



Domestic Solid Waste Recycling: Programs and Policies for Dubai

تدوير النفايات المحلية الصلبة: برامج وسياسات
لدبي

By

Padmini Acharya

Dissertation Submitted in partial fulfillment of
MSc Sustainable Design of the Built Environment

Faculty of Engineering & IT

Dissertation Supervisor
Professor Bassam Abu-Hijleh

March 2012

ABSTRACT

Recycling is an important part of conserving the natural environment, particularly in a city like Dubai with a limited land bank and natural resources. It would be prudent to prioritize recycling in all aspects as it has a lower impact than producing new products from raw materials. Developed nations have long committed to integrated waste management and many of the developing nations in Asia have started to formalize recycling with different approaches. This research proposes a recycling plan for Dubai and includes a survey on recycling habits of Dubai residents with the goal of determining the best way forward.

This research looks into the current situation in Dubai pertaining to domestic waste management and recycling. This paper also provides an understanding of recycling around the world and the various programs that are in effect listing their advantages and disadvantages. Best practices are discussed with information on related activities such as collection and key components of recycling programs by leaders in the field. A recycling program that ties into existing waste management was proposed for Dubai, which was presented to concerned authorities and stakeholders in the UAE. Feedback was then incorporated into the program and a revised recycling program for Dubai was devised. An e-survey was also conducted where Dubai residents answered a questionnaire about their recycling habits or the lack of it. Results support the proposed recycling plan for Dubai.

The findings show that environmentally beneficial action is very low in the UAE. While the reasons for this are many, the results of the survey find the lack of recycling opportunities as the main deterrent. The recycling program proposed for Dubai would need to be mandatory at least on some level and is designed to be implemented in stages. In the short term, the policies try to root recycling into the psyche of the residents as a part of UAE living. The long-term policies aim to elevate recycling to the point of revenue generation and to include extended producer responsibility. The survey findings show an overwhelming positive response to curbside / door-to-door recycling, and an acceptance of charged waste disposal in the event that the authorities implement such a scheme. Feedback from various stakeholders was considered and the final proposed policy revised accordingly to reflect a combination of methods that would best suit Dubai. The paper sheds light on the anticipated economic benefits of recycling which indicates that recycling of even the 3 major components of domestic waste can generate over USD 210 Million annually. The paper also describes the expected short term, medium term and the long-term outcomes of the said program and policy

الخلاصة

إعادة التدوير هو جزء مهم من الحفاظ على البيئة الطبيعية، وخاصة في مدينة مثل دبي التي لديها كمية محدودة من الأرض والموارد الطبيعية. سيكون من الحكمة إعطاء الأولوية لإعادة التدوير في جميع الجوانب. كما أن لديها أدنى تأثير من إنتاج منتجات جديدة من المواد الخام. وقد لجأت الدول المتقدمة إلى الإدارة المتكاملة للنفايات والعديد من الدول النامية في آسيا قد بدأت لإضفاء الطابع الرسمي لإعادة التدوير مع أساليب مختلفة. هذا البحث يقترح خطة لإعادة تدوير النفايات المحلية الصلبة في إمارة دبي بالإضافة إلى دراسة استقصائية عن إعادة تأهيل عادات السكان في دبي وذلك بهدف تحديد أفضل السبل للمضي قدماً.

هذا البحث يلقي الضوء على دبي فيما يتعلق بإدارة النفايات وإعادة التدوير. ويهدف هذا البحث أيضاً إلى تفهم عادات التدوير المتبعة في عدد من دول العالم ومختلف مزايا و عيوب البرامج المطبقة. وتناقش أفضل الممارسات مع معلومات عن الأنشطة ذات الصلة، مثل تعداد الخطوات الرئيسية لبرامج إعادة التدوير من قبل الرواد في الميدان. وهنا برنامج إعادة التدوير المقترح في إدارة النفايات الموجودة في دبي، الذي نقح بالتعاون مع السلطات المختصة والجهات المعنية في دولة الإمارات العربية المتحدة. وأجريت أيضاً دراسة عن طريق البريد حيث المقيمين في دبي للإجابة عن الاستبيان حول العادات إعادة تدويرها أو عدم وجوده. نتائج الاستبيان تثبت أهمية هذا البرنامج.

ان النتائج تظهر ان الوعي البيئي منخفض جدا في دولة الإمارات العربية المتحدة. في حين أن أسباب ذلك كثيرة، ونتائج الدراسة الاستقصائية أثبتت عدم وجود فرص إعادة التدوير كالرادع الرئيسي. والبرنامج المقترح لإعادة التدوير في دبي يأخذ بعين الاعتبار أهمية أن يكون إلزامي ويهدف إلى أن يتم إنفذه على مرحلتين. في المدى القصير، نهدف لعزيز عادة إعادة التدوير في نفسية السكان الحياتية اليومية في دولة الإمارات العربية المتحدة و في المدى طويل الأجل، تهدف إلى رفع مستوى إعادة التدوير إلى حد توليد مدخول رئيسي وتوسيع نطاق المسؤولية البيئية على المصنع. نتائج الدراسة تظهر تجاوبا إيجابيا كبيرا للناس مع فكرة خدمة جمع النفايات القابلة للتدوير من المنازل مباشرة من قبل فريق عمل، وقبول التخلص من النفايات المشحونة في حال أن السلطات قررت تنفيذ مثل هذا المخطط.

من ردود الفعل لأصحاب المصلحة والسياسة، قمت بتنقيح النسخة المقترحة النهائية وفقا لذلك.

كما يوضح البحث الفوائد الاقتصادية المتوقعة في حال تطبيق برنامج إعادة التدوير و ذلك على المدى القصير و المتوسط والطويل.

Acknowledgements

I would like to acknowledge and thank all those who have contributed in preparing and reviewing this Dissertation. I would like to express my thanks to my husband and my daughter who have been ever supportive and have constantly encouraged me in achieving this goal.

In particular, I would like to thank Professor Bassam Abu-Hijleh (Dean and Atkins Chair Head of the Sustainable Design of the Built Environment Program, Faculty of Engineering and IT, The British University in Dubai, BUiD) for his inherent patience, excellent direction and continuous support provided to me in completing this Dissertation. I am also grateful to the British University in Dubai, for providing an opportunity to myself and other students to reach our potential.

I would like to express my gratitude to Mr. Abdul Majid Abdul Aziz , Director of Waste Management at the Dubai Municipality, Mr. Ivano Ivannelli, CEO of the DCCE, Ms. Ines Monaster , Envirocare Manager at Tadweer and Engineer Odaiba Syeed of the MOEW for their time and feedback that contributed greatly to this paper. Furthermore, I would like to thank all the people that have made the time to answer the survey that is part of this dissertation. It is through the support and guidance of all of the people mentioned herewith, that I have reached my goal of having completed this Masters program.

Table of Contents

Abstract	2
Abstract in Arabic.....	3
Acknowledgements	4
Chapter 1. Introduction	12
1.1.Introduction.....	13
1.2.Historical Background.....	13
1.3 Need for Change.....	14
1.4 Benefits of Material Recovery.....	16
1.5 Research Aims and Objectives.....	17
1.6 Dissertation Breakdown.....	18
Chapter 2: Literature Review	20
2.1 Recycling figures from the US, Europe and Asia	21
2.1.1 Recycling in the Unites States:	21
2.1.2 Recycling in Asia:	23
2.1.3 Recycling in Europe:	24
2.1.4 Impacts of MSW Landfilling and Incineration:	28
2.2 Role of incentives and other methods in promoting Recycling.....	32
2.4 Study of key Recycling Programs and Contributors.....	34
2.3 Recycling in Multi-Family Dwellings	38
2.5 Recycling in Dubai	38
Chapter	
3.Methodology	43
3.1 Applied Research Methods	44
3.1.1 Literature Review Method	44
3.1.2 Survey Research Method	46
3.1.3 Interview/Feedback Research Method	47
3.2 Selection and justification of research methodology for this Dissertation	49
Chapter 4. Recycling Types, Recycling Program Components and Recycling Stakeholders in Dubai	51
4.1 Single Stream Recycling	52
4.2 Dual Stream Recycling	54
4.2 Recycling Program Components	55
4.3 Recycling Stakeholders in Dubai	59
4.3.1 Dubai Municipality.....	59

4.3.2 Tadweer	60
4.3.3 Ministry of Environment and Water	60
4.3.4 Telecommunications Regulation Authority.....	60
4.3.5 Emirates Environmental Group.....	61
Chapter 5. Recycling Programs and Practices.....	62
5.1 Waste Management Programs	63
5.2 Incentivized Recycling Programs	66
5.2.1 Curbside/Kerbside Recycling	66
5.2.2 Pay-as-you-Throw (PAYT).....	68
5.2.3 Recyclebank	70
5.2.4 German Green Dot Program.....	72
5.2.5 Container Deposit-Refund Legislations/Schemes.....	74
5.2.6 “Bring” Schemes	76
5.2.7 Cash for Trash	78
5.2.8 Financial Tax Credits for Recycling.....	80
5.2.9 Mandatory Recycling.....	81
5.2.10 Zero-Packaging Retail.....	82
5.4 Recycling in Multi-Family Dwellings.....	86
5.4.1 Space and Distance	88
5.4.2 Residents’ Characteristics.....	89
5.4.3 Education and Outreach	89
5.4.4 Incentives	90
5.4.5 Mandatory Recycling	91
5.4.6 Waste Streams and Disposal Systems.....	92
5.4.7 Population Transience	92
5.4.8 Fee systems.....	94
5.4.9 Recycling Inhibitors	94
5.5 Collection Methods and Efficiencies.....	94
5.5.1 Door-to-door collections	95
5.5.2 Collection points on each floor.....	95
5.5.3 Central Collection.....	96
5.5.4 Chute systems.....	97
5.5.5 Near-entrance collection facilities.....	98
Chapter 6. Survey on Recycling attitudes and habits in Dubai	104
6.1 Survey Design.....	105
6.2: Sample Selection and Timeframe.....	107
6.3: Survey Results and Analysis.....	107
Chapter 7. Proposed Recycling Program for Dubai and Revised Program based on Stakeholders Feedback.....	112
7.1 Highlighting Waste Management in the UAE	113
7.2 Draft Policy	115

7.2.1 Program Policies.....	116
7.2.2 Proposed Recycling program for Dubai	117
7.2.3 Five Years into the Recycling Program in Dubai	120
7.2.4 Amended Recycling Program for Dubai(Medium Term 5 - 10 years)	121
7.3 Meeting with Stakeholders.....	122
7.3.1: Meeting with TADWEER.....	123
7.3.2: Meeting with Dubai Municipality.....	125
7.3.3: Meeting with Ministry of Environment and Water	128
7.3.4: Meeting with Emirates Environmental Group.....	133
7.3.5: Meeting with DCCE.....	133
7.4: Expected Acheivements in the Long Term: Past the 10th Year.....	136
7.5: Revised Recycling program for Dubai based on Stakeholders feedback and recycling Survey.....	137
7.5.1: Highlighted issues in the proposed recycling program.....	137
7.6 An Economic Perspective to Recycling.....	140
Chapter 8.Conclusion and Recommendations.....	144
8.1 Conclusion.....	145
8.2 Recommendations.....	147
References	148

Recycling Survey Results (Survey Gizmo)

List of Tables

Table 2.1: Waste composition of low, middle, and high-income countries, 1995.

Table 2.2: Over all issues in Asian cities pertaining to MSW management.

Table 2.3: Impact of Recycling.

Table 2.4: Number of observations and percentage recycling for various combinations, by recycled material.

Table 2.5: Projected Changes in packaging consumption in Germany further to the introduction of the Green Dot program.

Table 2.6: Quantity of solid wastes as per its source in Arab countries.

Table 2.7: Collection rates of various items in the UAE through recycling.

Table 3.1: Comparison of reviewed methodological approaches.

Table 5.1: Multi-family waste and recycling collection costs vs Diversion rates achieved.

Table 5.2: MFD Recycling information from key recyclers around the world. France, Italy, US, UK, Singapore, France & Germany.

Table 5.3: Summary of the differences between MFD recycling and SFD recycling.

Table 5.4: Recommended features for a MFD recycling program.

Table 7.1: Municipal solid waste generation in the GCC countries.

Table 7.2: Short term policies of the proposed recycling program.

Table 7.3 Quick view of key features of the proposed recycling program for Dubai.

Table 7.4: Medium Term Policies of Recycling Program.

Table 7.5: Feedback from Tadweer.

Table 7.6: Feedback from DM.

Table 7.7: Feedback from MOEW.

Table 7.8: Feedback from EEG.

Table 7.9: Feedback from DCCE.

Table 7.10: Key Factors of the revised recycling program for Dubai based on stakeholder feedback.

Table 7.11: Rates for recovered resources in Dubai as of November 2011.

Table 7.12: Total value in AED of metals, plastics and paper in the waste stream in the year 2009 in Dubai.

List of Figures

Figure 2.1: MSW Recycling rate in the US between 1960 and 2009.

Figure 2.2: PerCapita Solid waste generation in Asian Countries.

Figure 2.3: Relationship between expenditure on MSW management and GDP in Asian countries.

Figure 2.4: Recycling figures for the European Union, 2008.

Figure 2.5: Municipal wastes generated and disposal methods employed, 2003.

Figure 2.6: Waste Management in Europe, 2004.

Figure 2.7: A typical landfill site.

Figure 2.8: Estimated share of GHG Emissions from 3 types of disposal methods between 1990 – 2008.

Figure 2.9: Statistics on Waste to landfill in Australia, 2007.

Figure 2.10: The annual CH₄ emission in Malaysia estimated using the IPCC 2006 FOD Model.

Figure 2.11: Results of a survey carried out by CRAI among a panel of 280 consumers on the Eco point system.

Figure 2.12: Synovate's Global Trends survey, 2011 on Recycling habits of residents.

Figure 4.1: Growth in Single stream Recycling in the US between 2007 – 2010

Figure 4.2: Residual rates of Single, Dual and source stream Recycling in the US between 2000 and 2005

Figure 5.1: Comparison of recycling rates between the United States and the European Union, 2005.

Figure 5.2: Recycling improvements in incentivized programs conducted in Brighton (UK) by a 2006 DEFRA pilot study.

Figure 5.3: Curbside Collection Containers (organics + paper) at the City of Lewiston, USA

Figure: 5.4: Typical PAYT disposal bags, cans and stickers/ Prepaid Tags.

Figure 5.5: A typical Recyclebank coupon received in exchange for points accumulated by recycling

Figure 5.6: The German Green Dot logo, indicating membership within the program found on packaging of member companies.

Figure 5.7: Statutory requirements and recovery rates achieved by the German Green Dot program in 2011.

Figure 5.8: Recycling drop off centre or “Bring” centre containers marked for recycle deposits.

Figure 5.9: The Terracycle Centre indicating drop off niche’s.

Figure 5.10: Zero Packaging Grocery store in Austin , Texas , USA

Figure 6.1: Screen Shot of Survey Questionnaire forming part of this paper.

Figure: 6.2: Recycling Questionnaire used in this dissertation.

Figure 6.3: Percentage of respondents that are aware of household recycling in Dubai.

Figure 6.4: indicates the top two reasons for not recycling in Dubai.

Figure 6.5: indicates the response rate for door-to-door collection of recyclables in Dubai, should it be available.

Figure 6.6: illustrates the percentages of items recycled in Dubai.

Figure 6.7: Respondents of the survey that displayed an interest in making recycling mandatory in Dubai.

Figure 6.8: indicates the percentage of respondents willing to pay for waste disposal in Dubai.

Chapter 1. Introduction

1.1.Introduction

Recycling is the processing of used unwanted materials (waste) into new products to prevent the unnecessary use of and therefore waste of new materials. The primary objective of the recycling process, is to salvage from an object the intrinsic material that it is made from so that, we may use this material in a new cycle of production. Recycling also reduces consumption of fresh raw materials, reduces energy usage, reduces air pollution (from incineration) and water pollution (from land filling) by reducing the need for "conventional" waste disposal, and lowering greenhouse gas emissions as compared to virgin production. Recyclable materials include glass, paper, metal, plastic, textiles, electronics, rubber, fabric, corrugated cardboard and in a newer sense wood, stone and any undamaged products which could be reused. CalRecycle, part of the California state government, defines recycling as "the practice of recovering used materials from the waste stream and then incorporating those same materials into the manufacturing process." The value of recycling can be appreciated when we take into perspective the fact that in 1960, the per capita generation of waste in the United States alone was 2.68 pounds per person per day, with total waste generated being 88.1 million tons, but by 2009, the per capita generation of waste had jumped to 4.34 pounds per person per day with waste generation reaching 243.0 million tons (Environmental Protection Agency). Furthermore 12.3 % of waste generated which amounts to 30 million tones of Municipal Solid Waste (MSW) is plastic in the US (EPA) and every molecule of plastic that has ever been created is still in existence. This is because according to The Container Recycling Institute of America, plastic bottles take approximately 700 years to breakdown into their toxic elements.

Recycling however is not a new concept. The practice of recycling has been around for thousands of years, Plato is believed to have practiced recycling as early as 400BC (Djpu.org). The logic behind recycling is that while an object may be considered garbage in one particular setting, the same object can be a useful, functional item in another setting, also known as repurposing of an object.

The following sections discuss the origins of recycling, the need for recycling, and the importance of material recovery in general.

1.2.Historical Background

“Recycling itself is probably as old as history and indeed, seems to be a fundamental characteristic of the human species. The archaeological record is crowded with artifacts that display the results of recycling behavior”(Rathje & Murphy, 2001). Rathje and Murphy note in their book *Rubbish!* that the pre-Columbian Mayan Civilizations (c. 2000 BC to 250 AD)suffered through periodic methane explosions at their open waste pits ,and as certain items became scarce, they learned to recycle as seen in various bits of ornamentation and building materials found at their archeological sites. It is believed that the broken pieces of the Colossus of Rhodes, (c.280 BC) a statue deemed one of the seven wonders of the ancient world, was also recycled for scrap (The Economist, 2007). Historically, the motivation for recycling was clearly that materials were expensive and labor was cheap (a case tht is still applicable in the developing nations), thus it became an obvious choice. Prior to the industrial age (1800’s), there is evidence to support the belief that scraps of bronze and other metals were collected throughout Europe to be melted down for reuse. Historians often describe the pre - industrial era in England as the “golden age of recycling” when clothing, metals, building materials, glass and other such materials were seriously being recovered to make other materials. To such an extent that, paper during these times was made entirely from recycled materials such as old rags (Ackerman, 1997). The Guide to Mining and Energy in the US suggests that the father of recycling is actually Benjamin Law who in 1813 developed a process of turning rags into what was then called 'shoddy' and 'mungo' wool in Batley, Yorkshire. This material was a combination of recycled fibers and virgin wool. The West Yorkshire shoddy industries are believed to have lasted from the early 19th century to at least 1914 (djpu.com).

Today's style of excessive packaging of consumer goods was unknown until the early twentieth century. Paper was an expensive product, made from cloth rags, and was used wisely. In the 19th century, the collection of ash from coal fires in cities throughout the UK was commonplace; this material was being used in the production of bricks (Kantaris, 2011). A noted publication, *The Economist* stated in 2007 that America's Institute of Scrap Recycling Industries (ISRI), a trade association with more than 1,400 member companies traces its roots back to a collective recycling organization founded in 1913. Wastewatch, a leading charitable environmental group in the United Kingdom chronicles the origins of waste stating that during The Great Depression after (World War 1) in the 1930s many people survived by recycling scraps of metal, rags and other items more out of necessity and economics. During World War 2 (1939 to 1945) almost every country involved in the war carried out extensive government promotion campaigns urging citizens to donate metals and conserve fiber, as a matter of patriotic importance. In 1939, Britain is believed to have launched the program 'Paper Salvage' to encourage the recycling of materials to aid the war effort. It was in the 1970's that the next significant recycle efforts were seen essentially due to rising cost of energy. *The Economist* reports that around 1970 the environmental movement in the US gave birth to America's first curbside collection schemes, which took some time to see success but eventually saw the cost of recycling drop from \$50 per ton to \$30 per ton, though this price remains a fluctuating number (*The Economist*, 2007). In 1991, as a step further in imbuing recycling into everyday life, Germany passed a historical ordinance shifting responsibility for the entire life cycle of packaging to producers. This turned out to be a rather expensive decision at first yet; it has been highly influential in making many other European countries adopt their own recycling initiatives with varying degrees of producer responsibility.

As we progress into current times, the EPA reports that in 1999 alone, recycling and composting activities prevented about 64 million tons of material from ending up in landfills and incinerators. This figure has almost doubled during the past 15 years with the latest figures by the EPA reporting that 33.8 percent of waste is now recovered and recycled or composted, 11.9 percent is burned at combustion facilities, and the remaining 54.3 percent is disposed of in landfills.

A study of facts and figures from around the world indicates that recycling is in fact a matter of great debate. One could assume that Europe's success in this regard could possibly be due to its enforced polluter pays principle. Yet a common issue that surfaces as one of the biggest barriers to recycling is that most products are not designed with recycling in mind. Obviously, the recycling industry is still in its infancy and there is plenty of opportunity for innovation and advancement. In 2007, the European Parliament voted to increase recycling rates by 2020 to 50% of municipal waste and 70% of industrial waste. Whether realistic or not a number of cities and firms in the US (including Wal-Mart, Toyota and Nike) are hoping to get to zero-waste targets. Dubai has also committed to Zero Waste by 2030. What is noteworthy is that from being a complete non-issue, recycling has now featured enough in the consciousness of this emirate that governmental goals are being set to achieve various levels of recycling in Dubai. A good start would be to try to recycle more and recycle better because it is only by recycling that a material can be embodied in service yielding commodities once again (Smith, 1972).

1.3. Need for Change

Municipal solid waste management has become a major issue of concern for several developing nations especially since it is coupled with population growth. There are various classifications for waste, however for the purpose of this dissertation, waste is any unwanted material intentionally thrown away for disposal, and is part of MSW.

Although residential waste accounts for an increasingly small fraction of the waste stream, this section addresses the issue of waste as a whole in order to provide an understanding of why change is deemed necessary. Industrialized countries house only 16 percent of the world's population yet they utilize about 75 percent of the world's paper supply (Hoornweg et al. 1999). Waste generation rates are directly linked to socioeconomic development, degree of industrialization, and climate of a region. Economically prosperous nations with higher urban population produce a larger amount of solid waste. In developing nations however this problem is compounded, as nearly 30% to 50% of the populations are urban (Zerbock, 2003 quoting Thomas-Hope, 1998). With urbanization and expansion of cities, spaces for waste disposal are also becoming harder to find and as municipal traffic increases; the transport of waste becomes longer, more time-consuming, less efficient and more expensive. A growing population means a greater strain on natural resources, thus recycling is vitally important to society and industry to meet the goals of cost reduction, necessary management of limited resources, and to minimize negative impacts on the environment. About 29 million tons of municipal waste, 87% of which was household waste, was produced in England between 2003 and 2004 most of which ended up in landfills, with only about 19% being recycled according to the Parliamentary Office of Science and Technology (POST, 2005).

The need for change, i.e. the need to recycle can be understood in simple terms - that recycling has a lower impact on the environment than producing new products from freshly extracted raw materials. Though the impacts of recycling or manufacture can differ according to the details of the systems under consideration, it still remains second only to source reduction. Recycling is particularly beneficial for common household waste streams such as paper, glass and metal as recycling incurs lower environmental costs than production from virgin materials. K.J.Martchek in his paper for the Fourth International Symposium - Recycling of Metals and Engineered Materials states that recycling has the potential to reduce material's production energy consumption by 95% for aluminum, 80% for magnesium and lead, 75% for zinc, and 70% for copper. In addition "metals are eminently and repeatedly recyclable, while maintaining all their properties " (European Association of Metals, "Eurometaux Position Paper on Recycling", September 1999). As metals do not readily degrade in our natural environment, recycling is particularly significant in the treatment and inturn reuse of metals. The Urban Development Sector Unit East Asia and Pacific Region reported that urban areas of Asia in 1999 spent about US\$25 billion on solid waste management per year and this figure is expected to rise to US\$50 billion by 2025. Japan reportedly spends about ten times more for waste disposal than its collection costs. So, consider a projection for the planet as a whole and one can see why strategies to minimize waste generation and ensure safe management are crucial to achieve sustainable patterns of production, consumption and existence. Waste reduction can be accomplished right at the source through source separation, subsequent material recovery and recycling which will result in us being able to reduce the amount of remedial measures at a later stage. The EPA reports that recycling just 1 ton of aluminum cans conserves more than 207 million Btu, the equivalent of 36 barrels of oil, or 1,665 gallons of gasoline.

Recycling also reduces the amount of waste that would need to be landfilled or incinerated, landing it higher in the recycling hierarchy. Solid wastes being directed to landfills is probably the oldest and definitely the most prevalent form of ultimate garbage disposal the world over. Though we cannot completely eliminate the use of landfills, greater recycling will reduce our dependency on them. The issues at hand here are the dangers of landfills and waste incineration.

A more integrated solution to solid waste disposal could herald change with the three R's of Reduce, Reuse and Recycle being the first step necessary to adequately address MSW in the future. The focus should be to implement solutions that are environmentally and economically sustainable. There should be appropriate weight given to the needs of all stakeholders particularly in developing countries so as to not

hinder development but attain holistic environmentally positive development. Decisions should consider the ability of developed nations, governments, affected landowners, the rural and the urban poor. On the flip side, this can be seen as an opportunity for nations to invest in recycling and use it as an economic driver.

Experts agree that recycling is possibly the best tool for risk management, as it reduces and potentially eliminates any risk that may be generated by the conventional disposal of products at the end of their life. There is no doubt that waste collection, treatment, and disposal costs place a large burden on all government finances, however improper disposal or wasteful expenditures on conventional methods will end up far more expensive in the long run, with costs accruing over many years.

1.4. Benefits of Material Recovery

The recovery or “taking back” of materials from waste streams for re-use in different applications by separating and preparing recyclable materials for marketing to end-user or manufacturers is called material recovery. Commonly recycled or recovered items are plastics, nearly all kinds paper, glass, metal, wood, white goods, clothing, batteries, electronic wastes, light bulbs and tires. Products commonly made from recycled materials include notebook paper, molded paper flowerpots, surfboards, corrugated cardboard and stained glass and waterproof fabrics, decorative items and furniture. The term material recovery is also sometimes referred to as resource recovery, in this section the terms are used interchangeably with recycling, but by definition resource recovery emphasizes separating and processing waste products to reclaim usable material and recycling emphasizes the waste minimization strategy, in which reusable materials are recovered from a waste stream for reuse. The facilities that conduct this operation are called materials recovery facilities (MRF's), materials reclamation facilities or materials recycling facilities. Modern MRF's are believed to have begun in the US in the 1970's.

In an ideal situation, waste management should be viewed as a combination of sanitation and material recovery. The process of waste disposal must include the recovery of valuable used materials thus reducing the need for new materials being extracted from the environment contributing to sustainable living. When the ideal situation cannot be implemented, an imbalance occurs resulting in an "ecological footprint" the size of which ends up many times larger than the city itself. According to the US EPA a disturbing 70% of waste generated in America ends up in landfills even though they are recyclable as is likely to be in several other parts of the world. If developed nations reflect such a disturbing statistic, the projections for developing nations would undoubtedly be frightening.

Modern day recycling for material recovery started as a response to mitigate adverse environmental affects as part of the upsurge in environmental consciousness and advocacy that began in the 1970s in the west. Recycling does not have to mean down cycling, Architect McDonough and chemist Braungart, in their book *Cradle to Cradle*, suggest that all materials used in the manufacturing process should ultimately either biodegrade harmlessly or be reusable without loss of quality, albeit completely repurposed. Material recovery and recycling can be used for nearly all types of productions. For example, old newspapers can be turned into insulation, cat litter, egg cartons, packing material, or even fresh new newspaper. Used metal cans can be turned into new cans, car parts, appliances and used in construction. Cardboard boxes can be used as roofing shingles. Various types of plastic recyclables can be reused for the creation of other plastic products, toys, buckets and furniture, fleece, carpet and waterproof materials for jackets, carpet underlay and backpacks. “In US recycling programs, more than half of the material collected is paper, whether measured by weight or by market value.” Says Frank Ackerman in his paper *Material Flows for a Sustainable City* (International Review for Environmental Strategies, 2005). In the same paper Ackerman states that producing fresh paper from wood takes more total energy than recycling of used paper, though

the energy used in virgin paper production comes from the parts of trees that are not useful for pulp or by products, in general paper recycling uses as much or more purchased energy, with a high demand on fossil fuels. While determining the value of material recovery and reuse Ackerman states that when a complete picture is read and carbon sequestration in forests due to recycling is included in the analysis, recycling comes out the clear winner.

By 2050, the global population is expected to hit 9.2 billion, up from today's 7 billion (Giller & Roberts, 2006) and one can only imagine the alarming quantities of waste generated by this population. Recovery or recycling reduces the amount of recyclable wastes from entering the waste streams. Although the materials most worth recovering are among the least likely to pose health or sanitary hazards, they still form the volume of waste that end up in our waste stream which can be put to better use. Recovery reduces the amount of waste that ends up in landfills and incinerators, which in turn reduces methane/GHG emissions from landfills and decomposition and groundwater pollution. The EPA in their November 2007 findings provide that material recovery also reduces emissions due to reduced energy consumption as manufacturing of goods from recycled materials typically requires less energy than production from virgin materials. Just as prevention is better than cure, waste prevention is even more energy efficient and environmentally friendly. Waste prevention and recycling of paper products prevents trees from being harvested thus allowing for carbon sequestering where in they can continue to remove carbon dioxide from the atmosphere.

Recycling a single soda can uses 96 percent less energy and 20 percent less water than making a new aluminum can from bauxite ore (Cummings, 2007). The Environmental Protection Agency states that the 83 million tons of waste recycled in 2008 reducing the total Carbon dioxide emissions by 182 million metric tons, which was "comparable to removing the emissions from 33 million passenger cars." (Wood, 2010). Recycling and composting saved the equivalent of 10.2 billion gallons of gasoline in 2008, according to the EPA. In addition to a positive contribution to the environment, recycling also benefits us in other ways; the EPA estimates that over 1 million jobs are created by the recycling industry alone and that recycling contributes \$236 billion to the U.S. economy. There are various other costs such as economic, human health, environmental and aesthetic costs associated with our culture of excessive waste generation and disposal that we must also take into consideration while calculating the benefits of recycling. The acquisition of detailed cost data containing all aspects of waste generation and disposal is far too complicated and no such comprehensive data was available for this research, yet it is safe to say that the costs are very high and rising

1.5. Research Aims and Objectives

The Middle East is estimated to produce 200 million tones of waste per year, as a result of which waste management is a key topic for development in the region (Clean Middle East, 4, 3). As one of the most dynamic market places in the Middle East, Dubai should have ideally become the master initiator of recycling activities for the region. One of the main challenges here is that there is no legislation concerning recycling, and no infrastructure for recycling, thus people do not feel obligated to do so. Most resident communities in the UAE do not have the household recycling collection system found in other countries. With regard to solid municipal waste, the gross generated quantity from Arab countries is estimated to be approximately 81.3 million tons annually based on an average rate of 0.7 kg per capita daily (AFED, 2008). It is believed that in the Arab region, less than 20% of the waste generated is properly treated or disposed of in landfills, and no more than 5% is recycled (AFED, 2008).

The fundamental aim of this dissertation is to devise a solid waste recycling program that can be implemented in Dubai based on similar programs and their successes from elsewhere. Other objectives of

this research are to obtain primary data on the recycling habits of the residents in Dubai and feedback from recycling authorities on the proposed recycling program. Finally the research aims to provide a brief indication of the economic potential of recycling for Dubai.

The proposed recycling program will be based on the study of recycling and its several components. The design of the recycling program will culminate from a study of recycling facts and figures from around the world, methods of recycling, collection technologies, material recovery, and successes and failures of similar programs elsewhere. This dissertation will also feature the study of recycling in multifamily dwellings (MFD's) and single family dwelling (SFD's) which will shed light on the benefits and pitfalls faced by other countries that have generated statistics on their experiences in the matter. A majority of the dwellings in Dubai are hi – rise MFD's which have been designed without integrated recycling facilities, in order for the proposed recycling program to be workable in this situation, the program must be capable of being retrofitted to the existing building stocks. The study of a wide variety of literature is aimed at obtaining a clear perspective on the important aspects related to the core idea of introducing recycling in Dubai. The objectives of the literature review are:

- 1.To obtain an understanding of recycling practices and statistics in the US, Europe and Asia.
- 2.To study important components of recycling and the main types of recycling.
- 3.To study the factors that have contributed to lethargic recycling in the UAE till date.
- 4.To analyze the main recycling programs in the world with an understanding of their pros and cons.
5. To understand recycling in Multi Family Dwellings and Single Family Dwellings.

In its aim to provide primary data on recycling, this research reaches the residents of Dubai directly on their attitudes towards recycling by conducting a survey. It has been observed that while interest in recycling programs is high among individuals and businesses, commitment to actually recycling is slower in becoming a mainstream activity. It has been difficult to obtain cohesive information quantifying the exact level of commitment to recycling in the region. The objectives of the survey are:

- 1.To obtain primary data on the level of commitment to recycling in Dubai among residents.
- 2.To ascertain if the recycling program if introduced will be accepted by the residents.
- 3.To determine the reason for the low levels of recycling in Dubai.

While aiming to propose a recycling program for Dubai, this research will study the existing conditions surrounding recycling in Dubai. UAE is a good position to catch up with the west on waste reduction and management activities by learning from their successes and failures. The challenge is to generate awareness of recycling amongst the transient UAE communities and to obtain commitment from residents. Another important aspect still neglected in the Arab world is the collection of accurate data, which is lacking, and mostly based on estimates. This research will identify the key stakeholders involved in MSW management in Dubai, and obtain their feedback on the proposed recycling program. The objective of this exercise will be:

- 1.To discuss the proposed plan with the stakeholders and obtain the benefit of their expertise on the relevance and suitability of the program.
- 2.To assess the potential impact of such a plan on Dubai and identify through their experience any shortcomings in the proposed program.
- 3.To revise the program based on the stakeholders feedback to be effective and aid any future research in the area.

1.6.Dissertation Breakdown

This dissertation is designed to have six main stages written in a total of seven chapters aiming to achieve its primary goal of devising a suitable solid waste recycling program for Dubai. The six stages of the

dissertation include Literature Review, Methodology, Survey, proposal write - up, Interviews/Feedback from the stakeholders and conclusions.

Literature Review: The literature review is the basis of the entire dissertation as it informs all observations and subsequent selections of methods, practices and proposals. The literature review selects a wide range of Academic journals, publications, websites, library journals and online articles to provide information on all important aspects of recycling that form this dissertation. Literature was selected based on their relevance to the topic and the quality of information presented so that they could strengthen the ultimate aim of this dissertation. This stage presents a comparison of recycling and its components from around the world, indicating the latest available figures, facts, studies, successes and failures by pioneers in the field and the status of recycling in Dubai that ultimately forms the infrastructure of the proposed recycling program. Chapter four, five and six also provide the results of a detailed literature review in their description of recycling types, methods and programs. This information is extremely important as it provides the basis for the design of the recycling program proposed and the design of survey conducted as part of this dissertation.

Methodology: This stage describes the various methods used in this dissertation to arrive at the stated conclusions which include a detailed literature review, analysis of information and data obtained, design and conduction of the survey, writing up of the recycling proposal, presentation of Interviews conducted with MSW stakeholders in Dubai and arrival at the conclusions.

Survey: After obtaining a thorough understanding of the components that form the entire lifecycle of recycling and the contributors for the slow growth of recycling in Dubai, a survey is designed and sent out via the Internet to be sent out to a sampling of residents to obtain primary feedback on current attitudes towards recycling amongst residents. Results of the survey are described in chapter six.

Proposal Write – Up: Based on the information studied so far and the results of the survey a recycling program and recycling policies are proposed for Dubai which include short and medium term policies. A general view of longterm policies will also be discussed. This program is proposed includes two variations, one for MFD's and an alternate version for SFD's taking into account all of the advantages and limitations of the region.

Feedback from stakeholders: Interviews with MSW stakeholders in Dubai forms the fifth stage of this dissertation, where the proposed recycling program and policies for Dubai are presented to experts in the field for their feedback. This is an important part of the dissertation as it determines the relevance and strength of the proposed recycling program. The proposed program will then be revised to reflect the comments and improvements suggested by the stakeholders.

Conclusions: This is the last and final stage of the dissertation that summarizes the results of the study and contains the final deductions made from the research. In essence this chapter reviews the entire research providing a conclusion on the work done. This final chapter also points out any limitations of this research indicating possible avenues for additional investigations to address the issues in the future.

Chapter 2. Literature Review

The purpose of this literature review is to summarize and review some of the key findings from published literature pertaining to recycling. The literature review also studies household recycling around the world and incentivized recycling programs thus placing the results in context justifying the selection of a recycling plan for Dubai. The selected papers study recycling motivators and inhibitors as seen in the experiences of the pioneers of recycling in the developed world for a more in-depth understanding.

2.1. Recycling figures from the US, Europe and Asia

2.1.1. Recycling in the United States: The United States has long embodied the “throwaway” society producing about 2Kg/ person/day of municipal solid waste each day (US EPA), perhaps this has led to the United States also having seen success in recycling/reusing municipal solid waste since the early 80’s, necessity being the mother of invention. Much will be said in this dissertation about recycling in the US with data by the US EPA as such information is collated and readily available. As a result this section on data from the US is kept to a minimum to avoid repetition. According to the EPA, the US’s recycling (and composting) rate of 32.5% has enabled them to diverted away from disposal 81.8 million tons in 2006 alone, up from 14.5 million tons in 1980, when recycling rate was 9.6% (EPA, 2006) Figure 2.1 indicates the US recycle rates from 1960 to 2009. The US has nearly 8817 municipal curbside recycling programs serving 51% of the United States population, 10,500 drop-off programs, and approximately 3260 yard waste composting programs that led to 82 million tons of materials being recycled in the year 2006 (US EPA).

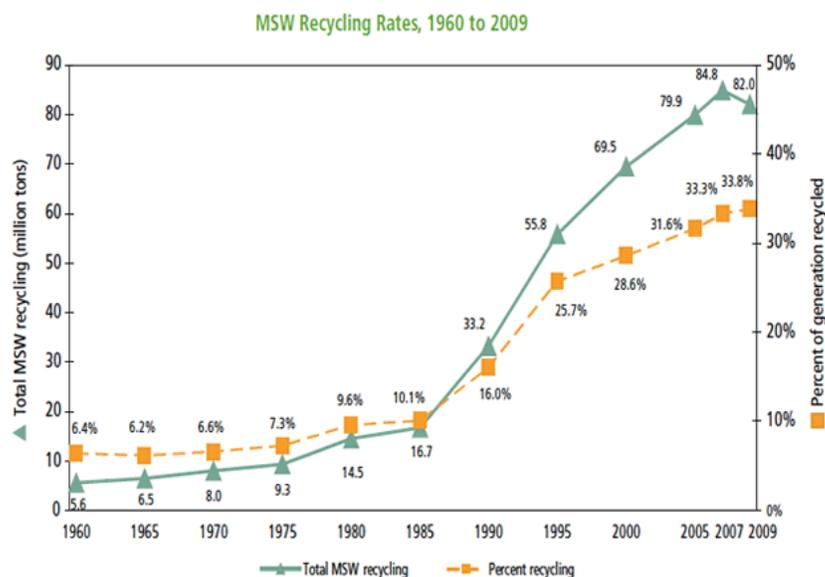


Figure 2.1: MSW Recycling rate in the US between 1960 and 2009 (US EPA) (<http://www.epa.gov/osw/nonhaz/municipal/>)

Lave et al.(1999) have suggested that curbside recycling , a form of recycling that serves a majority of the US population and instrumental in achieving their superior recycling rate is too expensive for most communities, they say that curbside recycling is only justifiable for some postconsumer waste, such as aluminum and other metals which have a value in the recyclables market. Lave et al. (1999) argue that alternatives to curbside recycling collection should be explored, such as product take back particularly for products with a toxic content (such as batteries) or products should be redesigned to permit more effective

recycling. This paper implies that the US must follow in the footsteps of Europe where the polluter pays principle is in place. Ackerman, 2005 details the origins of waste generation and waste management from periods before industrialization, to its culminations to current day integrated waste management through the study of papers by several other authors. Ackerman suggests that as people found items to be more affordable they also headed towards generation of larger amounts of waste. Table 2.1 shows the increase in packaging wastes in higher income categories supporting the author's theory.

Table 2.1 Waste composition of low, middle, and high-income countries, 1995 (Ackerman, 2005)

Percentage of Waste stream Consisting of:	Country Income Level		
	Low Income	Middle Income	High Income
Organics (eg. Food waste) + Other (eg. Ash)	88	69	40
Paper & Paperboard	5	15	36
Metals, Glass & Plastic	7	16	24
TOTAL	100	100	100

Ackerman (2005) also describes the importance of the composition of waste, because the amount of paper being discarded in the waste stream determines the size of a community's recycle program. In high-income countries, the most important material in the waste stream is paper. In the US recycling programs, paper forms more than half the waste stream, whether measured by weight or by market value. The decision on how waste is to be recycled, further to content analysis depends on a variety of characters such as the cost of the separating process, cost of virgin materials, supply /availability of virgin material and whether or not the materials are non-renewable (Neal & Mealy, 1972). Bohm et al. (2010) have obtained municipal level cost data with the aim of estimating the costs of waste collection and the costs of recycling. Bohm et al. (2010) are of the opinion that both waste and recycling services are expensive and require financing from local taxpayers and/or state governments to operate. Economic variables in this study impacting the data include market prices for labor, capital, fuel, and (disposal) fees. Results of their study suggest that waste collection and disposal costs exceed the costs of recycling, possibly due to the added cost of resources required to separate and process the recyclables. Bohm et al. (2010) are also of the opinion that municipal recycling programs contracting haulers from the private sector rather than public employees are more economically viable and recycling systems that feature centralized separation rather than curbside separation show lower costs.

A study of US recycling industry clearly demonstrates that the nation's recycling and reuse industry is extremely diverse in all aspects, i.e. types of materials recovered, average establishment size, technologies employed and programs offered. It appears that the recycling and reuse industry is just as large if not larger than the waste management industry. The US has a large land bank and landfill space is easily available, yet recycling and reuse is promoted as the preferred option. This is an indication of the value of recycling and reuse as a superior waste management strategy. In spite of a number of papers suggesting that recycling is in fact too expensive to justify, recycling in the US is a growing industry. This could possibly be due to the fact that recycling and reuse are inherently value-adding, whereas disposal is not, and value-addition processes create jobs, aiding the economy. But if recycling and reuse are value adding and create jobs, it does not exactly inspire the US to "reduce", which is the highest ranker in the waste hierarchy. The US has achieved an inspiring rate in recycling and reuse by adding an economic incentive

to it. It appears that sobering realities are now propelling the zero-waste philosophy that once started as a dreamy ideal.

2.1.2. Recycling in Asia: The case differs in low-income nations such as some African countries and developing countries in Asia. Ray (2008) describes the inadequacies of waste management in Asia, pointing out the fact that Asian countries can afford investments into waste management but continue to prioritize achieving high economic growth and pay little attention to waste management. In the very poor countries of Africa solid waste generation rates average at a low 0.4 to 0.6 kg/person/day, as opposed to 0.7 to 1.8 kg/person/day in fully industrialized countries (Zerbock, 2003) as a result of which we see that recycling is a non-issue in such countries.

With regard to Asia, problems within MSW management include institutional deficiencies, inadequate legislation and resource constraints. The Urban Development Sector Unit East Asia and Pacific Region report in May 1999 indicated that if Asia follows life style trends of the US and Canada, that they already seem to be doing, the world would be in need of about 500 million tons more resources by 2025. Ray (2008) quotes (Gupta, 2004) in saying that the large metropolises of India now generate more than 6,000 tons of solid waste per day, at this rate India is expected to generate more than 125,000 metric tons of waste every year by 2030 for each of its metropolises. The World Bank reports, that the urban areas of Asia currently produce about 760,000 tons of MSW per day, and this figure is estimated to rise to 1.8 million tons of waste per day by 2025 (World Bank 1999). Vishwanathan & Glawe (2006) say that the trend is similar in other countries such as Bangladesh, Afghanistan, Pakistan, Nepal, and Sri Lanka as well. Figure 2.2 indicates the percapita waste generation in Asian countries. Also in developing countries waste collection (including hazardous wastes) is largely done by the informal sector formed by underprivileged waste pickers and middlemen. The standard method of disposal is dumping of wastes in open fields, rivers, and canals by industries and households. Ironically the informal sector's waste picking and subsequent repurposing or sales of the collected items serves as informal recycling. Main items that are recycled include plastics, glass, steel, paper, cardboard, aluminum and alloys and e wastes (Vishwanathan & Glawe, 2006). Yet at the grassroots level there is a small amount of awareness developing India and it is slowly but surely seeing growth in the recycling industry, a single state in India (Andra Pradesh) spends approximately USD 2.5 Million on waste handling (Madhavan, 2009).

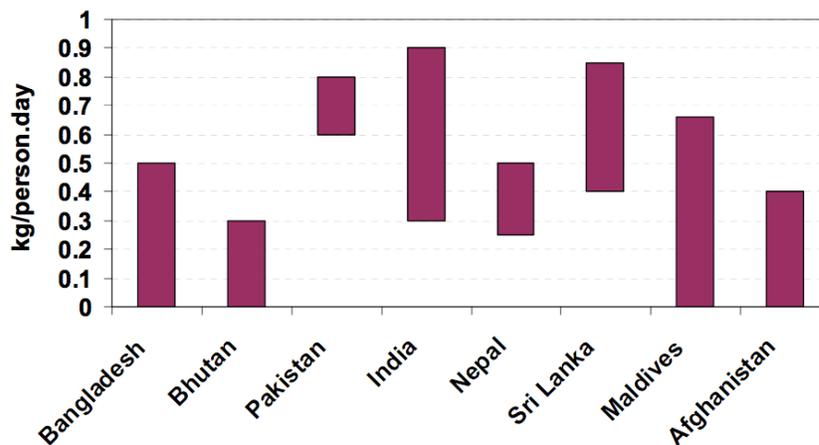


Figure 2.2: PerCapita Solid waste generation in Asian Countries (Vishwanathan & Glawe, 2006)

Within Asia, Japan has seen good progress in recycling because it is particularly difficult to secure landfill sites and incineration is extremely expensive. For example the typical dumping price at regulated landfills in Japan is (\$169) to (\$338) per ton where as the average solid waste tipping fee is a little less than \$40 per ton in the US (Nakamura, 2007) explaining the growth in recycling in Japan currently at 25.7 percent. Figure 2.3 describes expenditure on MSW management and GDP in Asian countries from the recent past.

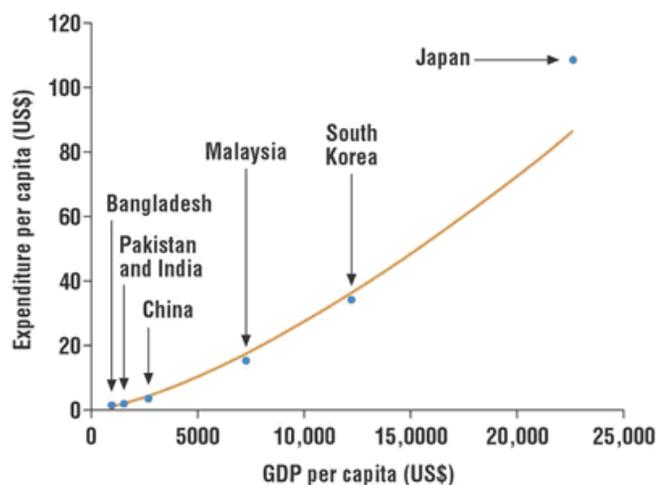


Figure 2.3: Relationship between expenditure on MSW management and GDP in Asian countries (Institute for Global Environmental Strategies (2001))

With regard to waste content, it is observed that in lower income countries, waste is composed of high organic content and high moisture. Content analysis is important as it determines the collection methods and compression rates as collection and transfer trucks that are able to achieve compression rates of up to 4:1 in industrialized nations may achieve only 1.5:1 rate in developing countries. Compression rates also impact compaction within landfills (Zerbock, 2003). Organic matter is the main component of MSW in Asia countries, ranging between 34 % to 70 %, higher than the 20-50 % seen in most European countries (OECD 2002).

Table 2.2 describes the over all issues in relation to waste management in Asia as formulated by Dr.Mara Regina Mendes of the Institute of the Global Environmental Strategies, Japan and Professor Hidefumi Imura of the Graduate school of Environmental Studies, Japan. According to Manandar (2002) MSW management costs in some Asian cities can reach up to 40% of the municipal operating budget, 70%-90% of which is spent on collection.

Terazono, Moriguchi et al., (2005) describe the complicated picture of Asia where each country and region has its own background and characteristics in relation to solid waste management and material-cycles policy, though they share the same global region. Obtaining accurate information for this region is extremely difficult due to the activities of the informal sector and self-disposal in these developing countries. Collection rates in developing countries are reported as; 72.5 percent for the urban areas in India, 70 percent in Malaysia, 70-80 percent in Thailand (Inanc et al. 2004) and 70 percent in urban areas

and 40 percent in rural areas of the Philippines (World Bank 2001a). Asian countries are now among the highest “waste creators” globally.

