Appendix A

Initial Waste Audit Form

Dear Respondent,

I am Amar Nath; conducting an academic survey on Waste Management Practices in Hotel Industry and the purpose of survey is to learn more about how we deal waste generation issues. The information you provide will contribute to an important study and only for academic purpose and no information will be shared with any third party.

Your opinions are extremely important for understanding these complex issues- we greatly appreciate your cooperation! We appreciate your willingness to help us in our research effort and look forward to receiving your response.

Hotel Waste Audit Form

Hotel Name, Add & Ph.:

Contact Person Name, Designation & Ph.:

No. of Visitors (per day): Lean season = Peak Season =

No. of Parties/Conferences (per year): Lean season = Peak Season =

Capacity: (1) No. of rooms = (2) No. of Kitchens/Restaurants =

Capacity: (3) No. of Banquet Halls = (4) No. of Lawn =

Gathering Capacity: 1st Banquet = 2nd Banquet =

Gathering Capacity: 1st Lawn = 2nd Lawn =

Seating Capacity: 1st Restaurant = 2nd Rest = 3rd Rest =

Seating Capacity: 4th Restaurant = 5th Rest = 6th Rest =

Garbage/Waste Vendor (Name, Add & Ph.)

Categorisation of Bins: YES/NO Specify: Wet □ Dry □ Mix □

Colour Code of Bins: YES/NO Specify: Green □ Yellow □ Red □ Black □

Capacity of Bins (Specify): Green Yellow Red Black

Dry Waste (Kg/day) = Wet Waste (Kg/day) =

Do you? Segregate □ Recycle □ Compost □ Landfill □

Does Your Vendor? Segregate □ Recycle □ Compost □ Landfill □

List of Waste Items	PEAK SEASON (Average per month)					LEAN SEASON (Average per month)				
	1st Month	2nd Month	3rd Month	4th Month	5th Month	1st Month	2nd Month	3rd Month	4th Month	5th Month
Papers:										
Newspapers										
Magazine										
Printouts										
Tissue Papers										
Tetra Pack (Juices)										
Copy paper										
Photocopies										
Brochures										
Books										
Toilet roll cartridges										
Packaging paperboard										
Carbon paper										
Plastics:										
Bottles										
Plastic Plates										

Packing Plastic and wrappers										
Mineral water bottles										
Plastic bags										
Plastic- or wax-coated paper										
Candy wrappers										
Foil gift wraps										
Shampoo bottles										
Carrier bags										
Plastic cutlery										
Toys										
Bleach & cleaners Bottles										
Textiles:										
Pillow cover										
Bed cover										
Table cloths										
Cotton cloth										
Carpets										
Towel										
Mattress										
Apparel										
Thread Waste										
Leather:										
Rexene										
Shoes										
Bags										
Garden wastes:										
Leaves										
Grass clippings										
Shrubbery										
Garden wastes										
Horticulture Waste										
Glass:										
BeerBottles										
Wine Bottles										
Food wastes:										
Vegetables waste										
Leftover food										
Fruit waste										
Egg shells										
Sea food waste										
Dairy products										
Oil waste:										
Vegetables oil										
Lube oil										
Other waste material:										

Date of assessment:

Thank You
(Your suggestions are welcomed at: amar.22n@gmail.com)

Appendix B

Final Waste Audit Form

Dear Respondent,

I am Amar Nath; conducting an academic survey on Waste Management Practices in Hotel Industry and the purpose of survey is to learn more about how we deal waste generation issues. The information you provide will contribute to an important study and only for academic purpose and no information will be shared with any third party. I request you to please take participation in waste auditing for accurate information.

Your opinions are extremely important for understanding these complex issues- we greatly appreciate your cooperation! We appreciate your willingness to help us in our research effort.

HOTEL WASTE AUDIT FORM								
Type of waste material	**NAME OF THE HOTEL**							
	DATE						**AVERAGE (Kg)**	**PERCENT**
	DAY (Kg)							
Recyclable Material	**PLASTIC PET BOTTLE**							
	MIXED PLASTIC							
	TETRA PAK (Laminated Paper)							
	ALUMINIUM							
	GLASS							
	NEWSPAPER							
	MIXED OFFICE PAPER							
	CARDBOARD							
Compostable	**COMPOST/WET WASTE**							
Inert (Direct Landfill)	**TRASH (Laminated Plastic)**							
TOTAL								

Name of the concerned person:

Designation & Ph.:

No. of rooms in hotel : Numbers of Kitchen:

Garbage/Waste Vendor (Name, Add & Ph.):

Dry Waste (Kg/day) = Wet Waste (Kg/day) =

Do you? Segregate □ Recycle □ Compost □ Landfill □

Miscellaneous Expense of Hotel (Regarding waste handling):

Thank You
(Your suggestions are welcomed at: amar.22n@gmail.com)