Table 2.2: Over all issues in Asian cities pertaining to MSW management. (<http://www.usinaverde.com.br/admin/anexos/panoramagestaoasia.pdf>)

	Less developed cities	Rapidly developing cities	Developed cities
Examples	Dhaka, Kathmandu, Karachi, Phnom Penh	Beijing, Shanghai, Guangzhou, Bangkok, Kuala Lumpur, Manila	Tokyo, Taipei, Seoul, Hong Kong, Singapore, Macao
Trends	Population growth Urbanization	Population growth Urbanization Industrialization and economic growth	Stable population Affluent society 'Throw-away' consumption
Urban characteristics	Mix of semi-urban and urban areas	Rapidly urbanizing and sprawling Number of irregular settlements such as slums and shanty towns	Highly urbanized Dense area
Barriers	Poverty Financial constraints poor management Capacity	Urban growth Low management capacity	Excess of waste Varied waste composition Land scarcity
PPP per capita^a 2002	Less than 2000	2000-15,000	16,000-30,000
MSW generation per capita (kg/p/day)	0.3-0.7	0.5-1.5	>1.0
Waste characteristics	High bulk density High organic content	Evolving or changing characteristics (transition)	Low bulk density High plastics content
Waste management	Priority to collection and transportation	Gradual improvement of final disposal	Advanced treatment Appropriate and well monitored final disposal
MSW collection rate (%)	<70	80-95	95-100
Recycling	Informal	Formal + informal	Formal
Rate of expenditure in total budget (%)	15-40	5-25	1-5
^a GNI PPP per capita is the gross national income in purchasing power parity.			

Rapid economic growth and urbanization and a lack of concerted effort in most developing nations is becoming a major social and poses some critical challenges. Economic integration in Asia allows the international trade of recyclable waste and with little regulation on import and export, the MSW waste situation is not positive. A common contender among the developing nations as seen in a number of academic publications mentioned above, is a situation where poverty, lack of awareness and inefficient resource management are intertwined. A lack of urgency, limited financial capacity, lack of technical

know-how and toothless laws are some of the barriers that prevent the initiation of environmentally sound, economically viable and socially acceptable waste management programs. An approach which allows jobs to be generated even at the grassroot levels, such as the informal sector (waste pickers) should be formalized as a start and awareness raised on the need for integrated waste management. Developing nations are fertile grounds for setting up and maintaining small enterprises for recycling and reuse, that could be integrated with existing formal municipal solid waste management systems.

2.1.3. Recycling in Europe: Europe has lead the way in terms of recycling with the issue of the European Union directive (1994) where in - EU countries would be expected to recover between 50 % and 65 % of all packaging material by weight, and recycle 25 % to 45 % of all packaging material by weight within five years of adoption of the directive (Russo & Shah, 1994) Figure 2.4 indicates the recycling rates for the EU for the year 2008 as stated by the CEWEP. Europe appears to be the undisputed leader in terms of recycling, some other reports indicate an even higher recycling rate such as a paper by Tojo & Fischer (2011) that show the rate is quite reasonably, >50% for at least 11 countries, with some countries like Denmark and Norway achieving over 70% recycling rates. In this report Tojo & Fischer say that only six of the European countries have a recycling rate below 30%. Germany and Sweden generate the least amount of waste per capita for industrialized nations, with just under 1KG per person per day (EPA).

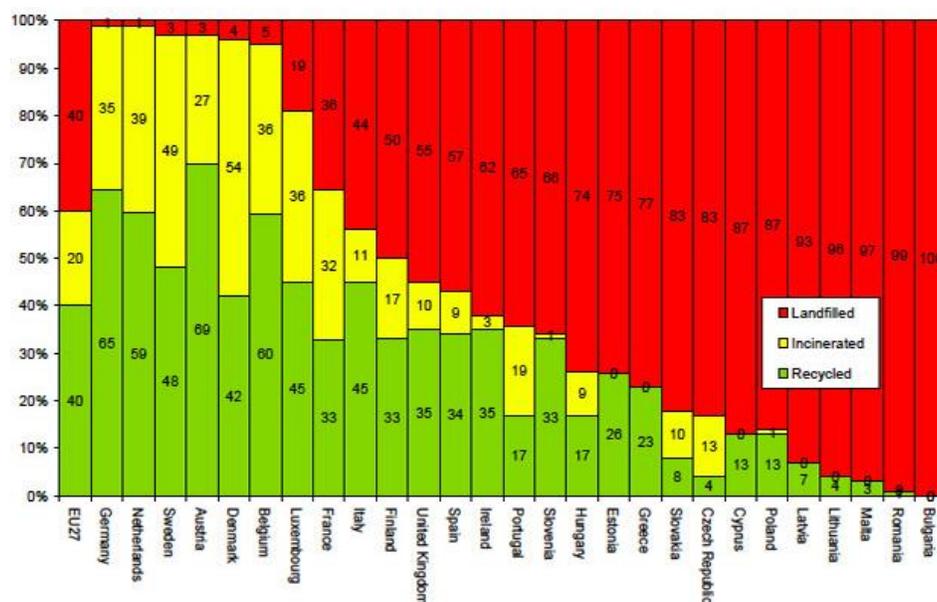


Figure 2.4: Recycling figures for the European Union, 2008 (CEWEP).

Germany in particular seems to be taking recycling very seriously. Though the separation of rubbish is not compulsory for the private citizen, surveys indicate that around 90% of Germans are willing to sort out their rubbish (Moore, 2005). In an article for the BBC, Imogen Foulkes reports that Switzerland has a strong financial incentive for recycling where throwing away rubbish costs money - each rubbish bag has to have a 1 Euro pre paid sticker on it in order to be cleared. Without these stickers, the authorities will not clear the rubbish. As a result in Switzerland 80% of plastic PET bottles are recycled - far higher than the European average of 20 to 40%. Aluminum and tin can be taken to local depots, batteries can be handed over at the supermarket, and old oil or other chemicals deposited at special sites. In the same article, Thomas Buch-Andersen reports that in Denmark, one of Europe's greenest countries government figures for 2003 suggest that 31% of all household waste was recycled, while 62% was incinerated. The

remaining 6% was landfill waste. In Denmark, more than 0.1% of the entire population is involved in waste collection. This article puts to shame Greece and Italy that are lagging behind with the high European standards of recycling. Greece has one of the largest recycling facilities in Europe, yet the plant - estimated to have cost at least 75M Euros (£50m) stands idle. According to the above stated BBC article, the UK has shown rather disappointing numbers with regard to recycling - 60% of all household waste could be recycled or composted, in the UK, but England appears to be recycling only 17.7%. However, Waste and Resource Actions Program (WRAP), an independent body that promotes resource conservation in the UK reported that 25.9 million tons of household waste was collected in England in 2006/07, 30.9% of which was collected for recycling or composting. These statistics can be better appreciated when compared on similar scales as seen in Figure 2.5 which offers a comparison of municipal waste generated along with disposal methods employed in some countries discussed in this chapter (The Economist, 2007).

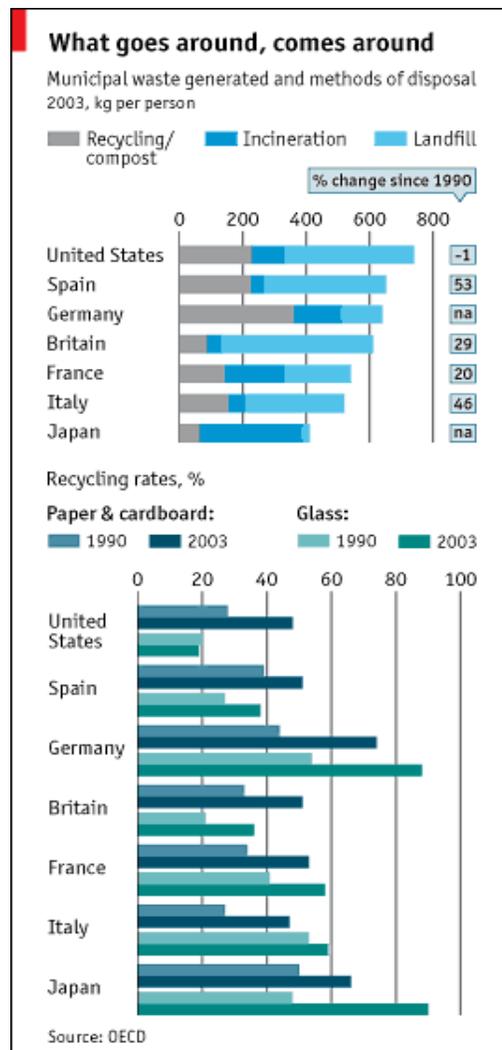


Figure 2.5 Municipal wastes generated and disposal methods employed, 2003.

(The Economist, 2007, http://www.economist.com/node/9249262?story_id=9249262)

Europe has a considerably varied spectrum of disposal systems and varying degrees of fragmentation are seen in the collection system, which is expected. Some member states such as Netherlands, Flanders and Denmark have banned the landfilling of most municipal wastes whilst others such as Finland are implementing such bans. Austria and Germany require landfilled waste to be pre-treated through stabilisation (mechanical biological treatment) prior to landfilling (Hogg, 2001). Disposal at landfills is still the predominant waste treatment option, but the volume dealt with in this way declined by 67 million tonnes, or 5 %, between 2004 and 2008(Schror, 2011).Figure 2.6 provides waste disposal figures for Europe for the year 2004.The report to the European Commission by Hogg (2001) states that not all countries have widespread kerbside / door-to-door collections in place, and those that do seem to adopt different approaches to collection, leading to different requirements for post-collection materials sorting. According to the EEA, Europe produces more than 250 million tons of municipal waste and over 850 million tones of industrial waste annually. Of the total waste treated in 2008: 49% was disposed, 46% was recovered and 5% was incinerated in the European Union as a whole (Schror, 2011).

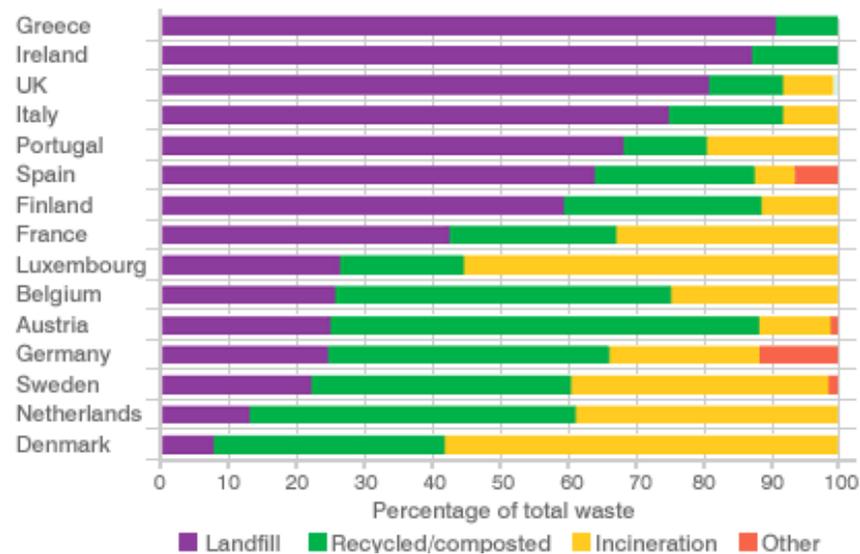


Figure 2.6: Waste Management in Europe, 2004 (BBC News)
(http://newsimg.bbc.co.uk/media/images/41230000/gif/41230329_graph.gif)

A study of waste management in Europe indicates that there is a great degree of involvement of public and private sectors in recycling and other waste management activities, though it varies across the EU member states. It appears that producer responsibility plays a very significant role in this and that possibly countries with strong producer responsibility legislations charge households less for the waste collection function, which garners a greater support for recycling. Although subtle undercurrents of several areas of conflict between the member states are noticeable, over all results for Europe are exemplary. What is apparent is that the EU has a comparatively greater focus on reducing the amount of waste generated through prevention initiatives, better use of resources, and encouraging a shift to more sustainable consumption patterns. Producer responsibility is definitely a take away from Europe that other nations must look into to catch up to superior waste management.

2.1.4. Impacts of MSW Landfilling and Incineration: Impacts of landfilling and incineration of MSW is an important aspect of overall solid waste management and forms a very wide topic in itself. This chapter touches briefly on the subject indicating a few statistics as a context to describe the importance of recycling. In spite of the costs of recycling, it seems to be growing in popularity largely due to the dangers of landfills and the external costs of garbage disposal such as transportation of solid waste to the landfill. Hoornweg et al. (1999) state that for every metric ton of unsorted municipal solid waste (containing 0.3 Mt carbon), 0.2 Mt are converted to landfill gasses. Landfills are the largest source of U.S. anthropogenic methane emissions claims a voluntary Climatic Actions Group called Power Partners in the USA. Figure 2.7 indicates a typical landfill site. Although experts insist that today's landfills are technically engineered and that these sanitary landfills are a far cry from the open dumps of the past, they still require extensive planning, engineering, monitoring and supervision both by law and public demand. In the absence of stringent guidelines, they often become mountains of our rotting rubbish that are known to leach chemicals into ground water and release noxious fumes and vast quantities of methane, not only causing explosions and fires at the site but directly linked to global warming. Decomposition of these materials in the landfills under anaerobic conditions, produce gases containing approximately 50-60% Methane (CH₄) and 30-40% Carbon Dioxide (CO₂) by volume (Abushammala et al., 2009).



Figure 2.7: A typical landfill site (<http://blog.envirosax.com/>)

CH₄ is a major greenhouse gas (GHG) because its global warming potential is more than 21 times that of carbon dioxide, which has known adverse effects on the environment. Furthermore, migration of CH₄ gas from landfills to the surrounding environment has negative effects on human life, apart from gas explosion incidents that are caused by landfills that were reported at Loscoe village in England in 1986 and Skellingsted Landfill in Denmark (Christophersen et al., 2001). In instances of closed landfills that have been improperly capped, direct contact with the toxic waste can occur as well. The siting of landfills is also believed to negatively impact the surrounding land value with adverse health issues reported by people living near landfills. According to a report by New York State Department of Health (USDOH, 1981) these health dangers include several types of cancers, birth defects and severe toxicity. Montague (1998) quotes an older 1990 study of 356 California landfills that found 240 of them (or 67%) emitting one or more toxic solvents. A report by the World Bank indicating the results of a survey with regards to the affects on human health due to improper sanitation, India, China, and South Korea ranked among the

top five countries that indicated that their health was affected a great deal or a fair amount, with a response of 94 by India, 93 by china, and 88 percent by South Korea (The Urban Development Sector Unit East Asia and Pacific Region Report, May 1999) Figure 2.8 compares greenhouse gases (GHG) production in the European Union (EU) by each waste disposal method between 1990 and 2008 , indicating clearly that landfilling is the graters geberator of GHG's. Figure 2.9 indicates waste to landfill statistics for 2007,Australia. The Australian Bureau of Statistics states that the recycling rate for Australia is 52% between 2006 and 2007. Yet, it is interesting to note that even in developed nations, in spite of waste reduction and years of success with recycling, landfills still count as the top waste disposal method. While other forms of waste disposal uch as composting and combustion also generate emissions, the worst offender appears to be landfilling, compounded by other negetive experiences associated with it.

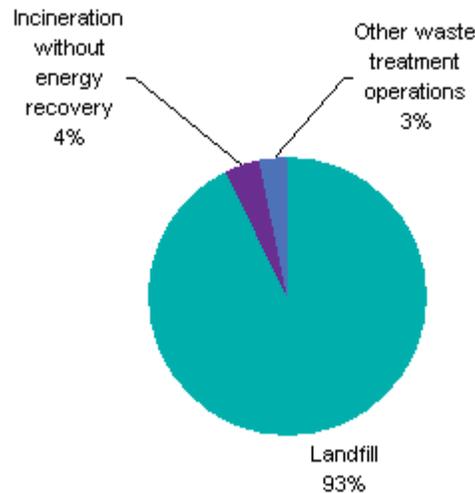


Figure 2.8: Estimated share of GHG Emissions from 3 types of disposal methods between 1990 – 2008, Europe, European Environmental Agency
http://epp.eurostat.ec.europa.eu/statistics_explained/index.php?title=File:Figure_1_Estimated_share_of_GHG_emissions_from_three_disposal_treatment_operations.PNG&filetimestamp=20110929122450

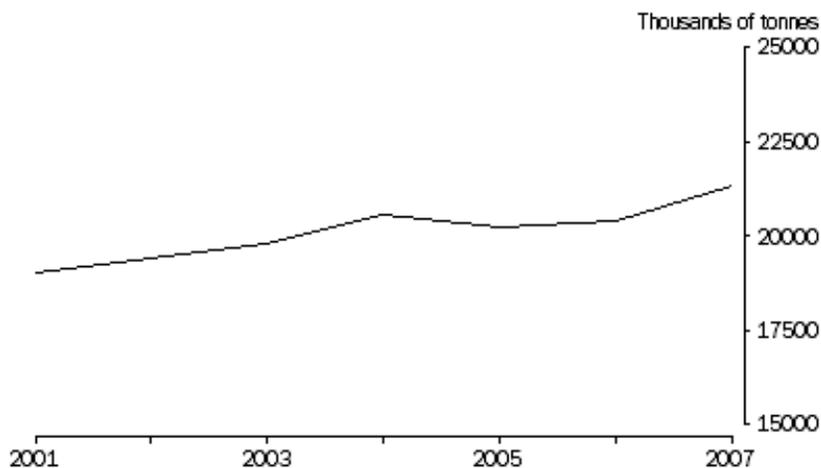


Figure 2.9: Statistics on Waste to landfill in Australia, 2007.
<http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/4613.0Chapter40Jan+2010>

Incineration is another conventional disposal method in which solid organic wastes are subjected to combustion or burning to convert them into residue and gaseous products. Incineration reduces the volume of waste to less than half or in some cases there is an 80 – 95 % reduction (Rand et al. 2000) but this method results in the production of gaseous pollutants. The incineration of municipal waste involves the generation of GHG's such as CO₂ (carbon dioxide), NH₃ (ammonia), N₂O (nitrous oxide), NO_x (oxides of nitrogen) and organic C measured as total carbon. This is a popular method for countries like Japan where land is scarce. Of particular concern in this method is the production of persistent organics such as dioxins, furans, PAHs, which have serious environmental consequences, in addition and the set up costs of incinerators are very high. High costs and environmental problems have led to incinerators being shut down in many cities, such as Buenos Aires, Mexico City, Sao Paolo and New Delhi (UNEP, 1996). It is vitally important that incinerators should not be located where prevailing wind patterns would carry emissions over nearby settlements. The option of incinerators is better suited for island nations with islands scattered about where transporting MSW would be difficult or too expensive. While it would have been helpful to have more data on disposal methods for Asia such data was not available during the preparation of this dissertation. Abushammala et al., 2009a however were able to predict CH₄ emissions in Malaysia using the IPCC 2006 FOD Model as indicated in Figure 2.10.

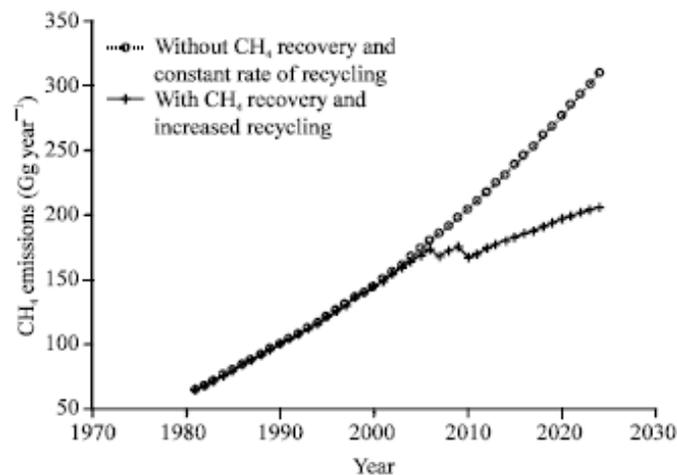


Figure 2.10: The annual CH₄ emission in Malaysia estimated using the IPCC 2006 FOD Model (Abushammala et al., 2009a).

Recycling of waste materials reduces the volume of waste disposed in landfills and reduces the need for other emission generating methods such as incineration. Landfills unfortunately cannot be completely eliminated as a waste disposal method, though this research would recommend that landfills be banned for anything which can be recycled, composted or reused thus reducing the quantity of waste that is directed towards them and tightening the construction, siting and operation of landfills. The study on life-cycle impacts of materials currently being disposed in landfills and the GHG emissions reductions that are possible by diverting discarded materials from landfills through recycling and composting can be appreciated by the data from Table 2.3 which indicates the impacts of recycling on the environment and reductions in energy use with recycling of certain products. In general, emissions can be minimized by reducing solid waste at the onset, pursuing recycling and reuse of material and most importantly regulating the disposal of solid waste. An appreciation of the alarming quantity of wastes world over being landfilled or incinerated suggest that where possible recycling should become a matter of policy over choice. The percentage of emission reduction achieved is significant enough to warrant the effort to

recycle

Table 2.3: Impact of Recycling (www.wasteonline.org.uk)

Material	% Of Household waste	Energy	Emissions	Raw Material Saved/Ton Recycled
Paper	18	28% – 70 % less	95% less (Air Pollutants)	-----
Glass	7	18% less	30% less	1.2
Plastic	7	Up to 66% less	-----	1.8
Cans (Fe)	3	70% less	86% less	2.0
Cans (Al)	3	95% less	95% less	4.0

2.2.Role of incentives and other methods in promoting Recycling

A number of papers in the recycling literature explore the role and value of incentives, education and communication in the promotion of recycling behavior. Iyer & Kashyap (2007) report in their paper “offering incentives appears to have an immediate and dramatic effect on recycling behaviors”. Ackerman (2005) suggests that larger incentives will be necessary to motivate the more affluent to recycle if in fact market incentives are to remain the motivating force. Halvorsen (2008) have said that “the largest effects on household recycling efforts comes from money incentives and the number of fractions collected by the municipalities, several of the norm-based incentives contribute significantly to Norwegian household recycling efforts”. Thogersen (2003) while supporting the idea of incentives driving recycling adds that incentives may induce previous non-recyclers to start (or try) recycling. David and Louis et al. (2004) suggest with regards to organic waste composting that the benefits go beyond just financial incentives; the benefit of obtaining buy in’s to recycling means that every ton of organic material that is prevented from going to the landfill would become useful in improving soil in household gardens instead. Reschovsky and Stone (1994) study the role of market incentives as opposed to a flat fee in promoting recycling finding that a combination of mandatory, curbside, and trash-tags achieved the greatest amount of additional recycling, but due to the lack of relevant observations they were not able to examine the significance of a curbside program operating in isolation.

While incentives play an important part in improving recycling Hong & Adams (1999) believe that it is important to consider other options in association with incentives such as varying container size, expanding the range of recyclable material collected and other non – price options to achieve long term improvement in recycling. Jacobs et al. (1984) found that informational brochures delivered to individual households increased participation rates by 6 %. Ackerman (2005) quotes (van Beukering, 2001) stating that in a study of four European cities, estimates of the willingness of people to pay for recycling programs indicated participants were willing to pay between €20 to €29 per household per year. Nixon & Saphores (2009) report that although print media is influential, it is face-to-face communication (through family/friends or work/school) that is the most effective in getting people to start recycling. In the study of growth and advancement in the recycling industry Woodbury & Mariani (2008) explore electronic bin tagging and weighing systems, through a case study conducted in New South Wales, the new systems doubled recycling rates from 22 % to 42 % within just a few months.

Reschovsky and Stone (1994) investigated the use of market incentives to encourage household waste recycling by pricing waste-disposal services according to the quantity of waste generated. The authors use data from a random survey of households in Tompkins County in the Finger Lakes region of upstate New York, Ithaca with a population of 28,158. The survey gathered information on household recycling behavior, other waste reduction behaviors, attitudes concerning county waste reduction efforts, and a variety of demographic information. Across the sample, very high rates of recycling were reported, ranging from 50 to 81 percent for the various materials. The most effective combinations of policies include curbside pickup, with different combinations being suited for different results, for example to improve collection of paper and glass, the best combination would be mandatory recycling and curbside pickup which increased the probability of recycling newspaper and glass by 22 and 37 percent. Other findings showed that married households were more likely to recycle than non-married households and more highly educated persons were generally more likely to report they recycled than less-educated persons. Table 2.4 indicates the number of observations and percentage recycling for various combinations, by recycled material.

Table 2.4: Number of observations and percentage recycling for various combinations, by recycled material (Reschovsky and Stone, 1994)

	Drop-off center only	Curbside only	Trash-tag only	Mandatory only	Curbside and trash-tag	Curbside and mandatory	Trash-tag and mandatory	Curbside, trash-tag, and mandatory	Total
Newspaper									
No. observations	83	31	432	11	140	57	43	566	1363
% Recycling	55	84	64	64	86	95	79	95	81
Glass									
No. observations	83	31	433	11	140	56	43	567	1364
% Recycling	54	77	60	91	89	96	84	97	81
Metal cans									
No. observations	80	18	841	—	340	—	—	—	1279
% Recycling	46	67	60	—	86	—	—	—	65
Plastic									
No. observations	82	19	848	—	340	—	—	—	1289
% Recycling	49	63	57	—	86	—	—	—	65
Cardboard									
No. observations	79	19	845	—	339	—	—	—	1282
% Recycling	23	74	36	—	87	—	—	—	50
Food/yard waste									
No. observations	182	—	1201	—	—	—	—	—	1383
% Recycling	26	—	51	—	—	—	—	—	65

With regard to recycling behavior itself, a study by Aoki (2005) suggests that past behavior was more effective than attitude in predicting recycling behavior. Aoki (2005) used the survey method collecting data from consumer monitors by mail survey in February 2002. The sample consisted of 1531 individuals in all (876 male and 655 female). The measures for the studies were all contained within a questionnaire booklet that respondents had to answer. The behaviors were measured on a five-point scale that went from “very seldom” to “very frequently”, with similar scales of measure for all variables. All of the variables were tested as continuous variables using multiple regression analysis. The author proposed two different hypotheses, Hypothesis 1: The lower the consumers’ involvement to recycle, the greater the effect of the past behavior for recycling. Hypothesis 2: When consumers’ involvement to recycle is high, the effect of attitudes and social norms will be greater than that of the past behavior for recycling. The author concluded based on the findings of the survey that recycling activity would not be a reasoned action, but a

systematic behavior in daily life and that past behavior enhances the predictive power of the model of reasoned action.

2.4. Study of key Recycling Programs and Contributors to recycling.

Russo & Shah (1994) study the ambitious German Green Dot program that was designed to enforce the "polluter pays" principle, where in the economic burden lies on the parties responsible for creating that waste, thus internalizing the costs of waste management. The immediate results of the German Green dot program can be seen in Table 2.5, which indicates projected changes in packaging consumption in Germany further to the introduction of the Green Dot program. This paper also reviews the German DSD System that collects and sends packaging bearing the Green Dot to selected sites of a contracted disposing company for subdivision and finally transport to recycling and processing firm. While the criticisms of the Green Dot program are many, companies are finally redesigning their packaging when faced with the take back policy.

Table 2.5: Projected Changes in packaging consumption in Germany further to the introduction of the Green Dot program. Source: Russo & Shah (1994).

CHANGES IN PACKAGING CONSUMPTION , 1991 THROUGH 1995				
	Change 1991 - 92		Projected Change 1992 - 95	
Material	(000 Metric tons)	(Percent)	(000 Metric tons)	(Percent)
Glass	-210	-4.5	-446	-10.1
Tin plate	-41	-5.2	-30	-3.9
Aluminium	-9	-7.4	-9	-8
Plastic	-64	-4	-44	-2.8
Paper/Paperboard	-174	-3.3	72	1.4
Composites	-8	-1.9	-3	-0.8
TOTAL	-514	-4	-459	-3.7
Source : Federal Environmental Ministry				

The paper by Jia-Yong (2008) provides an understanding of the advancement of European recycling system of packaging waste that emphasizes the role of the government in establishing the legal framework and prescribing taking back rate further to imposing a rigid law on recycling. Jia Yong proposes the adaptation of European successes with packaging reduction suggesting that it could be used as a reference for China's construction of packaging waste recycling system.

Miranda & Aldy (1996) in a case study of 9 municipalities found that recycling programs with unit pricing such as the PAYT found significant increases in recycling tonnages and participation. In addition the study found that the communities being studied recovered their costs for recycling collection through the unit pricing fee and the sale of recyclable materials to regional vendors. This is an added advantage to adopting such programs. In order to minimize undesirable diversion; the authors suggest complementary programs as one of the management mechanisms. Greenwalt (2010) compares Pay-As-You-Throw systems to incentivized systems while suggesting that the type of collection i.e single stream collection or dual stream collection has a serious impact on recycling. The argument is that incentive-based programs such as RecycleBank in the US tend to promote increased consumption while in a PAYT system; residents realize that they can make a difference in their costs. D.H Folz has stated that the PAYT policy could help officials advance the strategic waste management goals such as waste reduction, increased recycling, and reduction of ultimate waste disposal costs .In general much of the literature appears to be in

support of the PAYT program, this program has also been supported by the USEPA. A well-designed recycling system is a pre-requisite if the system of quantity based waste collection charges is to be successful along with subsidization of these activities to compensate for their contribution (Jeon Rhee, 1998). Oskamp, Zeleny et al. (1996) found that single stream recycling achieved a higher average weekly participation rate (58% vs. 42%) than the dual stream in curbside recycling. The commingled program also generated more gallons of recyclables (32.1% vs. 5.5% per household per week). As early as the 1990's, Folz & Hazlett (1991) stated that "although local conditions may determine which programs are selected, the ultimate performance of local recycling programs remains in the hands of their designers and managers", emphasizing the importance of a well designed recycling program that fits the needs of each society.

Jenkins et al. (2000) examines the impact of two popular solid waste programs on the recycle yield of several different materials in the waste stream such as glass bottles, plastic bottles, aluminum, newspaper, and yard waste. It is interesting to note that thirty-five percent of respondents in the above stated study report that participation in their recycling program is mandatory, which could have impacted the results. Jenkins (2000) used a latent regression model for ordered data as the framework to estimate the policy and socio-economic factors that influence the level of recycling effort households put into each recyclable material. In addition the authors use a large household-level data that included a survey asking respondents about their recycling participation. They determined that "curbside recycling has a significant and substantial positive effect on the percentage recycled of all five materials and that the level of this effect varies across different materials". They figured that the two most important features that almost always significantly affect the recycling rate are the availability of local drop-off recycling and existence of curbside recycling.

Miranda & Everett (1994) used data gathered through telephone and mail surveys of 21 cities, to demonstrate the strong potential for unit pricing to improve the efficiency of residential solid waste management. Most unit-pricing programs are seen to be categorized as either "bag," "sticker," or "can" systems, depending on how the household pays the unit fee. The average increase in recycling was an impressive 139 percent. In the 12 cities that operated recycling programs prior to adopting unit pricing, major increases in quantities were seen after switching to unit pricing. An important observation was that communities with mandatory recycling programs increased their tonnage recycled by an average of 83 percent only. Thus the authors feel that mandatory recycling does not motivate individuals to divert waste from landfills and officials are not keen on pursuing enforcement under such systems. Miranda & Everett (1994) concluded based on their research that unit pricing provides residents with an incentive to source reduce and recycle by forcing them to pay the increased disposal cost for each additional unit of garbage

Aadland & Caplan (2006) study the social net benefit of curbside recycling using household surveys in the US, alongside a contingent valuation method analysis, econometric methodology and willingness to pay (WTP) estimates. In their research the authors question the common understanding that recycling benefits the environment in an attempt to obtain an answer to the question - Should we be recycling at all? The research involved a random-digit dialed telephone survey regarding recycling behavior during the winter of 2002 to over 4,000 households in 40 western U.S. cities with populations over 50,000. The difference with the research by Aadland & Caplan (2006) was that unlike previous studies, they estimated the magnitude of the potential hypothetical bias in the WTP data by contrasting stated-preference information with revealed preference information. This estimate of hypothetical bias was used to calibrate the corresponding WTP estimates to the decisions made by households in a real market setting, resulting in more accurate data. Surprisingly by comparing their mean calibrated WTP and cost estimates, Aadland & Caplan (2006) were able to conclude that the social net benefit of curbside recycling is almost exactly

zero. Despite the benefit measure generated from household survey's being carefully calibrated for hypothetical bias, the authors find that, on average, the benefits and costs per household are almost exactly identical. What can be derived from this research however is that cities with significantly positive net social benefits should be supporting curbside recycling programs while cities with significantly negative net social benefits should consider other waste management options. However, on a city-by-city basis, the data analysis often makes clear predictions about whether a CRP is an efficient use of resources.

Minami et al. (2010) conducted an experiment on the benefits of packaging elimination as consumer and regulator concerns about the volume of discarded packaging is rising. Upon consideration it is easy to appreciate that if packaging didn't exist in the first place, there wouldn't be any need to recycle it, thus eliminating the need for complex, expensive reverse logistics processes. This paper discusses the EcoPoint system introduced in 2006 by CRAI (Commissionaria Riunite Italian food) in association with Planet Life Economy Foundation. 280 customers were surveyed for feedback. The survey panel was selected from a group of regular customers who had purchased Eco Point products over a six-month period. Their purchase behavior was compared to the average CRAI customer. Eco Points is a system designed to drastically reduce packaging by retailing products in the market system of generations gone by, where products are purchased by weight, loose and unpackaged. The study showed that in just one year, a store had reduced the number of packs distributed by 50,000 (about 2% of all units sold) translating to over 300 kg of paper, about 180 kg of glass and 280 kg of plastic. The resulting price cuts of products were between 10% all the way up to 70% in some cases. Other advantages were that people could buy exactly the amount of product required with no minimum quantity purchases. Figure 2.11 shows the results of a survey carried out by CRAI among a panel of 280 consumers on the Eco Point system clearly indicating the success of such a system.

Effects on customers		
	Average customers	Frequent Eco Point users
Single ticket value per visit (euro)	17.13	27.66
Single product value (euro)	2.14	1.97
Number of products bought per visit	9.31	14.05
Monthly frequency of buying	2.88	4.34
Percentage of Eco Point purchase on grocery's purchase	2.13%	8.85%

Source: In-house survey by CRAI of 280 customers

Figure 2.11: Results of a survey carried out by CRAI among a panel of 280 consumers on the Eco point system (Minami et al.2010)

Customer satisfaction levels with the Eco point systems were high, with 52% of the panel saying they would repeat the purchase, 44.3% saying they weren't sure, but only 3.4% saying they were dissatisfied. Minami et al (2010) conclude that this scheme can offer customers the triple benefit of economic value, self-esteem and entertainment in addition to the fundamental value of social responsibility. Another contributor to improved recycling was the use of technology as seen in the experiments by Woodbury & Mariani (2008) who employed the experimental research method to determine the value of electronic bin tagging and weighing systems in increasing recycling efforts in a community. They conducted a case study in the City of Ryle, New South Wales with a population of approximately 39,000 where in residents were provided with an improved configuration of waste disposal bins that were also fitted with electronic

tagging and weighing systems. The introduction of the new service almost doubled the recycling rate to 42 per cent of the total waste stream within the first few months and reached a plateau of around 50 per cent of the total waste stream by 18 months. A plethora of valuable information was obtained with regards to program requirements, participation rates, participant's attitudes and behaviors, cost of recycling and related activities, and potential improvements that could be enforced to a recycling program. Woodbury & Mariani (2008) safely concluded that the advantages of the electronic waste and recycling bin tagging and weighing system introduced within the City of Ryde substantially outweighed the respective costs and commitment to resources. Such new and dynamic information systems are expected to play pivotal roles in waste management in the future. The researchers, through their experiments and evaluations were also able to identify that such dramatic success rates were achievable due to combination of the new bin system and the extensive community consultation and education undertaken in the lead-up to the new service being available.

Schultz (1999) used the experimental method to observe curbside recycling behaviors of 605 residents of single-family dwellings, in La Verne, California for 17 weeks. La Verne already had a recycling program for newspaper, glass, plastic, and metal for 3 years. Groups of contiguous houses were randomly assigned to 1 of 5 experimental conditions: plea, plea plus information, plea plus neighborhood feedback, plea plus individual household feedback, or the control condition. Interventions were implemented in the form of door hangers delivered to each household over a 4-week period. Schultz (1999) determined, based on the results from this study that normative feedback intervention is an effective way to improve curbside recycling. All types have feed back showed an increase in material recycled as well as the frequency of participation, though contamination could not be reduced though feedback. This study also proved that participants used the feedback to regulate their behavior, particularly rate of participation. The lack of knowledge has always been an important barrier to action, yet motivation is the ultimate determinant of who will and will not recycle. However, persuading consumers to act in an environmentally or socially responsible manner is a particularly challenging task. As suggested by Schultz (1999) there is definitely a link between behavior change through norm activation and feedback. This idea is further supported by another experiment by Kronrod et al. (2012) that determined that persuasiveness of assertive language depends on the perceived importance of the issue at hand. The authors examine this prediction in three laboratory experiments and one field study employing assertive and nonassertive messages using Google's AdWords web advertising system. Kronrod et al. (2012) conclude that the usual assertiveness of environmental messages should be toned down slightly when directed at more environmentally concerned populations and for those who are less concerned about environmental issues, the importance of the issue should be elevated before assertive phrasing is used in more specific green requests.

As seen in the research presented herewith incentivising recycling is undoubtedly one of the most effective ways to jumpstart recycling, in addition to the adoption of newer technology and better communication. A number of studies support incentivized recycling, yet having reviewed a wide range of papers on the subject one could conclude that although it may encourage a change in behaviour, it is unclear if this would be sustained over time or if the same incentive would remain attractive over a period of time. Incentivized recycling is explored with greater detail in Chapter 5 of this dissertation due to its contribution to increasing recycling efforts. However, the success of programs such as PAYT and Recyclebank reiterate the power of incentives in our communities due to our consumerist culture. Though we must first significantly reduce our excessive wasteful consumption habits, the most effective means for waste management are either employing the polluter pays principle (regulation) as seen in several states in Europe or incentivized recycling in the absence of mandatory recycling laws. In spite of the offer of incentives it appears that a substantial reason for recycling is mediated through perceived self-efficacy and personal norms. Thus in a situation where regulations exist, it would communicate as the required

norms and therefore enhance internalized motivation in the form of a moral norm. An ideal combination however appears to be a combination of a broad regulation aided by the offer of a well-planned incentivized recycling program.

2.3. Recycling in Multi-Family Dwellings

Much of the literature and pilot programs pertaining to recycling seem to address single-family dwellings. Experts agree that recycling has been slow to catch on in multi-family dwellings, with one of the biggest obstacles being getting the recyclable items from the apartment units to the main recycling area (Schenkman (2003), Birkner et al. (2010), Robinson & Read (2010)). In 1999, the US EPA reported that one in six American homes are located in buildings or complexes with five or more levels. Residents in these households were not included in the community curbside recycling programs, indicating the need for attention to this area as a real contributor to recycling efforts. This situation is reflected in the UAE and bears significance in any recycling proposals for this region. A study of recycling in MFD's indicates that factors that decrease the time cost of recycling contribute significantly to increasing recycling efforts in MFD's. The US EPA reports that each multi-family household examined in their study set out an average of 0.14 tons of recyclable materials per year as opposed to single-family households that set out 0.23 tons per household per year. If recycling was made available to all multifamily housing units throughout a given state/country millions of additional tons of materials could be diverted from disposal facilities nationwide.

Ando & Gosselin (2005) found a strong connection between recycling rates and the perceived presence of adequate interior space for processing recyclables, and distance to recycling bins affects container-recycling intensity. This information has great significance for MFD's and the design of recycling programs for MFD's. The apartment industry houses 40% of Americans, Sadovsky (2008) found that only 10% of the people involved in MFD's make any effort to promote recycling. Several councils have been trialing door-to-door collection schemes and other initiatives, but results remain mixed with no single solution possible. A controlled experiment conducted on campus at Central Michigan University by Birkner et al. (2010) showed that out of the 182 participants 56% would "always" recycle if recycling bins were provided at their apartment complexes. Jenkins et al. (2000) found that residents of SFD's are substantially more likely to recycle larger quantities of their yard waste than residents of MFD's. Yau (2009) studied the recycling behaviour of 122 housing estates in Hongkong, specifically high-rise buildings finding that when all other variables were kept constant, multi-family dwellings also responded positively to incentive schemes. The researcher determined that incentive or reward schemes positively affect the per-household rate of recyclables collected. Europe and the US have made headway with regards to recycling, but as the developing world, which includes the UAE sees growth, the focus must shift towards attaining integrated waste management systems to create more sustainable cities.

The study of recycling in MFD's is significant to this dissertation as a majority of the residences in Dubai are MFD's posing a challenge with regards to recycling. One of the biggest challenges in evaluating MFD recycling program success is that there is minimal data available on the subject. It is clear from the review of the papers stated above that MFD recycling programs must be viewed as similar to small business recycling programs. Recycling should be made as easy and convenient as possible, within the limitations of the property and the waste collection system, creating individual solutions where required. The amount of time and effort dedicated to continuous outreach will depend on demographics and available resources which significantly influence results.

2.5. Recycling in Dubai

Recycling is not mandatory in the UAE, which explains at least in part, the lethargic attitude of the

residents towards this concept. While there are several smaller initiatives towards recycling by private companies and in general residents seem to be aware of recycling, it is not yet a mainstream activity. For Example, HP Computers, a technological giant recently tied up with Enviroserve (United Arab Emirates) to launch “touch the green” campaign, a program designed to encourage consumers to recycle their old computers, providing the local population with places to recycle electronic goods. Similarly Masafi, the mineral water and fresh juice company has started to collect plastic bottles from companies employing more than 200 employees for free. In a bid to battle the menace of plastic Masafi have managed to collect 500 tons of plastic bottles for recycling so far (Clean Middle East, 2, 3).

Averda, a privately owned Waste Management company had plans to deploy 106 reverse vending machines by end 2011, throughout the UAE in a incentivized program as part of a "Recycle, Redeem, & Reward" scheme. Participants who make the effort to recycle their cans will be rewarded with vouchers or cash. The machines will be placed in shopping malls, schools, universities and areas with a heavy flow of people, the success of which is yet to be determined (UAE Interact, 2011). Such programs, though a good start, are a small portion of the true measures required as they are independently run, small scale with insufficient outreach, are not ongoing. Synovate (the market research arm of Aegis Group) in its study of 22,000 people across 28 countries, conducted a research from July to September 2010 with people aged 16 to 65 years old found that only 24% of respondents in the UAE recycled waste at home. The study as seen in Figure 2.12 also found that among the recyclers, women recycled more than men did, with 28% of women overall saying they had recycled in the past week, compared to 22% of men. An interesting outcome of the study was that the UAE was quite good at buying ecological and organic products but did not fare well at recycling (Synovate's Global Trends Survey, Zawya, 2011).

The first major government mandate in the interest of recycling and environmental safety is the Ministry Of Environment & Water's mission to ban non-biodegradable plastic bags from the UAE by 2012 following awareness program that escalated and resulted into a mandate. One of the challenges in the UAE is the difficulty in finding buyers for recycled materials. According to Jeremy Byatt, Director for Environmental Responsibility at Bee'ah's an Environmental company in Sharjah, the key is to break the cycle of waiting and act first with some 'patience capital' to tide over the transition period (Clean Middle East, 12,2). Table 2.6 provides an indication of quantity of solid wastes as per its source in some Arab countries with the emirates showing the highest rates of waste in the comparison. The waste in Dubai in particular is comprised of 42% organic matter, 6% paper, 10% plastic, 3% minerals, 3% glass and 16% other items (AFED Report, 2008).

The EEG reports that the emirate of Dubai alone produces 31000 tons of waste per day, 8000 tons of which is domestic waste and 17% of which is plastic. In light of this information the collection rates indicated in Table 2.7 seems an inadequate statistic for recycling considering the financial resources available to this city. The EEG also estimates that 500 million canned beverages are sold every year in the UAE. Yet only 5% of these cans are sent for recycling as opposed to a whopping 63% recycled worldwide. The total waste collected in Dubai in 2005 was 11.3 million tons compared to 6.6 million tons in 2003, almost double the figure in just two years, the waste situation is clearly out of control (Aburawa, 2011). Environment of State Abu Dhabi has stated that per inhabitant in the UAE, a potential 2.3kg of waste was being thrown away every day (1.54kg was the average in Western countries). Habiba Al Marashi of the Emirates Environmental Group (EEG) has said that the fundamental issue remains getting the public involved (Clark, 2011). According to Al Marashi “Awareness and commitment are two different things. There are many very clearly labeled recycling bins around the city, but when you have a closer look you'll find people have used them as garbage cans”(Lowe, 2011).

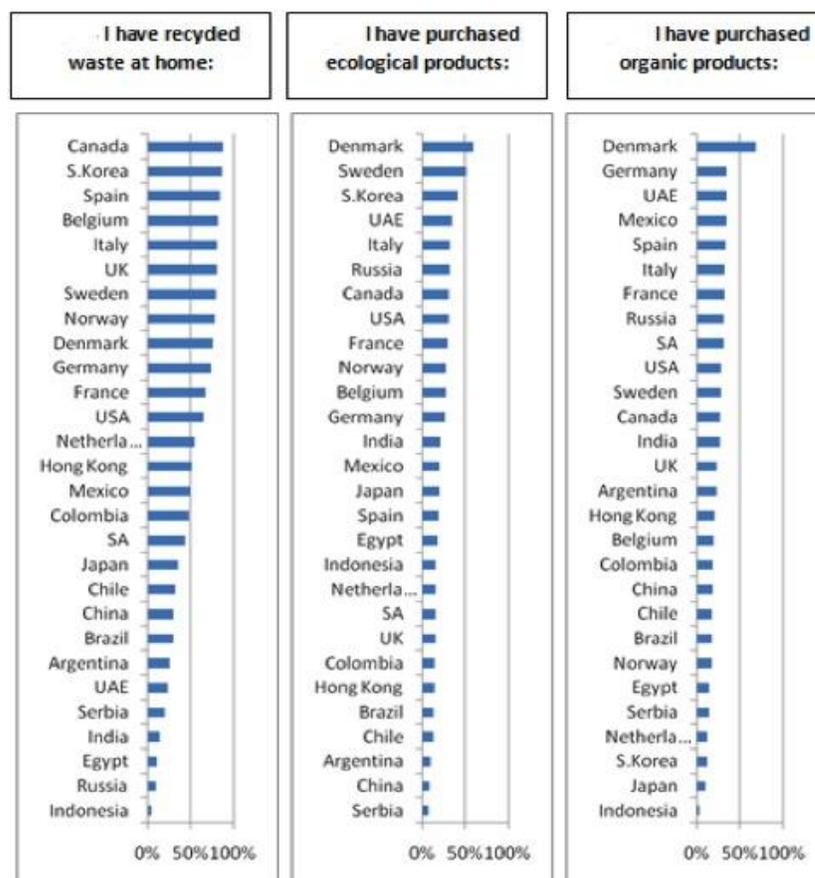


Figure 2.12: Synovate's Global Trends survey, 2011 on Recycling habits of residents.(ZAWYA, <http://www.zawya.com>)

Table 2.6: Quantity of solid wastes as per its source in Arab countries. (GCC 2004; 2005 Data, Egypt Ministry of State for Environmental Affairs 2006)

Source of Waste	Egypt Million tons/year ^[1]	Kuwait 1,000 tons/year	Bahrain 1,000 tons/year ^[2]	Qatar 1,000 tons/year	Emirates 1,000 tons/year
Municipal (domestic)	15-16	905	680	563	2,120
Demolition and construction	3-4	1,149	-	782	3,631
Industrial	4.5-5.0	7	140	64	95
Agricultural	25-30	-	-	-	615
Sludge	1.5-2.0	-	-	-	-
Health Care	0.10-0.12	33	911	450	-
Dredging of canals and drains	20	-	-	-	-

Sources: 1. GCC 2004 ; 2. 2005 data, Egypt Ministry of State for Environmental Affairs 2006

Waste generation in Dubai is so high that Tadweer, one of the largest MRF's in Dubai now has the capacity to sort only one third of the municipal solid waste produced in Dubai. Tadweer was expected to recycle at least 80 per cent of the waste, but due to high levels of contamination, only 20 per cent of the waste received by the plant is sent for reuse (Bains, 2009).

Some experts in the industry say that the local recycling market is limited to items that can be traded like paper, plastics and metal, while local manufacturing industries are also limited in their abilities to accept recyclable goods. The recycling industry has also faced a tough time since the 2009 downturn in other markets such as the UK and the Far East. Union Paper Mills reported that by offering companies paper boxes in which to put their waste paper they have obtained a commitment to recycling from 300 companies (Lowe, 2011). This of course is but a drop in the ocean, far too little

Table 2.7: Collection rates of various items in the UAE through recycling (EEG, 2011)

ITEMS	COMMENCEMENT DATE	QUANTITY
Can	Since 1997	161,167 kg
Paper	Since 2001	9,039,492 kg
Toner	Since 2001	49,073 pcs
Plastic	Since 2005	473,432 kg
Glass	Since 2005	1,045,300 kg
Battery	Since 2006	5,175 kg
Mobile	Since 2009	4,305 pcs
Tetrapak	Since 2010	7,350 kg

A very slight boost has come in the form of an increased number of recycling collection centers, attention to green issues in the media and an increased number of trade shows and exhibitions such as the Waste Summit, and the recently held Green Brunch by Enpark (Lowe, 2011). An essential preliminary step in municipal solid waste (MSW) management is the accurate determination of the quantities and composition of the wastes, which are not readily available for the UAE. Abu Qdais, Hamooda & Newham (1997) determined that the rate of waste generation was dependent on the income level with an increase of about 35% for the high-income residents over the average rate in the UAE. The waste in this region generally contained approximately 50% food waste (Abu Qdais, Hamooda & Newham, 1997) this could easily be reduced by source separation enabling superior recycling of collected waste. Other small steps towards a more responsible recycling society are seen in that Dubai Municipality has also signed build-own-operate deals with Emirates Recycling, a subsidiary of local conglomerate Al-Rostamani Group, for a tyre recycling facility and a construction and demolition materials recycling plant, located in Al-Qusais with a capacity to reprocess 1,200 tyres per hour into shredded granules. An AED65m (\$17m) construction and demolition waste plant at Al-Lusaily on the Al-Ain-Jebel Ali road that separates out wood, plastics, metal and aggregates is also in the works with a capacity to ramp up to 8 million-t/y in the near future (Bains, 2009).

It is reported that the emirate has also come up with a federal plan to set up recycling plants across different areas of the UAE. These measures are yet to take form, but are in the works. Most Recycling plants in the UAE are privately owned however, from 2009 onwards the UAE is said to be

investing in government-controlled waste management plants across the region (Business Source Complete, 2009).

By comparison, it can be seen that waste-management practices vary widely between developing and developed countries. Developed countries had established the need for waste management early on and have now achieved a fairly efficient system established over the years. Within the developed countries waste management receives considerable legislative and industry support, private participation in the entire process of waste collection is also high. Lave and Hendrickson (1999) bring to light that despite the progress in recycling, there is no consensus as yet on what constitutes MSW recycling, which postconsumer waste is included in MSW or on how to measure the fraction of material that is recovered for reuse. This is particularly important where laws declare, for example, that 50% of MSW must be recycled, without defining what is included in MSW. The authors argue that collection of glass in particular has no true value as glass is available in plenty and decomposes fully where ever it is disposed. This dissertation while fully promoting the need for recycling can appreciate Lave and Hendrickson (1999) in that there are greater benefits in curbside recycling of postconsumer metals as they can save money and improve environmental quality, if the collection, sorting, and recovery processes are efficient. Superior alternatives to curbside recycling collection would be welcome, including product take back for products with a toxic content (such as batteries) or product redesign to permit more effective product remanufacture in order to truly achieve MSW management. The goal should not only be recycling but overall MSW management such that it best contributes to the conservation. The evidence presented through the literature reviews suggests the importance of looking at a wide array of variables including MSW generation, recycling information from around the world, recycling programs, factors contribution to recycling behavior as well as socio-economic and demographic characteristics in order to evaluate what factors influence a household's decision to recycle and what is the best option for a dynamic fast growing city like Dubai.

Chapter 3.Methodology

Research, as suggested by the term can be broadly defined as the “search” for information or knowledge, conducted with an open mind using various systematic methods. Research methods are varied and often specific to the subject matter being researched and the results being sought. The following chapter explains the approach selected to study and evaluate the concept of solid waste recycling and surrounding issues, and the method adopted to finally arrive at the proposed recycling program for Dubai. This chapter highlights the strengths and weaknesses of the selected methodologies and describes each stage of the methodology used in this dissertation, which include the literature review method, the survey method, the interview method and the final design of the proposed recycling program. This chapter will determine the way forward applying the strategic methods described below.

3.1. Applied Research Methods

3.1.1. Literature Review Method

A literature review approach can be described as the process of reading, analyzing, evaluating, and summarizing scholarly materials already existing about the specific topic being researched that are presented by other experts in the field. Literature reviews are seen as the foundation or prerequisite to any other form of research, experiment, pilot study or field experiment. Information from primary and secondary sources published within the past 15 years have been used in the form of academic journals from online library’s, books, online articles, news articles, blogs and papers presented at international forums. A literature review approach will begin with the study of existing literature relevant to the topic, which have employed a variety of research methods. Studying a wide range of papers with conflicting points of view is extremely important to serve as a counter check on the methodology and results. For example, Kinnaman (2006) investigate the reasons for the growth and popularity of recycling where as Lave and Hendrickson (1999) question the true value of recycling suggesting recycling as an option only where environmental impacts and the resources required to collect, sort, and recycle a material are all less than the environmental impacts and resources needed to provide equivalent virgin material plus the resources needed in the disposal of postconsumer materials. A literature review is organized around the ideas of the researcher, as they aid in counterchecking the central idea of ones own dissertation. In this dissertation a narrative literature review has been presented by dividing the information into themes or categories wherein distinct ideas from the literature are discussed.

The literature review must also be wide in its selection of subject matter as seen in Chapter 2 of this dissertation. The papers selected for the literature review cover the central question of recycling and its value from several angles such as its origins, reasons for its growth, dangers associated with conventional disposal of waste, recycling programs from around the world and recycling types among others. The study of a wide range of papers on the subject helps to clarify the relationship between this research and the work that has previously been done. Literature reviews can be conducted with different approaches as seen in the paper by Frank Ackerman (2005) “Material Flows for a Sustainable City” where he uses a historical perspective to describe the importance of managing of municipal solid waste, where as Terazono et al (2005) describe the influences of economic growth and urbanization, on environmental issues and the current state of waste management in Asia with a very factual descriptive approach. Knowledge so generated from many disciplines in relation to the subject is then integrated in order to formulate a suitable research question, for quality and depth. The research question in this dissertation being the selection of an appropriate recycling program for Dubai based on a review of the successes of other such similar programs existing elsewhere. While several papers were studied and reviewed for this research, only papers that are directly related to the central subject are presented in the literature review in order to narrow the presentation of studies to the research question. Other papers that

were influential but were not mentioned directly in this dissertation are listed in the bibliography. This was done in order to keep the paper crisp and specific to the point. The selected papers were reviewed and the information appraised, applying the principles of analysis to identify unbiased information and conclusions. The literature review is written to read more like a discursive prose presenting facts, highlighting areas of ambiguous information, answering the research question in factual terms and ending with an unbiased conclusion. The main components of an explicit literature review based dissertation are “introduction”, “background”, “methodology” “results”, “discussion” and “conclusion”, although these can be elaborated or combined according to the type of paper and discipline.

The advantages of the literature review method in relation to this dissertation are as follows:

1. Literature reviews are versatile and can be conducted for almost any topic in any part of the world with the availability of e – libraries/online databases that have a wide range of quality publications.
2. Literature reviews are relatively inexpensive and a large amount of data can be collected in a short amount of time at minimal cost.
3. Literature reviews allow us to learn from other researchers' experiences and provide information ahead of time allowing us to implement specific responses with the knowledge of both the advantages and disadvantages of our choice of response.
4. A well-written article can serve as a guide in writing the paper, thus avoiding common pitfalls of writing research papers.

Despite the advantages of the literature review method, its reliability and validity remain in doubt as in many types of research. The limitations of this approach can be described as follows:

1. Literature reviews are limited to collecting information about what has happened in the past, and usually within the researchers own workplace.
2. In this method the researcher is not in full control of the variables and is open to subjective researcher bias.
3. Often funding and research grants cause researchers to manipulate their results to suit their paymasters.

As the literature review here was more of a narrative review, the primary focus was on the conclusions reached in various studies. These conclusions were required to arrive at the selection of a recycling program that would best suit local conditions, as similar examples of recycling in the Middle East were not available. There is extremely little information and data on recycling or its related components for the Middle East, let alone Dubai. It was also not possible to find studies with ‘exact replications’ and ‘precisely the same’ methods, approaches and results for a true comparison. Thus studies were selected that were ‘almost’ the same or relevant, and from there, conclusions were drawn. The methodology chapter in this dissertation has been placed after the literature review chapter and ahead of the detailed description of the various components of “Recycling” in order to retain the advantages of the detailed subjective narrative qualified by facts and data. The literature review has been presented in two parts : the formal literature review presented in Chapter 2 which reviewed a number of academic journals on various topics related to recycling with a broader perspective and the more informal literature review of recycling components and programs presented in Chapter 4 & Chapter 5 which presented more specific ,targeted information leading to the design of the proposed recycling program for Dubai.

The literature review has shed light on the value of recycling, the current status of recycling around the world, the pros and cons of recycling, the motivators and inhibitors of recycling, the various types and programs available for solid waste recycling and statistics from around the world. Data analysis focused on listing and comparing methods and programs available from around the world and selecting the most

suited combination as a program for Dubai. For example, information on recycling from the developed world was compared to that from the developing world to obtain new ideas and understandings from the evidence of a commitment to recycling and a lack of it. Information from countries like Japan and Korea indicate “next steps” as these countries have recently implemented recycling strategies that could inform selections for Dubai as seen in the paper by Terzano et al. (2005). Terazono et al. (2005) highlight the fact that each Asian country has its own background and characteristics in relation to solid waste management and material-cycle policy, even though they share the same global region making it rather difficult to define a cohesive Asian MSW strategy, this is very similar to the environment in the Middle East, this information serves to define the current problem in a more definitive manner. In order to achieve a more comprehensive and specific result in this research, the literature review method was combined with the survey method and interview method. Each of these methods add value to the dissertation and are detailed in the following sections.

3.1.2. Survey Research Method

In its strictest sense, survey research method is a quantitative research method that involves the use of questionnaires and/or statistical surveys to gather data or information about a particular experiment, phenomenon or behavior. Survey research is dynamic and serves almost any discipline. Glasgow (2005) quotes Isaac & Michael (1997) in saying that survey research is used: “to answer questions that have been raised, to solve problems that have been posed or observed, to assess needs and set goals, to determine whether or not specific objectives have been met, to establish baselines against which future comparisons can be made, to analyze trends across time, and generally, to describe what exists, in what amount, and in what context.” In this research method, independent and dependent variables are used to define the scope of study, but are not under the control of the researcher. In addition, there are several options in choosing the survey media, some common types being written surveys, verbal surveys, telephone surveys, face – face surveys, computer surveys/e-surveys, example surveys and mixed mode surveys. The actual survey in itself is a simple data collection tool. The term “survey instrument” is often used to distinguish the survey tool from the survey research that it is designed to support (Glasgow, 2005). In this case, the survey instrument is a web-based e-survey or an Internet based survey conducted with the help of free online software by SurveyGizmo.com. A web based survey is one in which the actual survey questionnaire physically resides on a network server or the Internet and that can be accessed only through a Web browser. An e – survey can be defined as one in which a computer plays a major role in both the delivery of a survey to potential respondents and the collection of survey data from actual respondents (Jansen et al., 2007)

Surveys are capable of obtaining information from large samples of the population. The type of survey used for the purpose of this dissertation is cross-sectional survey – these are surveys that are used to gather information on a population at a single point in time. The survey is described in detail in Chapter 6, the current chapter describes this aspect of the dissertation briefly in order to avoid duplication of information. The most important components of a survey are survey design, sample size, statistical power, and degree of precision. In an ideal situation, the sample must be large enough to yield the desired level of representation, the survey questions must be accurate to obtain unambiguous responses, the statistics generated must support the research question and care must be taken to ensure the results are accurate. Experts in the measurement sciences should ideally develop survey instruments, however the e - survey used in this dissertation is used as an informal indication of the general population’s attitude towards recycling, to provide an indication or support or opposition to the concept.

The advantages of e- surveys are stated below:

1. Turnaround time of e – surveys are very quick and a large number of respondents can be reached easily.

2. Questionnaire formats are available on line that are easy to use and save time.
3. Data can be captured efficiently and directly into the database and reports generated automatically, avoiding human errors.
4. IP addresses can be tracked in order to check authenticity of diversity in responses.
5. Confidentiality can be maintained and customized surveys issued simultaneously.
6. E – surveys are relatively inexpensive, can be administered even in remote locations and are flexible.

The main disadvantages of the E survey method are:

1. The data obtained through e - surveys are often very general and is open to manipulation or untruthful answers, or even responses by non – target participants.
2. There is a potential for limited access within target population, software compatibility issues or Internet problems causing decreased return rate.
3. Return rate could be adversely affected by respondent’s comfort level with the software, increasing incomplete response rate.
4. Self-selected web surveys are open to biased samples and provide little control over the sample.
5. As in any survey, the validity of the data is a matter of concern with e – surveys as well. For example, in the internet based survey conducted by Berkner and Celusnak (2010) for their paper titled “Predicted Recycling Bin Usage in Apartment Complexes”, 182 responses were received. This experiment was conducted on a college campus; however, the researchers could not guarantee that the target respondents answered the survey personally as these were e – surveys and if respondents answered more than one e – survey, as IP address tracking was not implemented in this survey. A similar issue was experienced during the survey conducted for this dissertation. The responses were tracked to the point of origin, and though only UAE residents were targeted, some responses were tracked to USA and South Africa. Upon investigation it was revealed that the respondents were travelling at the time of the survey and accessed the survey from their location out of the UAE. Such challenges are inherent with e – surveys.

The purpose of the e – survey within this dissertation was to reach the respondents quickly and inexpensively to obtain a general idea of their attitude towards recycling as no such experiment has been conducted in Dubai till date. The results obtained incurred virtually no coding or data-entry costs because the data was captured electronically, the survey was fast and provided a general perspective that was required for the design of the recycling program. A detailed analysis of the results is provided in Chapter 6. The e – survey was conducted as part of a 3 step research plan that included a detailed literature review as well as personal interviews conducted with high level stakeholders in the field. Each of these methods serve as a counter check on each of the other methods in arriving at a valid conclusion.

3.1.3. Interview/Feedback Research Method

An interview research method is a variation of the survey research method where the researcher may administer the survey to the respondent directly or indirectly. Interview surveys can be used to pursue in-depth information around the topic or can be used as a follow-up to certain questionnaires, e.g., to further investigate an issue (McNamara, 1999). While there are several approaches to an interview survey, the method used for this dissertation is the general interview guide approach wherein the same general areas of information are discussed and responses collected from each interviewee; this is a more focused approach than a conversational approach, but still allows a degree of freedom and adaptability in getting the information from the interviewee.

The advantages of the interview survey method are:

1. Interviews are a more personal form of research than questionnaires and allows for explanation of responses, which provides greater information to the researcher.

2. Interviews are particularly suited to obtain opinions on complex issues where a variety of responses could be appropriate, this method allows the researcher the opportunity to probe or ask follow up questions.
3. This is a more suited method for obtaining responses from high-level respondents who cannot be asked to fill a survey questionnaire for reasons of power, position or prestige.
4. Interview surveys provide a form of primary data that better qualifies the research as the interviews can be targeted to specific respondents that can provide the required level of guidance or data.

The disadvantages of the interview survey method can be:

1. Interview surveys are time consuming and resource intensive.
2. The interviewer is considered a part of the measurement instrument and interviewer has to be well trained in how to respond to any contingency (McNamara, 1999).
3. Since the interviewer can control the result of the interview there is a high propensity for researcher bias, advertently or inadvertently.
4. It is often very difficult to obtain interviews with top level individuals, which could delay the research.
5. There are several ethical issues with regard to interviews and the researcher must plan ahead and be careful to avoid issues of violation of privacy, illegal content, disclosure of privileged information, sampling bias and intentional manipulation of interviewees.

Having looked at the available research evidence concerning the use of interviews, it is clear that there are varying types of interviews as well as various styles an interview can take. The interview survey method for this dissertation was selected to obtain feedback on the proposed recycling program by experts in the field who met specific criteria. The target respondents for the interviews were top executives within the recycling stakeholders in Dubai with a high level of experience in the subject. All interviewees were asked the same set of questions further to an explanation on the background of the study and why the study was important. The sample selection included the Envirocare Manager of Tadweer, Dubai's largest MRF, The Director of Waste at the Dubai Municipality, Director of Chemical & Hazardous Waste at the Ministry of Environment and Water, Chairperson of the Emirates Environmental Group and a top level Executive of the Dubai Carbon Centre of Excellence, who had the added advantage of previously heading Resource Recovery for the United Nations. These individuals were selected to review the proposed short term and medium policies and provide feedback on the validity, value and potential of the proposed recycling program. Interviews were set up by phone, and conducted one on one at the offices of the said individuals. Every effort was made to not usher or influence the responses by the interviewees. Feedback was collated, tabulated and presented with critical analysis towards the end of the dissertation. Responses were recorded in brief hand written notes on paper, but not recorded electronically as some of the respondents were not comfortable with speaking on tape. The feedback from the interviewees was instrumental in shaping the final recycling program for Dubai, which took into account any suggestions, improvements and advice received. The amended recycling program reflects changes in five of the core program policies reflecting the depth of the discussion and application of practical advice that originated from suggestions, objections or concerns that were raised by the respondents.

The contributions of the interview method were invaluable to the research as the collective practical experiences of the sample group determined the design of the final recycling program. Their understanding of the subject in relation to Dubai provided primary information that would not have been available otherwise. The other methods as stated above i.e., the literature review method and the e – survey method are used along with the interview method to allow for more accurate results and greater understanding.

3.2. Selection and justification of research methodology for this Dissertation

This section selects and justifies the most appropriate research methodology in order to reach the aim and objectives of this dissertation. The primary aim of this dissertation is to devise the most suitable recycling program for Dubai, other objectives were to gain an understanding of the subject of recycling itself and an obtaining an idea of the attitude of residents towards recycling.

Although the experimental research method (one in which authors/investigators conduct/participate in experiments and control one or more elements of experiments to determine their effect on the outcome of the subject being investigated) is possible the most suited method for generating primary data, this method was not appropriate for this research. The advantages of this method are that the researcher has control of the variables, the data collected is primary data and it provides for greater transferability. The disadvantages of this method are that it is expensive, time consuming, is subject to human error and is open to personal biases of the researcher. In addition, the pilot or sample may not be truly representative of the issue and the results may be hard to replicate. With regard to this research, the greatest limitation of the experimental method would have been the cost and time factor. While other research methods could have been applied such as exploratory research, constructive research or empirical research, the research methodology selected seems the most appropriate and logical to arrive at the required conclusion. The literature review in this dissertation does however study a number of academic journals based on the experimental method and takes advantage of the primary data so generated such as Woodbury & Mariani (2008), Schultz (1999), Kronrod et al. (2012) and David and Louis et al (2004) among others. Table 3.1 shows a comparison of reviewed methodological approaches with specific advantages of each method in relation to this research. Sections 3.1.1, 3.1.2 and 3.1.3 have already listed the specific advantages of each of the selected methods in relation to the research question; Table 3.1 offers a quick view on the subject.

The most suited methodology to reach the aims and objectives of this dissertation therefore was the literature review method coupled with the two types survey methods. This would result in the application of qualitative as well as quantitative approaches. Multiple research approaches were used in this research as they can capitalise on the strengths of each approach and offset their different weaknesses. The idea was to select a combination of methods that could provide more comprehensive answers to research questions, going beyond the limitations of a single approach thus providing a basis for triangulation. Literature reviews in Chapter 2 and the detailed explanation of the various aspects of recycling and recycling programs in Chapter 4 and 5 provide a basis for selection of the best recycling program for Dubai by highlighting the advantages and disadvantages of each approach. The literature review enables the outlining of a variety of theoretical positions held by key writers in the area. The e survey as detailed in Chapter 6 sheds light on the attitude and understanding that Dubai residents have towards recycling. The interviews provide data that help define the complexities of making judgments about the suitability of the proposed recycling program. The proposed recycling program is presented in Chapter 7, which also lists the interviews conducted as part of the interview method that obtains feedback validating the proposed recycling program. This chapter concludes with the proposal of the revised recycling program. Conclusions and avenues for future research are presented in Chapter 8 of the dissertation.

The above listed combination methods are further enhanced by an informal financial calculation of the value of recycling and its potential for Dubai. The purpose of this brief financial perspective is to open avenues for future research into the complex matter of introducing recycling into the Dubai context. This provides a significant perspective on information specific to this region for which there is very negligible precedent. The combination of approaches used in the methodology of this dissertation thus results in the selection of a suitable recycling program for Dubai.

Table 3.1: Comparison of reviewed methodological approaches.

	Effectiveness	Time	Cost	Specific Advantage
Literature Review Method	Effective	Reasonable	Reasonable	Relatively Inexpensive and a large amount of data to specific topics can be collected in a short time.
Experimental Research Method	Very Effective	More Time Required	High	Researcher has greater control on variables & provides for greater transferability (of primary data)
Survey Research Method	Very Effective	More Time Required	Higher than Literature Review Method	Relatively inexpensive, yet can obtain primary data that is statistically significant.

The methodological process of Literature Review method, Survey Method and Interview method includes researching and collecting appropriate information, ensilsting the various approaches to the same central issue, comparing data, analyzing data, designing a survey, obtaining supporting data with information from the results of the survey and feedback and analyzing the resultant findings to lead to the final conclusion.

The steps of this dissertation can be listed as follows:

- Introduction and presentation of historical background on the subject of solid domestic waste recycling.
- Identification of research aims and objectives.
- Gathering broad range data through literature review.
- Explaining the methodology for this dissertation.
- Enumeration of specific targeted information on the various components of recycling.
- Design and issue of e-survey questionnaire.
- Collation and evaluation of data from the e - survey.
- Presentation of proposed recycling programs and policies.
- Feedback through interviews of key respondants.
- Analysis of interview responses and revision of final proposal.
- Conclusions and presentation of avenues for future research.

**Chapter 4. Recycling Types, Recycling Program
Components and
Recycling Stakeholders in Dubai.**

It appears that the recycling industry is a rather young industry only emerging as a practical business model in the 1990s. The key to achieving environmental and economic benefits of recycling is to keep a material circulating for as many product lives as possible thus preventing or reducing the demand on virgin materials (Morawski, 2009). The Institute of Scrap Recycling Industries (ISRI) a leading trade association of the recycling industry claims that the industry generated \$54 billion in sales in 2009 alone. A report from Waste Management Inc. indicates that recycling efforts would double by 2020 in the U.S alone. The company says that this figure is achievable by developing an array of single-stream recycling facilities, which are expected to increase citizen participation. This is based on their observation that single-stream recycling accounts for a 30 percent increase in the collected recyclables (Business & The Environment, 2009). While there are several different recycling methods offered around the world, the most popular types of recycling are single stream recycling also known as fully co – mingled recycling and dual stream recycling, known as source separated recycling. Both single stream recycling and dual stream recycling are featured within the various types of curbside recycling programs. This chapter also describes the various components of a well-planned recycling program, as the design of the program is often directly linked to the success of the program.

4.1. Single Stream Recycling

Single stream Recycling also known as “fully co-mingled” or “single-sort” recycling, a method in which all waste such as paper, fabrics, cardboard, packaging, plastics, glass and metals, are disposed off mixed together in a collection truck, instead of being sorted into separate waste disposal tracks by the resident i.e. citizens are allowed to put all of their recyclable material in one bin, organic household wastes will still need to be separated. The single stream system is designed in such a way that the collection and processing of materials fully support comingled wastes. In this method any material recovery happens at the materials recovery facility (MRF). J. Johnson of Waste News quotes, Michael Benedetto, Vice President of Tidewater Fibre Corp., USA, as having said that “We can utilize fewer, larger containers, and collect more tons for less money,” with the single stream system (Johnson, 2002). Solid Waste Association of North America (SWANA) reports that by 2007, over one-third of the US population was recycling single stream, with curbside recycling. This process has its share of pros and cons. The main advantages of single stream recycling are:

1. Reduced sorting effort for resident’s which aids in increased participation, as the residents do not have to pick, sort and take items to various recycle centers or hang on to wastes for disposal on set dates.
2. Reduced collection costs because this method requires single compartment trucks that can be automated, and are believed to be cheaper to purchase. With more compartments in a truck, one compartment often fills up before the other and the trucks have to go back to the MRF’s, without full capacity which increases time and costs. Larger trucks can be purchased and increased amounts of wastes collected for the same effort in the single stream system.
3. Also a single large bin can be provided to residents instead of several bins for different items, which reduces capital costs.
4. Efficiency is improved due to automated collections systems and decreased number of bins per household.

The greatest disadvantage however of single stream recycling is said to be the contamination of recyclable materials by non-recyclable materials, particularly for paper and glass, as a result of which recovered papers have to be down cycled i.e. used to create cardboard or packaging as opposed to being used to manufacture fresh paper. CIWMB (2003) states that single-stream increases contamination rates causing some recyclable materials to be diverted back to the waste stream. Glass

is also affected in this system due to breakage. Morawski (2009) reports in her paper for the Container Recycling Institute (2009) that 40% of glass from single-stream collection winds up in landfills, while 20% is small broken glass which ends up being used for low-end applications and only 40% is recycled into containers and fiberglass, where as in Dual Stream recycling, an average yield of 90% is seen for glass alone. Another disadvantage of the single stream approach is that it insulates citizens and authorities alike from the true responsibility of recycling, as it does not promote education and action (EPA). Single stream recycling also sees increased processing costs due to contamination as a result of which extreme care and cost go into the separation at MRF's because, if they produce materials that are highly contaminated, it is considered un-reusable garbage (Morawski, 2009). The implication of contamination can be better understood in an article by Jim Johnson for Waste News where George Elder, VP of SP Recycling Plant, Atlanta, is quoted saying "Even with a 1 percent contamination rate in recycled fiber collected in single-stream recycling, Elder's company would lose \$1 million per year". Some experts say the issue of contamination can be mitigated to a certain extent if the collector and processor are the same company (Johnson, 2002). Jim Johnson also reports that in single stream recycling, higher percentages of residuals i.e. contaminated materials are created and for certain items the contamination rate is at least 16 percent.

Either way, single stream recycling appears to be gaining popularity the world over probably because of the ease of operation. Solid Waste Association of North America (SWANA) in a presentation to the EPA in 2007 reported that the number of single stream MRF's in the US had gone up to 160 from a mere 70 in 2003. The report concluded that even though single stream recycling reduces collection costs, it increases processing costs (EPA). Figure 4.1 indicates the growth in single stream recycling between 2007 and 2010 in the US.

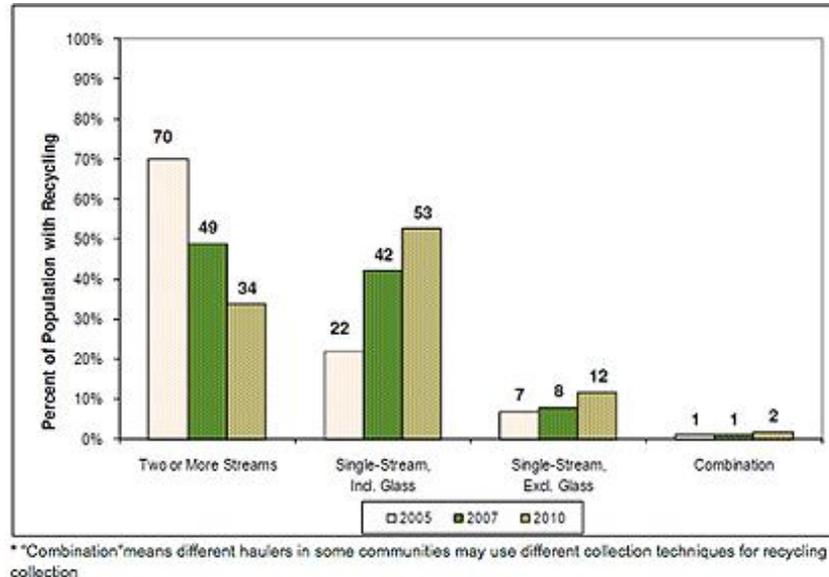


Figure 4.1: Growth in Single stream Recycling in the US between 2007 - 2010 (http://www.paperrecycles.org/news/exec_summ_2010.html)

According to a new study conducted for AF&PA by R.W. Beck, single stream recycling collection is on the rise. The Glass Packaging Institute says in 2005, only 29 percent of the population with recycling had access to a single-stream program, but this number had grown to 64% by

2010(gpi.org). The two major factors that have contributed to this growth according to Lisa Skumatz, principal and founder of Skumatz Economic Research Associates Inc.(USA) is the support for single stream approach from sophisticated MRF owners with good funding and the significant cost savings from more-efficient single stream collection (Schaffer, 2009), Wang (2006) through multiple regression analyses showed that a single-stream program significantly increases the amount of recyclable materials set out at the curb. This idea is supported by Stuart Oskamp's (1996) study on cities in southern California where he concluded that single-stream programs dramatically increase the number of participating households and volume collected due to greater convenience factor.

4.2.Dual Stream Recycling

Dual stream recycling also known as “multi stream recycling” a process in which there are 2 separate streams for collection, one for cans and bottles (1st stream) and the other for paper products (2nd stream). In this system, citizens have to separate the trash themselves in separate bins or bags. A variation of dual stream recycling is “source separated recycling” wherein individual containers are used to collect separate streams such as glass, metal, plastic, newsprint, and magazines. This is similar to dual stream recycling but with additional streams which vary among service providers. The separated trash is then collected in trucks that are compartmentalized to keep the items separate for processing at the MRF. The advantages of dual stream recycling are:

- Dual Stream Recycling minimizes contamination particularly for paper – as paper is collected separately in this approach, it remains clean, untouched by organic or other wastes that renders its quality content for recycling. This is one of the greatest advantages of dual stream recycling.
- Similarly glass shows reduced breakages with dual stream recycling thereby increasing recycling rates and returns. Dual stream recycling, on an average shows a yield of 90% as seen for glass alone, whereas a 40% yield seen in single stream recycling (Morawski, 2009).
- The compartmentalized trucks used in dual stream recycling are seen as more versatile. Depending on a hauler's needs, they can be used to pick up a variety of materials such as dry waste, refuse, recyclables, yard trimmings or any type of combinations of materials (Garnham, 1997). Recovered resources are more valuable and result in higher financial returns. Experts believe that this is an essential part of closing the loop as recovery of better quality materials reduces the demand on virgin material.
- Processing times are reduced in this system as citizens have source separated the recyclables already, as a result MRF's are able to do a final sorting at a much faster rate. In the dual stream system, due to separation of materials and compartmentalized transportation to MRF's, they remain uncontaminated, hence the residuals are also much reduced. Figure 4.2 by the Solid & Hazardous Waste Education Centre, USA (SHWEC) indicates comparative rates for generation of residuals within the different recycling approaches, showing a vast difference between single stream and dual stream in terms of residuals.

The disadvantages of Dual Stream recycling can be listed as follows:

- This type of recycling is more labor intensive for citizens as well as collectors with citizens having to sort their rubbish prior to disposal, and collectors having to collect and place items in separate compartments in the trucks.
- Collection efficiency is reduced as each collection takes longer due to separate bins that need to be emptied and when one compartment in the truck gets filled up ahead of the others, the truck would have to return to the MRF for offloading before continuing.
- Compartmentalized trucks are larger and so more often than not they cannot access the smaller streets. Compartment limitations of the trucks prevent expansion of materials being recycled. And

according to one comparison cited by Schaffer (2009) in his article for american metal market an automated single-stream truck can stop at 171 households an hour vs. just 130 for a dual-stream configuration. Therefore the question of efficiency with compartmentalized trucks can be viewed as a disadvantage.

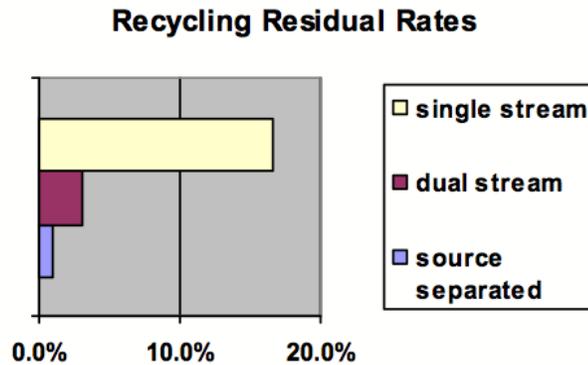


Figure 4.2 Residual rates of Single, Dual and source stream Recycling in the US between 2000 and 2005 (Solid & Hazardous Waste Education Centre, Wisconsin)

Schaffer (2009) assesses the proliferation of the single-stream approach in recycling in the U.S. ultimately concluding that it is the strategies and investment choices of material recovery facilities (MRF) that determine whether or not a single-stream product matches the quality standards of dual-stream facilities. Ackerman (2005) citing a case study by I.G Masaon et al. (2003) supports the value of source separation: this system was introduced at a New Zealand university campus of 9000 students and is centered around the kitchen/cafeteria and concourse over a 5 week in-semester period. A cross contamination analysis at the end of the study showed that improved source separation performance could increase the recycle rate to 88% for the kitchen/cafeteria residuals stream and to 84% in the concourse area (Mason et al., 2003).

Single stream recycling and dual stream recycling bit have their supporters and opponents, it is the subject of hot debate at conferences and industry gatherings but the jury is still out on the issue. It is safe to say however, that each method has it own advantages and disadvantages and a choice needs to be made by citizens, governments and city officials as to the most suitable program for each city/country. Considering land filling or incineration is the option, recycling should undoubtedly be the responsible waste management solution.

4.2. Recycling Program Components

The first national Earth Day celebration held in 1970 introduced the world to anti-litter campaigns, gave birth to the federal Environmental Protection Agency (EPA), and a few municipal and corporate recycling programs. From its humble beginnings recycling has now grown from a good idea to a regulatory requirement in some parts of the world. The EPA states that there are approximately 8,660 curbside recycling programs in the US alone as of 2006. In order to support recycling projects it is important to try to understand who recycles, how they recycle, and why they recycle. On a macro level, decisions regarding buying a recycled product may be impacted more by values, attitudes, and norms than by traditional price and product evaluations. The success of a recycling program depends on several factors, starting with how the program has been designed, or more specifically the components that make up the program. A good recycling program complies with the law, reduces

waste through a combination of source reduction and recycling, and saves natural resources through procurement & promotion of recycled products. Ideally a successful recycling program should see a product go through the three fundamental stages of:

- Proper collection of recyclable materials from the waste stream,
- Processing of the salvaged materials into new products,
- Sale or purchase of products containing recycled materials produced reducing the demand on virgin materials.

The demographics of a community determine the type of materials the program can target and the type of collection and education programs that can be promoted. Further to an understanding of the demographics, a goal can be established, around which the program generators can determine whether to increase, decrease or modify efforts, costs, reach, marketing and other components that make up the program. Goals must be in proportion to potential, For example, If 50 percent of the waste stream consists of paper and only 5 % is glass, then the recycle goal must focus more on recycling paper. The parameters for recycling models differ based on their application, i.e. a residential or institutional recycling program requires a different approach than does a commercial recycling program. The US government's 1993 Office Recycling Program Guide notes the five basic, interconnected components of a comprehensive recycling program to be: **education, collection, marketing, procurement, monitoring and evaluation** (Malonis & Cengage, 2000) These 5 basic components can be applied to a variety of or possibly all recycling programs as the basics.

Education should include education for leaders, operators and participants of the program. This could be achieved by companies, or community leaders preparing and distributing information packets or recycling kits or by employing environmental consultants to perform this function. Education must cover all grounds such as why should one recycle, what can be recycled and how items can be recycled. Education and outreach must also be a constant and provided with a variety of approaches .The most important aspect being that knowledge of methods, values and benefits of recycling must be communicated to participants. Iyer & Kashyap (2007) in their paper on Consumer Recycling conclude hat “either intervention program is effective, although informational programs appear to have more long-term effects than incentive programs”.

Collecting, processing, and marketing are essentially functions that need to work in harmony with local laws and MSW regulations. These could either be government run or privately managed. Collection technique plays an important role; the US EPA is of the opinion that there must be one drop-off location for every 3,000 to 3,500 people in a drop-off recycling program. Although larger bins and roll carts are preferred for curbside recycling, the EPA recommends a minimum size of 18-gallon plastic bin per household for curbside recycling programs. In each case, a good recycling program should stress on source reduction as it precludes waste management and its costs. Collection comprises separating, gathering, and storing recyclables from trash at their source. Although more and more programs are adopting single stream recycling, source separated recycling is the most beneficial for actual reuse, recycling of collected items as they are preserved in better condition with minimized contamination.

Marketing the recyclable materials involves contracting environmental service providers to pick up the recyclable materials. The generators of the program or the local governing agency should establish an agreement with the recycling groups that clearly states how the landfill owner, workers, or cooperatives will interact with the buyers and how the products will be handled and profits shared. Sears, Roebuck and Company's packaging reduction program alone, implemented in 1995, saved the

retailer an estimated \$5 million annually (Encyclopedia of Business, 2nd Edition, Recycling Programs). As awareness increases; a product's recycled content or recyclability is an advantageous marketable feature. Businesses involved in the marketing of recycled products must learn to cultivate it. It is essential that links be forged between businesses, industries, local and international governments to expand markets for recyclables and companies that accept the materials for reprocessing and reuse should be provided a business advantage.

As demand is the basis for production, procurement could possibly be the most important aspect of a recycle program as it "closes the recycling loop" by the purchase and use of supplies made from recycled materials. A 1991 *Purchasing World* survey noted that while 87 percent of respondents collected materials for recycling, only half of the very same respondents' companies purchased products made from recycled materials for use in their own operations (Malonis & Cengage, 2000). There are over 4,500 recycled – content products available to buy and this number is growing. Communities must be educated in the value of buying recycled and governments can promote closing of the loop in their own purchasing programs and guidelines as a start.

Monitoring and evaluation of a program are the final components of a good recycling program as this step determines the actions required to either maintain the success of the programs or improve elements of the program to reach established goals over time. This aspect determines efficiency of the program. Marketing positive results at regular intervals maintains enthusiasm for the program. Monitoring also involves visual inspection on a regular basis of the level of contamination, condition of storage /signage areas, type and value of materials collected in the trashcans.

While there is a great focus on the importance of a well designed recycle program including all the basic components, of equal importance is government regulation and adequate enforcement of the above components. Evert & Pierce (1993) determined that while income per capita, cost of residual waste collection, collection frequency and separate curbside collection of organic waste were all influencing factors, mandatory participation in residential curbside recycling programs were more successful in collecting more material than voluntary participation. The basic components are key to a successful program but equally, it is necessary to establish other supporting conditions through the system design that would ultimately facilitate the desire to recycle within both commercial and residential recycle programs. Research has indicated in the past that even well motivated citizens could perform badly in source separation programs either due to force of habit or due to the lack of appropriate knowledge pertaining to specific tasks (Thøgersen, 1994). Another study by Peretz et.al in 2005 also noted that recycling participation rates are also known to be higher among cities that offered more convenient recycling programs, reaffirming the importance of a well set out recycling program. Increased participation is noticed where residents had a higher mean household income. This study reported that cities that had a higher participation rate employed a decision-making process known as 'collaborative learning'. They imposed sanctions for improper sorting of recyclable materials, indicating the importance of regulation, and had a larger non-minority population (Peretz et al., 2005).

In order for recycling programs to be successful not only from the perspective of the citizens, but also for cities and nations to run, they must be economically efficient to the generators. The ideal program would need to comprise minimum-cost recycling networks in which the recycler and generator have the flexibility to determine the optimal number and location of receiving centers. They must also have the liberty to determine the correct financial incentive to be offered in order to stimulate collection of used or unrecoverable products to a degree required for regulatory or fiscal

reasons. In simple terms this would mean that even the best program couldn't be successful if the government cannot afford it. Some research suggests that the optimization model could play an important role in the development of a long-term cost effective program. Cost effective development of these programs will require meticulous and comprehensive planning and a flexible program design to accommodate the uncertainties associated with projections and changes in costs over time in order to remain effective. Experience indicates that the largest expenses in recycling efforts are usually labor and hauling costs. For smaller programs source separation would result in more value for recovered items thus generating better revenue to justify the recycling effort. In smaller programs or within younger recycling programs, there must be great emphasis on the value of clean recovery as the marketplace for recycled materials is a buyer's market and marketability of products will suffer greatly if contaminated. An understanding of market forces is also key to remaining a successful recycling program. For instance Bigger (2005) explains in his article *Recycling: 9 steps to Success*, that a decade ago not many companies considered recycling fluorescent bulbs and other e-wastes. By 2005, however, fluorescent bulbs had become a mainstream recycled product and computers did not yet see aggressive recycling. Yet the US National Safety Council estimated that businesses and consumers would take 500 million computers out of regular use by the end of 2007 (Bigger, 2005). Thus, market savvy recycle program generators could prepare for such an eventuality and capitalize on the awareness.

A preferred option for a recycling program would be that it is formed as part of a flexible adaptable integrated waste management system, as opposed to small independent programs. A flexible program that is supported by a larger government body, or is part of the municipal waste management system can accommodate escalating costs for disposal, any potential landfill bans that may arise along the way. Often unexpected litigation that might change the definition of an item from acceptable in a landfill to no longer acceptable, or sudden re-labeling of commodities as hazardous could affect the very basis of the program. For example, Valerie Streit (2009) reported that in August 2009, a recycler in Georgia could expect to receive about \$160 for a ton for curbside recyclables, however the recession brought this down to about \$37 a ton. When the industry goes through a slump, it is essential to have the support of the city governments to continue to run their recycling services. At times like this the city could propose a fee increase to help make up for the plummeting value of recyclables and keep recycling programs alive. It is essential that careful consideration be put into the collections systems of a recycle program (Streit, 2009). A successful program should invest in cautious contract management, budget appropriately, stay sharp about receipt of revenue and due payments. Other important aspects are personnel management, scheduling of deliveries and shipping of materials that all in all form important components of a recycling program. A creative and flexible approach to recycling can generate many environmental and economic benefits. An interesting case study in Brazil showed that organizing scavenging or waste picking activities into recycling cooperatives has been very successful for the Brazilian Business Commitment for Recycling (CEMPRE) a non-profit organization dedicated to the promotion of recycling within the scope of integrated waste management. A study of their informal recycling (scavenging) as compared to the official recycle program revealed that the official curbside recycling program in the city of Curitiba, collected 800 tons of recyclables a month at a cost of \$180 per ton, while local catadores (scavengers or waste pickers) collected over 3,000 tons a month at no direct cost to the city. Thus a free market approach can often be more economical when integrated with government-run curbside collection programs. As a result of this the informal recyclers have been grouped into cooperatives to enable members to sell to larger dealers at higher prices (EPA, 2002). This model could be a great solution for developing nations where scavenging is still a part of overall waste collection activities

4.3. Recycling Stakeholders in Dubai

In Dubai, recycling is still in its early days, though we are starting to see a change, it needs to be accelerated in order to achieve measurable results. MSW accounts for about 10-15 per cent of all waste produced in the emirate and studies have shown that about 82 per cent of it is recyclable. For example in 2007, 3.35 million tons of municipal solid waste was produced but just 1.42 per cent of it was sorted, this is an appallingly low recycling rate compared to western counterparts (Bains, 2009). Reports suggest that an estimated 2.5 million tons of domestic waste that could have been recycled was sent to landfill in 2007 alone (Bains, 2009). Without the participation and commitment of the public, recycling of domestic waste will be impossible. The three primary steps required among citizens to commit to recycling are motivation, information, and the overcoming of practical obstacles to recycling. Naji al-Radhi, head of waste treatment at Dubai Municipality says that "Fifteen years ago, Al-Qusais landfill was far from the city, now it is within the city," "It is hard to operate a site within a city. It is causing us problems and people are complaining because now it is surrounded by either industrial premises or by labor accommodation" (Bains, 2009).

In one of its more recent initiatives, which has long been in the pipeline, yet to be implemented, the Ministry of Environment and Water has set a deadline for plastic bag manufacturers to produce biodegradable bags. Local manufacturers have been given until the end of 2011 to register as a company that produces biodegradable bags using a ministry approved ingredient that can be added to plastic bag production lines to make them biodegradable. While this is a step in the right direction, a lot more effort, energy, funds and education is required to truly bring recycling into the consciousness of the people. Dubai has the potential to run with the best recycling systems from around the world, thus setting a standard for the rest of the region to follow. The government and semi – government authorities that are involved in and partaking in the future of waste management and recycling in Dubai are:

4.3.1. Dubai Municipality

Dubai Municipality is the foremost authority on waste disposal and management in Dubai. The Dubai Municipality (DM) was established in 1954 by the Ruler of Dubai at the time, Rashid Bin Saeed Al Maktoum to fulfill the role of city planning, citizen services and upkeep of local facilities. The Municipality has now grown to employ over 15,000 staff working in 32 organizational units to become the major driving force behind the development process of Dubai City as a whole. The DM is not only in charge of the city's sanitation/ sewage and infrastructure but also comprises several other departments such as the Roads Department, Planning and Survey Department, Environment and Public Health Department and Financial Affairs Department. The Waste Management department of Dubai Municipality is responsible for collection and treatment of general waste and horticultural waste. The Waste management system has a fleet of 350 semi – automated waste collection trucks that collect waste from 22,000 distributed bins. Dubai Municipality has signed a contract with Tadweer Waste Treatment LLC for recycling municipal solid waste. Tadweer's waste processing capacity is estimated to be about 4000 tons per day. Dubai Municipality in association with Emirates Recycling LLC is dedicated to the recycling and recovery of the city's construction and demolition (C&D) waste. Emirates Recycling LLC is believed to have the capacity to recycle 9.5 million tones of waste per year. Clean Middle East reports that Dubai Municipality is also working with Emirates Recycling LLC to construct a waste plant that has the capacity to process 1200 waste tyres per hour and another plant being built in association with Cyclo that can recycle 3000 tons of waste oil per year (Clean Middle East). The article reports that the waste management department of Dubai Municipality has also recently commissioned a medical waste incinerator with the capacity to process 19.2 tons of medical waste per day. The article states that for high density hard to reach areas

DM utilizes the haul system to collect waste – a system in which a series of strategically located satellite transfer points are used to collect waste is collected in skips and stationary compactors, then transported directly to landfills. In 2011, DM conducted the “Clean up the World” campaign, the country’s largest voluntary clean up drive that was initiated in 1994 currently in its 18th year.

4.3.2.Tadweer

Tadweer is a 27 million dirham solid waste sorting and recycling centre. It is a 1 Km square, 500-worker strong private waste management company that processes 4000 tons of waste per day. Tadweer aims to “facilitate, affect and influence” positively legislation that pertains to the environment in the UAE as well as furthering corporate social responsibility. In addition to Tadweer’s association with Dubai Municipality for waste removal and processing, Tadweer also provides services such as design and operation of waste management plants, data analysis, technical review and studies pertaining to waste management, machinery orders, installations and operations and promotion of waste reduction in Dubai. Tadweer houses the Envirocare department that attempts to promote the 3 R’s through educational partnerships, industry leadership and promotion of source separation programs. Tadweer is now “producing alternative fuel, electricity through Waste -to-Energy, green products used in buildings, and the biological treatment of waste to produce compost”. An article about this facility provides that Tadweer has the capacity to produce 1000kw/hr of power through anaerobic digestion technology and through generators working with methane gas produced from the anaerobic process of waste digestion (AME Info, 2010).

4.3.3.Ministry of Environment and Water

The Ministry of Environment and Water (UAE) was established to achieve integrated management of the Environment Ecosystem and Natural resources and to realize a green economy for the present and the future of the region. In addition to the several activities with regards to their core missions, the MOEW is also involved in a mission to ban non-biodegradable plastic bags from the UAE by 2012 (Chernik, 2010). As part of the campaign - Emirates Free from Plastics, launched on 20th October 2009, an animated film will be produced to educate the larger population to limit the negative impacts of non-biodegradable plastic bags on human health, other living beings and the environment. Chernik (2010) reports the results of a survey conducted by the Ministry that indicated that 85 percent of UAE residents were aware of the dangers of plastic bag use but less than half were doing anything about it, although the same survey reported that 93% of the people in the UAE were willing to support efforts to reduce the use of plastic bags. This information goes a long way in planning environmental initiatives for reduction or recycling. The ministry also plans to execute this campaign in 2 phases inclusive of educational activities in school, seminars, field visits, workshops, cleaning campaigns and educational exhibitions (www.moew.gov.ae). The MOEW has also partnered with Enviroserve, to provide the Dubai silicon oasis with effective disposal and recycling of electronic scrap & mobile phones collected from its premises in its attempt to promote recycling (UAE Interact, 2010).

4.3.4.Telecommunications Regulation Authority

Mobile phones and accessories contain persistent, bio-accumulative concentrations of toxic heavy metals including cadmium, lead, nickel, mercury, manganese, lithium, zinc, arsenic, antimony, beryllium, and copper. When discarded improperly, they end up in landfills and can potentially contaminate the soil prior to entering the food chain. The Telecommunications Regulation Authority has established the UAE Telecoms Recycling campaign that manages the collection and recycling of old or broken mobile phones, which contain substances that are damaging to the planet. Partners of TRA - EnviroFone, then recycle these unwanted phones by placing collection boxes in several conveniently placed locations. In addition to rewards for phone drop offs, this campaign also fulfils a

larger social responsibility, i.e. for every phone collected and recycled, 5 AED will be donated to the charity organization Gulf for Good (www.tra.gov.ae).