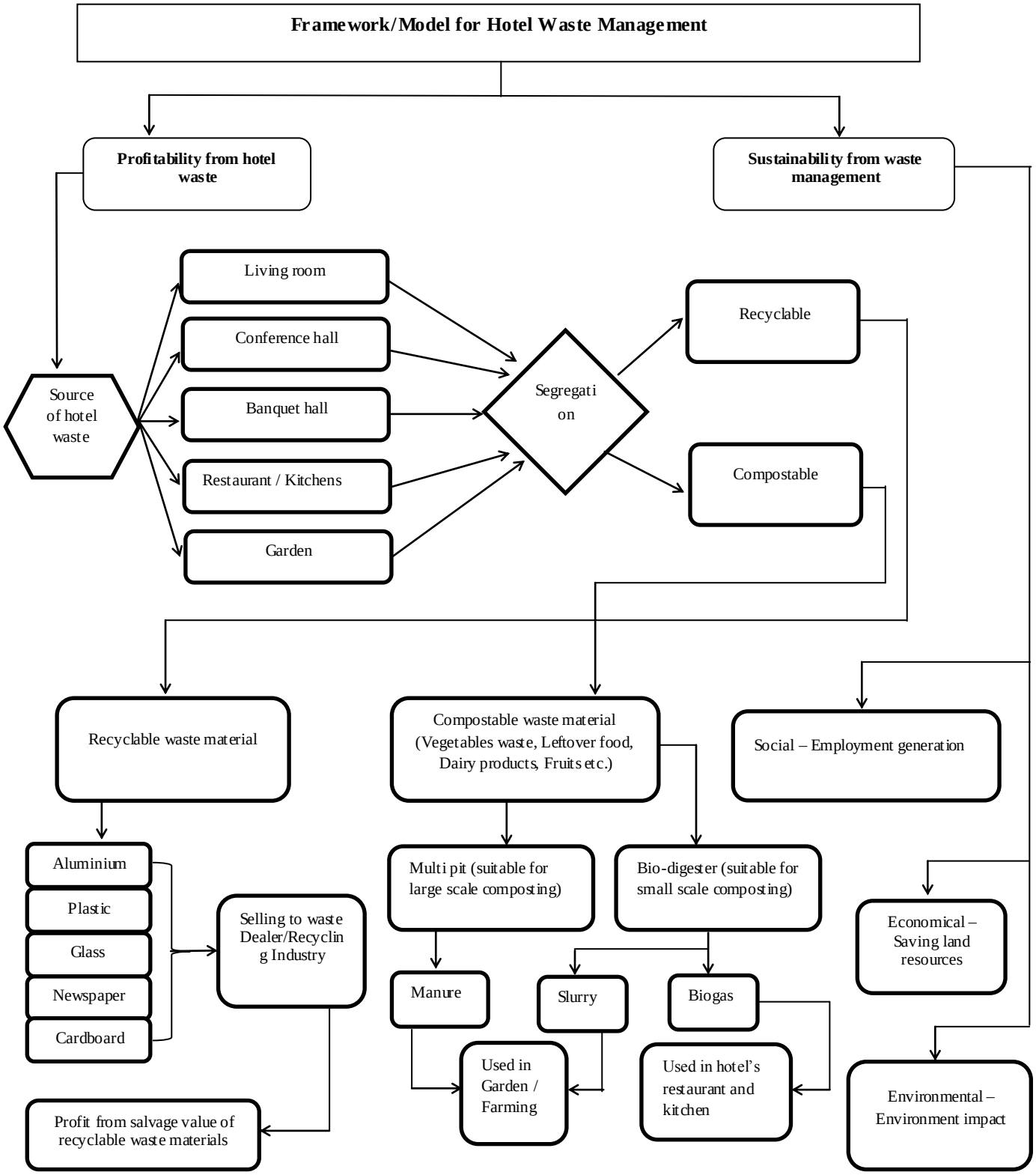
Appendix C

WARM Scenarios

	Baseline Scenario					Alternative Scenario				
Material	**Tons Recycled**	**Tons Landfilled**	**Tons Combusted**	**Tons Composted**	**Tons Generated**	**Tons Source Reduced**	**Tons Recycled**	**Tons Landfilled**	**Tons Combusted**	**Tons Composted**
Aluminium Cans				N/A	0					N/A
Steel Cans				N/A	0					N/A
Copper Wire				N/A	0					N/A
Glass				N/A	0					N/A
HDPE				N/A	0					N/A
LDPE	N/A			N/A	0		N/A			N/A
PET				N/A	0					N/A
LLDPE	N/A			N/A	0		N/A			N/A
Corrugated Containers				N/A	0					N/A
Magazines / Third-class mail				N/A	0					N/A
Newspaper				N/A	0					N/A
Office Paper				N/A	0					N/A
Phonebooks				N/A	0					N/A
Textbooks				N/A	0					N/A

	Baseline Scenario					Alternative Scenario				
Material	**Tons Recycled**	**Tons Landfilled**	**Tons Combusted**	**Tons Composted**	**Tons Generated**	**Tons Source Reduced**	**Tons Recycled**	**Tons Landfilled**	**Tons Combusted**	**Tons Composted**
Food Scraps	N/A				0	N/A	N/A			
Yard Trimmings	N/A				0	N/A	N/A			
Grass	N/A				0	N/A	N/A			
Leaves	N/A				0	N/A	N/A			
Branches	N/A				0	N/A	N/A			
Mixed Paper (general)				N/A	0	N/A				N/A
Mixed Paper (primarily residential)				N/A	0	N/A				N/A
Mixed Paper (primarily from offices)				N/A	0	N/A				N/A
Mixed Metals				N/A	0	N/A				N/A
Mixed Plastics				N/A	0	N/A				N/A
Mixed Recyclables				N/A	0	N/A				N/A
Mixed Organics	N/A				0	N/A	N/A			
Carpet				N/A	0					N/A

Appendix D


Framework/Model for Hotel Waste Management
Profitability from hotel waste
Sustainability from waste management
Source of hotel waste
Living room
Conference hall
Banquet hall
Restaurant / Kitchens
Garden
Segregati on
Recyclable
Compostable
Recyclable waste material
Compostable waste material (Vegetables waste, Leftover food, Dairy products, Fruits etc.)
Social – Employment generation
Aluminium
Plastic
Glass
Newspaper
Cardboard
Selling to waste Dealer/Recyclin g Industry
Profit from salvage value of recyclable waste materials
Multi pit (suitable for large scale composting)
Bio-digester (suitable for small scale composting)
Manure
Slurry
Biogas
Used in Garden / Farming
Used in hotel's restaurant and kitchen
Economical – Saving land resources
Environmental – Environment impact

Appendix E

Notes of technical terms

S.No.	Term	Description
1	GHG	A greenhouse gas emission absorbs and emits radiation within the thermal infrared range. This process is the fundamental cause of the increasing greenhouse effect.
2	EFW	Waste-to-energy or energy-from-waste (EFW) is the process of generating energy in the form of electricity and/or heat from the incineration of waste.
3	Combustion	It is a chemical process that reacts with oxygen and gives off heat. The original substance is called the fuel, and the source of oxygen is called the oxidizer.
4	Pyrolysis	It is thermochemical decomposition of wet/organicwaste material at elevated temperatures in the absence of oxygen that involves the simultaneous change of chemical composition and physical phase, and is irreversible.
5	Gasification	Gasification is a process that converts organic or fossil fuel based carbonaceous materials into carbon monoxide, hydrogen and carbon dioxide.
6	Landfill	A landfill is a site for the disposal of waste materials by burial and is the oldest form of waste treatment.
7	Biodegradable	It is capable of being decomposed by the action of biological agents, especially bacteria. Material that, left to itself, will be decomposed by natural processes.
8	Non-biodegradable waste	Non-biodegradable waste is a type of waste that can not be broken down into its base compounds by micro-organisms, air, moisture or soil in a reasonable amount of time. Non-biodegradable waste is an environmental concern, as it threatens to overwhelm landfills and create disposal problems
9	MRF	A Materials Recovery Facility (MRF) is where recyclable materials that are collected from households are sorted into different types (e.g. plastics, cardboard, paper, metal) using a mixture of manual and automated methods.
10	MSW	Municipal Solid Waste is the generation of everyday waste items that throw away, such as product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, paint, and batteries.
11	Rag pickers	A person who picks up rags and other waste material from the streets, refuse heaps, etc., for a livelihood.
12	Leachate	Leachate are the material acidic in nature that contaminate the ground water.
13	Methane	Methane is the second most prevalent greenhouse gas.
14	LFG	Landfill gas is not same as natural gas or methane. These gas are generated from landfill areas.

15	Extruder Machine	It is a device that pushes or pulls a material through a shaped die to make a continuous length of product
16	Bio digester	Bio digester is usually related to the reduction of waste volume that converts waste into useful gas and manure. It provides a relatively simple solution for waste management and energy production. The size, cost and output of the bio digesters ranged from single family use, small and large scale depend upon quantity and quality of waste.
17	Anaerobic composting	It's is a process of fermentation without oxygen. This decomposition process produces methane gases.
18	Vermicomposting	Vermicomposting is the process of decomposing vegetable or food waste, bedding materials with the help of earthworm.

Appendix F

Pilot study of customer preference of green hotel

Cronbach's alpha

Reliability Statistics

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items
.806	.817	25

Principle component analysis

Rotated Component Matrix

Rotated Component Matrix[a]

	Component			
	1	2	3	4
Q3	.677			
Q4	.610			
Q2	.604			
Q1	.571			
Q6	.563			
Q10		.798		
Q11		.732		
Q8		.497		
Q22			.799	
Q23			.669	
Q18			.536	
Q19				.792
Q20				.727

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Reliability Analysis

Factors	No of Items	Cronbach's Alpha
Factor 1 (Green awareness)	5	0.816
Factor 2 (Green practices)	3	0.778
Factor 3 (Eco societal benefit)	3	0.695
Factor 4 (Brand image)	2	0.546
Overall Reliability	13	0.760

Hotel industry experts validation

Panel of Experts		
Name of the Expert	**Organization**	**Designation**
Ashish Jain	Indian pollution control association (IPCA)	Director
Ajay Garg	Indian pollution control association (IPCA)	Manager (Compost & Recycling)
Dr. B.C. Sabat	Department of Environment, Govt. of Delhi	Head - Ozone Cell
AshieshBroota	Jaypee Greens Golf and Spa Resort	KST Manager
David Cranage	School of hospitality and management, PSU, USA	Professor
Seoki Lee	School of hospitality and management, PSU, USA	Professor
VivekTyagi	Shangri-La's - Eros hotel	F & B Manager
Shamsher S. Mann	Hospitality Valuation Services (HVS)	Associate Director
Ajay Verma	Hilton Hotel	F & B Manager

List of Publications

JOURNAL PUBLICATIONS

- Singh, N., Cranage, D. and Nath, A.,*"Estimation of GHG Emission from Hotel Industry"*, Anatolia: An international journal of tourism and hospitality research, DOI: 10.1080/13032917.2013.822817, publisher: Routledge- Taylor and Francis. ISSN No: 2156-6909, 2013

- Nath, A. and Singh, N.,*"Innovative waste management practices for ensuring sustainable business for Hospitality industry"*, Indian Streams Research Journal, Volume 2, Issue 10, ISSN No 2230-7850, pp. 5-9, 2012.

- Nath, A. and Singh, N.,*"Integrated Green practices for Sustainable Growth: A case study of Hospitality Industry"*, LingayasLalita Devi Journal of Professional Studies, ISSN 2230-987X, volume: 3, Issue: 1, pp. 45-48, 2013

- Nath, A., Shalender, K. and Singh, N., *"Significance and implication of value chain towards effective Waste Management and community development"* Review of research journal, Volume 3, issue 9, ISSN No 2249-894X, 2014.

- Nath, A., Singh, A. and Singh, N., *"Composting: A sustainable and profitable approach for hotel's organic waste",*Indian Streams Research Journal, Volume 4, Issue 9, ISSN No 2230-7850, 2014.

INTERNATIONAL CONFERENCES

- Nath, A, and Singh, N (2012), *"Integrated Green practices for Sustainable Growth: A case study of Hospitality Industry"* presented in International conference on "Innovative management practices for global competitiveness" held at LLDIMS, New Delhi on Nov 02 2012.

- Nath, A, and Singh, N (2012), *"Effective waste management practices for sustainability and profitability"* has been presented in International Conference on "Creating a sustainable Business: Managerial Implication and Challenges" held at Jaipuria Institute of Management, Jaipur on Dec 9-12, 2012.

- Nath, A, and Singh, N (2012), *"Management of Services for Enhancing Brand Image of Hospitality Industry"* has been presented in International Conference on "Marketing in Emerging Economies: An Agenda for Next Decade" held at PITK, Department of management, Amritsar Delhi on Dec 15-16, 2012.

- Nath, A, and Singh, N (2013), International conference on "South Asian Cities Summit 2013" on sustainability approach held at Hotel Imperial, New Delhi on April 17- 18, 2013.

NATIONAL CONFERENCES

- Nath, A, and Singh, N (2011), *"Management of hotel services & their waste for Profitability and Sustainability"* has been presented in National conference on "Marketing of Services in Global Scenario: Issues and Challenges" held in Gautam Buddha University, Noida on Dec 19, 2011.

- Nath, A, and Singh, N (2012*), "Effective use of value chain for community Development"* has been presented at National seminar on "Strategic Dimension of Value chain for sustainable Development" held in Shree Mata Vaishno Devi University, Jammu on Sep 1, 2012.

- Nath, A, and Singh, N (2012), *"Emerging issues and challenges for Hospitality Industry"* has been presented in National seminar on "Transforming Indian economy through service led growth in global era: Gains and Concerns" held in NIILM Centre of Management Studies, Noida on Oct 12, 2012.

- Nath, A, and Singh, N (2012), *"Innovative practices for effective management of waste from hotel industry"* has been presented in National Conference on "Innovative strategies for transforming Organizations" held in Guru Gobind Singh Indraprastha University, Delhi on Oct 19, 2012.

- Nath, A, and Singh, N (2013), *"Green Practices: Emerging trend in Service marketing to enhance customers' satisfaction"* has been presented in National Conference on "Innovative trends in Marketing in the new Millennium" held in LalBahadurShastri Institute of Management, New Delhi on Jan 05, 2013.