4.3.5.Emirates Environmental Group

The Emirates Environmental Group is a non – profit organization established in 1991.It is a 1200 member strong group that includes individuals, corporate members, federal and local government agencies, universities, colleges, schools, and international institutions. The EEG is a member of the United Nations Global Compact and is a focal point for the Global Compact in the GCC States and also a member of the International Union for Conservation of Nature (IUCN). It is the first environmental NGO in the world to be awarded an ISO 14001. EEG is heavily involved in increasing recycling efforts and environmental protection throughout the UAE helping to divert thousands of tons of material away from the landfills and promoting recycled products. The EEG organizes educational community lectures and campaigns such as “Clean up UAE” that is said to have collected 100 tons of waste in the year 2010 alone. The EEG has also expanded its environmental efforts by supporting 'Plant for the Planet' under a movement called 'The Million Tree Campaign' initiated in 2007 which has now come to an end after reaching its goal of planting 2 million trees. This interactive campaign has led to over 2 million indigenous trees and plants to be planted across all areas of the UAE (AmeInfo, Jan2011). In the year 2008, the EEG collected 20.5 tons of aluminum cans in its 14th cycle of 'Can Collection Drive' organized simultaneously in all the seven emirates. The EEG, with the help of local businesses has organized recycling centers in convenient locations all over Dubai and continues to organize and conduct several campaigns (paper, glass, toner, Tetrapak, battery and can collection) in its endeavor to promote holistic living and respect for the environment.

The stakeholders listed above are the key players to contend, within the domestic solid waste setting in Dubai.Toplevel executives that represent the stakeholders have been selected as the respondents for the interview survey of this dissertation.

Chapter 5. Recycling Programs and Practices.

A wide range of waste management programs are detailed in this chapter that provide a framework for the selection of a recycling program for Dubai based on the pros and cons of each method. This chapter makes special mention of recycling in multifamily dwellings, as information on the subject is fragmented and difficult to obtain. Recycling in MFD's is particularly significant to Dubai, as a majority of the constructions in this part of the world comprises MFD's. The purpose of this detailed study on existing recycling programs is to take from past experiences of others on the subject and make effective selections while preparing a recycling program for Dubai. A comparison of recycling in various parts of the world is tabulated towards the end of the chapter laying the groundwork for the proposal of a recycling program for Dubai.

5.1.Waste Management Programs

Since the first Earth Day in 1970, several laws and regulations have been enacted that have proved to be beneficial to the environment. Unfortunately, the problem is that our population is ever increasing with the cumulative volume of MSW rapidly expanding with each passing year. With the number of landfills for all this waste to be discarded declining rapidly, recycling has proved to be a worthy option, second only to source reduction. While less trash to handle would significantly ease the situation, our current focus is the selection of an effective recycling program as part of overall management of MSW. In an extensive investigation by WRAP (UK) it was found that in 83% of all scenarios that included recycling, it was indeed better for the environment (The Economist, 2007). While most recycling programs are aimed at household waste collection, a study by the US EPA has indicated that 40% of all waste is generated in the workplace. Another important aspect of improved recycling is legislation; a comparison of the US and EU recycling rates indicates this difference. Figure 5.1 provides a comparison of recycling rates between the 2 continents, where as in Europe recycling is mandatory (incorporating various versions of the Green Dot system), the US has a federal hands-off approach leaving recycling to the private sector. The results are indicative of the success of each approach.

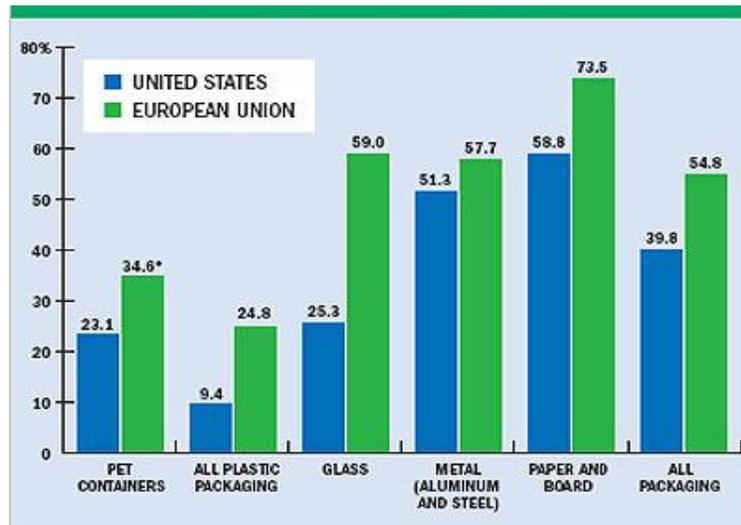


Figure 5.1: Comparison of recycling rates between the United States and the European Union,2005) (http://www.foodandbeveragepackaging.com/Articles/Supply_Chain_RFID/BNP_GUID_9-5-2006_A_1000000000000297542)

Recycling is the key component of modern waste reduction and the third component of the 3 R's: "Reduce, Reuse, Recycle" waste hierarchy. The most prominent recycling programs are curbside collection programs and unit or volume based programs. In countries where recycling is mandated by the state, legislative options have been implemented, these include, mandatory recycling collection, container deposit legislation, and refuse bans. Mandatory recycling involves setting targets for cities to meet where a certain percentage of material must be diverted from the city's waste stream by a target date and residents are required to recycle by law. Container deposit legislation offers a refund for the return of certain containers, typically glass, plastic, and metal. This refund is the return of a small surcharge that was added to the price when the item was purchased. Refuse ban functions by banning the disposal of certain materials as waste such as used oil, old batteries, tires and garden waste etc. thus creating a viable economy for proper disposal of such banned products.

An alternate approach to environmental regulation is the market-based instruments approach, which includes incentive based programs for waste management. Market-based instruments also known as economic or price-based policy instruments include charges, subsidies, tradable permits/points, deposit/refund systems, eco-labelling, licenses, and incentive programs. Incentives involve exchange of benefits between agencies, or agencies and individuals. Venner et al. (2009) stated that "The word incentive is defined as "something that incites or has a tendency to incite to determination or action," from Latin, "setting the tune, from *incentus*, past participle of *incinere* to play (a tune)." This suggests that incentives have a lot to do with harmonizing interests. Incentive based recycling programs are those in which residents are rewarded for their recycling efforts. They include variations such as point systems or coupon systems, rebates or tax - deductions that form the reward. Incentive-based approaches can be both voluntary and designed in conjunction with regulatory mandates. Economic-incentive instruments are regulations that encourage behavior through price signals rather than through explicit instructions on pollution control levels or methods (Hahn and Stavins, 1991). The value of incentives is further supported by the observation of recycling rates in the 11 US states with incentives that have an 80% rate of recycling cans and bottles, while the 39 states without the extrinsic incentives only recycle these items at a 46% rate (Container Recycling Institute, 2006). Other systems employed around the world include market-based tax systems that determine a maximum cost for control measures. In this system, polluters receive an incentive to reduce pollution at a lower cost than the tax rate. As there is no cap; the quantity of pollution reduced depends on the chosen tax rate. Other approaches used include the command -and -control policies, which specify uniform performance standards where specific goals must be met with a choice provided on how they are met. Technology based standards are those in which a particular equipment must be used by all firms to comply with regulation giving little flexibility to regulated firms. When managed appropriately, and in an ideal situation, recycling programs should cost less than garbage disposal for any given equivalent amount of material.

A 2006 Department for Environment, Food and Rural Affairs, UK (DEFRA) report qualifies the value of incentivized recycling through a 6 month pilot study that covered the five worst performing curbside collection areas, a total of 10 schools from these areas were selected for educational campaigns as part of the study. Schools were free to use methods of communication to promote recycling such as producing their own publicity materials, organizing events or setting up a recycling lottery. The incentive for schools to participate was the opportunity to win 1st, 2nd or 3rd prize for improving the amount of household waste collected on the curbside recycling round. Results or recycling tonnages were monitored in the pilot and an attitudinal survey was also completed. Figure 5.2 shows the results of the pilot comparing incentivized rounds with those in control areas. Over the trial period the average weekly tonnage collected in the control rounds increased by 6%, tonnages

collected in the pilot areas increased by 16% suggesting that the incentive increased collected tonnages by nearly 10% during the period of the pilot. While careful consideration of the replication potential of the impact of such a scheme would be required if it were to be introduced into other regions, it certainly provides for a good starting point.

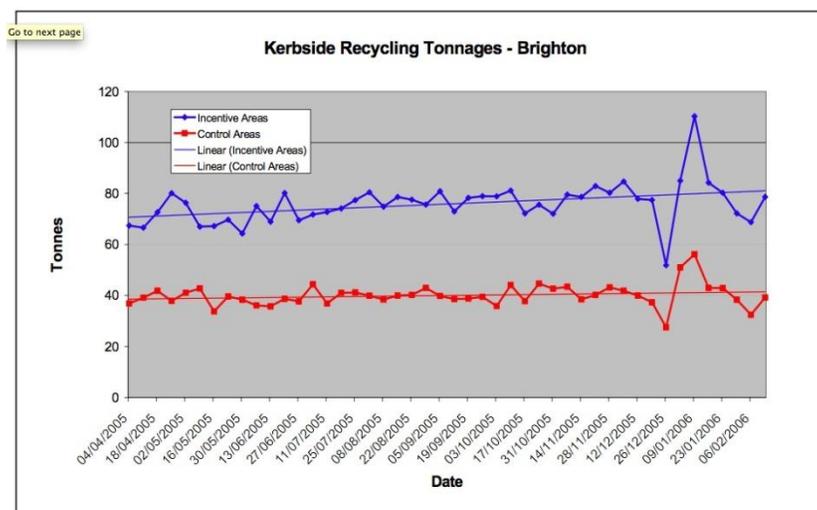


Figure 5.2: Recycling improvements in incentivized programs conducted in Brighton (UK) by a 2006 DEFRA pilot study. (<http://archive.defra.gov.uk/environment/waste/localauth/documents/aeat-appendix-southeast.pdf>)

The incentivized system is based on evidence that people are much more likely to recycle if they can see a benefit. This idea is supported by much research by experts in the field such as Ackerman (2005) Hong & Adams (1999), Iyer & Kashyap (2007), Halvorsen (2008) Thogersen (2003) Jheon Rhee (1998) Reschovsky & Stone (1994), Russo & Shah (1994) Canterbury (2005), Miranda (1996), Kelleher et al., (2005) and many others. Undoubtedly, the business of “trash” is an exceedingly complex reverse logistics operation. Our increased understanding of the effects of MSW on the environment has resulted in a whole host of environmental rules and regulations being implemented by governments and activists, sometimes adding significantly to the operating costs of MSW management. This chapter reviews some of the more popular and successful incentivized recycling programs seen around the world as a prequel to selecting a program for Dubai, UAE.

The various incentivized recycling programs discussed in detail in this chapter provide information on the permutations and combinations possible within recycling programs. The advantages and disadvantages of each type of recycling program are listed with rates of success and special features. A unique concept of zero packaging is also included, as it supports reduction, the highest order within the 3R’s. The programs described include:

1. Curbside Recycling
2. Pay as you Throw
3. Recyclbank
4. German Green Dot Program
5. Container Deposit Schemes
6. Bring Schemes

- 7. Cash for Trash
- 8. Tax Credits for Recycling
- 9. Mandatory Recycling
- 10. Zero Packaging Stores

5.2. Incentivized Recycling Programs

5.2.1. Curbside/Kerbside Recycling

Curbside recycling is usually a state or municipal run program (often in association with privately owned partners) that is operated to pick up a specific set of predetermined recyclable materials from households in urban and suburban areas. Curbside recycling service occurs at a regular interval, as determined by the municipal bodies usually weekly or bi-weekly. Curbside recycling programs can be volume based or weight based. This form of recycling is one of the most popular and convenient methods of recycling and serves half of the U.S. population (Earth911.com). A curbside recycling service provides the required bins to households from which workers of the municipality will collect recyclables. Curbside programs are meant to supplement, rather than replace, recycling centers. The most common items collected within curbside recycling are glass, plastic, aluminum, paper and steel: also known as the big five. Curbside recycling is implemented by either single stream recycling where recyclables are commingled, households do not have to separate any materials (they all go in one large bin) or dual stream recycling where containers go in one bin, and papers (such as newspaper, magazines and direct mail) go in another. Practices and collection methods vary widely between curbside programs. Fees for this service are collected through subscription fees, community maintenance fees, or even taxes. In some communities the charge for curbside recycling may not equal the full cost of providing the service, however it is still provided as a service to residents. The charges are often set based on a combination of costs and perceptions about appropriate levels for the service, to introduce the program to communities or because they receive government subsidies for the operation. Curbside collection, transportation, sorting, and processing costs average approximately \$2-\$7 per household per month (Beatty, 2007) Curbside collection programs based on volume or weight of mixed waste also score reasonably well on the environmental effectiveness and economic efficiency criteria (Turner, 1992) Figure 5.3 shows a typical curbside collection scheme where garbage is placed at the curb for collection. The advantages of curbside collection are:

1. Curbside collection of recyclable resources helps in recovering purer waste streams with higher market value due to separation of recyclables, minimizing contamination.
2. Curbside collection is based on convenience to the citizen and can be used to increase the public's awareness on recycling and waste reduction.
3. The convenience associated with this type of recycling usually results in improved participation rates.

The disadvantages of curbside collection are:

1. The large waste bins provided encourage “out of sight” attitude of increased waste generation.
2. This is a capital intensive program requiring intensive equipment and a large network of fleet and service providers and is considered an expensive recycling method (Beatty, 2007)
3. Many municipalities often reduce the frequency of both general waste and recyclables collections to manage costs leading to overflowing and fly tipping in the waste cans.
4. Some programs do not take all types of recyclables (eg. certain types of plastics, bottles, packaging) costing households additional time and effort to recycle these items. This could negatively affect the recycling motivation in a community.



Figure 5.3: Curbside Collection Containers (organics + paper) at the City of Lewiston, USA (<http://www.cityoflewiston.org/index.aspx?NID=311>)

In Australia, curbside collections service 87% of households (Australian Bureau of Statistics). Curbside collection and recycling encourages households to regard waste as a resource, which encourages separation in several communities. With advancement in technologies processing capacities have increased. In the UK, authorities provide every household with bins for separate collection of at least two types of recyclables. It is reported that 79% of households in the UK are now served by curbside schemes (POST). A number of communities in Japan have introduced or expanded curbside recycling programs with source-separated collection (Lease, 2002). Other popular variations within the curbside recycling program are:

1. Standardized Marked Bag Systems for Residential Garbage Pickup - where standardized marked bags are distributed by the municipality or can be purchased at any designated local retail store or municipal outlets. Some communities in Canada follow this practice called “yellow bag system”(Kelleher, 2005)
2. Weight-Based Systems for Residential Garbage Pickup - is a system in which the quantity of garbage generated by each household is measured as it is collected and households are billed on the basis of the total weight collected (EPA 2001). This system requires collection vehicles with electronic equipment to weigh each bag of garbage and record the address of the generator. This system is in operation in some communities in Ireland (Kelleher, 2005).

Woodard (2006) found after an analysis of 1400 samples in each category that participation rates of curbside programs are higher in schemes that collect more types of materials. Participation rates of 38%, 49% and 65% were observed in schemes that collected 1, 2 and 3 types of materials respectively. Jenkins (2000) have stated that introducing a curbside recycling program increases the probability of average households, recycling over 95 percent of glass and plastic bottles by more than 50 percent; aluminum by more than 39 percent; and yard waste and newspaper by around 25 percent. The researchers conclude that curbside recycling programs also have a bigger effect on behavior than drop-off programs.

5.2.2. Pay-as-you-Throw (PAYT)

The pay-as-you-throw (PAYT) program is also known as unit pricing or variable-rate pricing system, a variation of curbside recycling. In this program residents are charged for the collection of household trash based only on the amount of material they throw away. This is different from traditional methods in that it treats trash services just like electricity, gas, and other utilities. Households pay a variable rate depending on the amount of service they use on in this case, garbage they throw, thus providing an economic incentive to generate less waste. Waste is measured by weight or size while units are identified using different types of bags, tags or containers. This charge could be in the form of bag charge or weight of refuse charge.

The PAYT program is fully supported by the EPA as communities that have adopted the PAYT program have reported significant increases in recycling and reductions in waste (EPA). The USEPA states that this program promotes economic sustainability by helping communities pay for solid waste costs, environmental sustainability by encouraging them to recycle and reduce waste and equity by distributing costs more evenly among consumers. Household waste generation is positively related to household income so poorer families generating lesser waste will face lower waste collection charges under PAYT systems. These three factors are the most important advantages of the PAYT. Other advantages attributed to the PAYT are the conservation of natural resources as less needs to be extracted due to reduction and recycling and reduction of GHG's due to reduced manufacture, distribution, use, and subsequent disposal of products. Some residents also feel that PAYT is superior to standard incentivized recycle programs because standard incentive-based systems encourages you to discard more to obtain more reward points but in the pay-as-you-throw system, you only pay for what you throw meaning, residents are encouraged to throw less and pay less. Another advantage of the PAYT system is that they usually offer a variety of complementary programs such as support recycling programs, drop-off centers or curbside pickup and backyard composting programs. Canterbury (1998) found that the PAYT program in Dover, New Hampshire saved the city nearly \$300,000 in annual solid waste costs of which \$200,000 came from reduced collection costs alone. In addition collected trash decreased from 11,000 tons in 1991 (before PAYT) to 4,000 tons in 1998 (after PAYT) translating to a saving of \$45 in disposal per ton of garbage.

The biggest disadvantage of the system however, is that it could increase illegal dumping, unstable hauler revenues, waste compaction, negative impacts of variable fees on low-income residents, and service to multi-unit housings (Miranda, 1996). Other issues associated with the PAYT is littering and trash burning, a survey of Tompkins County residents found that 51 % of those surveyed said there was some increase in littering, and 20 % said that trash was burned (Miranda, 1996).

In order to achieve success in implementing the PAYT program, they must first be designed with cost savings in mind, taking into account the demographics of a population/community. Second, convenient access to a wide variety of recycling opportunities must be provided, so that residents can act on the price signals that PAYT sends. And third the program has to be accepted by the community for which an investment in community education and marketing must be made.

Most PAYT communities have volume-based fees, instead of weight-based fee structures. The three basic types of PAYT pricing systems include:

1. Proportional unit pricing in which the same amount of money is charged for each unit of waste brought out for collection. All bags placed at the curb are to be paid for in advance, either by purchasing a tag or sticker and placing it on each bag, or by paying on a monthly basis for a selected size of container.
2. Variable unit pricing where a substantially larger rate is charged for the second or larger trash can. Under this program some cities offer up to five different sizes of bins, while others offer two or three.
3. Multi-tiered pricing in which, residents pay a flat fee for a base level of service, and pay another fee for any additional disposal based on weight. If the householder exceeds the permitted number, then any additional bags or cans are paid for in advance by purchasing a tag and placing it on each additional container. Figure 5.4 indicates images of typical PAYT garbage bags, prepaid tags/stickers, garbage cans and recycle baskets provided to residents as part of the program.

Burkhalter (2007) quotes Skumatz (2002) in saying that communities that adopt variable rates in conjunction with recycling programs have reported between 25% to 45% reduction in tonnage of garbage headed to the disposal facility. PAYT programs resulted in residential waste declining from 9% - 38 % and increased recycling rates from 6% – 40% in the US. By 2004 an estimated 6,000 unit-pricing programs existed in the United States alone (Kelleher et al., 2005).



Figure: 5.4 Typical PAYT disposal bags, cans and stickers/ Prepaid Tags.
 (<http://www.tagsbagscontainers.com/payt.htm>)

It was after the 1980's that versions of PAYT caught on all over Europe. Since 1991 the European Waste Policy has required that "part of the costs not covered by revenues from material reuse must be recovered on the polluter-pays principle"(Reichenbach, 2008). In Asia after being introduced in the 1970s, 954 municipalities have implemented versions of the PAYT, which translates to a 30% implementation rate in Japan. Taipei has adopted a version of PAYT, which has resulted in a waste volume reduction of 35.08%, and a 2.6 fold increase in recycling from 1999 (Ross, 2007). This type of variable household waste tax does not simply reduce the

amount of residual household waste offered, but there appears to be an inverse correlation with the amount of bulky wastes put out for collection (European Commission).

5.2.3. Recyclebank

Patrick K. FitzGerald and Ron Gonen founded Recyclebank, a form of the unit based recycling program in 2004 (Kolodny, 2011). The underlying principle of Recyclebank is that environmental solutions can create economic opportunities as well. The Recyclebank program rewards people for recycling and green actions with discounts and deals from thousands of local and national businesses. To issue rewards for recycling, Recyclebank forms partnerships with cities, counties, towns, waste haulers, municipalities and businesses providing points to its members for an array of environmentally friendly behaviors. These behaviors include everything from recycling their household garbage, reducing energy and water expenditure, buying greener products and even walking instead of driving cars. Recyclebank also promotes sustainable education using digital platforms such as the Internet, Facebook and Twitter to educate consumers on green behavior. Consumers receive \$5 in rewards for each 10 pounds of material they recycle, with a maximum reward of \$400 annually that can be spent at more than 350 retail partners. The “Learn and Earn” quizzes conducted by Recyclebank give users points for correctly answering questions about ecology, energy and the like promoting sustainable education.

Subscribers of Recyclebank, earn Recyclebank dollars that they can redeem on rewards and discounts at businesses, both national and local. Rewards can also be redeemed in the form of groceries, gift cards, school supplies, restaurants and much more. Participants use an online interface to choose which coupons suit them best, order the coupons and receive them by mail. Recyclebank supports a single stream recycling system that allows all types of recyclables to be deposited in one single container. This program was previously not available on an individual subscription basis, but has evolved to allow individual subscription. RecycleBank partners with independent waste haulers or a municipality to bring this program to communities. Revenues for Recyclebank are based on two distinct principles. First, the company does not own any recycling equipment or trucks; instead Recyclebank negotiates partnerships with municipalities for haulers and waste processors who are compensated by the municipality. Recyclebank takes a small portion of the transaction as a fee to cover operating expenses. In addition the company generates revenues through their marketing platform, offering sponsorships and advertising through several of its marketing channels. The fundamental operating mechanism of Recyclebank is Recycle, Record and Reward as detailed below:

1. Recycle: RecycleBank provides your homes with 35, 64, or 96 gallon Recyclebank containers with an embedded radio frequency identification (RFID) barcode. All items that can be recycled such as paper, plastic, glass, cardboard, tin, aluminum can be placed into this container.
2. Record: Pickups of containers are weekly wherein, each container is weighed and the barcode is read, recording the amount a user has recycled. This data is then transferred to a user's individual account.
3. Reward: The weight of the recyclables placed in the container is converted to Recyclebank dollars that citizens can redeem at various outlets. Recyclebank claims that users can earn up to \$35 Recyclebank Dollars a month for recycling.

The advantages of the Recyclebank program are that it involves the whole community through its partnerships in sustainability and greener living choices. Recyclebank also gets the small corner shops involved so residents will see real savings right in their back yard. Figure 5.5 shows a typical Recyclebank coupon received in exchange for points accumulated. Coupons such as this one are presented to recyclers by partnering with MacDonalDs, or other establishments for different coupons, for the accumulation of a set number of recycling points. By engaging in community wide programs it elevates environmental stewardship, personal responsibility and volunteer action by rewarding good behavior. Recyclebank also helps companies increase their end-of-life (product) recycling rates through its product recycling awareness program "Points for Planet." Recyclebank is the recipient of several awards including the prestigious 2009 United Nations Environmental Program Champion of the Earth Award.

The biggest disadvantage of incentivized waste disposal is that it could encourage higher waste disposal in order to obtain more points. Critics have long maintained that such programs encourage greater consumption and greater waste production. Other disadvantages noted are that curbside taxes distort the cost-minimizing mix of recycling efforts between individual households and centralized facilities and that they do not create price incentives for centralized recycling facilities to internalize the external costs of waste disposal (Kinnaman, 2010).

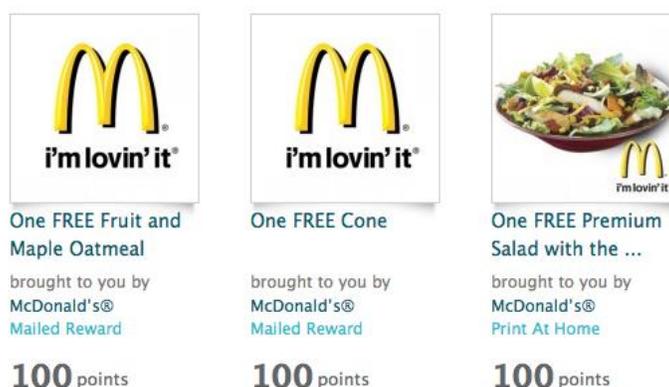


Figure 5.5:A typical Recyclebank coupon received in exchange for points accumulated by recycling (<http://couponkatarina.com/2011/08/recyclebank>).

In the US, the success of this program has seen Waste Management Inc. making an undisclosed investment in Recycle Rewards Inc., which operates the Recyclebank rewards program. The AnnArbor Chronicle reported in March 2010 that communities adopting the RecycleBank incentive program are likely to increase recycling rates from 357 pounds to 752 pounds, or over 200% annually. In addition the value of the incentive rewards to each household would average around \$250 worth of rewards a year.

Recyclebank says participation rates have jumped from 25 percent to between 80 and 90 percent in virtually every municipality. The amount of material recycled in those communities is reported to have doubled and tripled, with the average household recycling 100 pounds of materials each month, including 7 pounds of plastics mostly PET and high density polyethylene

containers (Verespej, 2008). The company is said to be partnering with more than 300 communities and 3.1 million members in the US alone (Nunez, 2011). Recyclebank services several communities in the U.K., 300 municipalities world over and 31 U.S. states (wiki.org). Education and reward programs have been proven to increase diversion of recyclables from landfills by 10 to 40 percent (Robbins, 2011) and increase a community's recycling rates anywhere from 5% to 40% (Johnson, 2011).

5.2.4. German Green Dot Program

The German Green Dot program managed by the Packaging Recovery Organization Europe is the first in a series of environmental laws to put into effect the "polluter pays" principle where the economic burden of waste is shifted on to the polluter rather than waste management companies alone. Originally introduced by Duales System Deutschland GmbH (DSD) in 1990 the Green Dot scheme program is now covered under the European Packaging and Packaging Waste Directive - 94/62/EC. This law is binding to all companies producing products with packaging and requires manufacturers to recover their own packaging. Since its introduction in Germany, the scheme has been rolled out to 23 European countries and is used by 130,000.00 companies. In order to be exempt from key Green Dot deposit and take-back provisions, manufacturers had to design and put into place their own recovery systems, which would have to meet targets of recapturing 64% to 72% of packaging materials (Motavalli, 2011).

The Green Dot as indicated in Figure 5.6, is in fact a green colored dot that manufacturers are authorized to put on their packaging if they are part of the Green Dot Program. What this dot indicates is that the manufacturer of the product contributes to the cost of recovery and recycling. These packages can thus be discarded with household waste collected by the authorities or in containers in public places such as car parks and outside supermarkets. The authorities will not collect discarded packaging without the Green Dot and manufacturers who do not have the Green Dot on their packaging will have to make arrangements to collect such packaging waste independently. In practice the ordinance simply requires that industry pay for the waste management costs. The license fee paid by the producers of the products towards the green dot finances the program. Fees vary by country and are based on the material used in packaging (Eg: paper, plastic, metal, wood, cardboard) thus encouraging manufacturers to minimize packaging waste. Joining fees vary in different countries and the scheme has other ongoing fixed and variable fees that cover cost of collection, sorting and recycling waste. The noted advantages of the Green Dot Program are:

1. The Green Dot program has led to a 14 percent decrease in per capita consumption of packaging (Toto, 2004)
2. The less the packaging weighs, the lower the license fee will be, thus encouraging manufacturers to reduce packaging at source.
3. The program has reportedly created nearly 17,000 jobs in the country and led to more than EUR 20 billion in investments by German industry (Toto, 2004).
4. The success of the program resulted in the reduction of packaging waste which in turn reduced collection expenditure leading DSD's customers to pay 23 percent less for licensing of the Green Dot in 2003 than in 1998. Figure 5.7 indicates data by Duales System Deutschland GmbH (DSD) indicating the recycling success in 2011 for key recyclables.



Der Grüne Punkt – Duales System Deutschland GmbH

Figure 5.6: The German Green Dot logo, indicating membership within the program found on packaging of member companies.
(<http://www.gruener-punkt.de/en/corporate/press/picture-database/news/article/the-company-logo-as-a-file.html>)

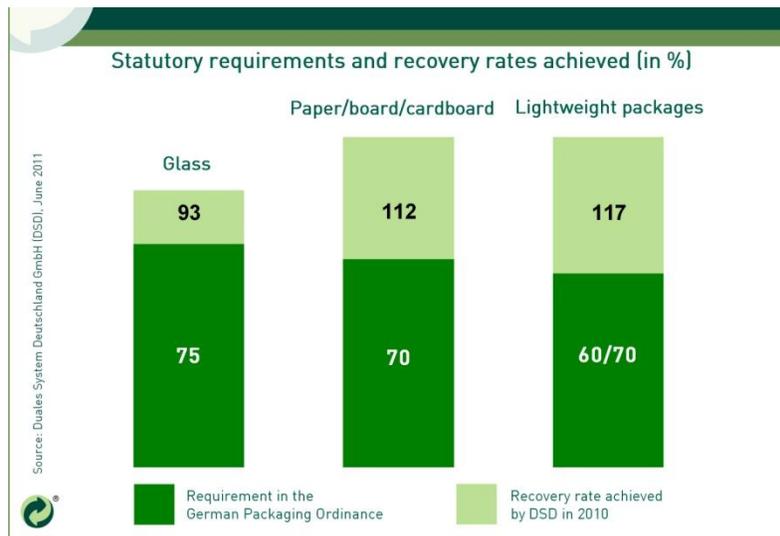


Figure 5.7: Statutory requirements and recovery rates achieved by the German Green Dot program in 2011, recovery rates were well over 100% for stated items.
(<http://www.gruener-punkt.de/en/corporate/sustainability/environmental-balance.html>)

Some Disadvantages of the program are:

1. These mandatory deposits, a part of the Green Dot program led to a sales loss of EUR 300 million in 2003, and the volume of glass collected dropped by about 160,000 metric tons (Toto, 2004)
2. The Green dot Scheme is expensive to operate: with a population of 80 million, it has been calculated that Germany is paying approximately \$28 per person per year to operate the system (Fishbein, 1998).

3. Other criticisms are that it results in fragmented waste collection with separate systems required for different products, i.e. separate collections for those part of the Green Dot and those that are not, including household organic wastes.

The three types of packaging that this ordinance covers are transport packaging, such as pallets and crates, secondary packaging, such as blister packs, toothpaste boxes and primary packaging, such as detergent boxes and milk cartons. Countries that followed suite and brought into place a packaging law are Austria, Belgium, Canada, France, Denmark, Italy, Netherlands, Sweden and the United Kingdom. One of the more important lessons learnt from the Green Dot program are that making fees weight-based and material-specific, increases the incentive for manufacturers to reduce the costs of packaging. Also the Green Dot taught us the value of setting standards, monitoring the program closely and adherence to fight against "free riders" not meeting fee-paying obligations to systems. Japan has adopted a similar scheme for packaging waste in 1995, and the law went into effect in 1997. The success of this program can be seen in that European shelves today see products from American manufacturers with far less packaging than their U.S. counterparts (Motavalli, 2011). Thus it can be expected that mandatory recycling will eventually be accepted by the people and become a norm with the success of the concept.

5.2.5.Container Deposit-Refund Legislations/Schemes

Container Deposit Schemes/legislation is a scheme or law that requires collection of a minimum monetary deposit at the time of purchase of any beverage (soft drink, alcoholic beverage, milk etc) and/or other containers of products. When the containers are returned to an authorized redemption center, or to the original retailer, the deposit is partly or fully refunded to the redeemer/ initial purchaser. Often the containers are returned through reverse vending machines that issue cash refunds or coupons for the returns made. This system offers a financial incentive for returning products or packaging to a centralized facility or to the point of sale, enabling recycling of containers and reduction in collection costs. Initially started for glass bottles, the program has seen the deposit extended to paper cartons e.g. Tetrapacks and cardboard boxes as well. Deposit-Refund systems are also used for lead-acid batteries, motor oil, tyres, electronics and more. Such deposit refund schemes can be mandatory or industry managed/voluntary, however, such schemes see improved recycling rates when coupled with legislation. The overall beverage container recycling rate for the US is approximately 33%, but states with the bottle bill show an impressive 70% average rate of beverage container recycling (Gitlitz, 2003).

The advantages of the container deposit scheme are:

- 1.Container Deposit Schemes (CDS) can essentially be self-funding without the need for large investments thus enabling them to be industry managed and any unredeemed deposit funds would also go to running the program.
- 2.This scheme results in minimized contamination of collected cans, as they will be source separated and reduces collection volumes and thus time for city haulers on collection rounds.
3. CDS can be an important environmental management principle, known as extended producer responsibility (EPR) when offered by producers.
- 4.These schemes serve as an anti-litter measure where curbside programs are not available and as a message to encourage consumers to return a container to collect the deposit, rather than dropping it in the street.

Critics of the program cite the following as disadvantages of the scheme:

1. Drink containers are an income generating part of councils' recycling collections, and vital to fund the other low or no value items in household garbage. Collecting bottles separately creates a parallel waste stream to the standard household waste stream.
2. Deposit-refund schemes are typically an added expense where curbside recycling already exists and would only be justified for products that have a very high cost of illegal disposal or manufacture.
3. Concern over flagging markets during the recent economic downturn raised questions about the viability of a policy that promoted the recycling of reduced value commodities (Turner, 1992).

An analysis by the Packaging Council of New Zealand in 2006-2007 concluded that though a deposit refund scheme would divert waste from landfill by approximately 45,000 ton. The net impact on New Zealand consumers using the mid range estimate indicated that the additional annual cost of the deposit refund scheme would be around \$1600 for every additional ton recycled (pac.nz) since without the critical mass offered by valuable drinks containers, the cost per ton collected is much higher. PAC.NZ suggests that there is no economic or environmental benefit to New Zealanders in introducing a tax on containers. The Industry Council for Packaging and Environment (INCPEN) UK has stated that even in the 1970s, with a 12p deposit on refillable bottles, the best achieved return rate was only a 33%. The Body Shop, an international cosmetics retailer discontinued its packaging return program in 2002 because only 2% of its customers used the service (INCPEN, UK). The UK had abandoned CDS as early as the mid 1980's.

Mandatory deposits on non-refillable containers operate in 11 US states out of 50, known as the Bottle Bill passed in 1971. In the United States beverage container legislation has reduced total roadside litter by 30% to 64% (bottlebill.org). The support of government mandated legislation in this regard in the US show that the recycling rate for beverage containers is vastly increased with a bottle bill i.e. legislation. The state of South Australia currently has a refund of 10 cents per can or bottle, raised from 5 cents in late 2008 (Beverage Container Regulations, 2008). Canada's CDS Deposits range from 5¢ to 40¢ per unit for alcoholic and non-alcoholic beverage containers: glass, plastic, aluminum, and tetrapak. In Canada, ten states and eight Canadian provinces have a deposit law requiring refundable deposits on certain beverage containers. Germany's container deposit legislation, was passed in 2002, and was implemented in 2003 with a standard deposit for all containers at € 0.25. Other European countries with the container legislation are Sweden, Norway, Denmark and Finland. Europe boasts a high return rate within the CDS; it is consistent with their higher in general recycling rate. In 2005, 93% of all recyclable bottles and 80% of all drink cans were returned into the deposit and recycling system in Norway (wiki.org). Sweden shows similarly high return rates for aluminum cans (91%) PET bottles (84%) and glass bottles - 99% for 0.33L bottles and 90% for 0.5 L bottles (wiki.org). However, use of refillables for beer, soft drinks and water fell from 31% of the market in 2005 to 14% in 2008 (INCPEN, UK). Asian countries such as Korea and Japan are also known to have adopted some form of container deposit system. Japan's legislation was modeled on the French deposit return system designed to limit disruptions of existing waste systems for separation and collection of recyclable materials. In Japan, milk and alcohol containers are reused more than ten

times on average as a result of existing programs (White, 2002). The Korean system was initiated in 1992 where recyclers are paid refunds from the ‘Account’ of retailers based on the recovery levels achieved for their products. The deposit-refund system was the key instrument that helped the country reach an 80% recycling rate for PET bottles within three years of its initiation in 1989 (White, 2002). UAE is in the process of deploying 106 reverse vending machines to collect cans, where drop off will be rewarded with vouchers or cash (UAE Interact, 2011).

Environmentalists argue that the repeal of the container deposit system would be a negative approach as a combination of the deposit-refund and focused curbside systems could achieve superior diversion rates on most beverage containers. In Greece, approximately 10,000 cans/month are collected by reverse vending machines. The cans collected are sold for aluminum at around 0.015 EUR per can, subject to market prices (European Commission for Environment). In Manitoba 80% of the municipal recycling program is funded by container deposits keeping the costs to taxpayers at a minimum (White, 2002). Recycling 1 ton of aluminum cans conserves more than 207 million Btu of energy, the equivalent of 36 barrels of oil, or 1,665 gallons of gasoline (EPA, 2009). Measures such as Deposit Refund schemes represent some of the most effective solutions to environmental problems applied in various countries around the world, while considering the cost of such a system their value to the health of the environment must not be overlooked. The Deposit Refund System would be easier to implement when the range of packages is reduced, therefore standardizing packaging sizes would potentially enable the system to become more economic. Rehkopf (2003) has stated that Container deposit legislation is particularly useful in reducing the amount of recyclables entering the waste stream where individuals, industries, and governments do not voluntarily comply with recycling programs.

5.2.6 .“Bring” Schemes

‘Bring’ schemes can be described as recycling schemes where residents are expected to “bring” their own recycling wastes to communal collection centers or depots located near their residences in public car parks, or by neighborhood community centers. This scheme is also known as “near entry scheme” or “voluntary drop off schemes” first started in the 1971 in the US; ‘Bring’ is the acronym for Benign Recycling in Neighborhood Groups (Wollner, 1999). “Bring” schemes are credited with laying the foundation for other formal recycling programs. The collection centers have large containers marked with the type of items to be deposited, residents are to bring in their recyclables and drop them into the appropriately marked containers. Figure 5.8 indicates a typical communal collection centre. Bring schemes are popularly used for dense apartment blocks where curbside collection is difficult or not possible. The most common items collected in the “bring” schemes are cans, bottles, plastics, paper, clothing, packaging, electronics and bulky old furniture. ‘Bring’ schemes are often run by NGO’s or charity centers in association with local municipal authorities. Such centers, also known as “waste transfer stations” exist as a supplement to other forms of formal recycling within communities. In order to have strong participation, a community needs one drop-off center for every 3,000 to 3,500 people according to the Mississippi Department of Environmental Quality.



Figure 5.8: Recycling drop off centre or “Bring” centre containers marked for recycle deposits. (http://www.dswa.com/programs_dropoff.asp)

The advantages of this system are:

1. ‘Bring’ schemes usually produce cleaner and less contaminated recyclables than those collected from the mixed domestic waste streams. As a result, they have the highest market worth, along with curbside separated material.
2. ‘Bring’ schemes are cost-effective and flexible to install; highly visible and operational costs are low. The investments in equipment are far lower in this scheme, and collection rates can be spread out to bi – monthly/ monthly as these containers only contain source separated recyclables.
3. This scheme provides an opportunity for reuse of unwanted items through “junk swaps”.
4. The footprint of this type of recycling is very small (approximately 10MSquare per centre) although this depends on the number of containers placed.
5. ‘Bring’ schemes are well suited to sparsely populated rural areas, where large transport distances can quickly undermine the benefits of recycling if curbside recycling were to serve such communities.

The disadvantages of the ‘Bring’ schemes are:

1. These schemes are entirely voluntary and residents need to be “urged” to recycle, through promotional campaigns, or marketing drives.
2. Such schemes are usually open to all without access control, therefore it is difficult to monitor what is deposited into the containers causing mixed up deposits or, scavenging out of these facilities. Mixing deposits have the added disadvantage of contaminating waste streams.
3. Without a proper tie up with the municipality or haulers, these containers can get over loaded causing litter in the area when collection frequencies are neglected and people continue leaving their garbage around the containers.
4. This sort of recycling is not conducive to walking, as it requires carrying large bags of garbage and is essentially patronized by those who have cars (Tucker, 2001). Powell et al (1996) famously established that a ‘Bring’ recycling scheme involved a vehicle travel distance of 271km per ton of material recycled, while a curbside collection scheme required only 14km per ton with supporting the critics of this scheme (POST).

Due to the problems of vandalism and misuse many municipalities are now insisting that collection centers be located in controlled areas. Distance and convenience of the recycling centers greatly impact the success of 'Bring' schemes. Tucker (2001) in an extensive study of recycling behavior noted 3 reasons as motivations for recycling in this scheme: convenience (i.e. co-location with other facilities such as supermarkets, or banks) proximity and better multi-material disposal provisions as compared with alternative sites. 'Bring' schemes are the easiest type of collection system to establish particularly for smaller communities and developing nations where formal recycling programs do not exist, but suffer from low and unpredictable throughput. Jenkins (2000) have shown that for all materials except newspaper, instituting a local drop-off program has a positive and significant impact on intensity of recycling effort. The US has approximately 10,500 drop off programs (Bohm et al, 2010). Drop off recycling centers or 'Bring' centers have grown in number in Dubai/UAE in the recent past and are currently the only type of recycling option continually available to residents. In the UK, the town of Surrey alone has 15 Community Recycling Centers. The commercial establishment 'LOWEs' has installed over 1700 drop off recycling centres through out the United States in the parking lot of all their retail stores (Businesswire, 2010). Exact statistics for 'Bring' schemes are not available as these are mostly conducted at the community level. *Recharge Asia* reports that 13 Singapore libraries now have drop-off centers for recycling through a joint recycling initiative between electronics giants Brother, Canon, Dell, Epson, and Lexmark, and the support of the National Environment Agency and the National Library Board of Singapore. 'Bring' schemes are available in several communities in most parts of the world either as independent recycling programs or as additional support programs to existing formal recycling schemes.

5.2.7.Cash for Trash

Cash for Trash programs are those where citizens can trade in specific recyclables for cash or coupons, either by mail or at drop off locations. Items so collected are either sold for scrap or sent to developing nations where they are required, as in the case of electronic items. City municipalities in association with sponsors can run cash for trash programs periodically as they are not continuous ongoing programs needing dedicated investments and management. The concept is simple: make recycling financially rewarding and easy. In some states in the US, this program is managed by Recyclebank, a recycling giant present in the US and in some parts of the UK. "Cash for Trash" program is identical to "Recyclingbank" in that, within the program, items brought to the recycling stations are immediately redeemed for cash, and for items that have no cash value, recyclers receive vouchers or coupons for their efforts. The "Cash for Trash" program also allows the trade-in of old items for a significant credit toward a brand new one. Residential utility customers may bring large trash items too, such as old furniture, household appliances (both large and small), large toys, and tires. Residents may also bring household hazardous waste items and electronic items (including all computer parts) to Cash for Trash for disposal or recycling. This program provides an alternative system, apart from the weekly trash collection system especially important for apartment dwellers or anyone with a number of large items to dispose. Some redemption centers in the US pay by counting containers or by weighing the material recycled. Data from California indicates that between 36% and 51% of the material generated by the redemption centers in Santa Barbara, California, would not have been captured by existing curbside recycling programs but have been obtained due to cash for trash programs (Ashenmiller, 2009).

While the ‘cash for trash’ system incorporates all the advantages of any incentivized recycling program, it differs in that it is actually paying or rebating citizens directly for the amount of recyclables they divert from the landfill. This is considered as superior version of the traditional PAYT or Recyclebank incentive program. Walmart in the US has such a program conducted by Terracycle where a “Store Collection System,” is installed in the parking lot of the supermarket; a 20-foot trailer that accepts all kinds of packaging that can’t be recycled in regular recycling waste stream. Residents get paid three cents for each piece of waste deposited. Since the program started in 2001, more than \$1.85 billion pieces of non-recyclable packaging has been reclaimed (Goldmark, 2010). Figure 5.9 indicates a Terracycle centre seen at Walmart in New Jersey, USA. “Cash for Trash” programs are popular in several Asian countries as well as a first step towards recycling awareness.



Figure 5.9: The Terracycle Centre indicating drop off niche’s for various items to be recycled, with a cash collection niche in the far right where individuals collect cash for the items they bring in.

(<http://www.greenbiz.com/news/2010/09/30/five-walmart-stores-collect-28-types-trash-terracycle>)

The Jurong Town Council in Singapore launched a first-ever "Cash For Trash" program to drive home the message that it pays to care for the environment in 2007 (Seiw Ying, 2007). Eco Everest Expedition with the help of other environmentalists started “Cash for Trash” program in 2008 on Mount Everest, the Eco Everest Expedition has been able to bring down more than 13,500 kilograms of garbage from the high mountains. For every kilogram of garbage brought down Rupees 100 (1 euro) is provided to the individual, encouraging the clean up of Mount Everest (Sherpa, 2011). The “Wealth Of Waste” (WOW) program is a “Cash for Trash” program launched by ITC Ltd in India where households put solid wastes in a bag provided by the company, while kitchen and wet wastes are kept separately. After collecting the recyclable waste, WOW’s team sends it to ITC’s reprocessing plants and recyclers are paid for their efforts.

Other versions of cash for trash are programs where retailers exchange products for return of used products such as bringing wire hangers to local dry cleaners for cash back, bringing old video games to toyshops for cash back rewards, bringing reusable coffee mug/tumbler to any Starbucks Coffee and receive \$0.10 off a drink purchase, bringing old iPods to an Apple Store and receive 10% off a new one and other such offers seen in several parts of the world. The success of this effort has resulted in a waste collection of 600 tons per month and 165 employees are involved with the initiative, which is now being duplicated all over the US.

5.2.8. Financial Tax Credits for Recycling

Tax credits for green behavior usually involves financial benefits or tax reductions received in return for recycling or any specific environmentally green behaviors. The United States has led the way with environmental tax credits with twenty-five states around the country offering some type of tax incentive or credit to promote recycling market development (EPA). There are also tax incentives offered for paper recycling in order to mitigate paper waste. Such credits are offered to manufacturing businesses and recycling plants to use or make recycled paper or business expansions that promote recycling. Some states such as Minnesota in the US offers a tax credit for businesses that purchase recycling equipment, although this credit extends only to businesses that create jobs. Delaware offers credits for investments and for job creation where a minimum of 25 percent secondary material removed from Delaware's waste stream are used. Delaware also offers a fixed amount of money (\$500) for each \$100,000 invested in recycling equipment (EPA). Iowa offers an income tax credit of up to 20 percent on recycling equipment costs that don't exceed \$30,000 per year. In addition the US has long offered federal tax incentives for energy conservation and green initiatives such as credits for energy & water conservation measures. Such tax credits are a first step in increasing recycling capacity as substantial investments in new recycling plants and equipment will be needed to promote recycling. In 2005 a bill was introduced in Missouri that would grant tax credits for companies and individuals that recycled electronics, starting with computers and televisions (Grossman, 2006). The US Department of Energy's ENERGY STAR program also offers tax credits for a variety of energy-efficient upgrades to homes.

Although certain carbon emission taxes have been enacted in British Columbia, France, and Scandinavia, curbside taxes on the collection of residential solid waste are perhaps the most common application of emission taxes and credits. Tax incentives can also be in the form of sales, or property tax exemptions on construction and renovation of recycling facilities. Information on financial tax credits in Europe and Asia are unavailable, possibly as such aid is not on offer in these countries. The direction of tax credit programs is still uncertain. Some states in the US are known to have abandoned them, while others still in the process of considering or developing such plans. It appears that there is a preference for loans and grants because financing recycling programs through tax incentives is expensive. A 1995 summary of California's program by two state agencies revealed problems with the tax credit program that caused the program to end just a year later. In the US alone, income tax credit programs have fallen from 21 in 1993 to 10 today. Tax credits are more oriented towards emerging markets and those that need market development and can benefit from the credit (Sparks, 1998).

5.2.9.Mandatory Recycling

Mandatory recycling laws are those made compulsory by the government where citizens are required to separate trash from the recyclable materials so that some or all recyclable materials are recovered rather than sent to landfills. Failure to do so can be punishable through fines or by garbage not being collected from such individuals. For example, mandatory recycling laws of San Francisco provide that each resident must separate dustbins in blue, green and black color meant for placing recyclable materials, composts and trash respectively. Though several nations have federal environmental agencies that support recycling, few have a federal recycling law. With the appreciation for recycling on the rise, a few states in the US such as San Diego, Seattle, New York, Philadelphia, Connecticut, and San Francisco have enacted their own mandatory recycling laws. Europe had long implemented the “polluter pays” law with the Green Dot program in the early 90’s. Europe also has some of the most comprehensive recycling laws, by 1992 the packaging law in Germany allowed customers to leave outer packages, such as the cardboard boxes that their tubes of toothpaste come in, behind at the store. The goal of the recycling laws, essentially are to reduce the amount of waste sent to landfills or burned in incinerators. The purpose of government mandated laws are to allocate responsibility to the polluters in equal measure ensuring that all citizens recycle, as voluntary recycling cannot always be consistent. Experts believe that recycling is on the increase mostly because of government pressure and, to a lesser extent, due to consumer demand for environmentally friendly products or environmental concern (Bonteoux et al., 1996). Some key of advantages of government mandated recycling laws are:

1. By implementing mandatory recycling laws, environment pollution and the volume of garbage is reduced drastically as all citizens must comply, and recycling is not left to individual choice or convenience.
2. Mandatory recycling laws could help in cutting down the costs of waste disposal, and help make recycling a norm thus saving resources.
3. As it takes labor, capital and energy to manage, collect, sort, sell, ship, process, remanufacture and market recyclables, it is often a job more for governments that have the financial backing of millions to tax dollars.