SYNOPSIS

PROFITABILITY AND SUSTAINABILITY FROM WASTE MANAGEMENT PRACTICES IN HOTELS AND ITS IMPACT ON ENVIRONMENT

1. INTRODUCTION

India is central attraction countries among the world because of their incredible natural beauty and culture. These qualities enhance the growth of hotel and tourism industry. The future of hospitality industry is shaped by many factors, like investment, growing capital needs and most important customers' needs and their expectation. These industries are dealing almost intangible services but neglect some tangible challenges like waste generation. Waste generation is a key concern in the hotel industry.Waste can be defined as unwanted and undesirable substance which is left after use or in general term waste is unusable object/material. Since the beginning of mankind all anthropogenic sources along with the growth of civilization, the waste generated become a very severe problem. Generation of waste now become a global issue around the globe; it is one of the biggest and most complex issues because the component of waste is highly toxic in nature that has the adverse effect on environment and human health. India generates million tonnes of solid waste daily, that is expected to increase in the coming future as the country strives to attain an industrializes nation status by the next decade.

India is still struggling for the better and effective waste management practices. Dumping of waste to landfill without any proper treatment can cause various hazardous gases that disturb the ecological balance. Due to anaerobic reactions, landfills emit methane and other hazardous gases to environment. Out of the hazardous gases methane (CH_4) is one of the most potent and dangerous gases than CO_2 [1] and [2]. There is planetary emergency for joint effort to reduce the emission level to maintain ecological balance.

Resolving this issue within a certain period of time is not possible and it is also not possible to cover the entire sector that generates waste, so it is better to focus on sector wise strategy. Hotel industries are main sources of waste generation, a large chunk of waste generated from

hotels lodging, storing and kitchen areas because hotel is bunch of rooms, restaurants, kitchen, banquet halls, conference hall, meeting rooms etc.According to Middleton and Clarke [3], accommodation in hotel industry plays vital role by providing the basic facilities that make comfortable. As per report of Ministry of tourism in India is that it is clearly estimated that there are 143950 numbers of hotels and motel in 2012 and this number is expected to reach at 261607 in 2022 [4]. It shows that the growth of hotel industry increases along with the growth of Indian economy and industrial developments. The major challenge in hotel industry is their produced waste, which are not properly treated due to insufficient technology and improper segregation practices, these wastes are directly sent to the landfill sites that create burden on dump sites. Apart from that landfill sites in India are non-scientific and out-dated that leads to odour and health problem along with environmental degradation by producing hazardous gases. Proper government policies and competent bureaucracies for management of proper solid wastes are there in India but they are not executed due to lack of implementation and supervising. Most of the policies are buried in files. There are no separate policies and laws for waste segregation and waste handling in hotel industry. So for providing better and hygiene environment to customer, it is a moral obligation for all hoteliers to adopt waste management practices. Waste management doesn't need any additional operating cost and time, it can be easily possible to implement at each operational activity from initial level.

Green practices like waste management is an effective and efficient tool to handle waste generation. For the hotel industry it is important to adopt such practices to boost their sustainability and profitability along with positive image amongst customer. It is indeed acting to implement green practices for reaping the rich monetary benefits from the available limited resources.

2. SCOPE OF THE STUDY

The focus of the research is on the most complex and worst situation of improper waste management practices in hotel industry. The study develops a sustainable waste management framework for the hotel industry that shows the optimum utilization of each waste material. The framework will include green practices for hotels of different categories and feasible solutions for the waste collection, segregation, processing, and disposal of waste. The study develops a sustainable waste management framework for hotel industry to reduce waste at source and help industry to add profit in their overall revenue. Effective and efficient green

practices are not only essential for environment protection but also add to the profitability of hotels.

Research computes the Cost Benefit Analysis (CBA) that helps to implement any practices accordingly. It is one of the most important techniques to estimate the cost vs. benefit. Basically it estimates the actual cost of implementing any business activity and their expected outcome along with its payback period.Cost benefit analysis creates a link between green practices and monetary and non-monetary benefit associated with it. Effective and efficient green practices are not only generating profit through recycling and composting but also help to maintain the ecological balance of environment. The main purpose of the entire research is to identify the gapbetween waste generation from hotel and their proper treatment, also establish a relationship between environment and sustainability practice to utilize each waste material.

3. RESEARCH OBJECTIVES

Following are research objectives of study:

- To estimate the waste generation from hotel industry.
- To know the impact of waste generated from hotel industry on environment.
- To conduct cost benefit analysis that creates a link between green practices and monetary and non-monetary benefit associated with it.
- To develop a holistic framework/Model for waste management in hotel industry.

4. LITERATURE REVIEW

The main objective is to develop a holistic framework or model for hotel industry to manage their waste effectively. In line with the purpose, the extensive literature review has been done in the area of waste management in India and its impact on environment, Emission of greenhouse gases from hotel waste and currently waste management practices in hotel industry and waste audit.

4.1 WASTE MANAGEMENT IN INDIA AND ITS IMPACT ON ENVIRONMENT

Waste is a one of the main concern in the hotel industry because hotel and restaurant industry are the major sources of waste generation by delivered services like serving food, catering from its kitchen and parties, conference, meetings, guest rooms etc. There are some studies and researches on environmental impacts of waste generation, in which authors discussed

about the current waste practices being done in India. The research shows that there is grave situation of open dumping. In India there is no sanitary landfill for waste dumping. Greenhouse gas (GHG) emissions are generated from the dumping of waste at landfill thatis too hazardous and leads to the deterioration of human health and environment. The effect of waste dumping increases along with passage of time. In one of the study in Thailand, author depicts that increasing trend of Municipal Solid Waste (MSW) generation with time have the deep impact on environment and health [5]. Similarly the same situation arises for hotel industry when wastes aredirectly dumped to the landfill sites, further it produces leachate that contaminate the ground water. It is well identified by Vasanthi[6] in his study on Chennai that the element of leachate damage land as well as ground water [7].

According to Memon, [8] integrated solid waste management (ISWM) is best strategy to manage waste in hotel industry along with the execution of 3R (reduce, reuse, and recycle) approach.

4.2 EMISSION OF GREENHOUSE GASES FROM HOTEL WASTE

Global warming becomes a serious concern since last few years.Greenhouse gas (GHG) Emission is the major threat for environment because when waste dumped to the landfill site it contaminate with other degradable and non-biodegradable material that release heavy amount of hazardous gases. As per reports of Indian Pollution Control Association (IPCC) reports reveals that Methane is most important GHGs gases because of its global warming.India is one of largest GHG emitter, the total net Greenhouse Gas (GHG) emissions in 2007 were 1727.71 million tons that increases year by year [9]. Appendix A shows the detail of methane emission and waste generation for the year 1995 and its projection.

Similarly Hoornweg [10] not only presented the emission from waste but also compared the data from different nations. The emerging fact about India indicates that by the year 2025 the rate of emission reached up to six times as compared to year 1995. Many countries are continuously making efforts to resolve this problem and different policies and frameworks have been developed regulations are made to cut emission rates worldwide. But due to industrial and economic growth among developing and developed countries, these policies are not being executed.

4.3 WASTE MANAGEMENT PRACTICES IN HOTEL INDUSTRY AND WASTE AUDIT

The word “hospitality” is defined as a broad field containing food service, leisure,lodging, conventions, travel, and attraction [11]. Many authors believe that tourism is one of the main factors that affect the environment with the help of hotel industry.

One of the researchers [12] examines the importance of implementing environmental management as a source of competitive advantage for the hotels. For the success of hotel industry and to remain in competitive and financial successful, the most important provision for service industry to meet customer expectation.In a study ofHatem [13],talk about the Solid Waste Management (SWM) in small hotels with the participation of local authority.

A waste audit is a most formal, and structured instrument used to calculate the amount of waste and its categorization. Waste audit is one of the most important practical activities that show the actual intensity of waste generated along with categorization of each waste material. According to Rushmore [14] and Environmental protection Agency (EPA) [15], proper assessment of waste audit helps to minimize waste and create various alternatives solution for hotel industry to recycle or sell recyclable items to generate revenue. It also helps to minimize the hauling or refuse fee for waste dumping. It a cost minimization strategy to minimize waste storage cost, transportation cost, waste handling cost and other miscellaneous expenses.

5. POLICIES, LAWS AND REPORTS ON WASTE MANAGEMENT

Policy is the path along which the government reflects its priorities.

5.1 POLICIES AND LAWS ON WASTE MANAGEMENT

- **The National Environment Policy, 2006**
- **The National Action Plan for Climate Change, 2009**
- **Plastic Waste (Management and Handling) Rules, 2011**
- **Municipal solid waste (Management and Handling) rules 2000**

5.2 REPORTS ON WASTE MANAGEMENT

There are reports and court judgments that remind the government to implement laws like:

- **Bajaj Committee, 1995**
- **Committee constituted by Supreme Court, 1999**
- **AsimBurman Committee, 1999**
- **CAG Audit on MSW, 2008**

6. RESEARCH METHODOLOGY

Both exploratory and descriptive research has been used in this study in order to develop a holistic framework/ model for waste management in hotel industry.

6.1 EXPLORATORY STUDY

The research has exploratory phase to determine the different waste management dimensions and their implications related to waste management in hotel industry. This is done with the help of extant literature review and then discussing the relevance of the identified dimensions with domain and industry experts. Secondary data is used from various sources like government reports, published papers, case studies etc.

6.2 DESCRIPTIVE STUDY

For descriptive phase primary data is collected through audit-form. The descriptive part of study is aimed to develop a holistic framework for hotel industry.

6.3 DATA COLLECTION METHOD

Waste auditing has been used for collecting primary data. Instrument used for collecting data is structured audit form consisting of tendifferent waste materials generated in hotels.Eight star rated hotels are selected randomly for auditing and each hotel audited at least 5 times to avoid the biasness of its average waste generation. Further it is extrapolated on Delhi NCR star rated hotels.

6.4 SAMPLING DESIGN

- Geographic Domain: Delhi-NCR
- Target Respondent: KST Manager, F&B Manager, Waste handling supervisor
- Sample Size: 40 Audits
- Sampling technique: convenience and judgmental

6.5 DATA ANALYSIS TECHNIQUES

Audit Form: It is used to know the intensity of waste generated in hotel industry. Auditing computes accurate value in different categories of waste material. Audit was conducted randomly, without any prior notification of visit to ensure unbiased audits and avoid any deliberate action by hotel to manipulate their recycling status. The data was collected using

‘Waste audit form’. Same process of audit was done in all selected hotels on 5 day audit per hotel to avoid the biasness of weight on a particular day. Further it is used to extrapolate on Delhi NCR hotel.

Waste Reduction Model (WARM): The Waste Reduction Model (WARM) was developed by the U.S. Environmental Protection Agency (EPA) for waste planners and organizations to estimate greenhouse gas (GHG) emission. It’s a tool to quantify the linkages between waste management practices and greenhouse gas (GHG)emission reductions. It calculates emissions in metric tons of carbon equivalent (MTCE) and metric tons of carbon dioxide equivalent (MTCO2E).

Equivalency Calculator: Equivalency calculator is used to represent the utilization of emission generated from hotel waste to other sectors like household, vehicles, electricity, energy, coal power plant etc. Equivalency calculator is used to convert results of WARM output in metric tons of carbon dioxide equivalent.

Cost Benefit Analysis (CBA): Cost benefit analysis is the key objective of the study. It is one of the most important practical activities that show the actual intensity of waste generated along with categorization of each waste material and theproper assessment of waste audit helps to minimize waste and create various alternatives solution for hotel industry to recycle or sell recyclable items to generate revenue. It is a cost minimization strategy to minimize waste storage cost, transportation cost, waste handling cost and other miscellaneous expenses.

7. ANALYSIS AND FINDINGS

7.1 Waste audit

On the basis of objective specifying and defining, the purpose of the study is to make a standardize audit form(refer appendix B).

Waste audit was conducted at eight selected hotels to find out the contents of the trash in their dumpsters and their current recycling status. Hotels were selected based on their consent and approval to participate in the waste audit. Audit was conducted randomly, without any prior notification of visit to ensure unbiased audits and avoid any deliberate action by hotel to manipulate their recycling status. At site auditors randomly selected any trash bags from dumpster, approximately 10-15% of total trash by weight. The data was collected using

‘Waste audit sheets’. Same process of audit was done in all selected hotels on 5 day audit per hotel to avoid the biasness of weight on a particular day.

Result and findings: After getting all data from each hotel, next step is to calculate the average value for all hotels waste per day/month/year (refer appendix C). On an average a star rated hotel generate approximately 780 kg of waste per day, then multiplied by 365 and divided it by 1000 to convert it to tons that are 280.86 tons per hotel. Now these wastes are extrapolated on all Delhi-NCR hotels to know the intensity or volume of waste generated in this geographical region. The average wastes generated from all-star rated hotels of Delhi NCR have been calculated i.e. 26,400.60 tons/year. This is an unexpected figure came out from a single service sector.In this scenario we can’t expect more or more landfill sites for waste dumping.

7.2 WARM Model

It’s a tool to quantify the linkages between waste management practices and greenhouse gas (GHG)emission reductions. WARM technique is used to calculate the estimation of greenhouse gases (GHG) with the help of date generated from audit sheet.