Disadvantages of mandatory recycling include:

1. The costs of mandatory recycling far outweigh the benefits - by an estimated \$100 per ton (Roberts, 1995). Though this fact is arguable with newer data.
2. State-determined recycling totals can also be manipulated or skewed, because waste haulers and citizens can avoid paying the tax by disposing recyclables illegally.
3. Michelle Roberts in her 1995 article, *RECYCLING: Is Mandatory Recycling A Wasted Effort?* has said that “deregulation of waste management would save the millions of dollars wasted on uneconomic separation, collection and administration.”

Although each city’s data varies, where recycling is mandatory, it has been found that often-recycling amounts increase as locals make quick adjustments to the new rules. According to Langston (2006) Seattle launched its mandatory recycling ordinance and, within a couple months of the program’s launch, 90 percent of businesses and apartment complexes were complying with the ordinance with negligible numbers of violations. In 2008, the European Union passed mandatory recycling standards for all EU member states. The laws dictate that EU

countries must recycle 50% of their total household waste, and 70% of industrial waste, by 2020. The Waste Electrical and Electronic Equipment (WEEE) Directive was agreed in February 2003. It sets a target for collecting and recycling an average of 4 kg of electronic waste per person every year; the UK is already achieving this. The Packaging Directive was amended in February 2004 and was set to be transposed into UK law by 2005. It sets a target for recycling at 55 per cent of packaging by 2008 December, with a higher target of at least 60 per cent recovery. There are material-specific recycling targets of 60% for glass and cardboard, 50% for metals, 22.5% for plastics and 15% for wood (European Commission). Other countries following the path to mandatory recycling are —Japan, South Korea and Taiwan where there have been laws tackling e-waste management since around 2000. The Republic of Korea covers all requirements pertaining to recycling under the Resources Conservation and Recycling Promotion Law and its EPR system. With regard to packaging waste, there are various bans or restrictions on the use of plastic bags in India, the Republic of Korea, and Taiwan (Terzano et al., 2005). More than 30 countries now have "producer responsibility" laws for packaging, 15 have battery recycling laws, and 12 now require electronics recycling (Businesswire, 2010). Though on a cursory look, the mandatory recycling laws and programs appear to be an intrusion on the personal liberty, or an iron handed approach, laws are essential to the continuing health and well being of our planet.

5.2.10.Zero-Packaging Retail

The primary purpose of food packaging is to maintain the safety, wholesomeness, and quality of food and be attractive to consumers. Zero packaging retail is a revolutionary concept in retail where products are sold without any packaging in an attempt to reduce the impact of packaging and subsequent disposal of such packaging on the environment. No packaging would mean no requirement to collect, discard or recycle the packaging. No packaging, zero waste stores traditionally sell items in bulk such as: produce, grains, flour, sugars, oils, spices, milk, cheese, alcohol, and cleaning supplies, with the added advantage of items being cheaper than in conventional supermarkets. Shoppers are to bring their own packaging, or use the store's compostable packages (which come with a slight charge) and buy items, as done in farmers markets. Zero-packaging stores usually source their product to the maximum from local suppliers and organic supplies; this also reduces cost due to minimized shipping expenses. Zero packaging stores have been around in Europe and Asia for several years now and are moving to other parts of the world. The Zero packaging stores follow the 3R's hierarchy as follows:

Reduce by only buying what is needed.

Reuse by bringing refillable containers for a refill at the point of purchase.

Recycle what you can't reuse; some basic amount of packaging that might be required to preserve food.

The incentive here for buyers would be fresher locally procured produce, lesser cost, packaging reduction and most of all the "warm glow" effect of having done "the right thing". Traditionally, the materials that are used in food packaging include glass, metals aluminum, foils and laminates, tin-free steel, paper, paperboards, and plastics. Food packaging is approximately 50% (by weight) of total packaging sales in the US (Institute of Food Technology, US) and approximately 31% of the MSW generated in 2005 was from packaging-related materials (EPA, 2006) Research by Which? A consumer watch group based in the UK found that 94% of shoppers would prefer reduced packaging, yet only 23 per cent did not buy a product due to too much packaging (Dilks, 2011) Figure 5.10 depicts a typical Zero packaging store where

customers fill up their refillable containers with items they need to buy.

The advantages of Zero packaging stores are:

1. It allows every buyer to buy food in the exact quantities they need thus minimizing waste eventually produced by normal packaged stuff that come in fixed quantities. This aids in reduced household bills. An Italian study has shown that buying exact quantities can save upto 775 Euros a year per household (Federconsumatori, 2008).
2. Reduces carbon food-print of the products, as they don't have to be transported long distances, in addition household waste generated from packaging is also reduced. It reduces wastage of resources at every level: production, storage, transport and disposal.
3. By removing packaging and sourcing organic produce from local businesses and farmers, the cost of grocery shopping is also reduced.

Disadvantages of a lack of packaging are:

1. The potential for cross contamination, and enterobacteria contamination due to handling of foods increases without packaging.
2. Packaging is required to retain freshness & prevent merchandise from getting "shop worn" and less saleable.
3. Without packaging, traceability and transparency are reduced: retailers and consumers alike should know which brand of product they are purchasing and where it came from. Stores filled with unbranded bulk products might lead to more taint (or perceptions of it.)
4. Detailed information about products cannot easily be passed on to consumers without packaging, making it hard for customers to spot the differences between products.



Figure 5.10: Zero Packaging Grocery store in Austin , Texas , USA indicating a customer filling up reusable plastic containers to purchase items. (<http://www.austinpost.org/content/zero-waste-grocery-store>)

Recycling was the initial solution to the problem of excessive packaging waste. Evidence from several studies however have shown that recycling and the reverse logistics that go with it carry the huge burden of cost and in some cases an equally large carbon footprint. Supporters of the zero waste

packaging philosophy argue that if packaging didn't exist in the first place, there wouldn't be any need to recycle it, thereby obliterating the need for complex, expensive reverse logistics processes. The US has recently opened its first no packaging store in Austin, Texas called "in.gredients" and the UK has its version of the Zero packaging store in a chain called "Unpackaged". In 2006, the Commissionaria Riunite Italian food" (CRAI) started a new scheme called 'Eco Point' designed to drastically reduce packaging waste where shoppers scoop the products into the compostable bags or reusable bottles, measure them with a scale and paste the price tag with the barcode and use-by date. The success of this concept has resulted in it growing to 25 stores from the first one in 2006. In just one year, 300 kg of paper; about 180 kg of glass and 280 kg of plastic were saved. Across the 25 stores surveyed, the reduction was up to 700,000 packages. Price cuts of items due to reduced packaging fell between 10-20% in some cases but were as high as 60-70% in some others. A survey of the customers of the Eco Point stores indicated that satisfaction levels were high, with 52% of the panel saying they would repeat the purchase, 44.3% saying they weren't sure, but only 3.4% saying they were dissatisfied (Minami et al., 2010)

If the concept of zero packaging retail succeeds, the environmental footprint, petroleum consumption and transportation emissions specifically of grocery shopping could be slashed effectively. This trend could then be applied to other products such as stationary, simple electronics, clothes to obtain greater environmental and economical gains. Success of the zero packaging concept is when we reach a point where we bring a refillable bottle into a supermarket and fill it with what we need, and leave the store carrying all our groceries with no more packaging than we entered with.

Waste recycling is as an integral part of solid waste management in many parts of the world. The varieties of programs from small-scale community recycling programs to government run programs have been analyzed in this paper. The rising costs of waste disposal are not only economical, but environmental as well and these combined costs are no longer affordable, leading to the growth of recycling. A case study conducted by the Technical University of Denmark can be cited which found that in 83 % of cases, recycling is the most efficient method to dispose of household waste (The Economist, 2007). In order to be successful a recycling program must be competitive in capital and operating costs and works in harmony with existing MSW management programs. There are a variety of options for developing a recycling system which best meets the needs of a community.

The jump in recycling rates with the introduction of incentivized programs as described in this chapter are a reflection of factual human behavior: incentives can and do work. The case against is that consumerist values are reinforced but the goal here is to propose the best method to increase recycling and not ponder human behavioral choices, positive or negative. Everyday green actions by recycling are not expected to stall climate change or drastically reduce our carbon footprint, but they do have the potential for making a relatively substantial impact if consumers commit to them en masse. The superior recycling rates in Europe and the 11 US states where legislation supports recycling indicates that, the framework within which decision makers operate in part determines the effectiveness of a policy. Enforced regulatory requirements such as the German Green Dot can directly restrict or modify consumption and disposal decisions. Price instruments such as fees, taxes or positive reinforcements such as incentives can change consumption and disposal decisions that govern behavior (Rechovsky & Stone, 1994, Iyer & Kashyap, 2007).

Currently the UAE does not have a unified recycling program. Introducing such a program within a transient population such as in the UAE will undoubtedly face obstacles that include insufficient public interest, economic risks and further uncertainties caused by lack of awareness, acceptance,

uniform guidelines and legislation. It has been established in the course of this research that people with access to a good structured recycling program show much higher levels of recycling than do people lacking such access. Usage of drop off recycling sites and recycling options is also determined by demographics such as age, education, income and household size (Siddiqui et al.2009). This means that within the same state a recycling program may draw different attitudes, acceptance and participation rates based on the locale. While incentivized recycling seems to have a positive effect on recycling, it must be noted that short-term monetary incentives, such as lotteries, lucky draws and gifts that reward a random recycler for recycling efforts, do not produce lasting behavior change. (DeYoung R, 2000, Iyer & Kashyap, 2007). Lansana (1993) has also stated “household recycling behavior is not consistent across communities due primarily to variations in demographic characteristics of residents and their evaluation of program policies.”

While there is sufficient data available on MSW and other waste flows, most countries lack a national comparative, current and comprehensive database on waste management programs and their successes and weaknesses. The two most significant recycling formulae however are either curbside recycling program or a unit pricing program. The command-and-control regulatory approach that sets a recycling policy (target) which the polluter/ citizen is required to honor, seems to produce the most favorable results as seen in the curbside recycling and German green dot program experiences. Yet the merits of incentivized schemes such as the Recyclebank approach and Cash for Trash cannot be ignored. A study of a range of different programs and policies including waste disposal taxes, product charges, deposit-refund systems and incentive programs suggests that an ideal recycling program would in essence be a combined tax and subsidy system (Turner, 1992). The command and control system could potentially be used to reduce MSW at source and the incentive approach for increasing recycling. Though a thorough recycling and waste minimizing program would include resource extraction taxes and user charges, as they serve to reduce the overall generation of waste (Turner, 1992) this paper will focus on the identification of a suitable recycling program for the UAE.

The most important criteria for the selection of a recycling program for the UAE would be one that employs environmental effectiveness, administrative cost effectiveness, acceptance from the citizens and be progressive to absorb future technologies. The criteria can be listed as follows:

- 1.The program should be able to tackle the primary recycling goals adequately: menace of packaging waste, lack of participation and contamination within recycling waste streams.
2. It must be relative to income of citizens throughout society, i.e. it should not confer a disproportionate burden on the least well off in society. It must take into account the proportion of expatriate communities and lifestyles in the UAE.
- 3.It must have low compliance / operational costs bearing in mind the demographics of the UAE: a majority of the residential and commercial units are high rises. The issues with high rises are that the amount of residual household waste is much higher and the amount of dry recyclables and separation is very low.
- 4.The chosen program should be compatible with the national objectives, and easily internalized by the existing market and institutional system. It should be progressive to be upgradable with improving technologies and changing regulations.

5. The program must be mandated or supported by legislation to ensure compliance particularly due to the large proportion of transient expat population in the UAE.

At least 28 countries in the world have laws designed to encourage recycling and reduce package discards (Bickford, 2009). The UK Household Waste Recycling Act was introduced in 2003. The UK Government has set targets to increase the recycling of municipal waste (recycle or compost) by at least 45% by 2015 and 50% by 2020. As of 2011 around 40% of waste from households was recycled compared to 11% in 2000/01 (recyclemore.co.uk). Several EU countries are already managing to recycle over 50% of packaging waste. As of April 2000, all paper and plastics packaging was included in the Law for the Promotion of Sorted Collection and Recycling of Containers and Packaging with both small and medium enterprises having to bear responsibility for their packaging (Lease, 2002). Though exact numbers for the UAE are not available, an indication of general waste generation is understood by the EPA's estimations of US household waste generation. Jenkins's (2000) finding that recycling effort increases with experience is consistent with the findings by Reschovsky and Stone (1994). Recycling programs appear to become more effective over time if managed properly. Though there are several other types of recycling programs in many parts of the world, many in the pilot stage, this paper has evaluated the tried and tested methods that are most replicable and applicable for the UAE given its demographics.

5.4. Recycling in Multi-Family Dwellings

Much research and experience has shed light on recycling in single-family dwellings (SFD's), yet recycling within multifamily dwellings (MFD's) poses a challenge for many communities. A multifamily dwelling is generally thought of as any structure with five or more units with shared collection services. Since 2008 for the first time in history, most people are living in urban areas mainly constituting MFDs and by 2030 this number is expected to swell to almost 5 billion (UNFPA). Most recycling programs are geared towards single-family homes. The EPA states that between 1960 and 1997, the U.S. recycling rates went up from 6.4% to 28%, with nearly 9,000 curbside recycling programs in the US to date, yet most of these programs were aimed at SFD's. Mcquaid & Murdoch (1996) have stated that well designed curbside collection programs can have a significant impact even in areas with high levels of multi-storey dwellings, low income and public housing. The EPA (1999, 2001) and Stevens (1999) have shown that waste-diversion rates are lower in MFDs than in SFDs. This could possibly be due to space constraints and because many MFD buildings are not usually designed to accommodate intensive recycling activities. Due to variations in building size, layout, waste generation characteristics, trash disposal systems, and regional demographics, each building would require unique arrangements to suit specific sites. As a result there can't be a single model for MFD recycling programs applicable to all MFD's. MFD recycling differs from SFD recycling in several ways in that they usually have different municipal or private collectors, different type of containers, different collection frequencies, and a different fee structure. Very often refuse collection from MFD's is largely left to the private sector and many cities overlook large multi-unit buildings in setting up their residential recycling programs. Even the waste composition differs between SFD's and MFD's. In general, MFD's have higher per-capita quantities of waste, lower participation, a worse quality of the collected recyclables as well as frequent problems with overflowing containers and littering (Lebersorger 2008).

Yet, recycling in MFD's can add significantly to waste diversion rates, up to 60% if conducted successfully (EPA, 1999). One particular MFD complex in Blossom Hill Estates, USA, avoided almost \$60,000 in trash disposal fees in 1997 just through recycling and composting (Lease, 2001). Governments are increasingly focusing on this market segment to meet recycling goals. Table 5.1 by

a 1999 US EPA study shows that recycling in multi-family housing does not necessarily have to cost much more than in SFD's to achieve a similar diversion rate.

Table 5.1: Multi-family waste and recycling collection costs vs Diversion rates achieved (EPA, 1999)

Cost Measures² and Multifamily Diversion Rates			
	Multifamily Curbside Diversion		
	<10%	10-20%	>20%
Collection Cost/Ton			
Multifamily Recycling	\$251.00	\$159.00	\$113.00
Multifamily Garbage	\$43.13	\$72.60	\$66.39
Single Family Recycling*	\$151.80	\$131.70	\$81.64
Single Family Garbage*	\$47.48	\$60.28	\$101.32
Collection Cost/Household/Year			
Multifamily Recycling	\$16.63	\$20.56	\$21.81
Multifamily Garbage	\$45.17	\$72.34	\$36.01
Single Family Recycling*	\$21.65	\$30.96	\$24.73
Single Family Garbage*	\$58.69	\$64.71	\$84.01
Tons/Household/Year			
Multifamily Recycling	0.061	0.145	0.211
Multifamily Garbage	1.023	0.934	0.595
Single Family Recycling*	0.139	0.260	0.297
Single Family Garbage*	1.312	1.123	0.951

*Does not include cost of yard trimmings.

Multifamily refuse collection costs an average of \$53.69 per household per year, comparable to an average of \$68.23 for single-family refuse collection (EPA, 2001). A new law in California known as the Renter's Right to Recycle Act now requires that recycling services be provided for paper, plastic and cans in buildings with five or more apartments (Solid Waste Report, 2011). Montreal has also introduced a plan to expand residential recycling programs to every apartment building with more than nine units subject to city approval (Resource Recycling, 2006). MFD recycling lowered trash volume by an average of 15 percent, according to a study by the U.S. Conference of Mayors, Washington, D.C (Foote & Foster, 2002).

The EPA (1999) estimates that if recycling was available to all of the 13.2 million multifamily housing units throughout the United States, a minimum of 847,000 additional tons of materials could be diverted from disposal facilities nationwide (EPA, 2001). The EPA (*Multi-family Recycling:*

Costs, Diversion, and Program Characteristics, U.S. Conference of Mayors, 1999) studied 40 sample communities (serving 3.9 Million people) that had MFD recycling programs for over a year, in selected geographical areas in the US, the total number of responses from which sampling occurred was 227 including 27 responses from the Northeast, 60 responses from the Midwest, 66 responses from the South, 72 responses from the West and two responses from Puerto Rico. This study found that the average (net) cost/ton to collect recyclables from multifamily households is \$177; however, this figure drops to \$113 for communities with diversion rates over 20 percent (this study determined a diversion rate of 20% as high for MFD's). Single-family counterparts average \$127 per ton of recyclables; the cost decreases to \$82 in high diversion communities. The same study indicated that multifamily recycling costs an average of \$20.50 per household served, compared to an average cost per single family household of \$28.76 (SFD's produce 65% more refuse per household than MFD households, EPA, 2001).

This chapter looks into MFD recycling and factors that contribute to reduced recycling in MFD's. The information so obtained is of particular significance to developing a suitable recycling program for the UAE where a majority of residences are MFD's. Local authorities here in the UAE now have to confront the challenges of MSW management and hopefully will take steps to implement recycling schemes for multi-occupancy housing in the near future. It has also been thought that apartment dwellers might have a reduced commitment to recycling because they do not pay for their trash disposal directly, as in single family dwellers who pay for curbside pick up. Matson & Pasternak (2006) discuss findings by R.W. Beck Co. in Seattle who in a study of 15 large US cities found that customer education, convenience, performance measures, and apartment managers buy-in, contributed to the success of any multi-family recycling program. The US, EPA defines success of a MFD recycling program as any program that achieves a diversion rate higher than the 14.6 percent average based on calculations in their 2001 study, which considers a 20% diversion rate as "high". Factors contributing to reduced recycling in MFD's when analyzed can be listed as:

5.4.1.Space and Distance

Many apartments do not have the space for storing suitable recycling containers or garbage containers in the building. Research by Ando & Gosselin (2005) and Omran et al. (2009) suggests a strong correlation between recycling rates and the presence of adequate interior space for processing recyclables, that is the lesser the space, the lower the inclination to recycle. MFD households with enough interior space to sort and store their recyclables report 10% higher recycling rates for paper, 12% higher recycling rates for containers and over all 12% more nonzero total recycling rates (Ando & Gosselin, 2005). The research by Ando & Gosselin (2005) Schenkman (2003) and Katzev et al (1993) all suggest that the lateral distance from front door to bin location (measured as total distance less the distance traveled on stairs) is more than twice as great for apartments, which presumably negatively influences recycling intensity. Space and Distance that contribute to the convenience factor also include the location of the recycling facilities, resident traffic and living units, and the absence of physical barriers to the facilities. DeYoung et al (1995) say the distance of the size of the MFD complex itself significantly affects the amount of recyclables collected and the level of contamination. Skumatz & Green (1999) have suggested modifying building codes to ensure adequate space is available for recycling in all new and remodeled MFD's if recycling is to be increased. SITA (UK) reports that drop-off recycling as seen in MFD's only gets a third to half the capture rate of curbside service due to convenience related issues. Space constraints can also affect the opportunity to set up recycling programs in existing buildings, where buildings are spaced tightly and high population density makes finding suitable places to place recycling points difficult. Another

effect of space and distance is seen in the EPA (2001) study that indicates that the higher the density per curb mile, the less time spent traveling between stops, and thus the lower the program costs. De Young et al (1995) have found that smaller complexes with less than ten units recycled up to three times the amount on a per unit basis as complexes with more units. Hage et al. (2009) conducted a postal survey of 2800 households with four different municipalities in Sweden with self-reported recycling information and analyzed the information in an ordered probit regression framework to determine among other factors that specifically convenience matters in MFD's who reported higher collection rates when collection systems were placed close to the home. The UK reported an increase in recycling rates following the introduction of curbside recycling collections for street level housing which further supports the correlation between distance convenience and participation (WRAP, 2006).

5.4.2.Residents's Characteristics

Individual residents play a major role in recycling participation in MFD's with their attitude, education, age, inclination and participation. Problems in MFDs in general are often tightly connected to social characteristics, such as a high population density, anonymity, a high tenant turnover and a lack of sense of personal responsibility (Lebersorger, 2008). A report by CalRecycle (2001) California state's leading authority on recycling says that participation of residents, building management, maintenance staff, and the recycling haulers is critical to the success of any MFD recycling program. Omran et al (2009) stated that in a survey in Malaysia about 99.5% of respondents ranked 'Collection points / station placed in more convenient locations' as the first requirement to increasing recycling activities. Some research has suggested that there is a need for recycling "champions" / "managers" or on-site enthusiasts that take ownership of the program, keep the space around the recycling containers clean, conduct meetings or training and in general keep the motivation levels high (Katzev et al.1993). Ando & Gosselin (2005) found that apartment dwellers are usually younger, with work and study commitments and a full-time workload, thus reporting 16% less recycling of paper and 6% less recycling of cans. The number of years of education tenants had also positively correlated with the amount of recycling. In terms of the socio-demographic factors, age and place of living (house vs. apartment) were the only significant predictors of recycling. Kaciak & Kushner (2009) in their study surveyed over 400 residents in the Region of Niagara, Ontario, Canada and also used the Means-End Chain (MEC) theory and the laddering technique. Respondents were chosen at random from the local telephone directory and included those who recycled and those who did not, Kaciak & Kushner (2009) found that residents 45 to 65 years old were more likely to recycle compared to the other age categories. Among the recyclers, 84% lived in SFD's and 16% in MFD's whereas among the non-recyclers, 45% lived in SFD's and 55% in MFD's suggesting that residents of SFD's are substantially more likely to recycle than those who live in apartments. The theory that most people would be willing to participate if recycling was more convenient is also supported by Kaciak & Kushner (2009) study which produced that residents will not recycle if they find it inconvenient (indicating personal choice) to do so even if they have very well articulated personal recycling goals.

5.4.3.Education and Outreach

It is particularly important to provide waste reduction education and information to new residents when they first move into units so they can follow the norms within the complexes. Communication, promotion and education in multiple languages or as visuals are important in introducing and maintaining a recycling program in MFD's. Recycling education messages should address both the "hows" and "why's" of recycling, be easy to understand, and be repeated often. CalRecycle (2001) in California reports that El Monte – a Spanish speaking community in California, uses bilingual waste

auditors to reach residents of multifamily units. The city distributes a brochure and a poster with text in both English and Spanish, side by side, to encourage residents of multifamily buildings to recycle. Many communities are shifting to communication materials in visual form to address people of different cultures and origins thus avoiding the need to reprint communication leaflets in different languages. Nixon & Saphores (2009) stress the importance of face-to-face communication, suggesting it could be superior to other non- personalized communication. In an EPA (2001) study of 40 communities it was revealed that 16 % of the communities rely on the property manager to distribute educational materials to individual households and another 16% of the program managers make personal visits to households to promote recycling. Mailings to the individual households range from an initial move-in flyer to materials mailed biannually, annually, or quarterly (EPA, 2001). Those communities with high diversion rates are more likely to have more frequent mailings to individual households, while communities with lower diversion rates tend to have less frequent mailings and rely more on the property managers. A study by Omran et al. (2009) showed that awareness of recycling did not always translate to actually practicing recycling. The researchers also conducted a survey in Malaysia that showed communication and education as the third most important step in improving recycling participation. Iyer & Kashyap (2007) have stated that interventions are vital to encourage recycling and disseminating information that increases consumer's knowledge has a dramatic and long lasting effect on recycling, more than offering incentives. MFD's also have higher turnover, therefore informative communication reaching newcomers is extremely important. Clear instructions must be provided to all tenants on how the schemes operate, the benefits of recycling must be communicated periodically, and program conductors must emphasize that recycling can be conducted without inconvenience (Read, 1999, Thomas, 2001). Preliminary data suggests that the door knocking campaign conducted in the UK has been effective with the tonnage of material collected increasing by 35%. Approximately 110 households per day (6 hours door stepping) must be targeted for projects involving flats with the aim of spending three minutes on each household and contacting residents at approximately one in three of these households visited (WRAP, 2006). Kaciak & Kushner (2009) have stated that for education programs to be effective, they must be supported by improvements in convenience, such as the provision of free containers and more frequent collections. From July 2006 to March 2008 Bexley London Borough Council ran a communications campaign to overcome problems associated with recycling within MFD's in Bexley through intensive campaigning. Campaign communications included translations of leaflets, strong graphic & design elements, producing a recycling document specifically for residents of flats, introducing door-to-door canvassing for flats and developing map signage for recycling facilities. As a result a significant increase was seen, a committed recycler rate of 63% in the target area post-campaign was achieved, an increase from the pre-campaign rate of 27% (WRAP).

5.4.4.Incentives

In addition to the characteristics and motivations of recyclers, the characteristics of the recycling policies themselves have a significant impact upon the level of participation such as organization, promotion, incentives and collection (Mcquaid & Murdoch 1996). In many cases, because of the communal nature of most trash collection and billing systems at MFD complexes, it is difficult to pass savings directly on to those residents reducing disposal. Incentives or market-based solutions have aided in successful SFD recycling numbers; experts see no reason for this to not be applied to MFD's as well. Incentives for recycling would give tenants a financial motive to participate regularly, they could also assist in maintaining long term participation and in keeping contamination low: thus qualifying the building to receive the credits. Lewisham in the UK has implemented a monthly prize draw of £500 to encourage residents to recycle, residents have to enter the draw and

winners will receive the prize further to conformation by officials that they are recycling suitably. Westminster (UK) has also introduced an incentive prize scheme aimed only at residents of flats. In January 2005, the Council awarded £1,000 to an estate that was considered the best recycling estate for the previous year. The prize money is to be used towards the entire estate, with the estate residents choosing exactly what it is spent on. The prize is open to both residents served by the curbside scheme and residents in flats with mini-recycling centers (WRAP, 2006). Skumatz & Green (1999) emphasized the importance of the incentives going to the tenants and not the building owners, as containers are “shared” it is difficult to see which tenant does or does not recycle. Incentives could even be in the form of credits towards utility bills, such as water and electricity. Incentives could come from the community to the haulers for increasing the recycling or meeting recycling goals from the target sector. In this case the service provider should be allowed to develop effective ways to achieve the goal (Skumatz & Green, 1999). The results of an experiment by Harder & Woodard (2008) show that participation rates in apartments increased significantly in most cases when incentives were provided, but greatest increase was seen where voucher values were over 100 cents, and for those rewarded individually rather than by road. A study in Hong Kong, of residents of a 122 apartment high-rise found that reward schemes coupled with environmental education had a significant positive relationship with the per-household weight of recyclables collected (Yung Yau, 2010). A 2006 DEFRA report describes a pilot project carried out in the UK, where a cash prize of £50 was offered to the winner of the incentive project who had to make a pledge and present their recycling box with the recycling sticker clearly marked on it. 10 winners per area (of 4 areas) would be selected randomly among those with the highest increase in recycling. A total of 25,186 households were involved in the trial, with mainly areas of low participation and flats being targeted. The results show that on average the participation rates in the incentivized areas increased by 13% compared to 8% in the control areas.

5.4.5. Mandatory Recycling

Mandatory recycling could be state mandated or implemented by the building by requiring residents to recycle as part of the lease. In 1995 the City of Malibu established a resolution requiring MFD residents to source-separate their discards and participate in a recycling program. New York city in the US now requires apartment complexes to follow the full recycling program requirements regardless of where the apartments are or how many units a building may have. Some cities are known to levy fines on those that do not recycle and deny trash services if complexes consistently set out contaminated materials. One particular ordinance in New Jersey, USA, allows the city to fine apartment management and/or discontinue both trash and recycling services for failure to comply with the city’s requirements (CalRecycle, 2001). In Seattle, Washington, apartments, townhouses and condominiums whose garbage containers are filled with more than 10 percent recyclables are tagged with warning notices by Seattle Public Utilities inspectors. After a third notice, a \$50 charge is added to the garbage account. The EPA (2001) suggests that the program be mandatory for complexes and not for households with clear specifications on which materials are to be recycled. Mcquaid & Murdoch (1996) found that introducing a recycling policy in multi-storey dwellings had an improved effect when compared to reliance upon ‘bring’ points for recycling. It may also be easier to enforce mandatory recycling at MFDs rather than to enforce a rule aimed at individual residents. A Portland, (USA) ordinance requires multifamily buildings to establish recycling programs that collect mixed paper, newspaper and three other materials. The Portland Bureau of Environmental Services reported that further to the mandate, the proportion of complexes with no recycling program dropped from 10% in 1995 to 2% in 1996 (Lease, 2001). Although mandating recycling cannot change the size of existing apartment units, policy efforts could influence factors that make up perceptions of adequate space (Ando & Gosselin, 2005). In most communities, MFD solid waste service costs are

based on container size and collection frequency, so urban areas with a dense distribution of MFD's can actually benefit from this if they recycled more. An EPA (2001) report on recycling in MFD's provides that communities with low-diversion rates report less enforcement activities, and those with high-diversion rates are more likely to report the use of fines, liens, or other sanctions against rule breakers, signifying the importance of mandating recycling in MFD's. Further support for recycling mandates can be seen in findings by Viscusi et al. (2009) who found that water bottle deposits and recycling laws foster recycling through a discontinuous effect that converts reluctant recyclers into diligent recyclers.

5.4.6. Waste Streams and Disposal Systems

The constituents of the recycling waste stream can determine the success of a program as programs that target more materials have the potential to reach higher diversion levels. Lockerbie (2010) support the theory that recycling rates are influenced by waste composition and materials collected. Programs that accept commingled recyclables enhance convenience and participation (Lease K, 2001). Materials accepted typically at both single and multi-family programs are – all paper, cardboard, boxboard, metal/aluminum cans, and hard plastics. Collection containers also significantly contribute to successful collection of recyclables (Omran et al, 2009). Color-coding containers can help residents differentiate trash containers from those for recyclables, thereby minimizing contamination. Foote & Foster (2002) and the EPA (2001) recommend a 90- to 96-gallon wheeled rollout cart as it would provide adequate volume for recyclables and can be moved easily. They also maintain that the key to an effective apartment recycling program is selecting the appropriate collection containers, suitable for collection, storage and hauling. Depending on the size of the apartments recycling collection containers can be specifically designed to fit under sinks or in other small spaces such as the MURFE (Multi-Unit Recycler for Everyone) stackable containers specifically designed for professional offices, apartments and condominiums. Innovations such as single indoor storage containers that house separate compartments for recyclables and trash could be retrofitted into existing buildings. Communal collections in MFD's can also be designed to fit collection spots at individual areas in the MFD's. Other systems that can be adapted to support recycling are automated chute systems, as seen in the 187-unit high-rise Commodore Club in Florida that uses a chute for trash and recyclables where computer controls ensure that source-separated materials drop into the proper receptacle (Lease, 2001). The EPA (2001) suggests that requiring multi-family households to place their recyclables in three or more containers is positively associated with increased diversion and the higher the amount of material set out for collection at each stop, holding constant the total amount of material collected, the lower the program costs. The programs with the highest diversion rates average 3.2 setouts, while programs with the lowest diversion rates average 2 setouts (EPA, 2001) perhaps because the sorting of recyclables into several containers reduces the temptation to contaminate the containers with garbage. Collection containers do not have to be elaborate but they must be well marked or color coded for easy comprehension.

5.4.7. Population Transience

Transient populations, such as students, tourists and short-term residents, are difficult to track and commit to the community's recycling program due to the limited amount of time they spend within the community. Urban areas housing MFD's are usually more densely populated, with a high degree of population transience, an issue all too familiar in the UAE. In general, multi-family buildings see a higher degree of transience. They comprise young, workers, families with average income, students, new immigrants or newcomers to the city that are not familiar with recycling services where such services are offered. Case studies by SITA in the UK have shown that there is an urgent need for detailed on-site assessments to improve the adequacy of recycling provisions to address issues

related to movement within MFD's. The impact of transient populations on recycling behavior in a densely populated urban environment has been studied by Timlett & Williams (2009), in the city of Portsmouth, the most densely populated area in the UK and all of Europe. A survey of 62,299 households showed that in some areas 10% of participants stopped recycling completely at certain times. Upon investigation it was found that the key issue for this stoppage was population transience, which was found to be greater in urban areas. It was found that changes in "physical" circumstances were the causes behind those properties that stopped recycling, changes such as a change of address, a change in occupants or a bin going missing. Timlett & Williams (2009) were able to conclude that longer-term residents showed the highest recycling behavior because they felt a sense of ownership whether they owned or rented their apartments. Shorter term residents and the newly arrived had a lower recycling rate because they were less invested in the neighborhood, didn't know their way around the rules and because they didn't have enough bins or they had gone missing. A high population turnover rate means that there is an increased need for frequent updates on recycling information to ensure that new residents are aware of the services and participation requirements. This however adds to the cost of the program.

5.4.8. Fee systems

The planning of the fee structure is an important aspect that influences recycling and diversion rates. Implementing a recycling program to customers, via any system except mandated subscription service, generally requires government funding mostly derived from tax paid by citizens. Higher MSW management fees and a fee for multifamily recycling is associated with higher diversion rates. Seventy percent of those communities with high diversion rates charge multifamily households for recycling, compared to only 50 percent of communities with low-diversion rates (EPA, 2001). In Austria, fees for waste collection have to be paid by the apartment owner. The fee is charged based on the number and volume of containers for residual waste on the property and their collection frequency. San Jose, California, charges MFDs for trash services and provides recycling and yard debris collection at no additional cost (CalRecycle, 2001). The EPA recommends a variable-based fee for refuse collection as it provides the opportunity for customers to reduce the overall cost of waste and recyclables service by active participation in recycling, and also to reduce the size of the refuse container and thus, the refuse collection fee. Often residents of MFDs pay the fee indirectly, usually to the property management, allocated to a unit according to its floor space. Some experts have suggested the introduction of pay-as-you-throw systems, for MFDs similar to SFDs with the idea that they contribute to providing comparable conditions. Although it should be noted that the fee system affects only one of several complexly interacting conditions. To make the fee-system for waste collection in MFDs fairer, Lebersorger (2008) has listed the following options that can be inclusive of recyclables as well as residuals.

1. Trivial systems: Each household has its own container. The fee is calculated according to the volume and/or the collection frequency, which is similar to PAYT in SFDs.
2. Lock systems: a popular system where waste containers with definite volumes and locks are provided to residents; they can open the locks with a corresponding chip or magnetic card and discard their waste. The fee is calculated on the basis of the frequency of use and the volume of the lock.
3. Volume systems: Residents are provided with identity chips or magnetic cards to open the locks to containers into which the waste is discarded. After the lock has been closed, the waste is

compressed until a defined pressure is reached. The remaining volume is registered and allocated to the user.

4. **Weighing Systems:** Residents are provided with identity chips or magnetic cards with which the waste containers can either be opened or waste can be put into a lock. The waste quantities are then weighed directly and residents credited.

5.4.9. Recycling Inhibitors

Just as there are specific conditions that aid recycling behaviour, the opposite can be true of behaviours that inhibit commitment to recycling. Attitudinal research has shown that several factors can have a negative impact on residents' propensity to recycle. This is particularly the case in high-density low-income areas where the lowest diversion rates are seen. A 2006 WRAP report states that the condition of residents' immediate and local environment is an important concern in their lives. In situations where space is limited residents often tend to dispose of their general waste on a daily basis. At a number of such locations residents have cited the following as obstacles to disposing both their recyclables and general waste. These included:

- Overflowing communal bins (both general waste and recycling bins)
- Blocked refuse chutes
- Untidy or dirty bin areas
- Lack of convenience
- Recycling and general waste bins being stored in separate areas due to restricted space resulting in reduced convenience
- Contamination of recyclables with general waste and plastic carrier bags
- Vandalism and other security issues affecting bin stores
- Restricted access for the collection vehicle, often due to parked cars

It has been reported that in most blocks of flats, the most convenient recycling option is likely to be the installation of dedicated recycling containers alongside existing refuse bring-facilities for convenience and cost measures (WRAP, 2006). In England, only 19% (4.1m) of households are flats and only 14% (3m) were purpose-built blocks of flats. By contrast, 42% of households in France are flats, 61% in Germany, 62% in Spain and 65% in Italy (WRAP, 2006). Studying the individual characteristics of particular properties and the residents should lead to higher levels of success when developing a recycling collection system for MFD's.

5.5. Collection Methods and Efficiencies

In the developed world the main drivers for providing flats recycling schemes is the need to meet statutory recycling targets. A waste characterization study can determine the composition of waste produced, based on which a collection stream can be defined based on which a collection method can be selected. With all factors being equal, a recycling or refuse program is considered efficient if it serves a greater number of households per crew shift, whether they are single family or multifamily households. This number tends to increase or decrease based on variables such as collection frequency, program participation, quantities collected and collection operation. For example, the EPA (2001) study compared crew shift efficiencies of MFD & SFD programs within 40 sample communities serving a population of 3.9 million and found that in SFD programs an average of 2,167 households were served per crew shift and in MFD refuse collection programs an average of 1,559 households were served per crew shift. In the US, a large percentage of programs collect multifamily recyclables on the same routes as single-family recyclables, using the same truck and crew to serve both types of customers on a single route (EPA, 2001). Further to collection, the monitoring of

weights data would add considerable value to improving the efficiency or design of collection rounds. On-board weighing systems are now available which record weights for each bin collected. Where chipped bins are used, on-board weight data can be captured electronically. Where bins are not chipped, collection crews will be required to fill in monitoring sheets relating weights recorded to particular locations. The most popular collection methods seen around the world for MFD recycling programs include:

5.5.1. Door-to-door collections: This system is similar to curbside collection. Residents are supplied with a box or plastic bag/basket as seen in Figure 5.11 to collect & store recycling items within their apartment; collected items are then placed outside their door for collection on a weekly basis. Collection authorities then transport the recycling to the ground where it is bulked up for collection by city/private haulers. Door-to-door schemes are easy for residents to use, inexpensive to set up / implement and have been reported to encourage participation (WRAP, 2010). Disadvantages being that residents might have trouble storing the recyclables and placing bags in the corridors could block access ways.



Figure 5.11: Door to Door collections recycle basket.
(<http://www.southernpines.net/publicworks/wastemanagement.aspx>)

In this system the materials can be transported in various ways, for example: In Falkirk, Scotland, materials are emptied into bulk sacks and carried downstairs and in the City of London dry materials are transported in a caged part of a trolley and food waste is put into sliding drawers at the bottom of the trolley. In some cases materials are bulked up and may be put into Bring banks; potentially with some on site sorting of materials, as they are not collected fully co-mingled. WRAP in the UK reports that MFD's over five floors recycled approximately 1.8 kg/hh/wk on door to door collections and MFD's with less than 5 floors or low-rise properties recycled 1.5kg/hh/wk in the same borough.

5.5.2. Collection points on each floor: Collection points are specific drop-off points or “garbage” rooms located in strategic locations on each floor of high-rise blocks as seen in Figure 5.12. Material from these collection containers is then taken to a central bulking area of the building by collection operatives or caretakers. Caretakers use a trolley to transport recyclable materials to load recycling into large recycling banks ready for collection by haulers. In this system residents can deposit bags for recycling at any time and the collection points are emptied once or twice a week. The advantages of this method are that residents do not have to store recyclables in their apartments, and corridors

are not blocked with bags or boxes placed there for collection. In many older buildings this method is used for food waste collections although odors and leakage of liquids would need to be closely monitored and controlled. The disadvantages are that storage of materials is considered a potential fire risk and some tenants see carrying materials from apartments as inconvenient. Also manual handling of recyclables is needed during collection, particularly if there are no lifts or they are regularly out of order. Although this is a very common method of refuse collection in MFD's in the developing world, data on this system is not available, WRAP found from two small trials in two separate London Boroughs, that residents recycled an average of 2.52 Kg /hh/wk when this system was in place.



Figure 5.12: Recycling collection points on individual floors in apartment blocks. (<http://www.mmtl.jp/english/detail.asp?id=10046>)

5.5.3. Central Collection: Central Collection are those in which residents are expected to bring their recyclables to the refuse storage areas located anywhere within the grounds of a property where residents and collection crews can access them, such as basements, rooftops or a designated floor. A variety of containers in different sizes are used within this scheme such as small and large wheeled bins, underground containers, or frames with drawers that pull out. During the collection process, full containers may be exchanged for empty ones. Figure 5.13 indicates a central collection point as seen in Manchester, UK. Such methods are cheap to run, can be implemented in older building without specific recycling allocations and they allow residents to deposit material at anytime without having to store them. The disadvantages are that historically, locations of bring banks are areas perceived as dirty and potentially dangerous places, and people tend to avoid using them. Having to transport waste to these areas is seen as inconvenient and the degree of contamination can be high. Performance of such schemes varies between sites and often depends on the relative ease with which residents can recycle, collection frequency, size of the building complexes, existence of chutes and internal container provision - Average collections are seen to be higher where an internal receptacle was provided to residents to store their recyclables. Depending on the conditions, collections in this method vary between 1.15kg/hh/wk to 2.54kg/hh/wk (WRAP). This scheme is known to have generally the lowest capture of any recycling scheme.



Figure 5.13: Central Collection or bring Schemes (WRAP, 2006)

5.5.4.Chute systems: Chutes are channels or tracks that empty into large containers or wheeled carts. They are designed to either collect co-mingled recycling in sacks that are collected in bulk from the basement or have a rotating system that delivers specific materials to the correct bins. In flats where there is more than one chute, one or several chutes can be dedicated to the collection of recyclables with other remaining chutes for refuse disposal. The refuse and recycling chutes are usually located side-by-side for easy disposal and recycling. Chute systems are convenient and significantly minimize manual handling of wastes. Figure 5.14 & 5.15 depicts typical chutes at MFD's, single and multiple chute systems. Trash chutes can be effectively incorporated into a recycling program by modifying the chute system or alternating collection days for refuse and recyclables. They also reduce the distances residents have to transport waste and subsequently have been reported to increase capture rates (WRAP, 2010). The disadvantages of this system are that they are expensive to install (especially for retrofitting existing buildings), maintenance costs can be high, and controlling contamination is difficult. WRAP found from three small trials in three separate London Boroughs, that residents recycled an average of 3.69kg/hh/wk. This is the highest performing collection system for flats recorded. Although there are several types of chutes systems, the most common types of chute systems are:

Mechanical Chute System: A system in which a lever or button is provided at the mouth of the chute which moves a mechanism that guides recycling or refuse into the correct collection containers at the bottom of the chute. The collection containers can either rotate on a platform beneath the chute or a basket may catch materials at the base of the chute and drop them into the correct container. The advantage of mechanical chute systems is that they can be retrofitted to existing refuse chutes, though they are easier to introduce in new developments.

Vacuum Chute System: are those in which a vacuum is created to draw materials to a central collection location instead of collecting materials from different areas, in this system the collection vehicle only has to visit one location. The chutes can be upto 2km (1.25 miles) in length, meaning collection points can be located at the edge of an estate. The system has been used in more than 30 countries and originated in Sweden in the 1960s. In some systems waste is sucked through a series of

pipes at 70km/h (43mph) to a central collection point, where it will be picked up twice a day (BBC, 2008).

Other Chute systems: include those in which the same existing chutes can be used for recycling and refuse at different times of the week based on a schedule. The collection crews would need to make sure that the correct container was under the chute at the correct time, and communications would need to be clear so that residents understood which day and/or time was for which materials. Segregated Chute Systems are those that have separate channels for wet and dry wastes and disposed wastes are collected much like the mechanical system at the collection points.



Figure 5.14: Single Chute Systems in Apartment blocks for waste and recyclables disposal.

(<http://www.arcacat.com/arcacatcos/cos31/arc31437.html>)



Figure 5.15: Segregated Chute System (Carlisle, 2011)

Some of the disadvantages of the chute system are the build up of grease, sludge and grime, potential build of bacteria in dirty chutes, faulty trash chute doors, and clogged air vents and resulting offensive odors, all of which pose genuine threats. Also during a fire, if the trash chute doors are not closed properly, a wind tunnel effect is created funneling the fire up and down the building. Some times residents get confused on the set dates for different wastes to be disposed, thus causing contamination of wastes at the collection point.

5.5.5. Near-entrance collection facilities: This system is often referred to as “On Street” containers. The principle behind this method is that a recycling facility close to the entrance to the block of flats will provide reasonable convenience even though the refuse facilities may be somewhere else. These systems are similar to central recycling facilities and share some of the same advantages and disadvantages. Figure 5.16 shows a typical near entrance collection facility. This system also enables haulers to collect the recyclables with relative ease. This system can be used where refuse areas have insufficient space for additional recycling containers. This system can be retrofitted to apartments that were not designed with recycling space, however tenants could view carrying materials from apartments to the main entrance of a building as inconvenient. Finding appropriate space for recycling containers can be difficult for flats above shops and converted houses where external space can be limited or leads to commercial areas open to the public, as a result contamination might be difficult to identify. Being easily accessible to the public, this system attracts

fly tipping and use by commercial users. Much like the central collection schemes, this system sees collections vary between 1.15kg/hh/wk to 2.54kg/hh/wk (WRAP).



Figure 5.16: Near entrance collection facility (WRAP, 2006)

The UK has adopted the chute system for a majority of their MFD's, Spain has opted for a comprehensive central collection system or the vacuum chute system. The US has a number of central collection systems and chute systems in place for their MFD's (Lapointe et al., 2010). Door to door collection systems are popular in several parts of the UAE and Asia. In Europe, Paris has 94.9% of their housing as MFD's and yet they have achieved an almost 100% rate of recycling services provided to the nearly 1,054,682 apartments (WRAP, 2006). In Austria, collection schemes for the separate collection of recyclables are principally provided to all MFDs, which is different to the situation in most other countries. In Austria fees are charged for collection of organic household waste, but collection of packaging waste is funded by the Austrian Waste Packaging Ordinance through royalties from producers, distributors and importers and are therefore free of charge for the residents. Containers for the separate collection of recyclables are usually provided to all households irrespective of the building type MFD or SFD in Austria (Lebersorger 2008).

There are a very limited number of studies concerned specifically with recycling in multi-occupancy buildings the world over. Table 5.2 provides information on MFD recycling from a few case studies for an understanding of different aspects of recycling in various parts of the world. Similarly, literature discussing recycling services for transient populations, such as that in the UAE and residents in temporary accommodation, is also very narrow. Lebersorger (2008) have brought to light differences in MFD recycling from SFD recycling such as the fee system, responsibilities and decision processes, constructional and spatial conditions, social aspects, interdependencies between space and residents and their implication on waste management that contributes to lethargic growth in this sector.

Table 5.2 : MFD Recycling information from key recyclers from around the world, France, Italy, USA, UK, Singapore and Germany. Source: WRAP (2006), SITA, EPA, and Waste Management World.

Sample Size	Dwelling Type	Mandatory programs	Private Collection	Municipal Collection	Subscription Collection	Collection Frequency	Items Collected	Container Type	Recycling Fees	Diversion / Recycling rate	Refuse collection cost /house/year
Experience - USA (Source : EPA,2001) Number of cities in the US with MFD recycling programs - over 111 cities. (Varied Collection Methods)											
40 communities serving 3.9 million people	MFD	61.50%	67.50%	32.50%	17.50%	0.98/week	1 to 16 / 9 Average	1 set / 20 .5 households set= 1 to 7 Receptacles)	Flat Fee for recycling	D 14.6%	USD 53.69
	SFD	64.10%	60%	30%	10%	0.90/week	1 to 16	3 containers	Flat Fee for recycling	D 16%	USD 68.23
Experience - FRANCE (Source: WRAP,2006) (Door to Door & Bring Systems)											
1,054,682 households	95% MFD	100%	100% +Eco Emballage	Green Dot System	NIL	1/week for recyclables	6 +	240, 360 ,1100 litre wheeled bins	NO Fees	R 15 %	Recyclables Col.Cost - 166 Euros /Ton /year
Experience - SALERNO , ITALY (Source :SITA, 2010) (Door to Door Collection)											
146,324 Households	MFD	100%	European packaging Consortium	in Association with CONAI	NIL	1 - 3 /Week (Varied based on Apt complex size)	5	Bags, 360 ,1100, 1600 litre wheeled bins	NO Fees	R 72%	N/A
Experience - Berlin, GERMANY (Source : WRAP,2006) (Central or Near entrance Collection)											
1,874,313 Households	90% MFD	100%	DASS mBH	BSR + Berlin Recycling	NIL	0.5 - 1/Week	3 + Green Dot Packaging	Yellow Bags,240, 660,1100, litre wheeled bins	Variable Recycling Fee	R 33.5%	N/A
Experience - SINGAPORE (Waste Management World) (Door to Door collection)											
4131200 Population	82% MFD	Voluntary - 63% participation	VEOLIA +	Public Waste Collection Contracts	NIL	2/week	5 +	Green Bags & Collection Bins	No Fees	R 56%	N/A
Experience - City of Westminster , UK (WRAP,2006) (Varied collection methods)											
102,593 Households	87.2% MDF	Voluntary	VEOLIA + Cleaning Contractors	NIL	NIL	1/Week	5 +	35 L basket, Woven bags , 180 ,240 ,1100, 1280 L Wheeled bins	No fee	R 26% (UK Average)	GBP 17 (UK Average)

In any case multifamily programs should ideally be measured in relation to other multifamily programs and not with curbside programs, to assess fairly the potential and limitations of a program. Table 5.3 as proposed by Lebersorger (2008) provides a summary and differences of MFD's to SFD's, their effect on the resident's attitudes as well as on waste management and suggests possible solution.

Table 5.3: Summary of the differences between MFD recycling and SFD recycling. (Lebersorger, 2008)

Basic difference MFD to SFD	Consequences for residents	Effect on waste	Suggested solutions
Fee system for residual waste			
- based upon floor space of unit - component of running costs	- no direct influence - not transparent	diversion rate, amount of residual waste	- pay-as-you-throw
Decision processes and responsibilities			
- several different actors - resident have little possibilities of participation in decisions	- lacking feeling of responsibility	diversion rate, amount of residual waste rate, littering	- on-site manager - caretaker - waste management service
Constructional and spatial conditions			
- less availability of (exterior) space - distances, being "out of the way" of waste collection points	- less convenience	diversion rate, littering	- guide for the planning of waste collection points - means for facilitating separate collection
Social aspects			
- anonymity - "Tragedy of the commons" - segregation	- missing feedback - lacking feeling of responsibility	diversion rate, amount of residual waste /household waste, littering	- pay as you throw - caretaker - education and communication

With multi-occupancy dwellings likely to account for a rising proportion of the UAE housing stock in the future, it should be mandatory to include recycling provisions into all new-build properties, in addition existing or old apartments must be retrospectively adapted to accommodate at least a minimal level of recycling. An important reminder is always that statistical significance does not always imply practical significance because all contributing factors must be weighed carefully, for example Kuo & Perrings (2010) found that the higher the frequency of waste collection, the less recycling and the more disposal to landfill there will be. This is because frequent collection reduces the marginal time-cost of disposal to landfill indicating that recycling depends on management of the time-costs it involves as well. Recycling in high-rise buildings offers a unique opportunity to collect a large volume of recyclables at a single location. The more a community recycles, the more cost-efficient recycling programs become. The EPA (1999) recommends an ideal MFD recycling program to feature the components as described in Table 5.4 to improve their potential for success.

Among the worlds highest recyclers are Europe, with Austria being crowned top of the European recycling league as Austria recycles or composts 70% of municipal waste. This high rate of recycling is probably achieved because in Austria, communities (both SFD's & MFD's) are legally obligated to recycle waste using either their municipal service (Lebersorger, 2008). Data released by Eurostat indicate that recycling was most common in Germany where 48% of waste is treated, Belgium and Sweden at 36%, Slovenia and Denmark at 34% and Ireland and the Netherlands at 32%. The Member States with the highest composting rates for municipal waste were Austria (40%), Italy

(32%), the Netherlands (28%), Spain and Belgium (both 24%) and Luxembourg (20%). The UK's recycling rate for in 2011 was 26% (ClickGreen, 2011). The percentage of total waste that was recycled in the United States in 2008 was 33.2 % (EPA). Data from 2006 showed that Australians were recycling nearly half their waste at a rate of 46% (Australian Bureau of Statistics). Japan's waste recycling rate in 2007 was 20% (Japan for Sustainability). Total waste recycled in Singapore in 2007 was 54%, Philippines - 28% and Korea - 60.1% (Borongon & Okumura, 2010).

Table 5.4: Recommended features for a MFD recycling program (EPA, 1999, 2001)

Container Type	Collection Stream	Contractor	Fee	Outreach	Collection Frequency	Participation
90 Gallon Cart type, 1 set to serve 15 – 19 Household. 3 Container setouts	Minimum of 3 newspapers + Old corrugated cardboards + "mixed" recyclables glass, plastic & metals.	Private - Using same crew and route as SF recycling.	Variable Fee systems for refuse collection with charge / month of \$2 per household for collection of recyclables	Targeted Outreach - regular mailings + personal visits	Bi – weekly	Mandatory participation recommended.

MFDs have to be considered as a special field and require the development of specifically adapted solutions, which allow for the unique conditions surrounding MFD's. Within MFD's, the many different types of architecture and resulting spatial differences present challenges and opportunities for recycling. MFD's also differ in terms of the social make up and management and this always requires different approaches to recycling and communications. Primarily, recycling has to be integrated into the cities infrastructure, further to which education and incentives would drive a growth in recycling. Successful practical examples illustrate that some effective approaches already exist, as seen in France and Austria. Further to an analysis of the information presented in this paper, it is found that communities with fewer collection points serving many households, communities with high participation rates, and communities that include many materials in their recycling programs would all be expected to have lower collection costs per ton than communities with the opposite characteristics.

There is however a great need for further research into MFD recycling and for the practical development of innovative technical solutions that take into account the demographics of each zone and country where MFD recycling solutions are required. Recycling and refuse disposal are related because recycling will change the way one disposes of refuse/waste and implementing a recycling program also provides another opportunity to reevaluate the way waste is disposed with a chance to move to a more integrated format. A number of case studies observed by SITA (UK) in their study of international experiences on MFD recycling have shown the values of detailed on-site assessments to improve the adequacy of recycling provisions and resolve access issues. Investments are required in the form of community engagement work at the level of individual blocks of flats in order to meet success in recycling in MFD's. Assuming collection scheme for recyclables and residual waste in an MFD is the same as in SFDs, the same performance of the waste collection and recycling scheme cannot be expected due to the surrounding conditions of each type of dwelling and its resident's

characteristics. The cumulative value of recycling however have been documented by several studies such as the EPA(2001) study of 40 communities serving 3.9 million people where over time it was noted that the quantity of materials recycled increased and the quantity of materials discarded as refuse decreased. Vining and Ebreo (1992) also found that the value and success of recycling appreciate over time, the proportion of households indicating that they recycled increases along with the actual volume of materials recycled in the community. General environmental concerns and specific attitudes regarding recycling also become more favorable over time with recyclers exhibiting stronger pro-environmental attitudes. Such outcomes greatly enhance the economic viability of recycling providing further proof of the overall value of recycling.

Chapter 6. Survey on Recycling attitudes and habits in Dubai.

This section describes the e-survey conducted as part of this research to discover the attitude and commitment of people in Dubai towards recycling. The survey type selected was web-based survey that can be best described as survey instruments that physically reside on a network server accessed by respondents on the Internet. This method was chosen due to the easy access to computers that people have Dubai. The all-electronic web-based survey was chosen for short turnaround time, convenience, efficiency, ease of reaching the required audience and to minimize bias. Although some of its drawbacks are the issues faced with technology problems (as seen in the partially completed surveys) and the potential for bias in the sample.

6.1.Survey Design

The survey type selected for this paper was the e-survey method. The focus here is more on the expected outcome rather than the method by which it is achieved. E-surveys are Internet based and often described as faster and more efficient. Reports are also generated electronically avoiding chances of human error. **SurveyGizmo** - a free non-commercial use web based student software was used for this survey. This online survey can be published in its own page, or embedded into another web site by using a snippet of Javascript or an iFrame. The Survey was designed with questions to be answered by checking the answers from a given set of choices. The questionnaire was posted on the Facebook media and was also e-mailed to select addresses in an attempt to obtain a fair sampling. This method enabled the survey to reach the intended audience despite their geographic locations. Selected respondents, irrespective of their exact location, would click on the link, which would take them to the survey questions directly. The total number of questions in the survey was 8, to keep the survey short and specific. Each question was on a single page with the choice of answers for the question on the same page. After checking their answers from the given choices, the respondents had to select the option: NEXT, to move to the next page for the next question. A screen shot of the Survey Questionnaire is indicated in Figure 6.1. When a respondent completed the survey, the data showed up in the survey results within 5-10 minutes. Incomplete surveys were also recorded. The total number of questions in the survey and the sequence of questions are indicated in Figure 6.2

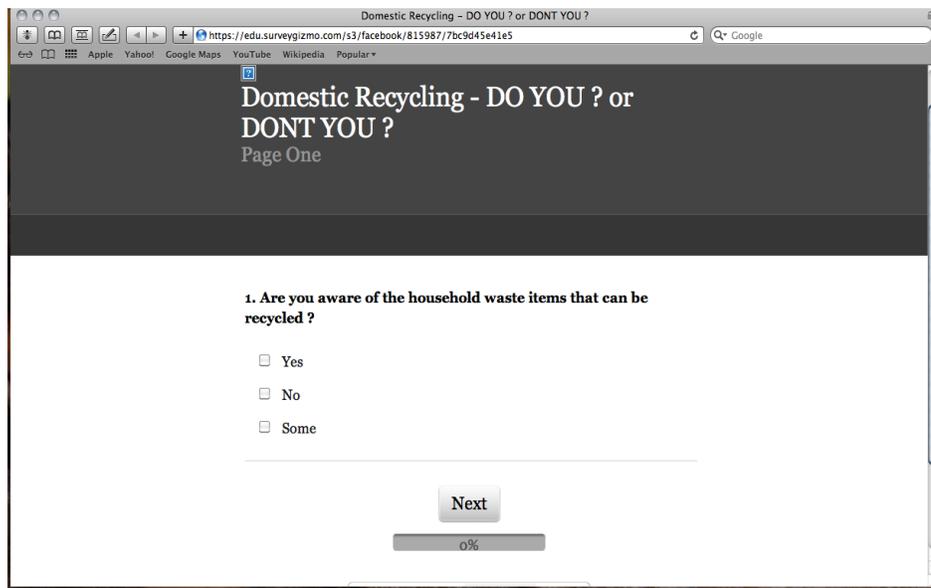


Figure 6.1:Screen Shot of Survey Questionnaire forming part of this paper.

The questionnaire was designed to obtain information one whether or not respondents recycled, if not - the reason for not recycling, what items they recycled and whether or not they were willing to recycle if residual waste collection would be charged. They were also asked if they would support mandatory recycling. The questions selected surrounded the proposed recycling plan as described in this paper. The purpose of the questionnaire was to determine the relevance of the proposed recycling plan for Dubai and whether or not residents would support such a concept. Respondents were not briefed about the paper or provided any background information on recycling in an attempt to minimize bias. Selected respondents were contacted via email or through Facebook message with the link to the survey, which could be accessed even if they were out of the country at the time of the survey.

DOMESTIC RECYCLING - DO YOU ? or DON'T you ?

1.Are you aware of the household waste items that can be recycled?

- Yes
- No
- Some

2.Do you recycle? (Or encourage your house help to recycle?)

- Yes - regularly
- Yes - Sometimes (once / 3 months)
- Rarely (once/6 months)
- No

3.If Yes - why do you recycle?

- Its good for the environment
- It is a habit

4.What do you recycle?

- Paper /cardboard boxes
- Glass
- Plastics
- Cans
- All of the above
- Other - pls specify

5.If No - Why don't your recycle?

- I don't care about recycling.
- It takes too much time.
- There is no recycling centre nearby.
- I don't have space to store the items until I take them to the drop off centre.
- It won't make a difference to the planet anyway

6.Would you recycle if you had to pay by weight for the garbage you throw? That means by separating recyclables and dropping off at the drop of centre you could reduce the weight of your garbage and pay less.

- Yes
- No
- Maybe

7.Would you recycle if the Municipality collected your recycled items at your residence/ Apartment building (free of charge)?

- Yes
- No
- Maybe

8.Do you think the law in Dubai should require Recycling as it is in Europe?

- Yes
- No
- I don't care either way

Figure: 6.2: Recycling Questionnaire used in this dissertation.

6.2. Sample Selection and Timeframe

A judgment sampling was conducted for this survey with potential respondents randomly selected to best represent the population demographics of Dubai. Although a smaller group of people was used to make inferences about larger groups of people, every effort was made to include a variety of nationalities, income levels, age groups and social attitudes that is representative of Dubai. All selected respondents were residents of the country for minimum of 3 years and above. The disadvantage of this method of sampling is that subconscious biases may creep into the selection of the sample, however a conscious effort was made to avoid any biases. The frame population included a larger proportion of South Asians (45), followed by South East Asians (25), Europeans (25), UAE nationals (25), Americans (10), Australians (5), Arab expats (25) and randomly selected respondents (35, selected to reduce the chances of bias) which represents as best as possible the existing population in Dubai. Response rates can be classified as modest to good with a response of over 50% out of the 195 surveys sent out. The survey time frame was set for 10 days from date of going live. Some of the respondents selected were travelling at the time they received the questionnaire, however the advantage of the e-survey is that it is accessible in any part of the world where Internet connections are available, thus they were able to access the survey. It is possible that the results could be minimally affected by non response bias and sample size bias, however the issue with surveys is that no matter how big the sample or how carefully controlled, the estimated answer is not going to reflect the absolute truth even if the entire population was observed.

6.3. Survey Results and Analysis

The key findings of the survey are illustrated in this section. The total number of responses received out of 195 questionnaires sent out was 113 responses. One of the primary observations was that knowledge of recycling and its benefits did not entirely motivate residents to actually recycle. The results indicated that 72.6 % of respondents were aware of recycling, yet only 30.4% recycled regularly (out of 112 responses), with 33% indicating that they recycled on an average of once in 3 months only, these rates are illustrated in figure 6.3 and 6.4. Recycling activities thus appear to be minimal bordering on inadequate in Dubai, particularly when compared to data from other western countries.

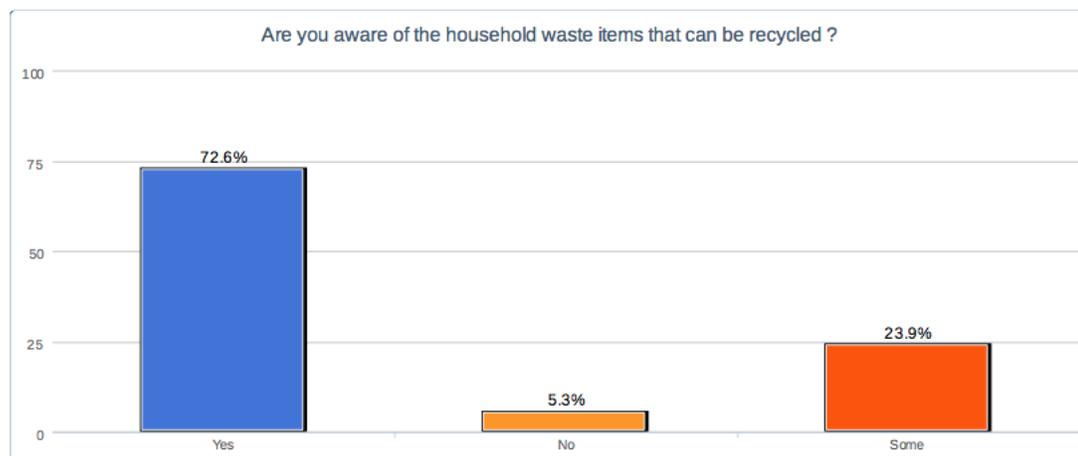


Figure 6.3: Percentage of respondents that are aware of household recycling in Dubai.

Among those that did not recycle 71.7% cited the reason that there were no recycling drop off centers nearby followed by 45.7% citing lack of space to store recyclables as the reason. This is consistent with the observation that residences in Dubai do not have specific allotted storage space for storage of household garbage, let alone recyclables. Building regulations in Dubai do not warrant such storage spaces. This issue has been taken into consideration in the proposal of a recycling program for Dubai as described in Chapter 7. The second top reason for not recycling indicated was the lack of recycling centres at convenient /nearby locations. While Dubai has seen an increase in the number of drop – off centres, it has not yet been able to garner recycling support by the residents. In the absence of actual data on the exact number of recycling drop off centres and the low recycling figures, one can only assume that the dropoff centres are insufficient in quantity and location.

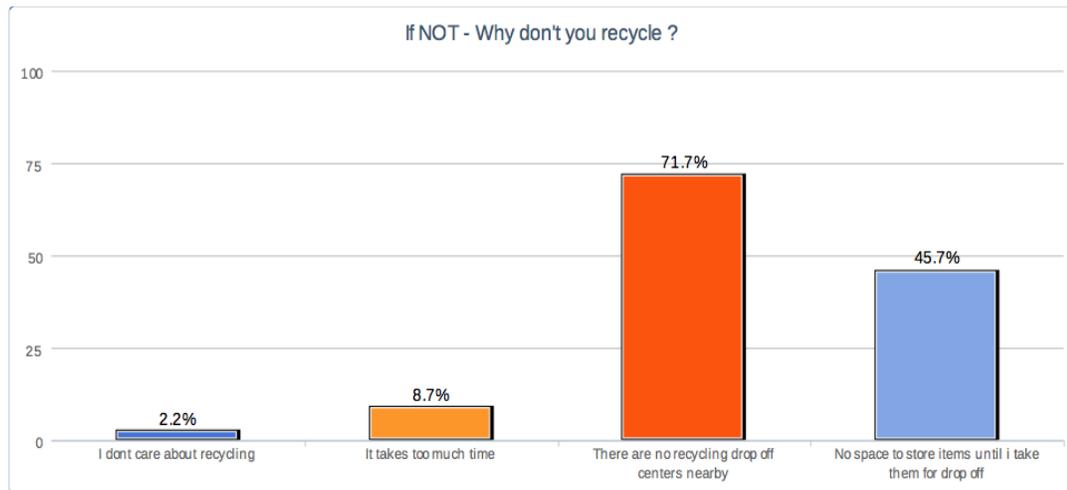


Figure 6.4: indicates the top two reasons for not recycling which are the lack of recycling centers at close quarters and lack of space to store recyclable items.

The results of the survey as seen in Figure 6.4 have been taken into consideration in the proposal of door-to-door collection of recyclables in the recycling program for Dubai. The survey also asked the question “ Would you recycle if the Municipality collected your recycled items at your residence/ Apartment Building? (Free of Charge?)”, an overwhelming 94.5% of respondents indicated they would recycle if they were provided door-to-door recycling collection services suggesting the potential for success if a door – to door recycling program were to be introduced in Dubai as seen in Figure 6.5.



Figure 6.5 indicates the response rate for door – to door collection of recyclables in Dubai, should it be available.

The reasons for not recycling cited by residents are consistent with my observations of the lack of sufficient recycling facilities in Dubai and residences that do not include space for storage of recyclables. The recycling program proposed in this dissertation suggests the collection of a minimum of 4 items for recycling that are source separated – this includes, paper, glass, cans and plastics. The survey found that while 47.5% of respondents recycled all four items, the highest recycled items were paper/cardboards at 50.5% and plastics at 33.7% as seen in Figure 6.6. The selection of materials to be recycled for Dubai is supported by the survey results affirming the basis of the proposed recycling program collection stream.

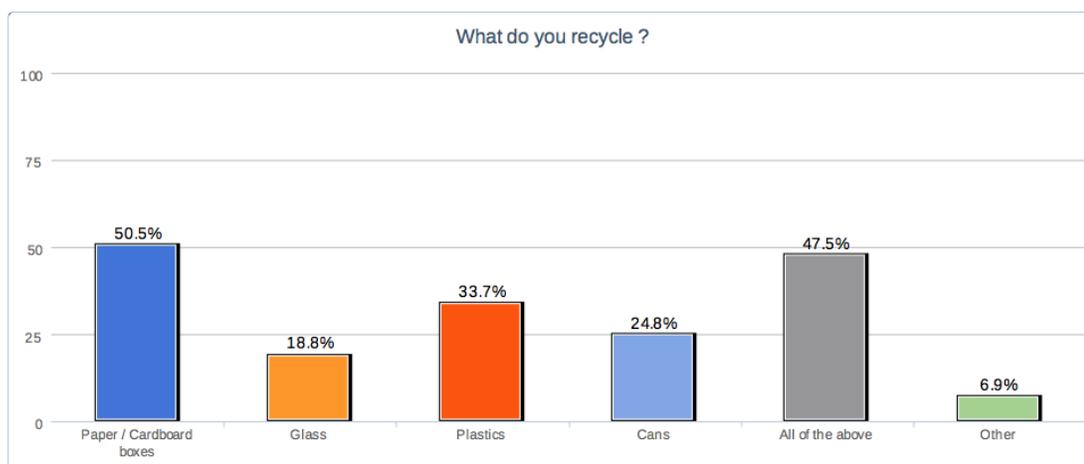


Figure 6.6: illustrates the percentages of items recycled in Dubai.

Knowing the proportion of each item in the waste stream such as paper, glass, plastic etc. helps determine the most suitable waste-recycling program that can offer the greatest disposal reductions for the money spent. The overall recycling rate in Dubai is a low 10% (Karkain, 2011), the fastest way to improve this rate in my opinion would be to introduce mandatory recycling laws. This survey's intention was also to discover the opinion of residents towards mandatory recycling. As depicted in Figure 6.7, 86.7% of the respondents were in favor of the introduction of recycling laws

in Dubai. This research proposes a waste management program for Dubai that would be mandatory in order to jumpstart recycling avoiding a situation where residents feel recycling is optional. Acceptance of mandatory recycling suggests greater degree of flexibility and acceptance on the parts of the residents, which leads us to believe that mandating recycling at least in the short term would be the right way to start in Dubai. Although a majority indicated acceptance of mandating recycling, only 57.1% of residents were willing to pay for waste disposal, and 7.6% stating that they would not pay for waste disposal, this ratio is indicated in Figure 6.8. This is understandable as mandating recycling leads to residents incurring a timecost that is possibly more acceptable than a cash cost. This survey also found that 96% of respondents that recycled did so as they believed it was good for the environment, and not out of habit. The question now is whether increasing the number of recycling drop off centers would in fact bring in the desired improvement in the rate of recycling, as only 18.2% of the respondents were in the habit of recycling. Since habits can be inculcated by law, the habit of recycling can be inculcated by the enforcement of recycling laws (Refer Complete Survey results at the end of the dissertation).



Figure 6.7: Respondents of the survey that displayed an interest in making recycling mandatory in Dubai.

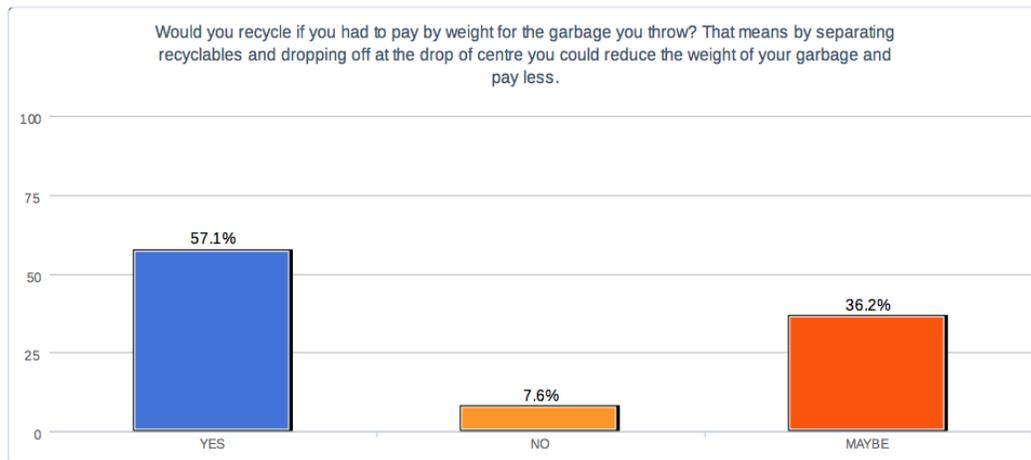


Figure 6.8: indicates the percentage of respondents willing to pay for waste disposal in Dubai.

The open and eager response received for this survey indicates that there is an interest among the residents towards environmental stewardship. It would be of value if the public were involved in the determination of any future waste recycling programs and policies and a consultation phase must be included in the planning process before adopting the final waste management plan and its initiatives. Recycling costs vary by city according to a number of factors such as demographics, availability & proximity to landfills, labor costs, amount and method of recycling and real estate prices. A general understanding of all these contributing factors indicate that Dubai is in a strong position to move forward with enforced recycling thus setting an example for other cities in the region. It is important to appreciate that cities with limited natural resources don't recycle to save money; they recycle to save resources and the environment. The findings of the survey have been taken into consideration and inform the proposed recycling plan for Dubai, as seen in Chapter 7. The most significant outcome of the survey was that the residents of Dubai are not in the habit of recycling and are willing to allow the hand of the law to create a structured recycling program that is understandable and aids the general population in achieving superior recycling targets. The survey also suggests that the proposed recycling plan for Dubai should ideally be one that improves the convenience of recycling in order to obtain resident's buy in.

**Chapter 7. Proposed Recycling Program for Dubai
and
Revised Program based on Stakeholders
Feedback.**

This chapter discusses the proposed recycling plan for the UAE. This discussion is based on research, observation and information presented so far within the previous chapters. The survey conducted as discussed in Chapter 6 informs and supports the strategies upon which the proposed recycling program is based. The design and selection of the recycling program itself is informed by the advantages of a variety of similar programs seen in other parts of the world as discussed in Chapter 5. A combination of the best features of such programs provided the framework for the recycling program proposed for Dubai. There are also other points to consider with promoting recycling: for example as recycling increases, the use of landfills decline, thus revenues from tipping fees decline, which means the budget for recycling subsidization declines. The overall success of a waste reduction program must take into consideration its design, legislative support, appeal to a population and support itself financially. Given the transient population and the demographics of the UAE, the best way forward appears to be a calculated introduction of recycling measures coupled with legislation. The roles of all participants must be clearly defined, and goals must be established to measure performances. Due to the nature of the population in the UAE, legislation takes precedence over voluntary participation as a basis for the program, with a need for increased private sector investment in recycling industries. The greater the recycling opportunities the lower the time cost to individuals: the cost of recycling to disposers includes cost of recycling services (fees paid) and time cost, such as the time cost invested in sorting household recyclables. What works for the United States or Europe is not necessarily an ideal plan for the UAE.

7.1.Highlighting Waste Management in the UAE

In 2010 alone, the GCC countries generated over 22.2 million tons of municipal waste and nearly 4.6 million tons of industrial solid waste (Al Ansari, 2012). The waste management ethic of any country includes the attitude of the people and leaders towards recycling and littering. As stated previously, public action on recycling is rather poor in the UAE, any independent recycling programs that do exist lack the needed coverage, intensity and continuity required to improve the apathetic public attitude towards the goal. The only comprehensive form of recycling available within the UAE is recycling of paper and cartons (Alhumoud, 2005). Environmentalist researchers have found that though household waste was collected effectively, the problem lies in its management after collection; collected MSW is dumped into the landfills in the area. Cooper (2007) report that these landfills have created potential problems for both groundwater and marine water resources in the country.

The gulf region has a high per capita waste generation, higher than those of developed nations across the world. An estimated 120 million tons of waste is produced annually with municipal waste being the second largest waste category by source, second only to waste generated from construction and demolition activities. Table 7.1 indicates comparative waste generation in the GCC counties and potential savings of recycling. MSW in the UAE is largely comprised of decomposable and recyclable organic waste, which can easily be recycled, yet MSW is disposed off into landfills, not a prudent idea in a country where land resources are limited (Gautam, 2009). In December 1997, GCC countries adopted a uniform waste management system and a monitoring mechanism for waste production, collection, sorting, treatment and disposal, however implementation has been weak.

It is estimated that greening the waste management sector would save Arab countries \$5.7 billion annually in addition to offering unique investment opportunities in recycling, composting, and energy production (AFED, 2011). As Al Ansari (2012) has stated: “If recycling rates were set for

19% and land was worth US\$ 661 per m², investing in recycling efforts could save over US\$ 478 million annually”.

Table 7.1: Municipal solid waste generation in the GCC countries (Al Ansari, 2011)

GCC country	Solid waste (Kg/capita/day)	Population (millions)	Total waste (tonne/year)	Land requirements for disposal (m ²) ^a	
				No recycling	Recycling
Bahrain	1.8	1.04	683,280	145,538.64	109,324.80
Kuwait	1.4	2.23	1,139,530	242,719.89	182,324.80
Oman	0.75	2.3	629,625	134,110.13	100,740
Qatar	1.5	0.46	251,850	53,644.05	40,296
UAE	1.4	2.3	1,175,300	250,338.90	188,048
Saudi Arabia	1.6	23	13,432,000	2,861,016	2,149,120

^aCalculations are based on a density of 0.5 tonnes for MSW.

^bCalculated based on an assumption of US\$ 661/m² as research over statistical land prices in GCC survey done by researcher over lands in the GCC(2011)

The Arab Forum for Environment and Development (AFED) reports that less than 20% of MSW is properly treated or disposed of in landfills in the Gulf Countries, and no more than 5% is recycled. Abdulla (2011) of ConstructionWeekOnline reports that Abu Dhabi spends over \$400m each year to process 30,000 tons of waste with much of it ending up in landfills.

Recycling however, involves more than just separation and collection of post consumer materials. The materials must be processed and reused in order to have a beneficial effect on the waste stream and the environment, if not the “returns” cannot be recovered. Recovered products can be used in the production of materials or energy. Although recycling is often viewed as a resource conservation activity, it may facilitate higher energy savings for many products (Al Ansari, 2012). The European Union, has planned to meet a recycling goal of 1.7 million tons per year, however the majority of the GCC states have never set any national or regional recycling targets. Current recycling estimates for Dubai indicate a 10% recycling rate; Dubai had plans to increase this recycling rate to around 15-20% by the end of 2011(Karkain, 2011). In order to correctly devise a recycling program for Dubai, the challenges to recycling must first be analyzed. To begin with MSW collection and recycling in Dubai or the UAE as a whole, suffers from the following weaknesses:

Weak Waste Collection, Transportation and Handling Infrastructure: Recyclable recovery rate is low, as UAE does not require separation of wastes or recycling in any form. Most of Dubai’s MSW is collected in a mixed form and mostly deposited in landfills. Waste collection and transportation operations must be streamlined as intermingling of hazardous waste and municipal waste is not uncommon. In addition, the sorting process does not recover recyclables for processing (Gautam, 2009). Storage and collection of MSW in Dubai are different for different locations, with the Dubai Municipality responsible for areas of Dubai located around the creek and developers and businesses responsible for waste produced in the freehold areas and Free Zones.

Waste Recycling is disorganized: Though recent years have seen some increase in the number of waste recycling facilities the economics of recycling is still not very favorable. There is very minimal recycling education, awareness and promotion. A majority of the recycling programs employ the

“bring” format, which without proper management sees the pitfalls of this program more than the benefits as described in chapter 5.

Under Developed Market for Recycled Products: Insufficient demand for recycled products in the local market hampers any potential growth of the waste recycling industry. There are a few units engaged in recycling waste paper, paperboard and plastics but it is reported that recycled products are then exported to markets like India, Pakistan and other Southeast Asian countries (Gautam, 2009), thus there is no opportunity for development of a recycled goods market in Dubai.

Lack of Information, Awareness and Legislation: There is a lack of laws, surveys, statistics and consequently data and information on recycling in particular, this coupled with incomplete institutional structure limited participation of governmental and nongovernmental organizations and minimized public participation put serious limitations on recycling in Dubai. It is imperative that recycling be provided appropriate legislative frameworks and be upheld by supporting laws due to the diversity in the population of the region. In the absence of legislation, the least expensive option will always prevail as has till date.

Opportunities in the sector are still largely untapped with only a limited number of contracts issued to the private sector operators for setting up Integrated Waste Management Facilities or waste recycling units. Abu Dhabi Municipality has set up the Nadhafa (cleanliness) program, which levies tax from companies on waste disposal. It is expected that this will cut waste production and avert damage to the environment. Bee’ah of Sharjah announced a similar aim of achieving zero waste in Sharjah by 2015. Bee’ah is obtaining inspiration from Netherlands, whose waste diversion rate stands at an impressive 98.2%. The only recorded early education on recycling was conducted in October, 2011 with the launch of the Bee’ah School of Environment which is now engaged with 102 schools - a total of 85,000 students across Sharjah who are getting an hour of education every week regarding the environment (Abdullah HF, 2011).

For Dubai, statistics from 2008 show organic waste as the largest component of MSW at 34%, plastic and paper as the second and third largest the components at 18% and 15% respectively (Dubai Statistics Centre). As per 2011, it was estimated that the UAE economy is losing US\$ 410 million per year due to inadequate recycling of waste (Kader, 2011). Dubai had adopted the single stream waste collection method, the advantages and disadvantages of which have been discussed in Chapter 4. International best practice and the Integrated Waste Management Hierarchy place landfill disposal as the least desirable option for waste management, yet around 97% of waste generated in Dubai is being disposed of in landfills (Karkain, 2011). Moving forward any waste management strategy should look to reduce the amount of waste being sent to landfill and prioritize reduction and resource recovery. This chapter proposes a recycling program for Dubai that is a culmination of the information presented so far as part of this dissertation.

7.2.Draft Policy

The recycling program must be implemented in Dubai with a methodical focused approach. The goal is to build a stable program framework, and develop supporting policies that will aid in promoting the acceptance of the program and that can be implemented even through to the long-term. Continuous monitoring and timely amendments that shape the policy to obtain superior performances by residents will ensure success of the program. The following outlines will need to feature as fundamental support systems for the program.

Program Outlines:

- To be transparent and easy to understand.
- Program to be in line with the country’s future growth targets and strategies.
- To create an accurate environmental tracking system.
- To provide an opportunity for accurate monitoring.
- To pave the path for other countries in the region to observe and follow the program thereby improving the environment as well as promoting economies of scale.

7.2.1.Program Policies

In order to have the intended effect, the proposed recycling program should be based on sound policies. Policies are those guiding directives that are intended to influence and determine decisions, actions, and other matters. Table 7.2 addresses the immediate or short-term policies required to establish a recycling program for Dubai and Table 7.3 provides a quick view on key features of the proposed recycling program for Dubai. Table 7.4 indicates the medium term policies leading to the amended recycling program past the initial 5 years of operation. The total number of policies covers both the short term and the medium term, 8 of the policies would continue through to the medium term, with 2 additional policies being introduced in the medium term, after the first 5 years of the recycling program being in place.

Table 7.2: Short term policies of the proposed recycling program (Time frame 1 – 5 years)

Policy Term	Experience Gained From	ACTION to be Taken By
1.A Recycling Program	All Developed Countries	Dubai Government Dubai Municipality EEG DEWA Consultants Tadweer
2.Law Enforcement	Europe (France, Italy, Germany, Denmark) Some states in the US.	Dubai Government
3.Recycling Bills	Some US states, Europe	Dubai Government RERA Dubai Municipality (Building Codes)
4.Collection Technology	USA, UK, France, Italy, Australia	Dubai Municipality Private Haulers
5.Financial Incentives	USA, UK, India, Australia	Dubai Municipality Private Companies Sponsors

6.Free Market Recycling Services	France, Germany, USA, UK, Singapore	Federal Government Private Companies Dubai Municipality
7.Fines & Levies & Controls	Switzerland, Germany, Denmark, Japan, Korea	Dubai Municipality DEWA
8.Education & Outreach	US, EU	Dubai Municipality Private Companies Developers /Landlords Schools

7.2.2.Proposed Recycling program for Dubai

The following sections describe the components of the proposed recycling policy for Dubai within the context of the short-term policies.

1. The Recycling Program: Further to the study of various recycling programs from around the world in the previous chapters. I would recommend a recycling program that is a combination of the PAYT and the recycling system in Switzerland where recycling is free but disposal of waste is charged under the advanced disposal charge (OECD). The charge for disposal of waste is expected to act as an incentive to reduce waste and promote recycling. Recycling is to be supported through a network of drop off centers and free door-to-door pick up of recyclables. The goal should be to have a minimum of 200 full-sized drop-off centers throughout Dubai as additional support to the main door-to-door collection of recyclables. Best practices recommend that there should be one drop off centre for every 5000 – 10000 residents (Lund, 2001), although 1 drop off centre for every 3500 residents would be ideal (EPA). In the short term Dubai should aim to have a minimum of 200 drop off centres, to be increased as we get to the long term.

The recycling program is to charge residents for disposal of residual household waste based on the PAYT system, i.e. residents would need to pay in proportion to the waste they dispose. The recyclables are to be source separated per item by residents and shall be collected by private collection companies at no charge to residents. This basic household recycling system shall be supported by a good network of drop off centers and bottle/can banks in several convenient locations through out the emirate – specifically at large supermarkets, residential hubs and community centers. Residual household waste after separation of recyclables would need to be disposed in specifically marked bags that are to be bought from authorized retailers in several convenient locations. These bags would be pre – paid bags issued by the Dubai Municipality that would be retailed by all supermarkets and convenience stores increasing accessibility. These bags are to be available in 3 sizes, small medium and large - which would suit all types of disposal quantities and accommodation types: MFD’s & SFD’s. Revenues generated form the waste bag sales would go towards funding the integrated waste management program, which would serve as an indirect trash tax. As this would be a very large operation with large costs, the indirect trash tax would not only aid in funding the program but also inculcate waste reduction habits among residents. A waste stream analysis must be conducted at the onset to determine the correct recyclables collection stream for Dubai. The program could start with recycling materials that have the greatest value in the recycled materials market and that form the greater part of disposed waste, such as paper (23.4%), plastics (23.46%), Glass (4.18%)

and metals (3.95%) (Dubai Statistics Centre, 2009). Plastic cartons (made from recycled plastic) are to be provided by Dubai Municipality for the collection of recyclables in SFD's and card-controlled receptacles to be provided at MFD's for collection of recyclables. The sizes of the receptacles in MFD's can be determined based on space available or space retrieved for placement of such receptacles.

Proposed Recycling Program for SFD's: All residual waste is to be disposed in the prepaid garbage disposal bags. Each single-family household must employ the near-entrance-collection system. City haulers will collect garbage on a set day of the week from garbage containers placed at the front of villas/SFD's. Garbage is to be placed at the point of collection in authorized bags only. Garbage will not be pickup if they are placed in any alternate bags. Recyclables will be collected on another day (bi monthly) or as set by municipal authorities based on collection streams and disposal quantities. Items for recycling will need to be separated into baskets and are to be brought out for collection. Residual waste bags to be available in 3 sizes, 30 liter, 60 liters and 90 Liters, recycling baskets can be made available in 3 sizes 14 Quart or Small (14.25"L x 8.25"W x 12.25"H), 28 Quart (14.25"L x 10.5"W x 15"H) and 41 Quart or large (15.25"L x 11"W x 19.9"H). Depending on disposal quantities residents can select the size of basket they require, which will be provided to them initially free of cost, with annual replacements. Interim replacements due to mishandling will be charged to customers.

Proposed Recycling Program for MFD's and Commercial Establishments in Buildings: Residents of MFD's and offices in multistory buildings will need to dispose their residual waste in prepaid bags similar to SFD's.

- Buildings with garbage rooms per floor or central facility: In buildings that have garbage rooms for waste disposal or a central facility, the garbage room will need to be adapted to house electronic waste receptacles accessed through reader cards for residual waste as well as recycled waste. Residents and offices will need to dispose the waste in the appropriate receptacles. Residual waste will need to be disposed in the prepaid bags and recyclables into the recycling receptacles as marked for glass, plastic, metals and paper. Garbage rooms and receptacles will be accessed with entry cards to record drop offs and violations. Household waste can be collected every day and recyclables weekly or as required.
- Buildings with no dedicated space for waste disposal: Multi storey buildings with no dedicated spaces for garbage collection can commence a door-to-door collection service establishing set dates and times for collection of recyclables and residual wastes (which are collected everyday) by the caretaker of the building. If such a caretaker is not available for a building: one shall be appointed by the landlord/developer. Residual wastes are to be disposed in the prepaid garbage bags and recyclables can be left outside the door for collection in stackable baskets that occupy minimum space. This system can work for both residential and commercial establishments in multistory buildings. The care taker then transports the wastes in a wheeled trolley to the collection point on the ground floor for pick up. Alternatively such buildings can convert a few parking spaces to hold waste and recycling receptacles and residents can bring their garbage to this collection point for dumping. In buildings where parking spaces cannot be spared, discreet recycling receptacles can be placed at the entrance or reception areas and residual waste collected daily through door-to-door collection.

Law Enforcement:

The Dubai government shall enforce a Mandatory Recycling Law for household wastes that requires all residents to recycle their garbage. Enforcement can be conducted through a multi-step program

ranging from public announcements in newspapers, hoardings, door-to-door leaflets, information passed through notices on DEWA bills and subsequently through warnings (following inspections) to violation notices and ultimately to fines. By regulation, building codes must be modified for all new constructions to ensure recycling facilities are incorporated into the design of MFD's, SFD's and Commercial buildings.

Recycling Bills:

The Dubai Government shall further improve recycling by introducing recycling bills that cover other recyclables such as mobile phones, e wastes and home appliances. The Dubai Municipality can run authorized collection centers and a fee can be paid by producers of electronics, home appliances and consumer gadgets in proportion to their materials ending up at disposal.

Collection Technology:

Where collection can be difficult to attribute to specific residents such as in MFD's and commercial buildings, the Dubai Municipality or authorized haulers for specific areas/zones must install RFID (Radio Frequency Identification) technology or computer chips. An RFID tag, can identify the individual trash can or card holder, waste management companies can find out which of their users is putting out that specific can and charge accordingly or identify abusers. Other types of technology use computer chips in recycling bins to collect data on refuse disposal, bringing in accountability. Selected technologies shall be upgradable for future retrofitting.

Financial Incentives:

An annual budget must be provided to enable financial incentives to support and promote recycling activities. Government shall provide financial incentives to organizations and communities that achieve consistent high recycling rates with minimized contamination. This could be done through direct financial reward schemes for a community that shows the highest improvements in recycling rates during a set period or by encouraging sponsors to issue rewards in return for marketing mileage. On a micro level, individual households could receive free disposal bags, which translate into savings for the household as a reward for good performance. This can be applied at the emirate or federal levels.

Free Market Recycling Services:

Government can provide opportunities for private concerns to offer to manage the recycling services in Dubai/ Emirates. The profit motive will encourage private firms to offer the services efficiently at the least cost, which can be held to standard by Dubai Municipality overseeing the operations. This would provide opportunities for Small and Medium Enterprises's to participate in the recycling industry making it a bonafide business. Freemarket recycling companies could also collect items that may not be collected by the government run program.

Fines & Levies & Controls:

Dubai Municipality must fine recycling violations with fines, for example a fine of AED100 (first Notice), AED 200 (second Notice), 550 (third Notice), and AED 1000 (four or more Notices within a six-month period). These fines could be communicated on the DEWA bill, and offences past the fourth notice could see services being terminated to the household. Such a system already exists in Dubai for non-payment of water & electricity bills. Control measures for MFD's can be applied with the application of RFID Technology and for SFD's random checks into disposed garbage can reveal violators. Fines must also be imposed on apartment building owners and developers for failure to post signs, failure to provide recycling information to new tenants/ buyers, or failure to provide a

place for containers. Besides civil and criminal penalties, licensed haulers, who collect solid waste and recyclables, could get their licenses revoked for non-compliance.

Education & Outreach:

Residents must be informed of the incorporation of Recycling law through a variety of outreach methods. In addition Dubai Municipality along with NGO's must conduct programs, organizes events and distribute information to promote these initiatives to the general public as well as the school communities. Recycling education must become part of the curriculum for all schools, as should recycling on school grounds. Landlords or developers must provide recycling information to all new tenants or buyers of new homes/ offices and establishments in addition to information on the consequences of noncompliance.

Table 7.3 Quick view of key features of the proposed recycling program for Dubai.

PROGRAM TYPE	Dwelling Type	Mandatory programs	Private Collection	Municipal Collection	Bag size	Collection Frequency - Recyclables
Location : Dubai (Population - 1.7 Million with 80% Urban population)						
PAYT for Garbage + FREE recyclables pick up.	MFD	Mandatory	Recyclables	Waste	30 L , 60 L & 90 L bags + S,M,L baskets for Recyclables	1 per week
	SFD					1 per 2 weeks
Items Collected	Container Type	Recycling Fees	Support	Collection		
4 items at MFD's	Central receptacles	No fee for Recycling + Bag Fee for Waste	Dropoff centres + Can & Bottle Recycling Machines	Collection at central point at MFD's with collection from apartments by building caretakers.		
4 items at SFD's	Curbside	No fee for Recycling + Bag Fee for Waste		SFD's - waste and Recyclables pick up from curbside.		

7.2.3.Five Years into the Recycling Program in Dubai

Further to the implementation of the recycling plan in Dubai, it is expected that the residents will require 1 – 3 years for acceptance of the program. This time is also required for residents to start practicing recycling and develop the required level of consistency and commitment to the program. This time period is also valuable for stakeholders and officials to determine the strengths and weaknesses of the program. The recycling program can then be amended and improved further to an analysis or a feasibility study conducted to appreciate the surrounding conditions in Dubai. The program can then be amended towards set recycling goals for the Emirates. The medium terms goals of the recycling program have the additional purpose of increased diversion of waste from landfills, substantial reduction in packaging wastes, development of markets for recycled products and the

adoption of an integrated approach to waste management. Table 7.4 indicates the medium-term policies of the recycling program past the 5-year mark.

Table 7.4: Medium Term Policies of Recycling Program (Time frame 5 – 10 years)

Policy Term	Experience Gained From	ACTION to be Taken By
Amendments to Recycling Program	All Developed Countries	Dubai Government Dubai Municipality EEG DEWA Consultants
Extended Producer Responsibility (EPR)	Some US states, Europe, Japan, Korea, Canada	Dubai Government Manufacturers Distributors
Collection Technology	USA, UK, France, Italy, Australia, Greece	Dubai Municipality Private Haulers
Financial Incentives	USA, UK, India, Australia	Dubai Municipality Private Companies Sponsors
Creating Markets for Recycled products.	France, Germany, USA, UK, Asia	Federal Government Private Companies Semi Government /Commercial establishments
Fines & Levies & Controls	Switzerland, Germany, Denmark, Japan, Korea	Dubai Municipality DEWA
Education & Outreach	US, EU	Dubai Municipality Private Companies Developers /Landlords Schools

7.2.4 Amended Recycling Program for Dubai (Medium Term 5 - 10 years)

Further to the passing of the short-term implementation of recycling program, certain improvements and amendments can be introduced to the proposed recycling program within the framework of policies described in Table 7.3. Following are the details of the proposed items in the medium-term policies required to develop the recycling program for Dubai in the medium term.

Amendments to Recycling Program:

A feasibility study shall be conducted towards the end of the first 5 years of the recycling program's operation. The program shall then be amended according to the requirements of the Emirates Solid Waste Management Plan and to accommodate any changes for minimizing operation costs, improving recycling rates and expanding the waste stream. The amendments shall provide for the planning and regulation of solid waste storage, collection, transportation, processing treatment, disposal and changes to permits and licenses to improve and develop the recycling program. The program by this time should see the placement of a large number of drop-off centers throughout Dubai to encourage residents to bring their recyclables for disposal and residents recycling on a regular basis.

Extended Producer Responsibility:

The Government shall now introduce the environmental policy approach in which a producer's responsibility for a product is extended to the post-consumer stage of a product's life cycle, transferring some of the responsibility to those who design, market and profit from the products. This principle is already in place in several parts of the world and will aid in the reduction of packaging burden on the Emirate.

Collection Technology:

Dubai Municipality and any involved private haulers shall stay abreast on developments in collection technology which would optimize time and cost of waste management from the combined usage of fleet management systems, RFID technology and dynamic reporting of waste weight during the collection and any new and improved technologies that could lead to useful conclusions on waste management.

Financial Incentives:

Further to a basic acceptance of recycling within the communities, financial incentives could be offered on additional items that are brought to the drop of centers, items that are not part of the mandatory recycling measures.

Creating markets for recycled products:

Authorities shall focus on creating markets for recycled materials starting with establishing government procurement policies that purchase recycled products, implementing policies that will deter consumers from purchasing 'brown' products, and promoting a consumer shift to 'green' items.

Fines & Levies & Controls:

Fines, levies and control measures shall continue to act as the green police for the Emirate. This is required as the emirate has a transient population of varied cultures. Mandates and policing are required for compliance in situations where not all residents are appreciative of the benefits of recycling. Revenues generated from the fines can be reinvested in the recycling program.