In this technique the material wise data collected and used to analyse Metric Tons of Carbon Dioxide (MTCO2E) equivalent.WARM model has two different scenarios i.e. baseline and alternate. Baseline scenario determines the amount of waste that goes into landfills and alternative scenario determines the various solution of each waste material like combustion, recycling, composting, incineration etc.

Result and findings: The calculation of WARM model indicate that when hotel doesn’t do any green practices and send their entire waste to landfill then it generate 343 MTCO2E in atmosphere, which is an alarming situation because there are large number of star rated hotel in Delhi NCR that generate 31748 MTCO2E. The amount of emission generated by all hotels is unexpected. Similarly when hotel adopt waste management practices like recycling and composting then it will save – 263 Metric tons of Carbon Dioxide Equivalent(MTCO2E). Negative sign show the emission reduction. Therefore the overall change in GHG emission will be -606 MTCO2E from one hotel and -56756 MTCO2E from all-star rated hotel in Delhi NCR.

7.3 GHG Equivalency calculator

Last step is to convert the result output in metric tons of carbon dioxide equivalent (MTCO2E) for the communicationbecause in the climate change world, people speak and compare value in terms of carbon dioxide equivalents. The value which derived from both scenarios is again put into WARM calculator, which calculates the equivalencies. Each equivalency represents the full benefit of hotel waste management decision.

Result and findings: Results generated from WARM model is 606 Metric tons of Carbon Dioxide Equivalent from one hotel and 56756 MTCO2E from all-star rated hotel in Delhi NCR is equivalent to use of passenger vehicles, gasoline consumption, oil consumption, energy uses, electricity generation etc. Appendix D represents the detail utilization of greenhouse gases in other sector for example annual greenhouse gas emission from 126 passenger vehicles is equivalent to 606 MTCO2E, similarly CO2 emission from 67937 gallons of gasoline consumed is equivalent to 606 MTCO2E and so on. It indicates that we can utilize or consume the same amount of emission in other sectors.

7.4 Cost Benefit analysis

Cost benefit analysis is the key objective of the study. It is the main gap, which needs to be bridged so that the hotel industry may be shown the potential of waste management.After getting the data from waste audit, the next logical step is to know the salvage value of each recyclable waste material. To know the selling price of each waste material, second party and third party scrap dealer/recycler are considered. Rates were calculated from various sources like recycling units, Municipal cooperation, rag pickers, scrap dealers etc. These values are used in cost benefit analysis to calculate the cost of implementing green practices and its benefit.

The following facts and logic were made to this analysis based on the experience of the waste audit, discussions with practitioners like hotel managers, waste supervisors and NGO associated with hotel's waste dealing:

- Average cost of extra labour paid to worker is Rs 7000/labour/month, as per the norms of minimum wages regulation act (1948) and decided by NDMC along with the report ofChintan (NGO).
- Cost of bins is based on the available price range starting from Rs. 1092 to Rs 3300 depending on the size of bins and its requirement like 50 liter, 80 liter or 120 liter.

- Salvage value of recyclable waste material was calculated by considering IPCA (NGO) and the rates of three different scrap dealers/recycling units, finally took the average rate of each waste material.
- Reduction of labour cost by 50% from 3rd year due to experiential learning's, habit and trainings. So no additional labour required from 5th year.
- The estimated composting cost may vary; depend on the scale of production.

Result and findings: While taking consideration of the above assumptions and logics, Appendix E shows the analysis of cost benefit. Result interprets that:

Expense in 1st year: Hotels need to invest approximately Rs 8 lakh in very first year for implementing green practices in their premise. This includes cost of extra labor for waste segregation i.e. 1 labor segregate 100 kg of waste, so 8 labor required to segregate around 800 kg of waste per day, as per the source of Chintan (NGO) along with an working project with NDMC and CPCB. Similarly cost of bins and miscellaneous expenses also include in first year.

Expense in 2nd year: In the second year of its operation the hotel will not be paying any cost for bins again because it is onetime expense, therefore Rs 42,954 will not be added in the second year. Salvage value is deducted from overall cost i.e. Rs 824333 because it is the additional revenue generated from selling of recyclable items to scrap dealer. Thus, in the second year hotel will start earning profit of approximately Rs 62,333 per year.

Expense in 3rd and 4th year: From its 3rd and 4th year of operation the labour cost should ideally be reduced to half (50%) as already stated on basis of experience learning. So Rs 336000 is given to 4 labours per year only and the amount of salvage value Rs 824333 is deducted from overall cost. So in this year hotel will earn approximately Rs 3.98 lakh.

Expense in 5th year: From the 5th year onwards hotel will not require to spend any amount on labour or miscellaneous expenses rather they start earning Rs 8.24 lakh subsequently for each successive year only from the selling of sorted recyclable material to scrap dealer.

Revenue through composting: Revenue through composting is another option for hotel because the contribution of food waste is approximately 61.29% of total waste generated.

Proper treatment of organic waste like composting can generate additional revenue by adopting one of the two options.

1st option: Bio digester is the 1st option for hotel, it required small area for establishment with on an average cost of Rs 10.7 lakhs that generate profit of approximately Rs 22 lakhs per year depend on the quality of sorted waste material for compost.

2nd option: Multi pit composting is second option, it is suitable for centralize composting of many hotels that required some amount of land, which is given on the subsidy of Government that would cost less than 4 lakh for 100- 150 sq. yard and generate Rs. 76,500 per year by selling of compost.

8. FRAMEWORK/MODEL FOR HOTEL WASTE MANAGEMENT

On the basis of waste audit, WARM model, equivalency calculator and cost benefits analysis, a holistic framework is developed for hotel industry with special focus on profitability and sustainability aspect. With the help of this framework, it has been proved that waste is revenue earning source for the hotels provided there is a well laid-out mechanism for effective waste management.

This model not only brings in revenue but also save on the cost incurred by hotels like hauling cost, transportation cost etc. Framework will create options to save the cost paid to the local vendors and save labour cost for waste handling. Refer appendix F for detail.

9. LIMITATION AND SCOPE FOR FURTHER RESEARCH

The data is based on the waste-audit conducted on hotels in Delhi NCR region only but the hotels in other area may have a different practice for recycling which limits generalizability of this study's findings.The estimation of labour cost and salvage value is a dynamic in nature which changes with time and place. Customer view point about waste management has not been included as research was focussed single-mindedly from organizations' point of view.

It is proposed that further research is needed to bring more clarity and strengthen the ides of recycling.It could be extends to household waste and small or medium hotel and restaurants.

REFERENCES

[1] Indian Network for Climate Change Assessment (INCCA), *India: Greenhouse Gas Emissions*, 2007.

[2] CPCB, *"Bio-degradable Plastics- Impact on Environment"*, Ministry of Environment and Forests, Government of India, India, 2009

[3] Middleton, V.T.C. and Clarke, J., *Marketing in travel and tourism*, Butterworth Heinemann, Oxford, 2009

[4] Ministry of tourism, *"Study to Assess the Requirement of Manpower in Hospitality and Travel Trade Sector"*, Department of tourism, Government of India, 2012

[5] Chiemchaisri, C., Juanga, J.P and Visvanathan. C., *"Municipal solid waste management in Thailand and disposal emission inventory"*, received: 29 June 2006/Accepted: 19 September 2006/Published online: 10 May 2007, Environmental Monitoring Assessment, 135:13-20, 2007

[6] Vasanthi, p., Kaliappan, S. and Srinivasaraghavan, R., *"Impact of poor solid waste management on ground water"*, Environmental Monitoring Assessment, Accepted: 27 August 2007/ Published online: 13 November 2007, 143:227-238, DOI 10.1007/s10661-007-9971-0, 2007

[7] Robinot, E. and Giannelloni, L.J., *"Do hotels' "green" attributes Contribute to customer satisfaction? "*, Journal of Services Marketing, Vol. 24(2), pp. 157–169, 2010

[8] Memon, A.M., *"Integrated solid waste management based on the 3R approach"*, Journal of Material Cycles Waste Management, 12:30–40, DOI 10.1007/s10163-009-0274-0, 2010.

[9] Ottenbacher, M., Harrington, R. and Parsa, H., *"Defining the hospitality discipline: a discussion of pedagogical and research implications"*, Journal of Hospitality & Tourism Research, Vol. 33(3), pp. 263-83, 2009

[10] Hoornweg, L. Thomas, K. Verma, *"What a Waste: Solid Waste Management in Asia"*, Washington DC: The International Bank for Reconstruction and Development/World Bank, 1999.

[11] Pizam, A. and Shani, A., *"The nature of the hospitality industry: present and future managers' perspectives"*, Anatolia: An International Journal of Tourism and Hospitality Research, Vol. 20(1), pp. 134-50, 2009.

[12] E. Claver, Moliner, J.P and Lopez- Gamero, M.D., *"Environmental management and their impact on hotel performance",* Journal of sustainable tourism, Vol. 15(6), DOI 0966-9582/07/06 663-17 $ 20.00/0, 2007.

[13] Hatem R.I. Radwan, E Jones and Dino M, *"Managing solid waste in small hotels"*, Cardiff School of Management, University of Wales Institute, Cardiff, UK, Journal of Sustainable Tourism Vol. 18(2), 175–190, 2010.

[14] Rushmore, *"Don't forget your waste audit"*, Lodging Hospitality; May 1998; 54, 5; pp. 14, 1998.

[15] The EPA, *"Manual for Waste Minimization Opportunity Assessments"*, US Environmental Protection Agency, Cincinatti, Ohio, EPA/600/2-88-025, 1988.

LIST OF APPENDICES

APPENDIX A: Waste generation and methane emissions from waste disposal (1995-2025)

	1995 Figures			2025 Projection		
Country	Urban MSW generation rate (kg/cap/day)	Methane Emission (kg/year)	Methane Emission (kg/cap/year)	Urban MSW generation rate (kg/cap/day)	Methane Emission (kg/year)	Methane Emission (kg/cap/year)
China	0.79	898.52	2.35	0.9	4075.12	4.93
India	0.46	474.55	1.92	0.7	2774.92	5.37
Indonesia	0.76	457.49	6.52	1	1581.74	9.05
Thailand	1.1	165.33	9.44	1.5	424.39	13.58
Malaysia	0.81	68.91	6.08	1.4	281.11	11.09
Bangladesh	0.49	38.66	1.46	0.6	243.69	3.29
Vietnam	0.55	31.76	1.96	0.7	189.87	4.6
Myanmar	0.45	18.46	1.61	0.6	106.41	3.94
Cambodia	0.69	2.67	1.64	0.8	25.5	3.5

Source: Urban MSW generation rate as cited by Hoornweg et al. (1999)

APPENDIX B: Waste audit form

	Hotel Waste Audit Form							
Type of waste material	**NAME OF THE HOTEL**							
	DATE						**AVERAGE (Kg)**	**PERCENT**
	DAY (Kg)							
Recyclable Material	**PLASTIC PET BOTTLE**							
	MIXED PLASTIC							
	TETRA PAK (Laminated Paper)							
	ALUMINIUM							
	GLASS							
	NEWSPAPER							
	MIXED OFFICE PAPER							
	CARDBOARD							
Compostable	**COMPOST/WET WASTE**							
Inert (Direct Landfill)	**TRASH (Laminated Plastic)**							
	TOTAL							