Education & Outreach:

Education and outreach must continue to induct newcomers to the emirate into the recycling program in Dubai. Awareness campaigns and recycling information must be provided to all new tenants and buyers of property to maintain continuity and the cumulative effects of recycling. Recycling education in schools and universities must also remain an ongoing aspect of education.

7.3 Meeting with Stakeholders

This section discusses the feedback and attitude of different stakeholders, which are involved in policy decisions of the Waste Management Sector in Dubai such as the Dubai Municipality, DEWA, Ministry of Environment & Water, Tadweer and NGO's like EEG. The purpose of these meetings is to obtain feedback positive or otherwise on the value and feasibility of the proposed recycling program from experts in the field, as they address various aspects of solid waste disposal in Dubai on a daily basis. It is expected that each of the experts would address specific components of the proposed recycling program thereby helping to finetune the program, highlighting any deficiencies. Feedback so received from the stakeholders was then absorbed into the proposed recycling program and a revised recycling program for Dubai has been proposed towards the end of this chapter. The revised recycling program reflects what is seen as workable in the context of Dubai and is aimed at achieving a suitable integrated waste management plan with the final goal of moving from waste management to waste reduction.

7.3.1.Meeting with TADWEER

Table 7.5 illustrates feedback from Tadweer - Dubai's largest MRF with a strategic partnership with Dubai Municipality. All specified policy terms were discussed.

Meeting with Ms.Enas Monaster, Envirocare Manager, Tadweer

Meeting Date: 16th February 2012

Venue: Tadweer Office, Hatta Oman Road, Dubai.

Table 7.5 Feedback from Tadweer.

Policy Term	Feedback from TADWEER (Short Term & Medium Term Policies)
1.Recycling Program	1.A charged element to the recycling program is a preferred idea as it generates revenue for recycling which is very expensive. 2.It would take 1 to 5 years for the recycling program to be accepted in Dubai. 3.Proposed collection box sizes might be a problem in smaller apartments and in low income , shared living that is seen in several parts of Dubai. Suggest the use of Dubai Municipality bags for recyclables as well. 4.Tadweer has information from their Strategic Partner - Dubai Municipality that a recycling program is being planned for Dubai but Tadweer cannot give out details at the moment. 5.Sorting at source is vital for collected recycled items to have any value for further processing. 6.Tadweer offers a free recycling service to commercial establishments but demand is very low in Dubai. 7.Recycling program should run a test phase - as UAE nationals may not support paid recycling.

2.Law Enforcement	<p>1.Recycling should definitely be mandatory in Dubai as environmental awareness is very low.</p> <p>2.It is unlikely that UAE nationals will recycle unless it is mandatory.</p>
3.Recycling Bills	<p>1.Additional recycling bills are necessary for items such as e - waste, as Dubai does not have any end –of - life plan for electronics.</p> <p>2.Building codes must be amended so future constructions can facilitate recycling.</p>
4.Collection Technology	<p>1.Tadweer uses both manual and automatic collections. Tadweer is not aware of RFID technology.</p> <p>2.New and more efficient collection technology will be required if recycling becomes mandatory in Dubai.</p>
5.Financial Incentives	<p>1.Financial incentives are always a good idea but they will not get UAE nationals to recycle for the reward.</p> <p>2.Financial incentives are a feasible idea to get the expat population to commit to recycling.</p> <p>3.This should be an ongoing part of the program, during both the short term and the long term plans.</p>
6.Fines & Levies & Control	<p>1.Fines, Levies & Controls are a must in the implementation of any policy especially in a community that is apathetic to recycling.</p> <p>2.Enforcement of fines and levies must be consistent and fair to avoid confusion and demotivation.</p>
7.Free Market Recycling Services	<p>1.This system already exists in Dubai; Tadweer is a free market agent that has no government involvement. Others include Emirates Recycling, TrashCo etc. However, with growth in recycling could see a need for more free market services. Possibly in the long term. Directives and proper governance must support this.</p>
8.Education & Outreach	<p>1.Education and Awareness is THE most important investment that the government needs to make if recycling has to succeed in Dubai.</p> <p>2.Education must be made part of the school curriculum from an early age in order to achieve commitment in the long term towards recycling.</p> <p>3.Face-to-Face education programs and awareness programs are required to communicate the importance of the program.</p>

<p>9. Market for Recycled Products. [Medium Term Policy]</p>	<p>1. Market for recycled goods is not very strong in Dubai. 2. Tadweer exports the granules they produce from recycling PETE 1 & HDPE 2 Plastics to France, China and India. 3. If Dubai Municipality sold recycled bags as per proposed program, they could be produced from these granules, this could help close the loop. 4. A market for recycled products can be expected when recycling is a reality in Dubai, possibly in the long term.</p>
<p>10. Extended Producer Responsibility [Medium Term Policy]</p>	<p>1. EPR is a must in the future of the program, but maybe Dubai Government should initiate it along with the start of the recycling program. 2. EPR will take time to establish; so the sooner we start the better.</p>

Discussion: The interviewee here, Ms. Enas Monaster of Tadweer stresses the importance of source separation and mandatory recycling for Dubai. Being in the business of recycling, Ms. Monaster has a deep understanding of the loss of recycling opportunities and therefore recycling revenues due to contamination in the conventional disposal of wastes in Dubai. The low demand recycling education that is provided for free by Tadweer further supports my observation that environmental needs are not a priority among residents in Dubai. Ms. Monaster raises the issue of involving UAE nationals in recycling, which resonates my personal belief that getting the nationals to recycle will be a challenge. The interviewee's support for mandation of recycling clearly comes from her observation that Dubai residents do not walk the extra mile required to integrate environmental sustainability into their lives. The suggestion of closing the loop by using locally produced recycled plastic granules for garbage production and early introduction of EPR are valuable suggestions and will be absorbed into the amended recycling program that will be proposed later in this chapter.

7.3.2. Meeting with Dubai Municipality.

Table 7.6 illustrates feedback from Dubai Municipality - Dubai's foremost authority on waste management. All specified policy terms were discussed.

Meeting with Mr. Abdul Majid Abdul Aziz, Director of Waste, Dubai Municipality

Meeting Date: 20th February 2012

Venue: Dubai Municipality Head Office, Deira, Dubai.

Table 7.6 Feedback from DM

<p>Policy Term</p>	<p>Feedback from Dubai Municipality (Short Term & Medium Term Policies)</p>
<p>1. Recycling Program</p>	<p>1. The proposed recycling program seems appropriate and is in line with what DM is currently working on and has appointed Mot Macdonalds Waste Management Consultants from the UK to come up with an Integrated Waste Management Master Plan for the emirates. The plan will be ready by June 2012.</p>

	<p>2.MFD's to be retrofitted, as 80% of Dubai residences consist of MFD's , thus making them the largest waste generators.</p> <p>3.It would take 1 to 5 years for the recycling program to be properly implemented in Dubai.</p> <p>4.DM is conducting a pilot program on household recycling for SFD's at Al Mizhar with 3700 villas participating. The results of that will determine the future of recycling in Dubai.This initiative will commence 1st February. The program is called "My City. My Environment". Each SFD will be provided with one 240 L container for organic waste disposal and one 240 L container for recyclables disposal.</p> <p>5.DM recommends that in the short term, residents should put all the recyclables in one container; source separation of each category of items can be introduced in the long-term policy.</p> <p>6.As of 1st of March 2012, Source separation will become mandatory for all Shopping Malls in Dubai.</p> <p>7.Dubai aims to reach Zero Landfill by 2030.</p> <p>8.Ideally, for greater success all waste Management activities in all the Emirates should be under the Ministry of Environment & Water, currently all the Emirates have their own departments and guidelines and this is inhibitive.</p> <p>9.Long Term policies and amendments should be determined further to pilot project and completion of short-term policy implementation.</p>
2.Law Enforcement	<p>1.It would be advisable to start with the Quota system – where each household can dispose a certain amount of waste for free, any disposal over this amount should be charged at a considerable rate.</p> <p>2.Recycling has not received support, as the residents are not concerned with environmental issues.</p>
3.Recycling Bills	<p>1.Dubai has defined a Zero Waste 2030 plan, which will provide an understanding of laws that are to be established including EPR, Changes to Buildings codes, a plan for E – waste etc.</p> <p>2.Enforcements of these laws are of greater significance; it is essential that authorities focus equally on enforcement of set laws.</p>
4.Collection Technology	<p>1.Setting up of advanced collection methods must come before charging residents for recycling to have a well-operated program without glitches, if not there will be confusion and chaos.</p> <p>2. RFID is a very expensive technology, and its use must be justified with a successful waste program.</p>

5.Financial Incentives	<p>1.Financial incentives though successful in the West will not work in Dubai for the upper strata. DM has seen that the DHIRAM 1 return for cans fed into the reverse vending machines have had very poor response.</p> <p>2.This may work for the low-income residents, but this aspect must be well thought out to attract other income groups.</p>
6.Fines & Levies & Controls	<p>1.Fines, Levies & Controls should be used as the last resort however, if required, it must be done.</p>
7.Free Market Recycling Services	<p>1.This system already exists in Dubai; with growth in recycling this is inevitable.</p> <p>2.This would be an option and revenue generating option possibly in the long-term. Implementation of this policy will require caution and regulations.</p>
8.Education & Outreach	<p>1.Education and Awareness are a prequel to implementation of any recycling program.</p> <p>2.DM suggests educating the house - help as well as the housewife through face-to-face communication to achieve better results, as the culture in Dubai dictates that the househelps are in charge of most of the disposables in the kitchen.</p> <p>3.It has been observed that further to education and outreach activities, 80% of the 3700 households in the pilot study group are willing to recycle and the remaining 20% are ready to try recycling.</p> <p>4.Awareness campaigns must be introduced to school curriculums as part of youth education and must continue to periodical adult education in the work place as well.</p>
9.Market for Recycled Products. [Medium Term Policy]	<p>1.Market for recycled goods is not very strong in Dubai, as recycling is only conducted informally.</p> <p>2.More research and better definition of this aspect is required, however this can only be achieved further to implementation of recycling program - possibly in the medium to long term.</p>
10.Extended Producer Responsibility [Medium Term Policy]	<p>1.EPR is a concept that took over 15 years to truly be engrained into businesses in the west, this policy is expected to become a reality well into the long term recycling plan as it takes a large infrastructure and well thought out support system.</p>

Discussion: The interview with Mr. Abdul Aziz of the Dubai Municipality was of great value to this dissertation. Mr. Abdul Aziz provided information on a recycling pilot project being conducted in Dubai, information that was not available elsewhere. The indication that a formal recycling plan is in the works for Dubai and is similar to the plan proposed in this dissertation is of great significance as it indicates that the framework of the recycling program proposed in this dissertation is appropriate for Dubai. Other valuable outcomes of this interview are the suggestion of the quota system, need for education and infrastructure ahead of the mandating of recycling in order to achieve better results. The positive response to the pilot program “My City. My Environment” within the UAE national community provided a basis to expect that UAE nationals might react more favourably to the proposed recycling program than initially conceived. In the UAE, and especially amongst the UAE nationals, domestic helps, who are largely uneducated labourers from the Far East, South Asia and Africa, carry out activities of cleaning and disposal. The approach taken by the pilot program “My City. My Environment” that educated the housewives as well as house-helpers through direct face-to-face outreach programs seems to have had an influence on the acceptance of recycling on the household and in getting the domestic helps to participate in recycling. To successfully reduce and improve recycling, both residents and their domestic helps must receive recycling education and awareness.

7.3.3. Meeting with Ministry of Environment and Water

Table 7.7 illustrates feedback from Ministry of Environment and Water (MOEW). All specified policy terms were discussed.

Meeting with Ms. Odaiba Sayeed, Director of Chemical & Hazardous Waste, MOEW
 Meeting Date: 23rd February 2012
 Venue: MOEW Head Office, Abu Hail, Dubai.

Table 7.7 Feedback from MOEW

Policy Term	Feedback from MOEW (Short Term & Medium Term Policies)
1. Recycling Program	1. The proposed recycling program appears to be similar to successful programs in western countries. Adaptation of a tried and tested method is a good start. 2. A charged element to the recycling program though, should be implemented in the long-term policy after UAE residents have been given time to get used to the formalized recycling program. 3. It would take 1 to 5 years for the recycling program to be accepted in Dubai, and the first 5 years should be free for waste disposal. 4. Proposed bag system and collection box sizes seem appropriate as a test, can be amended in the long term if required. 5. Sorting at source is the most important part of this program that must be enforced strictly. 6. Engineer Odaiba is apprehensive of the idea that UAE nationals will

	<p>accept payment for waste disposal.</p> <p>7.MOEW also feels that charging for waste disposal could encourage fly tipping and other illegal methods of waste disposal such as dumping and disposal into water bodies.</p>
2.Law Enforcement	<p>1.Dubai already has a law - Law No.24 that pertains to proper handling of waste, but it is not implemented well.</p> <p>2.MOEW supports mandatory recycling, but cannot comment on the value of the same, as there is no precedent from which they can draw conclusions.</p>
3.Recycling Bills	<p>1.Dubai does not have any end-of-life plan for electronics – this should be implemented immediately as e – wastes are currently being disposed off in landfills.</p> <p>2.Modification of building codes to support recycling should be implemented retrospectively as well.</p>
4.Collection Technology	<p>1.New and more efficient collection technology as proposed in the program will be required if recycling becomes mandatory in Dubai.</p> <p>2.This is expensive, so a large budget will need to be authorized by the government to put these support systems in place.</p>
5.Financial Incentives	<p>1.Financial Incentives are a good idea, but they have to be substantial to motivate the UAE nationals in Dubai to recycle. This aspect needs to be defined better to appeal to people.</p> <p>2.This is more suitable for low-income areas in Dubai.</p>
6.Fines & Levies & Controls	<p>1.Fines, Levies & Controls though required for implementation of such a program in a multicultural environment like Dubai, should be used with caution. MOEW is not in favor of large debilitation fines.</p>
7.Free Market Recycling Services	<p>2.This system already exists in Dubai; Dubai Municipality would be in a better position to advise on this, however with growth in recycling there could be a need for more free market services in the long term.</p>

8.Education & Outreach	<p>1.Awareness about recycling is extremely low in this region; Maybe it would be a better idea if awareness programs preceded mandatory recycling, in order to achieve better results. Intensive education must be offered to the residents that continually produce low results.</p> <p>2.Education must be made part of the school curriculum from an early age in order to achieve commitment in the long term towards recycling. Recycling must be made compulsory in all schools/Universities to instill this habit in the youth.</p>
9.Market for Recycled Products. [Medium Term Policy]	<p>1.Market for recycled goods is not very strong in Dubai. Support by government bodies is essential in promotion of recycled products.</p> <p>2.People will only invest in this type of businesses if recycling becomes a law thus showing potential for medium to long term lock in.</p>
10.Extended Producer Responsibility [Medium Term Policy]	<p>1.EPR is a must in the long term, but this is likely to take much longer to achieve. Governments should focus on achieving a good waste disposal system and slowly introduce EPR. This should be secondary to establishing a good waste disposal system.</p>

Discussion: The interviewee, Ms. Odaiba Sayeed fully supported the idea of a recycling program for Dubai saying that this was indeed long overdue. Being a UAE national herself, she seemed to suggest that the indirect trash tax might not be accepted by residents and that the program should be free of charge until residents understood the concept and made a habit of it. A suggestion that forced charges for recycling could lead to illegal disposal echoes instances seen in other parts of the world with trash fees yet, the MOEW is against the concept of issuing fines to recycling violaters. An important issue highlighted by Ms.Odaiba was the lack of enforcement of laws, law No.24 does infact require citizens to dispose of waste in an environmentally safe manner, however this is currently not being enforced in Dubai. It is essential that the commitment to recycling translate to enforcement of any new laws issued, and not just the development of a strategy that remains in the books. A majority of the interviewee's supports the idea of mandating recycling and Ms.Odaiba's suggestion that a market for recycling can only develop when investors can see longterm benefits is a valid one. Unless investors are assured of a continous supply of recycled material, it would not be possible to develop associated businesses. This interview furthur supports my belief that small incentives will not attract the UAE nationals, who are financially stonger, and thus incentive programs must take into consideration most importantly, the value of the incentive to the dempgraphic they are addressing. MOEW also feels that education and outreach must preceed the introduction of recycling into the everyday lives of residents, a point to be reconsidered during the amendment of the proposed recycling program in this dissertation.

7.3.4.Meeting with Emirates Environmental Group.

Table 7.8 illustrates feedback from Ministry of Environment and Water. All specified policy terms were discussed.

Meeting with Ms Habiba Al Marashi, Chairperson of the Emirates Environmental Group (EEG)

Meeting Date: 23rd February 2012

Venue: EEG Head Office, Jumeirah, Dubai.

Table 7.8 Feedback from EEG

Policy Term	Feedback from EEG (Short Term & Medium Term Policies)
1.Recycling Program	<p>1.A charged element to the recycling program is realistic as it generates revenue for recycling, which will be an expensive operation to implement.</p> <p>2.It would take 1 to 5 years for the recycling program to be accepted in Dubai assuming awareness programs are carried out ahead of the commencement of the program.</p> <p>3.Proposed bag system can be used for collection of recyclables also, there is no need for separate plastic boxes for this.</p> <p>4.Sorting at source must be managed appropriately, to avoid contamination, if not the whole operation will be of no value.</p> <p>5.It is unlikely that UAE nationals will accept payment for waste disposal; the payment for bag system should be started as a pilot project to review resident’s response.</p> <p>6.Lack of commitment from residents is the greatest inhibitor for recycling. I would suggest inviting the families to sign up for the recycling program where they can be properly educated about its values.</p>
2.Law Enforcement	<p>1.Recycling should be mandatory in Dubai in order to get residents to recycle. Legislation is very important part of these policies – perhaps the most important one. It has been seen so far that voluntary recycling has achieved very poor results.</p> <p>2.It is unlikely that UAE nationals will recycle unless it is mandatory.</p>
3.Recycling Bills	<p>1.Additional recycling bills are necessary for the recycling program to be comprehensive and cover all elements that can be recycled. This is the only way to achieve the goal of Zero waste 2030 that UAE has committed to, and that is by recycling bills that cover all aspects of waste.</p> <p>2.Building codes must be modified along with awareness programs,</p>

	which should precede implementation of the recycling law.
4.Collection Technology	1.New and more efficient collection technology will be required if recycling becomes mandatory in Dubai, existing systems are very basic.
5.Financial Incentives	1.Financial incentives are a must - A suggestion is that when families sign up for recycling programs they are provided incentives, which are redeemable upon reaching certain recycling goals. 2.Financial incentives could be offered to the house-helpers / maids in order to motivate them to recycle as such incentives are unlikely to attract financially stable home owners. 3.This should be an ongoing part of the program, during both the short term and the long term plans.
6.Fines & Levies & Controls	1.Fines, Levies & Controls will be required throughout the process of implementation of any policy especially if it seen as an inconvenience by the residents. 2.Fines and penalties will need to be a part of the program through its entire course.
7.Free Market Recycling Services	1.This system is good as it brings down the price of recycling as more companies will participate and increased competition will bring down costs. 2.Proper guidelines will need to be imposed on free market services. It could artificially inflate the market for raw materials.
8.Education & Outreach	1.Education and Awareness are going to determine the success of the entire recycling campaign. The UAE government must invest in promoting knowledge of recycling aggressively to change the mindset of the residents towards recycling. 2.Education must be made part of the school curriculum from an early age, with it progressing to adult education and awareness in the long-term. 3.Awareness programs must be tailored to local needs and must suit different locales within Dubai. One size fits all approach will not work.

<p>9. Market for Recycled Products. [Medium Term Policy]</p>	<p>1. It can be expected to develop sooner than 5 years if recycled products are priced correctly, people will have no problems buying them. 2. Commercial establishments, government and semi – government bodies could be required to buy a minimum of 50% of their consumption of paper products as recycled goods.</p>
<p>10. Extended Producer Responsibility [Medium Term Policy]</p>	<p>1. EPR should be introduced from the onset of the program so as to change the mindset of the residents gradually and inculcate the habit so that it becomes part of a routine. 2. Companies that have EPR in other nations must follow the same here in Dubai and local companies can then follow examples. The knowledge is there, it is a matter of the strong arm of the law that is required to follow through.</p>

Discussion: The interviewee, Ms. Marashi, Chairperson of the Emirates Environmental Group described her years of struggles in trying to bring recycling to the forefront in Dubai, which makes her support a more iron handed approach. This is inline with the original proposal, which recognizes the need for a recycling law in order to obtain quick and immediate buy-in from the UAE nationals as well as the expatriates. The feedback by Ms. Marashi, much like that of DM & MOEW suggests preceeding the recycling mandate with education and commencing the groundwork on EPR at the onset. This leads me to believe the initial proposal might have overlooked the value of timing on the said issues, which will be amended in the revised proposal. An important take-away from this conversation was the idea of tailoring the incentives towards to the house-helpers who are responsible for disposal of domestic wastes and who are still within the social bracket to be engaged by smaller financial incentives. Ms. Marashi is of the opinion that unless additional recycling support laws are put into place, Dubai will not achieve its Zero Waste goal by 2030. The additional recycling bills in the proposed recycling plan are aimed at addressing this issue and should be developed and integrated with the early introduction of the EPR.

7.3.5. Meeting with DCCE.

Table 7.9 illustrates feedback from Dubai Carbon Centre of Excellence. All specified policy terms were discussed; this meeting is of particular significance due to the collective experience of Mr. Ivano Iannelli who previously headed Resource Recovery at the United Nations, and is currently the CEO of the DCCE.

Meeting with Mr. Ivano Iannelli, CEO of the Dubai Carbon Centre of Excellence.

Meeting Date: 28th February 2012

Venue: DCCE Head Office, Al Quoz, Dubai.

Table 7.9 Feedback from DCCE

Policy Term	Feedback from DCCE
-------------	--------------------

	(Short Term & Medium Term Policies)
1. Recycling Program	<p>1. A charged element to waste disposal is not a preferred idea. There should be a public private partnership and recycling should be a market-based instrument.</p> <p>2. A charged element to recycling will impact economic development and encourage violations/ fly tipping.</p> <p>3. A system where all the deposits made by residents is recorded and residents then get rewarded according to their recycling quantities will motivate people to recycle.</p> <p>4. Collection of recyclables for FREE is appropriate, as collections generate good revenue for recycling companies and residents should not have to pay for this.</p> <p>5. It takes a minimum of 7 - 12 years for the educational cycle to get inculcated in the minds of people; therefore true change in the attitudes of people will be seen only by the end of the medium term.</p> <p>6. Proposed bag size and collection box sizes seem appropriate, and can be modified at a later stage if required.</p> <p>7. Amendments to recycling plans can be made in the long term after reviewing the success of the recycling plan.</p>
2. Law Enforcement	<p>1. It is unlikely that UAE nationals will support a waste disposal charge.</p> <p>2. It is preferred that source separation be required / mandated instead of the recycling law itself.</p>
3. Recycling Bills	<p>1. Retrofitting of the several MFD's will be expensive; this needs to be done in the most efficient manner.</p> <p>2. Supporting recycling bills can be introduced as part of the overall waste management plan. Dubai requires these bills, incentivizing such actions will motivate individuals to follow any related soft regulations.</p>
4. Collection Technology	<p>1. Implementing the latest in collection technology, such as the RFID should be a priority, a system that records individual residents recycling quantities is recommended.</p> <p>2. Door-to-door collection for SFD's and central point collection for MFD's through a single chute system is advised.</p>
5. Financial Incentives	<p>1. Financial incentives are always a good idea, this is the system that should be used to bring about the recycling culture in Dubai. This approach is a community participatory approach and is preferred by DCCE.</p>

6.Fines & Levies & Controls	1.Fines, Levies & Controls must be exercised with caution, a carrot approach is preferred. Given the situation in Dubai, it is understandable that such control measures may need to be applied.
7.Free Market Recycling Services	1.This system already exists in Dubai but on a small scale. With increased recycling several Small & Medium Enterprises's will come into existence and recycling can then be a recognized business. It is expected that this aspect will develop in the long term, but this must be regulated carefully.
8.Education & Outreach	1.Education and Awareness is THE most important investment that the government needs to make if recycling has to succeed in Dubai. 2.Education must be made part of the school curriculum from an early age in order to begin the educational cycle on people that can take up to 20 years – from early school to university to generate educated environmentally responsible adults. 3.Education must cover not only the need to recycle, but also the economic benefits to individuals, to really capture their attention.
9.Market for Recycled Products. [Medium Term Policy]	1.Market for recycled goods is only just developing now, though the value of recycled resources is seen to be good at the moment. 2.DCCE has found in one of their studies that a single community of 2500 SFD's can generate revenue of AED 2.3 million AED for their recycled materials per year. 3.A market for recycled products can thus be expected to be very lucrative when recycling is a reality in Dubai.
10.Extended Producer Responsibility [Medium Term Policy]	EPR is viable in the long term, but the Dubai Government should initiate it along with the recycling program as such operations are very large scale and buying in the support of the business community will take time.

Discussion: The feedback from Mr.Iannelli, CEO of the Dubai Carbon Centre of Excellence shed light on the proposed recycling plan by challenging the concept of conventional trash tax. This interview offered a completely different perspective on recycling in Dubai, which was a significant contributor to the final revised proposal. The public private partnership concept is qualified by the information provided by Mr.Ianelli on the financial value of recycling based on a pilot project conducted by DCCE.Although details of the pilot could not be revealed, its suffice to say that recycling in Dubai would be financially rewarding, and the timing is right for businesses to further investigate the matter. A market-based approach has the added advantage

of garnering participations by the residents as well as revenue generating businesses. It could also be expected that public and private sectors, by working together could develop technologies and business models that use resources more efficiently, thus creating new jobs and fostering economic development. Another interesting value addition received in this feedback is that of the educational cycle which apparently takes 7 – 12 years to be absorbed by individuals. While the study of the educational cycle is not part of this dissertation, it establishes that recycling can be expected to become an accepted reality closer to the medium term and not the short term as initially understood. It was also observed that all the interviewees stressed the importance of thorough education and outreach programs preceding the mandating of recycling and the commencement of EPR at the earliest.

Almost all the interviewees indicated apprehension about obtaining buyin from UAE nationals on the recycling program. There was some degree of doubt about residents accepting a charge for waste disposal as well. However, creating a strong infrastructure for recycling and educating the residents on recycling will be extremely expensive, and should not be solely the responsibility of the government. Obtaining atleast a minimal amount of funding by the residents to dispose their waste should not have to be negotiable. As with most things, mandating recycling will offer it the required legal support and increase acceptance. Policies and decisions must incorporate economic and environmental concerns and are crucial in our efforts as a nation to maintain a quality standard of living that is sustainable for future generations. Support by lawmakers for local recycling manufacturers and other environmentally conscious companies will also promote eco-conscious behaviours. It can be expected that educating the public about the urgency of our wasteful disposal will undoubtedly bring about the change in the long-term.

7.4.Expected Acheivements in the Long Term: Past the 10th Year.

The long-term goals or expectation of implementing the above stated recycling program primarily include the diversion of waste from landfills, and recovery of resources to promote economic gains. In doing so, negative environmental impacts are expected to reduce and sustainable living promoted. It is expected that by the 10th year or in the long-term, recycling would become a part of daily life of not only Dubai residents, but also the residents in all the emirates that form the UAE. It is expected that by the long term, the program and policies pertaining to recycling would be amended and improved to best serve the UAE and aim to support itself economically. Past the 10th year and into the long-term, it is expected that EPR will be a part of the business strategy of all producers and importers in the UAE. Individuals and organizations are expected to recycle enough to increase the UAE's capacity to process these recyclables and carry them to an end-user, developing strong growth and trade within the region.

Within the context of recycling, the role of authorities will need to remain influential, as recycling is still seen in this part of the world as inconvenient. Newer residents entering the UAE, who might be unaware of the value of recycling will need to comply with local recycling needs and the quickest way to achieve their participation is through mandating of domestic recycling. The UAE has committed to Zero Waste by 2030, and the recycling program and policies will be a major contributor to achieving this goal. Recycling targets can be met with an aim to surpass these targets, as seen in several of the EU states. It is also essential that targets and goals be encapsulated into measurable physical terms so that development can be managed.

It is expected that as part of the long-term vision, the focus would shift towards:

- Reducing municipal solid waste by implementing policies that encourage better product design rather than just waste reduction or recycling. The natural evolution of a well-run recycling program must focus on reduction at source i.e. better product and packaging design aimed at minimal utilization of material, that which can be recycled or reused.
- Just as eco-labelling now serves to distinguish a product from its counterpart, the long-term policy must try to establish a public and widespread “cradle to cradle” certification program. A decade of recycling programs in the Dubai should ideally encourage individuals and organizations to reuse everyday products instead of purchasing new ones. Educational programs must now start to include the promotion of the “cradle to cradle approach” into their marketing and educational material.
- Policies must now focus on creation of regulations for the purchase of 75% post-consumer products in government and semi-government bodies, and incentivize the same for other establishments in Dubai. This directive must also encourage individuals and businesses to purchase locally produced products and materials.
- Elimination of waste will be the ultimate goal of municipalities, product manufacturers and buyers; this can begin with products being designed for recycling and reuse, rather than for dumping at a landfill.
- The long term goals can also begin to educate residents on an acceptable ecological footprint that residents should aim for with the ultimate goal of achieving an ecological footprint per person not exceeding 3 hectares, to be reviewed again past the 20 year mark. The UAE currently has the highest per-capita ecological footprint, 10.68 hectares per person (Todorova, 2010)
- In the longterm, for recycling to remaining a policy it must become a more attractive financial option than landfilling. Recycling must end up the more cost-effective alternative, or it must have the potential to generate revenue. This can be achieved by creating markets for recycled materials, promoting trade in recycled resources, establishing green procurement initiatives, deterring consumers from purchasing 'brown' products, and rigorously promoting a shift to 'green' items, all of which will form the content of the long term policies.

7.5.Revised Recycling program for Dubai based on Stakeholders Feedback and Recycling Survey.

This section takes into account feedback from stakeholders the Dubai Municipality, Tadweer, MOEW and Mr.Iannelli from the DCCE with regards to the proposed recycling program for Dubai. While the stakeholders deemed a major part of the proposed recycling program appropriate, the following concerns were highlighted.

7.5.1: Highlighted issues in the proposed recycling program.

1.Short Term policies: Policy No. 1 – Recycling Program

- Policy No.1: (Recycling Program Paid Bag system + Recycling credits) The volume based pricing system is to be modified, such that a certain allotted amount of waste disposal per household would be free, disposal of any additional waste beyond the allotted quota would need to be disposed in the pre-paid Dubai Municipality marked bags only, which would charge at a substantial rate. Recyclables will be collected free of cost in a weight based system, where collected waste will be weighed and credits issued to the recycler at SFD’s. At MFD’s the RFID sensor at the garbage chute, or the waste receptacles record the weight of the disposables and attribute credits to the recycler. These credits could be converted to cash rewards or used towards utility bills.

- Policy No.1: (Recycling Program) Source separation of recyclables individually as proposed previously to be simplified into separation into 2 streams, one for paper/cardboard items and the other for glass, plastic and metal cans. Paper will be collected separately to minimize contamination and improve their value in the recycling market.
- Policy No.1: (Recycling Program) The program shall start with all disposals in plastic bags, manufactured locally from recycled material. The plastic boxes for recyclables as proposed in the original program should be optional, left to the resident's discretion.

2.Short Term policies: Policy No. 2 – Recycling Law

- Policy No.2: (Recycling law) is to be modified into Source Separation Law. The law shall mandate source separation of wastes in the revised policy and not recycling itself. Wastes are to be source separated into 3 categories. Category 1 would include all papers and cardboard packaging. Category 2 would include all glass, metal and plastic items and category 3 would comprise organic/ residual household wastes. Each category would need to be disposed in separate bags. Disposal of wastes beyond the established “quota” would need to be done in marked prepaid Dubai Municipality garbage bags to be bought from authorized retailers.

3.Short Term policies: Policy No. 3 – Recycling Bills

- Policy No.3: (Supporting Bills) Supporting bills for proper disposal of electronic waste and modification of building codes to support recycling for all new buildings to be implemented alongside commencement of recycling program.
- Policy No.3: (Retro Fitting of existing MFD's) Retrofitting of existing MFD's to support recycling to be mandated as part of Policy no. 3.Retrofitting should adopt the single chute system with sensor waste and ID recognition, as this is the most cost effective system for MFD's.

4.Short Term policies: Policy No. 5 – Financial Incentives

- Policy No. 5: Financial incentives in this credit-based program will be issued directly in proportion to the amount recycled. This is a system that can be uniformly applied to all types of residences and income groups. In addition, special sponsored programs can be conducted to increase participation in areas that show continuously low recycling rates.

5.Short Term policies: Policy No. 8 – Education and Outreach

- Policy No.8: (Intensive education in low performing areas) Education and outreach to be more specific, with face-to-face communication prioritized in areas where recycling is likely to be really low.
- Policy No.8: (Awareness Campaigns) Information about the upcoming mandating of recycling, and intensive awareness campaigns shall begin 12 months ahead of the commencement of the law.
- Policy No.8: (Recycling Education for Youths) The Ministry of Education shall require all schools and Universities to conduct recycling education, with a set number of compulsory hours per academic year. Furthermore, all schools and universities shall be required to conduct recycling on campus continually.

6.Medium Term policy: Policy No. 10 – Extended Producer Responsibility

- Policy No.10: (EPR) If the producer does not have to bear any part of the cost of disposal, there will be a bias toward virgin materials and away from recycling. Therefore, groundwork for the inclusion of EPR shall begin along side the implementation of the recycling law, such that by the end of the

short term, Dubai will be ready to implement EPR. There is no need to wait till the completion of the short term to commence inclusion of EPR.

Table 7.10: Key Factors of the revised recycling program for Dubai based on stakeholder feedback.

Policy Terms	General Components of Revised Recycling program for Dubai
1.A Recycling Program	1. Volume based pricing with fixed quota of free disposal of organic waste per household. Additional disposal beyond quota of organic wastes to be charged through prepaid bag system. 2. Weight based disposal system for recyclables that will be weighed and credits issued to recycler based on weight recycled. Residents will be rewarded for proper disposal of recyclables in proportion to their disposal weights. 3. Prepaid bag system distributed by DM - Small, Medium & Large Bag sizes priced respectively to be used for additional organic waste disposal that exceeds free quota. 4. Recyclables to be separated into 2 categories, one for paper and cardboards + one bag for plastics, cans & glass. 5. Doot-to-Door collection for SFD's + Central Collection for MFD's 6. Dubai to have a minimum of 200 full scale recycling drop off centers in various locations.
2.Law Enforcement	1.Source separation to be enforced by law in Dubai.
3.Recycling Bills	1. Supporting bills to include e – waste recovery bills. 2. Supporting bills to mandate change of building codes to ensure recycling facilities are built into all new constructions. 3. Supporting bills to ensure existing building are retrofitted to enable recycling.
4.Collection Technology	1.Collection Receptacles & RFID technology to be introduced, and retrofitted where necessary PRIOR to recycling law coming into effect.
5.Financial Incentives	1. Financial incentives to be customized for different income levels and cultural groups in Dubai. 2. Incentives to be directed at recycler rather than the homeowner to encourage commitment to recycling in homes where disposal is managed by house-helps.

6.Free Market Recycling Services	1.Free market recycling services to be encouraged to support increased recycling and create opportunities for SME's within the industry. 2.Specific guidelines and increased regulations to be put into place to govern free market recycling services. Private collection companies to be issued permits and to be regulated and monitored by authorities.
7.Fines & Levies & Controls	1. Fines, levy's and other control measures to be exercised with caution as a last resort to individuals and establishments that commit violations. 2.Fines: AED100 (First Notice), AED 200 (Second Notice), 550 (Third Notice), and AED 1000 (Four or more Notices within a six-month period).
8.Education & Outreach	1.Education, Outreach and Awareness programs shall commence at a minimum of 12 months ahead of the recycling law coming into affect. 2.Hi – density, low-income areas will receive intensive face-to-face communication on the benefits of recycling and the cons of not recycling. 3. Recycling will be compulsory in all educational institutions and students will receive a certain number of mandatory environmental awareness classes.
9.Market for Recycled Products. (Medium term Policy)	1.Market for recycled products will be developed by the use of recycled products such as SME's that will trade in resourced commodities, exports commodities etc. 2.Government, semi government and large commercial establishments shall ensure a minimum of 30% of their paper consumption is recycled paper.
10.Extended Producer Responsibility (Medium Term Policy)	1.Supporting groundwork for the implementation of EPR shall commence with the commencement of the residential recycling program. 2.EPR shall come into effect by the end of the short term and early in the long term.
11.Cradle-to-Cradle Certification program. (Long Term Policy)	1.A cradle-to-cradle certification program shall be introduced where environmentally conciousus businesses can be distinguished from their counterparts, this will in turn enable the consumer to make more informed choices.
12.Establishment of Targets (Long Term Policy)	1.Specific targets shall be set for waste reduction, diversion from landfills and reduction of percapita ecological footprints, which shall coincide with the Zerowaste 2030 initiative.

7.6. An Economic Perspective to Recycling.

As this paper has continuously surmised, the benefits of recycling to the environment are many, primarily with recycling, the use of landfills is reduced, and our ecological footprint on earth is reduced. Recycling has now evolved from an environmental responsibility to a preference in several developed nations, as it is also a revenue generator for the economy. With significant growth in world population, the effects of household consumption will be seen on stocks of natural resources, environmental quality and climate change, leaving no valid reason in actuality to not recycle.

This dissertation has already shed light on the benefits of recycling, obtained a perspective of UAE residents with regard to recycling through a survey and consequently proposed a recycling program for Dubai. Yet one could argue that while recycling may well be good for the environment, we could choose to maintain current consumption patterns and that technological innovation would likely take care of the needs of future generations. The real boost to recycling would only come if its economic perspective could be appreciated to stimulate interest, a step ahead of just learning to do more will less. The US EPA states that recycling and remanufacturing industries account for approximately one million manufacturing jobs and more than \$100 billion in revenue in the US alone. The economics of recycling is the maker or breaker of the future of recycling. The very recyclables that we place in our disposal bins or take to a drop-off center can end up on the market as valuable commodities that contribute significantly to the economy, allowing the use of each material to its maximum potential. From a wholly economic perspective, the recyclables discarded can be reprocessed extracting several valuable materials, as a result of which in this dissertation, domestic recyclables are referred to as “resources”. This value in extracted material comes in many forms such as: ferrous metals (iron or steel) non-ferrous metals (aluminum, bronze or copper) and numerous other products, such as cardboard, paper, used oil, batteries, plastic (PETE1 and HDPE 2), glass and scrap rubber. Each of these items has dynamic value for dealers in the recycled products market, where business very much resembles commodity trading. Other economic benefits of domestic recycling come from jobs created, and by rendering recovered materials into usable products once again. Unlike jobs in waste disposal, jobs in the recycling industry add value to the materials, as such contribute to a growing labour force of skilled workers, such as material sorters, dispatchers, truck drivers, sales representatives, process engineers and even chemists. As marketing benefits and economic value in waste reduction and recycling start to become apparent, public-private partnerships will become more commonplace further cementing the success of domestic recycling.

To obtain an economic perspective of the potential for revenue generation from domestic recycling, an informal calculation has been extrapolated below based on general prices of waste streams, waste stream components in the UAE and average waste generated in the UAE. Averda Environmental Solutions LLC (Dubai) has provided current rates for stated recovered materials as indicated in Table 7.11. As stated in Table 7.11, the UAE’s waste generation amounts to approximately 1,175,300 tons per year. Percentage distribution of collected solid waste components for the Emirate of Dubai in the year 2009 indicate collection rates of 3.95 % for metals, 23.4% for plastics and paper alike (Dubai Statistics Centre, 2009). .

Table 7.11: Rates for recovered resources in Dubai as of November 2011.

Item	Date of Price Issue	Price per ton in AED
------	---------------------	----------------------

Mixed Metals	Nov 2011	3350
Plastics (PET 1 & HDPE 2)	Nov 2011	1150
Mixed Paper	Nov 2011	1150

Table 7.12 attributes a cash value for the materials that could have been recovered from the waste generated in Dubai in the year 2009 alone. The purpose of this informal economic perspective is also to indicate that recycling and reuse industries can and do compare favourably to other key industries. There is obviously a market for recyclable materials and the returns on investments in the recycling industry can be quite high.

Data from 2009 has been used for the above analysis, as it is the latest available data on waste stream components for Dubai. Other resources that can be recovered from the waste stream but are not included in the above calculation include aluminum foil, glass, wood, e – waste, fibres and organic waste that can be composted. In addition, non-recycled plastics discarded as waste can be used to generate electricity by the process of waste-to-energy (WTE) recovery, further adding to revenue generation possibilities.

Table 7.12: Total value in AED of metals, plastics and paper in the waste stream in the year 2009 in Dubai.

Item	Amount found in waste stream in the year 2009	Price per ton in AED of recovered material	Value of recovered resources in AED
Mixed Metals	46,424 tons	3350	155,520,400
Plastics (PET 1 HDPE2)	275,020.2 tons	1150	316,273,230
Mixed Paper	275,020.2 tons	1150	316,273,230
Total Value in AED for the 3 materials			788,066,860

The calculations indicated in Table 7.12 are not comprehensive of all waste streams but assess the benefits of recycling some of the more important materials by volume that are found in Dubai's municipal wastes. In addition, the calculations show the percentage of materials that are assumed to be technically recoverable as 100% of the total disposed waste, this is done for the purpose of estimating the full potential, assuming source separation was achieved to its maximum value. Thus the cash value of just 3 items in the waste stream in the year 2009 is seen to be approximately **AED**

788,066,860 (USD 215,908,729). This dissertation has not presented a cost-benefit analysis for the implementation of the recycling program in Dubai yet a simple calculation of the value of the waste stream indicates opportunities for net economic benefits from increased levels of waste sorting and recycling. Although the collection, sorting and processing of materials gives rise to some environmental impacts, energy use and costs, the revenue so generated and the resulting environmental benefits aid in closing the loop as a result of which most developed countries are seeing growth and investments in domestic recycling. Investments in recycling programs also pay great dividends by creating private sector jobs, investment opportunities and manufacturing of new products from recycled goods.

Dubai has committed to a Zero Waste by 2030 initiative; it would extremely difficult if not impossible to achieve this goal without a commitment to recycling. The recycling program proposed herewith is aimed at inculcating environmentally green behaviors in the residents of Dubai, diverting a majority of recyclables form land fills, creating jobs within the recycling industry, generating revenue from processing recyclables and reducing the negative environmental impacts of human consumption patterns. The introduction of EPR will shift a part of the responsibility on producers and in time, it is expected that products and packaging will be designed more efficiently, further minimizing waste. There is an emerging consensus that land filling our trash at the present rate is the worst environmental choice, with the increasing economic value of recycling it would be the most cost-effective way to alleviate Dubai's solid waste burden while still making responsible economic choices.

Chapter 8. Conclusion and Recommendations

8.1. Conclusion

The concept of recycling and its understanding is in the early stages in Dubai. However, the leaders of the nation are aware of local limitations and the need for commitment to environmentally responsible actions such as recycling. Dubai Municipality under the directives of the Executive Office has initiated a study by international consultants to devise a suitable integrated waste management and recycling program for Dubai. This dissertation has reviewed the current situation pertaining to waste management and recycling in Dubai highlighting the deficiencies and the contributing reasons. The goal of this dissertation was to provide a background on recycling, understand the reasons for the residents' lack of commitment to it, devise a recycling program for Dubai and investigate its value and economic potential. This dissertation through the results of a locally conducted survey has identified the top reasons for this lack of commitment to recycling and generated a best-fit recycling program for Dubai, having absorbed all the contributing issues. Similar studies for Dubai are unavailable, thus it is anticipated that this research would be a valuable reference document on a national and international level for policy makers, students and individuals alike when studying the subject of domestic recycling in Dubai.

The Dubai culture is not only notorious for its consumption but also suffers from a dearth of waste-management interests, experts and laws complicated only by the extreme heat that hinders decomposition. Yet, Dubai is in a sound position to initiate environmental stewardship within the geographical region of the Gulf. Efforts by the government, such as the ban on plastic carrier bags and the rising number of recycling drop-off centers, are heading in the right direction. This research

recognizes that there is a pressing need for a stronger approach to waste management to reduce the UAE's ecological offences. The emergence of the Zero Waste concept and the UAE's committing to the Zero Waste 2030 initiative is evidence that recycling has the potential to be a wholly sustainable loop. With ZeroWaste 2030 the UAE government has declared its desire to create and expand recycling, the next steps now involve converting intent into action. An overview of the origins of recycling, to current recycling methods and experiences from around the world are enumerated in this research, based on the study of which a recycling program was proposed for Dubai. The proposed program was developed to appreciate the local conditions and was refined by the advice of leading stakeholders in the field. The recycling system proposed is technically and environmentally sound and takes into consideration the unique positioning of Dubai as a social and economic hub in the Gulf. Government intervention to encourage recycling is thus justified on the basis of market failure due to the transient population and the wide cultural mix in Dubai. The policies propose that source separation become mandatory, an indirect tax be charged for waste disposal beyond the allotted quota, door-to-door collection be provided to all residents, recycling be incentivized and all residents receive environmental education. The policies also require investments into superior collection technologies, the initiation of EPR, purchase & promotion of "green" products and cradle-to-cradle certification in Dubai. The policies also stress on the importance of the development of technologies that are integrated with recycling and are energy efficient. Education is vital in obtaining buy in by residents and influencing public perception towards domestic resource recycling.

Recycling must be adopted and promoted by the UAE as it is a catalyst for community and environmental betterment. There exists in Dubai a golden opportunity in recycling as a way of solving the Emirate's excess waste problems as well as creating economic avenues for technological and business development. Awareness will play a major role in trying to reduce the amount of waste produced, and cooperation between service providers and residents directed by a recycling mandate is expected to achieve the desired results. The most important policy term suggested by this paper is the mandating of a well-designed recycling program. The most important contribution of regulations are that they will require residents to act responsibly whether they choose to do so or not. Dubai has witnessed significant economic growth in the recent years and is a major business center in the Middle East; this enables Dubai to forge strategic partnerships with the best knowledge providers from around the world. This paper suggests a multi phase 10 + year program that is aimed at achieving these goals. The 10+ year program is devised as a fast tracked program so as to encourage recycling business's to be able to develop alongside the public acceptance of the program, thus enabling residents to see the benefits of recycling in real time. The purpose of the recycling policies are to improve the whole recycling process and the efficiency of the various recycling methods used through governance and the experience of appointed authorities. The proposed program recognizes that such an effort will see extremely large costs and for this reason, an element of revenue generation through paid bags, fines and control measures are retained as the core of the proposed recycling program. Products like paper and scrap metal have been recycled for decades; this program aims to bring this concept closer to the everyday lives of Dubai residents. It must be appreciated that from an economic perspective, recycling is the first step in a chain that feeds into larger, more profitable components of the industry, this however can only be achieved if policy makers can see this potential and capture it. There is the potential to increase rates of recycling at a positive net benefit for nearly all waste streams if source separation is implemented in Dubai. The right step forward must begin with the implementation of legislation that will not only initiate focus on recycling but will evolve into eco labeling, extended producer responsibility schemes, green procurement policies, cradle-to-cradle certification initiatives and responsible environmental management systems. Moving forward, a commitment to recycling and continued environmental

education is expected to influence future generations to absorb the 3R's as a part of everyday existence on this planet.

In conclusion, it must be appreciated that domestic recycling is a valuable component of sustainable development. The purpose of these recycling policies are primarily to reduce the consumption of each non-renewable raw material and to re-extract value from waste. Ultimately, to be efficient recycling should be developed to much higher rates than the ones observed for most recycled materials in the world today and the policies and program proposed in this paper are aimed at achieving this goal. There is every expectation that if the right investments are made in education, awareness, laws and infrastructure Dubai can reach its environmental objectives with the full cooperation of its residents.

8.2.Recommendations

The recycling program presented in this paper is designed specifically for the city of Dubai. While the conditions are similar in the other emirates, the data, statistics and observations are as seen in Dubai and, the proposal has received feedback from stakeholders of Dubai only. In order to be applicable in its strictest sense to the other Emirates, the proposal would need to be reviewed by stakeholders such as Masdar City, Ministry of Environment and water - Abu Dhabi, Local Municipalities in all the other emirates and experts in the field. The paper would have had a larger scope if statistics for all the emirates were included individually.

The waste management planning process in principle is a continuous process, where the program and policies need to be revised at regular intervals. The process if described in detail, includes several phases such as program components, planning, consultation process, test phase, implementation and plan revision. Each one of these phases is extremely detailed and warrants a thorough investigation, which is beyond the scope of this paper.

Other issues such as infrastructure support, costs of program implementation, processes of introductions of laws into the legislation of the UAE, branding and roll out have not been discussed in this paper. Expanded discussions on collection technologies and their selection, the importance of addressing different cultural groups and a deeper study of designing a recycling program for a transient multicultural population would have added greater scope to this paper. Other related aspects

for further study are the potential for revenue generation within the recycling business and job creation within the recycling industry.