APPENDIX C: Averages of hotels waste

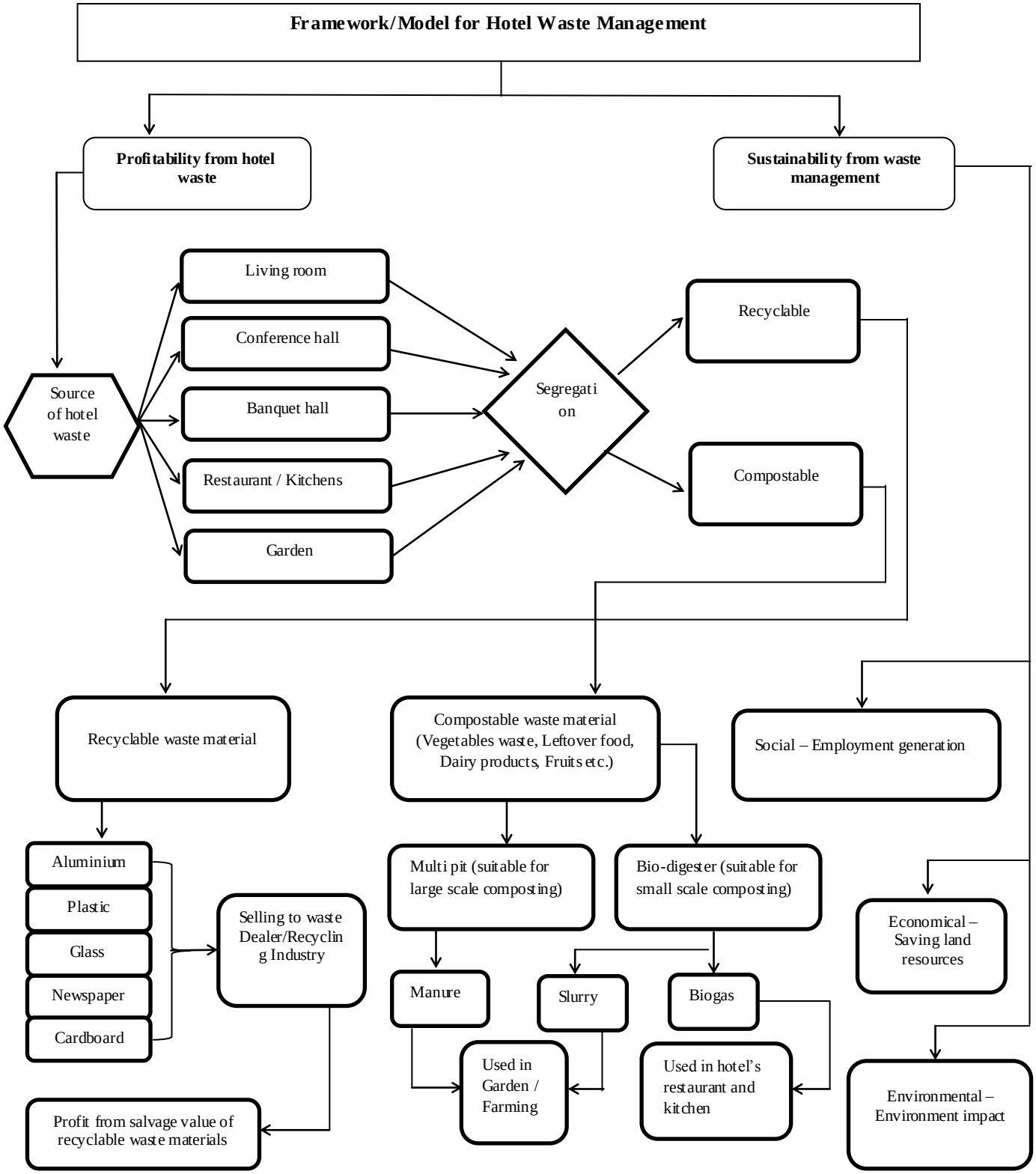
Average of Hotels											
Material	Shangri-la Hotel	Hilton Hotel	Jaypee Vasant Continental	Country INN	Park Plaza	Jaypee Greens Golf & Spa Resort	Jaypee Sidharth	Lemon Tree	Avg/day (Kg)	Avg/Yr (Kg)	Percentage of waste (%)
PLASTIC PET BOTTLE	5.90	7.58	6	6.76	6.58	5.84	6.26	7.16	6.51	2343.06	Recyclable - 38.49%
OTHER/MIXED PLASTIC	7.82	6.63	26.2	6.7	6.76	4.14	7.3	6.34	8.99	3235.23	
TETRA PAK (Laminated Paper)	5.4	5	2.1	4.7	4.58	2.04	3.46	5.14	4.05	1458.9	
ALUMINIUM	2.62	4.48	3.3	2.9	3.64	5.58	3.68	3.30	3.69	1327.5	
GLASS	194.2	127.94	61.56	131.22	113.8	56.78	92	147.00	115.56	41602.5	
NEWSPAPER	80	60	60	65	20	20	35	45.00	48.13	17325	
MIXED OFFICE PAPER	10.78	4.14	9.4	5.3	3.76	5.16	3.6	4.22	5.80	2086.2	
CARDBOARD	249.9	133.9	53.4	190.7	37.84	25.72	26.2	143.00	107.58	38729.7	
FOOD/WET WASTE	1559.16	291	493	900	121	117.6	112.6	231.00	478.17	172141.2	Compostable - 61.29%
TRASH (Laminated Plastic)	2.24	2.78	0.82	1.64	1.8	0.76	1.334	2.14	1.69	608.13	Inert - 0.22%
Total	**2118.02**	**643.45**	**715.78**	**1314.92**	**319.76**	**243.62**	**291.43**	**594.30**	**780.16**	**280857.42**	100%

APPENDIX D: Equivalencies result

Annual greenhouse gas emissions from **126** passenger vehicles.
CO_2 emissions from **67937** gallons of gasoline consumed.
CO_2 emissions from **1409** barrels of oil consumed.
CO_2 emissions from **8** tanker trucks' worth of gasoline.
CO_2 emissions from the electricity use of **83.4** homes for one year.
CO_2 emissions from the energy use of **30.3** homes for one year.
CO_2 emissions from **25250** propane cylinders used for home barbeques.
CO_2 emissions from burning **2.6** railcars' worth of coal.
Greenhouse gas emissions avoided by recycling **227** tons of waste instead of sending it to the landfill.
Annual CO_2 emissions of **0.0002** coal fired power plants.

Source: Generated using EPA Calculator (Greenhouse Gas Equivalencies Calculator)

APPENDIX E: Cost benefit analysis

Cost Benefit Analysis									
Extra labours cost (a)	**Extra bins cost (b)**	**Miscellaneous expenses (c)**	**Salvage value (d)**	**Expense in 1st Year**	**Expense in 2nd Year**	**Earning in 3rd Year**	**Earning in 4th Year**	**Earning in 5th Year**	**Saving from Biogas/ Compost**
8 Labour * Rs 7000/month * 12	50 Liter - 2 qty 80 Liter - 10 qty 120 Liter - 8 qty	waste storage/cleaning/transportation etc- Rs 7500/month* 12	Income from salvage Rs 68694 per month* 12	Currently hotel doesn't adopt any waste management practices like segregation	Hotel adopt waste segregation practices and sell scraps to vendor. Expenses on bin also reduced	In this year only half of the labours required because 50% labor cost is reduced due to experiential learning	Again in the 4th year only 50 percent labour are required because of experiential learning	Neither extra labour cost nor any miscellaneous expenses paid because segregation at source implemented	Option 1: Through biodigester - Hotel save around Rs 21,90,000. Option 2: Through multi pit - Hotel save around Rs 76,500 by selling @ cost of Rs. 30/Kg
a= Rs 6,72,000	b= Rs 42,954	c= Rs 90,000	d= Rs 8,24,333	**a+b+c= Rs 8,04,954**	**a+c-d= Rs (+ 62,333)**	**a/2+c-d= Rs (+ 3,98,333)**	**a/2+c-d= Rs (+ 3,98,333)**	**Rs (+ 8,24,333)**	**Rs (+ 21,90,000)/ Rs (+ 76,500)**

APPENDIX F: Framework for Management of Hotel Waste