Other elements that would aid the study of domestic resource recycling and the selection of a program and policies for Dubai are:

- A pilot study, wherein the proposed program would be implemented within a controlled group for a period of two years to demonstrate the feasibility of such a program in its actuality.
- An enhanced survey of a larger sample population where respondents would be required to provide feedback on the proposed recycling program. Such a survey would obtain valuable information on the program/policies well ahead of the process of implementation.
- A detailed study on the potential challenges that policymakers would face in the implementation of a domestic recycling program in a multicultural environment such as seen in Dubai.
- Research on the time, types and extent of education and outreach material that would be required to properly inform the population (that includes the various cultural groups) that exists in Dubai.
- A Cost Benefit Analysis of implementing the proposed recycling program in Dubai and to determine the economic costs and benefits of diverting waste streams from current disposal practices.

References

Aadland, D, & Caplan, A., (2006). Curbside recycling: Waste resource or waste of resources?, *Journal Of Policy Analysis & Management*, 25, 4, pp. 855-874, Business Source Complete, EBSCOhost,[Accessed 30th December 2011]

Abdulla, H.F., (2011). Waste not, Want not, *ConstructionweekOnline.com*, Online article [Accessed 4th February 2012] Available at <http://www.constructionweekonline.com/article-14677-waste-not-want-not/1/print/>

Aburawa A .,(2011). Dubai's waste among the highest in the world, online, *greenprophet.com*, [Accessed 24th November 2011] Available at <http://www.greenprophet.com/2011/03/dubai-high-waste/>

Abushammala, M. F. M., Basri, N. E. A., Basri, H., Kadhum, A.A.H and El-Shafie, A.H (2010). Estimation of Methane Emission from Landfills in Malaysia using the IPCC 2006 FOD Model, *Journal of Applied Sciences*, 10:15, pp1603-1609, [Accessed 14th October 2011] Available at <http://scialert.net/fulltext/? doi=jas.2010.1603.1609&org=11>

Abu Qdais, H.A., Hamooda, M.F, Newham, J., (1997). Analysis of Residential Solid Waste At Generation Sites, *Waste Management & Resources*, 15, 4, pp 395-405, [Accessed 14th October 2011] Available at Sage Journals, doi: 10.1177/0734242X9701500407

Ackerman, F., (1997). *Why Do We Recycle? Markets Values, and Public Policy*, Washington, DC: Island Press, 2000,pp 223-229.

Ackerman, F., Gallagher, K., (2002). Mixed Signals: Market Incentives, Recycling, and the Price Spike of 1995, *Resources, Conservation, and Recycling*, 35,pp 275-295, Business Source Complete, EBSCOhost [Accessed 2nd January 2012]

Ackerman, F., (2005). Material Flows for a Sustainable City, *International Review For Environmental Strategies*, 5, 2, pp. 499-509, Business Source Complete, EBSCOhost [Accessed 2nd November 2011]

AFED Conference on Green Development, (2011). Green Change can save Arab economies, [Accessed 4th February 2012] Available at http://www.zawya.com/story.cfm/sidZAWYA20111027153124/AFED_Conference_on_Green_Economy

Al Ansari, M. S., (2012). Improving Solid Waste Management in Gulf Co-operation Council States: Developing Integrated Plans to Achieve Reduction in Greenhouse Gases, *Modern Applied Science*, 6, 2, [Accessed 5th February 2012] Available at <http://ccsenet.org/journal/index.php/mas/article/download/14351/9878>

Alhumoud, J.M., (2005). Municipal solid waste recycling in the Gulf Co-operation Council States, *Resources, Conservation & Recycling*, 45, 2, pp. 142-158, Environment Complete, EBSCOhost, [Accessed 25th January 2012]

AME Info, (2010). Tadweer Waste Treatment: The first company in the region to produce alternative fuel and green products, online business source, [Accessed 6th November 2011] Available at <http://www.ameinfo.com/230516.html>

AME Info, (2011). Emirates Environmental Group launches 10th edition 'Clean Up UAE', Press Release, [Accessed 7th November, 2011] available at <http://www.ameinfo.com/275218.html>

Ando, A, & Gosselin, A, (2005). Recycling in Multi – family dwellings: does Convenience matter?, *Economic Inquiry*, 43, 2, pp. 426-438, Business Source Complete, EBSCOhost, [Accessed 4th December 2011]

Andersen, T. B, (2005). Recycling around the world, BBC Online News, [Accessed 9th January 2012] Available at <http://news.bbc.co.uk/2/hi/europe/4620041.stm#map>

Aoki, M., (2005). An Analysis of Determinants of Consumer's Recycling Behavior, *Advances In Consumer Research - Asia-Pacific Conference Proceedings*, 6, pp. 322-325, Business Source Complete, EBSCOhost, [Accessed 28th December 2011]

Ashenmiller B, (2009). Cash Recycling, Waste Disposal Costs, and the Incomes of the Working Poor: Evidence from California', *Land Economics* Vol. 85, 3 pp 539-551, EBSCOhost, [Accessed 4th December 2011]

Arab Forum for Environment and Development Report, (2008). Arab Environment: Waste Management, Chapter 8, [Accessed 16th November 2011] Available at <http://www.afedonline.org/afedreport/Full%20English%20Report.pdf>

Arab Forum for Environment and Development, (2008), Arab Environment: Future Challenges, Chapter 1, [Accessed 16th November 2011] Available at <http://www.afedonline.org/afedreport/Full%20English%20Report.pdf>

Australian Bureau of Statistics, (2003). 4602.0 - Environmental Issues: People's Views and Practices, viewed [Accessed 15th January 2012] Available at <http://www.abs.gov.au/AUSSTATS/abs@.nsf/Lookup/4602.0Main+Features1Mar%202003>

Australian Bureau of Statistics, (2006). Environment Snapshot: recycling up, but e-waste a looming issue, [Accessed 9th February 2012] Available at <http://www.abs.gov.au/AUSSTATS/abs@.nsf/mediareleasesbyReleaseDate/FB2F33C170E4987DC A2572210077D0FA?OpenDocument>

Bains, E., (2009). Dubai takes a pragmatic approach, MEED: Middle East Economic Digest, 53, 42, pp. 34-35, Business Source Complete, EBSCOhost, [Accessed 13th December 2011]

BBC News, (2008). Chutes to suck waste from estate, [Accessed 7th February, 2012] Available at <http://news.bbc.co.uk/2/hi/7772752.stm>

Beatty, T.K.M., Bereck, P and Shimshack , J. P., (2007). Curbside Recycling in the presence of alternatives, *Economic Inquiry*, 45: pp739–755, Hibeam Research, doi: 10.1111/j.1465-7295.2007.00055.x ,[Accessed 20th January 2012] Available at <http://www.highbeam.com/doc/1P3-1380753321.html>

Bickford, M., (2009). Recycling, Packaging. Kirk-Other Encyclopedia of Chemical Technology, pp1–12,Wiley Online Library, DOI: 10.1002/0471238961.recy-pack.a01, [Accessed 14th December 2011]

Bigger, A. S., (2005). Recycling: 9 steps to Success, FacilitiesNet, online article, [Accessed 10th November 2011] Available at <http://www.facilitiesnet.com/green/article/Recycling-9-Steps-to-Success--3454#>

Birkner, A., Celusnak, K., Nutini, G., Rycenga, J., Wood, W.H., Nartker, J., (2010). Predicted Recycling Bin Usage in Apartment Complexes, *Undergraduate Research Journal for the Human Sciences*, Vol 9, [Accessed November 12th 2011] Available at <http://kon.org/urc/v9/birkner.html>

Burkhalter ,E., (2007). Pay As You Throw: A Weighty Issue., *Urban Ecology* 5443 , [Accessed 3rd January 2012] Available at <http://students.ou.edu/B/Ella.M.Burkhalter-1/pdf/solidwaste.pdf>

Businesswire, (2010). Lowe's Launches Recycling Centers in U.S. Stores, [Accessed 21st January 2012] Available at <http://www.businesswire.com/news/home/20100928006319/en/Lowe's-Launches-Recycling-Centers-U.S.-Stores>

Business & the Environment with ISO 14000 Updates, 2009, 2020 Vision, Waste Management Expects Recycling to Double, 20, 3, pp. 10-11, Business Source Complete, EBSCOhost, [Accessed 31st October 2011]

Bohm, R. A., Folz .D, H., Kinnaman ,T .C., Podolsky, M. J., (2010). The costs of municipal waste and recycling programs, Resources, Conservation and Recycling, 54,11, pp 864-871, [Accessed 21st January 2012] Available at <ftp://cee.ce.cmu.edu/wharriga/Public/Composting%20Data/Economics/costs%20of%20recycling%202010.pd>

Bontoux, L., Leone, F., Nicolai, M., Papameletiou, D., (1996). The recycling industry in the European Union: Impediments and Prospects, Institute for Prospective Technological Studies, EUR 17271 EN, [Accessed 9th January 2012] Available at <http://ftp.jrc.es/EURdoc/eur17271en.pdf>

Borongan, G., Okumura, S.,(2010). Municipal Waste Management Report: Status Quo and Issues in South East and East Asian Countries, pp 8, [Accessed 9th February 2012] Available at <http://www.environment-health.asia/userfiles/file/Municipal%20Waste%20Report.pdf>

Bottle Bill Resource Guide, Beverage Container Legislation, Australia, [Accessed 12th January 2012] Available at <http://www.bottlebill.org/legislation/world/australia.htm>

Canterbury, J., Eisenfeld, S., (2005). The Rise and Rise of Pay-As-You-Throw, MSW Management, Online Journal, [Accessed 9th February 2012] Available at http://www.forestermedia.net/MSW/Articles/The_Rise_and_Rise_of_PayAsYouThrow_1520.aspx

Canterbury, J., (1998). How to Succeed with Pay-As-You-Throw, Biocycle, Issue 12/1998, [Accessed 4th January 2012] Available at <http://www.epa.gov/osw/conserves/tools/payt/pdf/bc1298.pdf>

CalRecycle, (2001). Recycling in Multifamily Dwellings:A Model for Local Government Recycling and Waste Reduction, Doc Ref - 31001012, [Accessed 7th February 2012] Available at www.calrecycle.ca.gov/publications/.../31001012.doc

CalRecycle, (2002). 'Innovations' Case Studies: Curbside Recycling, the Next Generation, [Accessed 15th January 2012] Available at <http://www.calrecycle.ca.gov/LGCentral/Library/innovations/Curbside/Program.html>

California Law Requires Recycling Availability at Apartments, (2011). Solid Waste Report, 42, 16, p. 8, Environment Complete, EBSCOhost,[Accessed 25th January 2012]

Carlisle, T., (2011). Stockholm could teach Abu Dhabi a few green lessons, The National, [Accessed 8th February 2012] Available at

<http://www.thenational.ae/thenationalconversation/industry-insights/energy/stockholm-could-teach-abu-dhabi-a-few-green-lessons?pageCount=0>

Christophersen, M., Kjeldsen, P., Holst, H., Chanton, J.,(2001). Lateral gas transport in soil adjacent to an old landfill: factors governing gas migration, *Waste Management Research*, 19, 2, pp. 144-159, Highbeam Research [Accessed 23rd October 2011]

Chernik ,K.,(2010). UAE Environment and water to use animated film to promote plastic bag ban, online article Green Prophet, [Accessed 7th November 2011] Available at <http://www.greenprophet.com/2010/09/uae-plastic-bag-ban/>

Clean Middle East, Waste management comes under the spotlight at Gulf Environment Forum, 4: 3, [Accessed 14th November 2011] Available at <http://www.cleanmiddleeast.ae/articles/298/waste-management-comes-under-the-spotlight-at-gulf-environment-forum.html>

Clean Middle East, UAE Companies partner to deal with plastic waste, 2:3, [Accessed 14th November 2011], Available at <http://www.cleanmiddleeast.ae/articles/263/uae-companies-partner-to-deal-with-plastic-waste.html>

Clean Middle East , Dubai Municipality's sustainable waste management initiatives, 11: 2, [Accessed 6th November 2011] Available at <http://www.cleanmiddleeast.ae/articles/199/dubai-municipality-rsquo-s-sustainable-waste-management-initiatives.html>

Clean Middle East, The Challenge to Waste Management in the Region, 12:2, [Accessed 14th November 2011] Available at <http://www.cleanmiddleeast.ae/articles/215/the-challenge-to-waste-management-in-the-region.html>

ClickGreen, (2011). Austria tops the European recycling league table, new data reveals, online article, [Accessed 9th February 2012] Available at <http://www.clickgreen.org.uk/analysis/general-analysis/121999-austria-tops-the-european-recycling-league-table.html>

CIWMB (2003). "Innovations" Case Studies: Curbside Recycling and the Next Generation, [Accessed 9th November 2011] Available at <http://www.ciwmb.ca.gov/LGLibrary/Innovations/Curbside/Program.html>

Cooper, J., (2007). Dubai is down in the dumps, *Materials Recycling Week*, 190, 10, p. 91, Environment Complete, EBSCOhost, [Accessed 25th January 2012]

Clark, G., (2011). Time Out looks at the UAE's plans to tackle waste and recycling, *TimeOut Abu Dhabi*, [Accessed 24th November 2011] Available at <http://www.timeoutabudhabi.com/community/features/5223-recycling>

Cummings. L., (2007). Facts About Aluminum Recycling, online article, earth911.com, [Accessed 16th October 2011] Available at <http://earth911.com/news/2007/04/02/facts-about-aluminum-recycling/>

Councils step up work to improve recycling in flats (2009). ENDS (Environmental Data Services), 411, pp. 22-23, Business Source Complete, EBSCOhost, [Accessed 4th December 2011]

Covering Recycling Policy in 38 Countries Including Europe, Asia & Latin America, (2010), Research and Markets: Recycling Laws International, Businesswire, [Accessed 8th January 2012] Available at <http://www.pr-inside.com/research-and-markets-recycling-laws-r1993442.htm>

Dahab ,D. J., Gentry, J. W., Su ,W., (1995), New Ways to reach Non recyclers : An extension of the model of reasoned action to recycling behaviors, Advances in Consumer Research ,Association for Consumer Research, 22, pp251-256, [Accessed 9th November 2011] Available at <http://www.acrwebsite.org/volumes/display.asp?id=7710&print=1>

David, E. N., Mealy, G.A., (1972). Recycling: Problems and Proposals, 2 Golden Gate University Law Review. 2:1,[Accessed 8th October 2011] available at <http://digitalcommons.law.ggu.edu/ggulrev/vol2/iss1/25>

David, A.G., Leland, Jr.L. S., Davies, A. M., Walsh, K., (2004). Reducing curbside waste volumes by promoting household Composting, Journal of Environmental Sustems, 30,4, pp 317-332,EBSCOhost [Accessed 23rd November 2011]

DEFRA Report, (2006). Evaluation of the Household Waste Incentives Pilot Scheme, AEAT/ED51352/Issue 1,[Accessed 3rd January 2012] Available at <http://archive.defra.gov.uk/environment/waste/localauth/documents/aeat-appendix-southeast.pdf>

De Young, R., (2000). New Ways to Promote Pro-environmental Behavior: Expanding and Evaluating Motives for Environmentally Responsible Behavior, Journal of Social Issues, 56, pp509–526,WileyOnline library doi: 10.1111/0022-4537.00181,[Accessed 28th December 2011]

Dilks, R., (2011). Over packaging – are shoppers or supermarkets to blame?, online article ,Which ? Conversation, [Accessed 15th January 2012] Available at <http://conversation.which.co.uk/consumer-rights/excess-supermarket-packaging-investigation/>

Djpu.org, Guide to Mining and Energy, Brief History of Recycling, online blog, [Accessed 14th October 2011] Available at <http://www.djpu.com/brief-history-of-recycling.htm>

Dubai Statistics Centre, (2007 – 2009), Percentage Distribution of Collected Solid Waste Components - Emirate of Dubai, [Accessed 9th March 2012] Available at http://www.dsc.gov.ae/Reports/DSC_SYB_2009_15_09.pdf

Dvorak, R., Kosior, E., Moody,L., (2011). Development of NIR Detectable Black Plastic Packaging, pp.28 – 30, WRAP, [Accessed 27th October 2011] Available at: http://www.wrap.org.uk/downloads/Recyclability_of_black_plastic_packaging1.d2a2462c.11203.pdf

Earth Talk, “Do the Benefits of Recycling Outweigh the Costs?” online article, [Accessed 15th January 2012] Available at http://environment.about.com/od/recycling/a/benefit_vs_cost.htm

The Economist, (2007). The Truth about Recycling, web edition, [Accessed 12th October 2011] Available http://www.economist.com/node/9249262?story_id=9249262

Encyclopedia of Business, 2nd Edition, Recycling Programs, online encyclopedia, [Accessed 9th November 2011] Available at <http://www.referenceforbusiness.com/encyclopedia/Pro-Res/Recycling-Programs.html#b#ixzz1dBq56gDJ>)

EPA, (1994). Solid Waste and Emergency Response, EPA530-F-94-007, [Accessed 12th January 2012] Available at <http://www.epa.gov/wastes/partnerships/wastewise/pubs/howtopdf.pdf>

EPA, (1999). Complex recycling issues: strategies for record-setting waste reduction in multi-family dwellings, EPA-530-F-99-022, [Accessed 26th January 2012] Available at <http://www.epa.gov/wastes/conserves/downloads/f99022.pdf>

EPA, (1999). Multifamily recycling: A golden opportunity for Solid waste reduction, EPA530-F-99-010,[Accessed 6th February 2012] Available at <http://www.epa.gov/osw/conserves/rrr/pubs/multi.pdf>

EPA, (1999) .Complex recycling issues: strategies for record-setting waste reduction in multi-family dwellings, EPA-530-F-99-022,[Accessed 15th January 2012] Available at <http://www.epa.gov/wastes/conserves/downloads/f99022.pdf>

EPA,(2001). Multifamily Recycling A National Study, EPA530-R-01-018, [Accessed 26th January 2012] Available at <http://www.epa.gov/wastes/nonhaz/municipal/pubs/multifamily.pdf>

EPA, (2001). Multifamily Recycling: A National Study, EPA530-R-01-018,[Accessed 6th February 2012] Available at <http://www.epa.gov/osw/nonhaz/municipal/pubs/multifamily.pdf>

EPA, (2002). Solid Waste Management: A Local Challenge With Global Impacts, viewed on 12th November 2011 available at <http://www.epa.gov/osw/nonhaz/municipal/pubs/ghg/f02026.pdf>

EPA, (2007). Methodology for estimating municipal solid waste recycling benefits, [Accessed 24th September,2011] Available at <http://www.epa.gov/osw/nonhaz/municipal/pubs/06benefits.pdf>

EPA, (2009). Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2008, F-009-021, [Accessed 9th February 2012] Available at <http://www.epa.gov/wastes/nonhaz/municipal/pubs/msw2008rpt.pdf>

EPA, (2009) MSW Fact Sheet, [Accessed 16th January 2012] Available at <http://www.epa.gov/osw/nonhaz/municipal/pubs/msw2009-fs.pdf>

EPA, 2010 MSW Fact Sheet , [Accessed 16th January 2012] Available at http://www.epa.gov/osw/nonhaz/municipal/pubs/msw_2010_factsheet.pdf

EPA , Undated , Pay-As-You-Throw , [Accessed 3rd January 2012] Available at <http://www.epa.gov/osw/conserves/tools/payt/>

European Commission Report, (2002). Financing and Incentive Schemes for Municipal Waste Management, [Accessed 20th January 2012] Available at

http://ec.europa.eu/environment/waste/studies/pdf/financingmunicipalwaste_management.pdf

Evertt ,J.W., Pierce, J.J., (1993). Curbside recycling in the USA – Convenience and Mandatory Participation, *Waste Management & Research*, 11, pp 49 – 61, Sage Online Journals, Doi: 10.1177/0734242X9301100105, [Accessed 9th November 2011]

Fareed, M. A. R.,(2006). City battles Mountain of waste-Recycling in Dubai, online article OhmyNews, [Accessed 5th November 2011] Available at http://english.ohmynews.com/articleview/article_view.asp?menu=c10400&no=328297&rel_no=1

Federal Income Tax Incentives for Energy Conservation and Green Initiatives, (2009). Venulex Legal Summaries, pp. 22-37, Business Source Complete, EBSCOhost, [Accessed 5th January 2012]

Federconsumatori (Italy), (2008). Consumption: Against the Caro prices and increased environmental packaging "THE PLUG" Save about 774.58 Euro per year , [Accessed 15th January,2012] Available at <http://www.federconsumatori.it/ShowDoc.asp?nid=20081016150707&t=news>

Fishbein, K.B., (1998). EPR: What Does It Mean? Where Is It Headed? Pollution Prevention Review, 8,pp. 43-55, [Accessed 9th January 2012] Available at <http://www.informinc.org/eprpr.php>

Foulkes, I., (2005). Recycling around the world, BBC Online News, [Accessed 9th January 2012] Available at <http://news.bbc.co.uk/2/hi/europe/4620041.stm#map>

Footo, K., Foster, S.,(2002). Moving on Up, *Waste Age*, 33, 5, pp. 70, Environment Complete, EBSCOhost, [accessed 25th January 2012]

Folz, D. H., Hazlett, J.M., (1991). Public Participation and Recycling Performance: Explaining Program Success, 51: 6, pp. 526-532, Business Source Complete, EBSCOhost, [Accessed 23rd November 2011]

Garnham, P., (1997). Collection vehicles take a new turn, *Biocycle*, 38, 3, pp. 75, Business Source Complete, EBSCOhost, [Accessed 2nd November 2011]

Gautam,V., (2009). Solid Waste Management in GCC: Challenges & Opportunities, Frost & Sullivan Market Insight, Online article, [Accessed 4th February 2012] Available at <http://www.frost.com/prod/servlet/market-insight-print.pag?docid=186566927>

Gitlitz , J., (2003). The Role of the Consumer in Reducing Primary Aluminum Demand, International Strategic Roundtable on the Aluminum Industry, [Accessed 12th January 2012] Available at <http://www.container-recycling.org/assets/pdfs/aluminum/Aluminum-RoleofConsumer.pdf>

Giller. C., Roberts, D., (2006). Green gets Going, *Fast Company*, 103, pp. 72-78, Business Source Complete, EBSCOhost, [Accessed 18th October 2011]

Gillan, D., Leland Jr.L., Davies, A., Walsh, K., (2004). Reducing Curbside Waste Volumes by Promoting Household Composting, *Journal Of Environmental Systems*, 30, 4, pp. 317-332, Business Source Complete, EBSCOhost, [Accessed 11th December 2011]

Grossman, E., (2006), HighTech Trash: Digital Devices, Hidden Toxics, and Human Health, Hardcover Shearwater Books; 1 edition.

Glasgow,P.A.,(2005). Fundamentals of Survey Research Methodology,Mitre Product, [Accessed 13th April 2012] Available at http://www.mitre.org/work/tech_papers/tech_papers_05/05_0638/05_0638.pdf

Goldmark, A., (2010). Walmart Recycling Program Pays Cash for Trash, ERWW New Consumer, [Accessed 8th January 2012] Available at <http://www.thenewconsumer.com/2010/11/15/wal-mart-recycling-program-pays-cash-for-trash/>

Gupta, S. K., (2004). Rethinking waste management, online article, [Accessed 28th December 2011] Available at <http://indiatogether.org/2004/apr/envrethink.htm>

Hage ,O., Söderholm, P., Berglund, C., (2009). Norms and economic motivation in household recycling: Empirical evidence from Sweden, Resources, Conservation and Recycling, 53, 3,pp 155-165, Science Direct, ISSN 0921-3449, 10.1016/j.resconrec.2008.11.003, [Accessed 7th February ,2012] Available at <http://www.sciencedirect.com/science/article/pii/S0921344908002000>

Hahn, R. W., Stavins, R.N., (1991). Incentive-based Environmental Regulation: a New Era from an Old Idea?, Ecology Law Quarterly 18, pp1-42, [Accessed 4th January ,2012] Available at http://www.hks.harvard.edu/fs/rstavins/Papers/Incentive-Based_Environmental_Regulation.pdf

Halvorsen, B., (2008). Effects of Norms and Opportunity Cost of Time on Household Recycling Land Economics, 84, 3, pp 501-516, Business Source Complete, EBSCOhost, [Accessed 4th December 2011]

Harder, M. K., Woodard, R., (2008). Incentivizing Householders to recycle with vouchers, Waste: The Social Context, X1-X10. Environment Complete, EBSCOhost [Accessed January 25, 2012]

Heimlich, J. E., Landfill Fact Sheet, CDFS 111, Ohio State University, undated, [Accessed 24th October 2011] Available at <http://ohioline.osu.edu/cd-fact/0111.html>

Hoornweg, D., Thomas, L., Varma, K., (1999). What a waste: Solid waste management in Asia, Urban Development Sector Unit East Asia and Pacific Region,[Accessed on 12th October, 2011] Available at: http://www.worldbank.org/urban/solid_wm/erm/CWG%20folder/uwp1.pdf

Hoornweg, D., Thomas. L., Otten, L., (1999). Composting and Its Applicability in Developing Countries, Urban Waste Management Working Paper, Series 8, [Accessed 26th December 2011] Available at <http://www.bvsde.paho.org/bvsacd/cd48/paperseries8.pdf>

Hong, S., Adams, R. M.,(1999). Household Responses to price incentives for Recycling: Some further evidence , Land Economics, 75,4, pp 505 – 514, Business Source Complete, EBSCOhost , [Accessed 9th December 2011]

- Hogg, D., (2001). Costs for Municipal Waste Management in the EU, Final Report to Directorate General Environment, European Commission, Eunomia, Research & Consulting, [Accessed 9th December 2011] Available at <http://ec.europa.eu/environment/waste/studies/pdf/eucostwaste.pdf>
- Inanc, B., A, Idris, Terazono,A., Sakai S, 2004, Development of a database of landfills and dump sites in Asian Countries, Journal of Material Cycles and Waste Management, 6,2,pp 97-103,Business Source Complete, EBSCOhost, [Accessed 11th November 2011]
- Institute of Food Technology, (2007). Food Packaging and Its Environmental Impact, [Accessed 15th January 2012] Available at <http://www.ift.org/knowledge-center/read-ift-publications/science-reports/scientific-status-summaries/editorial/food-packaging-and-its-environmental-impact.aspx>
- Iyer, E., Kashyap, R., (2007). Consumer recycling: Role of incentives, information, and social class, Journal Of Consumer Behavior, 6, 1, pp. 32-47, Business Source Complete, EBSCOhost, [Accessed 9th November 2011]
- Jansen,K.J.,Corley,K.G., Jansen,B.J., (2007). E – Survey Methodology, Chapter 1, [Accessed 13th April 2012] Available at http://faculty.ist.psu.edu/jjansen/academic/pubs/esurvey_chapter_jansen.pdf
- Japan for Sustainability, (2008). MOE Sets Targets to Reduce Waste, Increase Waste Power Generation and Recycling by 2012, [Accessed 9th February, 2012] Available at <http://www.japanfs.org/en/pages/027149.html>
- Jacobs, H., Bailey, J., Crews, J.,(1984). Development and analysis of a community-based recourse recovery program, Journal of Applied Behavior Analysis, 17, pp127-145, Environment Complete, EBSCOhost, [Accessed 9th November 2011]
- Jeon Rhee, J., (1998). Economic incentives and optimal waste management: Korean experiences in Unit pricing for garbage collection, Environmental Economic and policy studies (1999) 2, pp113 – 128, Business Source Complete EBSCOhost, [Accessed 9th November 2011]
- Jenkins, R.R., Martinez, S.A., Palmer, K., Podolsky ,MJ., (2000). The Determinants of Household Recycling: A Material Specific Analysis of Recycling Program Features and Unit Pricing, Resources of the Future, [Accessed 15th January 2012] Available at <http://www.rff.org/documents/rff-dp-98-41-rev.pdf>
- Jia Yong S., (1998). Experience and Enlightenment of recycling system of packaging waste in Europe, China-USA Business Review, 7,5,pp48-54, Environment Complete, EBSCOhost,[Accessed 9th November 2011]
- Johnson, J., (2002). Debate: To mix or not to mix, Waste News, 8, 2, p. 5, Business Source Complete, EBSCOhost, [Accessed, 31 October 2011]
- Johnson, J., (2011). Waste Management, Recyclebank see benefits from combo, Waste & Recycling News, 17, 13, p. 0001, Business Source Complete, EBSCOhost, [Accessed January 12th 2012]

Kaciak, E., Kushner, J., (2009). Determinants Of Residents “Recycling Behaviour”, International Business & Economics Research Journal, 8,8, Online Journal, [Accessed 7th February 2012] Available at <http://journals.cluteonline.com/index.php/IBER/article/view/3154/3202>

Kader, B.A., (2011). Poor waste management costs UAE Dh1.5b a Year, Gulf News Publication, [Accessed 11th February 2012] Available at <http://gulfnews.com/news/gulf/uae/environment/poor-waste-management-costs-uae-dh1-5b-a-year-1.772661>

Kantaris, A., (2011). History of Recycling, Online Article, [Accessed 24th October, 2011] Available at <http://www.yooarticles.com/article/history-of-recycling>

Katzev, R., Blake, G. and Messer, B. (1993). Determinants of Participation in Multi-Family Recycling Programs. Journal of Applied Social Psychology, 23: pp.374–385. Wiley Online Library .doi: 10.1111/j.1559-1816.1993.tb01093.x, [Accessed 24th December, 2011]

Kelleher, M., Robins, J., Dixie, J., (2005). Taking out the Trash: How to Allocate the Costs Fairly, C.D. Howe Institute Commentary 213, pp.1-22, [Accessed 4th January 2012] Available at http://www.cdhowe.org/pdf/commentary_213.pdf

Kinnaman, T.C ., (2010). Optimal Solid Waste Tax Policy with Centralized Recycling, National Tax Journal, 63, 2, pp. 237-251, Business Source Complete, EBSCOhost, [Accessed 5th January 2012]

Kinnaman, T.C., (2006). Examining the Justification for Residential Recycling, Journal Of Economic Perspectives, 20, 4, pp. 219-232, Business Source Complete, EBSCOhost, [Accessed 30th December 2011]

Karkain, R.M., (2011). Dubai’s Need for Innovative Municipal Solid Waste Treatment Technologies, Paper from 3rd e-Health Conference in the Middle East, HBMeU Annual Congress, [Accessed 5th February 2012] Available at <http://congress.hbmeu.ac.ae/downloads/Healthcare-Conference-2011.pdf>

Kronrod, A., Grinstein, A., Wathieu, L., (2012). Go Green!! Should Environmental Messages Be So Assertive??, Journal Of Marketing, 76, 1, pp. 95-102, Business Source Complete, EBSCOhost, [Accessed 30th December 2012]

Kuo, Y.L, Perrings, C, (2010). Wasting Time? Recycling Incentives in Urban Taiwan and Japan, Environmental and Resource Economics , 47, 3 pp 423 – 437 , [Accessed 4th January 2012] Available at [http://perrings.faculty.asu.edu/pdf_papers_Perrings/Kuo_and_Perrings_EARE_\(2010\).pdf](http://perrings.faculty.asu.edu/pdf_papers_Perrings/Kuo_and_Perrings_EARE_(2010).pdf)

Kolodny, L., (2011) Recyclebank's CEO Jonathan Hsu On New Site, Rewarding Green Behavior Beyond The Bin, techcrunch.com, Online Article , [Accessed 17th February 2012] Available at <http://techcrunch.com/2011/02/01/recyclebank-ceo-hsu-on-site-redesig/>

Langston, J., (2006). Mandatory recycling program working well, Seattle PI ,[Accessed January 9th January 2012] Available at <http://www.seattlepi.com/local/article/Mandatory-recycling-program-working-well-1198413.php>

Lansana, F. M., (1993). A Comparative Analysis of Curbside Recycling Behavior in Urban and Suburban Communities. *The Professional Geographer*, 45: 169–179, Wiley Online Library, doi: 10.1111/j.0033-0124.1993.00169.x [Accessed 8th January 2012]

Lapointe E., Valenzuela M., Watson T., Donley A., (2010). A report compiled as part of the INTERREG IVa Waste in Action Project , [Accessed 28th January 2012] available at http://www.actiondechets.fr/upload/medias/group_c_final_report.pdf

Lave, L., Hendrickson, C., (1999). Municipal Solid Waste Recycling Issues', *Journal Of Environmental Engineering*, 125, 10, pp. 944, Business Source Complete, EBSCOhost, [Accessed 29th December 2011]

Lebersorger, S.S., (2008). Waste Management in Multifamily Dwellings – Structural Barriers and approaches to overcome them, *Waste: The Social Context* (2008), pp. X1-X10, Environment Complete, EBSCOhost, [Accessed 31st January 2012]

Lease .K., (2001). Recycling in Multifamily Dwellings: A Model for Local Government Recycling and Waste Reduction, Report prepared for the California Integrated Waste Management Board,[Accessed 25th January,2012] Available at <http://www.calrecycle.ca.gov/Publications/default.asp?pubid=920>

Lockerbie, A., (2010). Aiming high, *Materials Recycling Week*, 196, 22, pp. 18-20, Environment Complete, EBSCOhost, [Accessed 25th January 2012]

Lowe, A., (2011). Recycling gains momentum in the UAE” *Gulf News* , [Accessed 25th November, 2011] Available at <http://www.green-middleeast.com/pressdtls.asp?PID=246>

Love Canal: A Special Report to the Governor & Legislature, (1981). US Department of Health, New York, [Accessed 26th October, 2011] Available at : http://www.health.ny.gov/environmental/investigations/love_canal/lcreport.htm

Lund, H.F., (2001). *The McGraw – Hill Recycling Handbook* , RR Donnelley & Sons, Co , pp5.28.

Macnamara, C., (1999). General Guidelines for Conducting Interviews, Minnesota, [Accessed 13th April 2012] Available at <http://www.hsse.nie.edu.sg/webquest/Econ/2003%20NIE%20Webquests/Webquest%20-%20Exchange%20Rate%20Policy/General%20Guidelines%20for%20Conducting%20Interviews.htm>

Mahavan, N., N., (2009). Trash to Cash, *Business Today*, 18, 7, pp. 110-113, Business Source Complete, EBSCOhost, [Accessed 21st November 2011]

Manandhar, R., (2002). Private sector participation in solid waste management in Kathmandu, Paper presented at the Kitakyushu Initiative Seminar on Solid Waste Management: 1st Thematic Seminar, held in Kitakyushu, Japan, 19-20 September 2002 [Accessed 28th December 2011] Available at [http://www.kitakyushu.iges.or.jp/docs/.../3%20Kathmandu%20%20\(Paper\).doc](http://www.kitakyushu.iges.or.jp/docs/.../3%20Kathmandu%20%20(Paper).doc)

Malonis, J.A., Cengage, G., (2000). Recycling Programs, Encyclopedia of Business Education, online, eNotes.com, [Accessed 8th November, 2011] Available at <http://www.enotes.com/biz-encyclopedia/ recycling-programs>

Mason, I. G., Oberender, A., Brooking, A.K., (2003). Source separation and potential re-use of resource residuals at a university campus, 40,2,pp155-172, ScienceDirect, ISSN 0921-3449, 10.1016/S0921-3449 (03) 00068-5 [Accessed 2nd November 2011]

Matson, B., Pasternak, S., (2006). Taking the next step: How multi-family efforts can give cities a boost in recycling rates, Resource Recycling, 25, 3, pp. 17-19, Environment Complete, EBSCOhost [Accessed 25th January 2012]

Minami, C., Pellegrini, D., Itoh, M., (2010). When the Best Packaging Is No Packaging, International Commerce Review, ECR Journal, 9, 1/2, pp. 58-65, Business Source Complete, EBSCOhost, [Accessed 30th December 2011]

Mining and Energy Blog, (2011). Brief History of Recycling, online article,[Accessed 16th October 2011] Available at: <http://www.djpu.com/tag/benjamin-law>

Miranda, M., (1996). Unit Pricing of Residential Municipal Solid Waste: Lessons from Nine Case Study Communities, [Accessed 3rd January, 2012] Available at [http://yosemite.epa.gov/ee/epa/erm.nsf/vwAN/EE-0306-1.pdf/\\$file/EE-0306-1.pdf](http://yosemite.epa.gov/ee/epa/erm.nsf/vwAN/EE-0306-1.pdf/$file/EE-0306-1.pdf)

Montague ,P., (1998). Land Fills are Dangerous, GreenLeftWeekly , Independent Online Newsletter (Australia) , [Accessed 23rd October 2011]Available at : <http://www.greenleft.org.au/node/16621>

Morawski, C., (2009). Understanding economic and environmental impacts of single-stream collection systems, Container Recycling Institute. p. 3, [Accessed 31st October 2011] Available at <http://www.container-recycling.org/assets/pdfs/reports/2009-SingleStream.pdf>

Motavalli, J., (2011). In Europe, EPR is the law. Extended Producer Responsibility, E Magazine, Earth Action Network, Inc., HighBeam Research, [Accessed 22nd January 2012]

Moore, T., Buch-Andersen, T., Foulkes, I., (2005) Recycling around the world, BBC News Article, [Accessed 18th October 2011] Available at <http://news.bbc.co.uk/2/hi/europe/4620041.stm#map>

Nakamura, Y., (2007). Waste Management and Recycling Business in the United States and in Japan, USJP Occasional Paper 07-09, [Accessed 20th September 2011] Available at <http://www.wcfia.harvard.edu/us-japan/research/pdf/07-09.Nakamura.pdf>

Nishio, C., Takeuchi, T., (2005). Factors of Household Recycling and Waste Reduction Behavior, Advances In Consumer Research - Asia-Pacific Conference Proceedings, 6, pp. 46-51, Business Source Complete, EBSCOhost, [Accessed 21st November 2011]

Nixon, H., Saphores, J.D., (2009). Information and the decision to recycle: results from a survey of US households, *Journal of Environmental Planning and Management*, 52, 2, pp257 – 277, Taylor & Francis Online, DOI: 10.1080/09640560802666610, [Accessed 27th October, 2011]

Nunez, M., (2011). Recycle bank Turn trash to rewards for 3million+ Members, online article, *International Business Times*, NY [Accessed 4th February, 2012] Available at <http://newyork.ibtimes.com/articles/268082/20111215/recyclebank-trash-rewards-3-million-members.htm>

OECD, (2009) Switzerland, Environmental Performances Report, [Accessed 11th February 2012] Available at <http://www.oecd.org/dataoecd/8/31/2451893.pdf>

Omran, A., Mahmood, A., Abdul Aziz, H., Robinson, G. M., (2009). Investigating Households Attitude Toward Recycling of Solid Waste in Malaysia: A Case Study, *International Journal of Environmental Research*, Vol. 3, No. 2, pp.275-288,[Accessed 24th December,2011] Available at <http://www.bioline.org.br/request?er09030>

Oskamp, S., Zelenzy, L., Schultz, P. W., Hurin, S., Burkhardt, R., (1996). Commingled Versus Separated Curbside Recycling Does Sorting Matter? *Environment and Behavior* 28, 1 pp73-91, Business Source Complete, EBSCOhost, [Accessed 23rd November 2011]

PAC.NZ, Packaging Council report shows that introducing deposits on containers may make us feel better but will hit us in our pockets, [Accessed 12th January 2012] Available at http://www.packaging.org.nz/policy/policy_container_deposit_legislation.php

POST, (2005). Recycling Household Waste, No 252, [Accessed 20th January 2012] Available at <http://www.parliament.uk/documents/post/postpn252.pdf>

Rand, T., Haukohl, J., Marxen, U., (2000). Municipal Solid Waste Incineration A Decision Maker's Guide, Washington, DC: The International Bank for Reconstruction and Development, World Bank. [Accessed 13th January ,2012] Available at <http://www.eawag.ch/forschung/sandec/publikationen/swm/dl/incineration-dmg.pdf>

Rathje,W., Murphy, C., (2001). Rubbish!, The archeology of garbage, HarperCollins Paperback, pp. 191–192 , [Viewed 20 October 2011]

Ray, A., (2008). Waste Management in Developing Asia Can Trade and Cooperation Help?, *Journal Of Environment & Development*, 17, 1, pp. 3-25, Business Source Complete, EBSCOhost, [Accessed 28th December 2011]

Reschovsky, J. D. and Stone, S. E., (1994). Market incentives to encourage household waste recycling: Paying for what you throw away, *Journal of Policy Analysis and Management*, 13: pp120–139, Environment Complete, EBSCOhost [Accessed 21st November 2011]

Recyclebank's Incentive Contract, (2010).The AnnArbor Chronicle,[Accessed 8th January 2012] Available at <http://annarborchronicle.com/2010/03/19/council-banks-on-single-stream-recycling/>

Recycling, greenwiki.com, [Accessed 28th December 2011] available at <http://green.wikia.com/wiki/Recycling>

Rehkopf, L., (2003). Container Deposit Legislation, Environmental Encyclopedia, HighBeam Research, [Accessed 21st January 2012]

Reichenbach, J., (2008). Status and prospects of pay-as-you-throw in Europe – A review of pilot research and implementation studies, Waste Management 28, pp 2809-2814, Environment Complete, EBSCOhost [Accessed 4th January 2012]

Resource Recycling, (2006). High-rise recycling coming to Montreal, 25, 6, p. 9, Environment Complete, EBSCOhost, [Accessed 25th January 2012]

Russo, A. S., Shah, S. P., (1994). Packaging taxes and recycling incentives: The German Green Dot Program, National Tax journal, 47, 3, pp 689-701, Business Source Complete, EBSCOhost [Accessed 23rd January 2012]

Robinson, G. M., Read, A.D., (2005). Recycling Behaviour in a London Borough: Results from large-scale Household Surveys, Resources, Conservation and Recycling, 45, 1, pp 70-83, Environment Complete, EBSCOhost, [Accessed 4th December 2011]

Robbins, R., (2011). Recyclebank Poised for Future Growth, says CEO, Mother Nature Network, Online Article [Accessed 4th January 2012] Available at <http://www.recyclebank.com/corporateinfo/index/presscoveragearticle/id/299>

Roberts, M., (1995). RECYCLING: Is Mandatory Recycling A Wasted Effort?, online article, Waste360.com, [Accessed 8th January 2012] Available at http://waste360.com/mag/waste_recycling_mandatory_recycling

Ross, J., (2007). What I picked up about Trash in Taipei, The Washington Post, [Accessed 4th January 2012] available at <http://www.washingtonpost.com/wpdyn/content/article/2007/11/29/AR2007112901887.html>

Sadovsky, A., (2008). To Recycle or Not--There Is No Question, Multi-Housing News, January, Business Source Complete, EBSCOhost, [Accessed 4th December 2011]

Schenkman, L., (2003). Recycling at Apartments May be in the Bag by '08', Waste Age, 34, 6, p. 12, Business Source Complete, EBSCOhost, [Accessed 4th December 2011]

Schaffer, P., (2009). Ultimately, the choice rides on cost and local preference, American Metal Market, 118, 2, p. 27, Business Source Complete, EBSCOhost, [Accessed 2nd November 2011]

Schultz, P., (1999). Changing Behavior With Normative Feedback Interventions: A Field Experiment on Curbside Recycling, Basic & Applied Social Psychology, 21, 1, pp. 25-36, Business Source Complete, EBSCOhost, [Accessed 30th December 2011]

Schorr, H., (2008). Environment and energy, Eurostat – Statistics in Focus, 44/2011 [Accessed 11th April 2012] Available at http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-SF-11-

044/EN/KS-SF-11-044-EN.PDF

Seiw Ying, W., (2007). Jurong Town Council launches "Cash For Trash" programme', Channel News Asia, online article [Accessed 5th January 2012] Available at <http://www.channelnewsasia.com/stories/singaporelocalnews/view/313604/1/.html>

Sherpa, S., (2011). Cash for Trash - Cleaning up Mt. Everest, DW-WORLD.DE, online article , [Accessed 5th January 2012] Available at <http://www.dw-world.de/dw/article/0,,6546102,00.html>

Siddique, F, S., Lupi, F., Joshi, S. V., (2009). The effects of behavior and attitudes on drop off recycling activities , Resources , Conservation and Recycling , 53,3, pp 163 – 170 , Business Source Complete, EBSCOhost, [Accessed 14th January 2012]

SITA UK, (2010). International recycling experience for multi-occupancy households, [Accessed 25th January 2012] Available at <http://www.sita.co.uk/downloads/SITAUK-LookingUp-web.pdf>

Skumatz, L.A. & Green, J.L, 1999, 'Movin' On Up – Strategies for Increasing Multifamily Recycling' , Skumatz Economic Research Associates, Inc., viewed 25 January 2012 available at <http://www.paytwest.org/images/PAYT-Multifamily-recycling.pdf>

Sparks, K., (1998). Tax Credits: An Incentive for Recycling?, EPA Literature for Resource Recycling Magazine , [Accessed 16th January 2012] Available at <http://www.epa.gov/osw/conserves/rrr/rmd/docs/taxcred.pdf>

Structure and Policies, (2009). UAE Country Profile, pp. 62-63, Business Source Complete, EBSCOhost, [Accessed 13th December 2011]

Streit, V., (2009). Recession squeezes recycling programs, CNN Online News, [Accessed 12th November 2011] Available at http://articles.cnn.com/2009-03-19/tech/recycling.issues_1_curbside-recycling-recyclable-materials-biweekly-collection?_s=PM:TECH

Synovate's Global Trends Survey, (2011). Recycling habits of Residents, Zawya Online Press Release [Accessed 15th November] Available at http://www.zawya.com/story.cfm/sidZAWYA20110523060907/UAE_is_among_top_purchasers_of_ecological_and_organic_products_but_low_in_recycling_household_waste_Synovate_survey

Terazono, A., Moriguchi, Y., Yamamoto, Y., Shinichi, S., Inanc, B., Jianxin, Y., Siu, S., Shekdar, A., Dong-Hoon, L., Idris, A., Magalang, A., Peralta, G., Chun-Chao, L., Vanapruk, P., Mungcharoen, T., (2005). Waste Management and Recycling in Asia, International Review For Environmental Strategies, 5, 2, pp. 477-498, Business Source Complete, EBSCOhost, [Accessed 21st November 2011]

The Economist, (2007). The Truth about Recycling, web edition, [Accessed 12th October 2011] Available http://www.economist.com/node/9249262?story_id=9249262

Thøgersen, J., (1994). A model of recycling behaviour, with evidence from Danish source separation programmes, International Journal Of Research In Marketing, 11, 2, pp. 145-163, Business Source Complete, EBSCOhost, [Accessed 9th November 2011]

Thomas-Hope.Elizabeth, (1998). Solid Waste management: Critical Issues for Developing Countries, Kingston: Canoe Press, Paperback, viewed 12th October 2011

Timlett, R.E., Williams, I.D., (2009). The impact of transient populations on recycling behaviour in a densely populated urban environment, Resources, Conservation and Recycling, 53, 9, pp498-506., ScienceDirect ,ISSN 0921-3449, 10.1016/j.resconrec.2009.03.010, [Accessed 2nd February 2012]

Todorova.,V (2010), UAE has world's largest environmental footprint , online news paper , The National News , [Accessed 7th March 2012] Available at <http://www.thenational.ae/news/uae-news/environment/uae-has-worlds-largest-environmental-footprint>

Tonn, J., Tonn, B., Folz, D., (2005). Explaining the Performance of Mature Municipal Solid Waste Recycling Programs, Journal Of Environmental Planning & Management, 48, 5, pp. 627-650, Business Source Complete, EBSCOhost, [Accessed 9th November 2011]

Toto, D., (2004). Green with envy: Germany's Green Dot program continues generating good collection numbers, CBS Interactive Business Network Resource Library, [Accessed 9th January 2012] Available at http://findarticles.com/p/articles/mi_m0KWH/is_10_42/ai_n6276858/

Turner, R. K., (1992). An economic incentive approach to regulating the throw away society, European Environment, 2, 3, pp 2–8, Wiley Online Library, DOI: 10.1002/eet.3320020303 [Accessed 17th January 2012]

Tucker, P., (2001). Understanding Recycling Behavior, Newspaper Industry Environmental Technology Initiative, University of Paisley , pp 95-101, [Accessed 20th January 2012] Available at http://www.uws.ac.uk/schoolsdepts/science/environment/documents/Und_Rec_Beh1.PDF

UAE Interact, (2011). Online article, [Accessed 15th November 2012] Available at: http://www.uaeinteract.com/docs/Residents_to_be_rewarded_for_using_recycling_machines/46860.htm,

UAE Interact,(2010). Online article, [Accessed 7th November 2011] http://www.uaeinteract.com/docs/Dubai_Silicon_Oasis_Authority_Signs_MoU_with_Enviroserve_for_Disposal_and_Recycling_of_Electronic_Scrap_/42136.htm

UNEP (1996). International Source Book on Environmentally Sound Technologies for Municipal Solid Waste Management. UNEP Technical Publication, [Accessed 8th November 2011] Available at <http://www.unep.or.jp/ietc/estdir/pub/msw/>

US recycling rates reach record levels, (2011). Cantech International, 18, 7, p. 13, Business Source Complete, EBSCOhost, [Accessed 20th November 2011]

UNFPA (2007). Urbanization: A Majority in Cities, linking Population, Poverty & Development, [Accessed 12th February 2012] Available at <http://www.unfpa.org/pds/urbanization.htm>

- Venner, M., Paulsen, C., Gallivan, F., (2009). Incentive based approached for environmental Stewardship, Paper by American Association of State Highway and Transportation Officials (AASHTO), [Accessed 29th December 2011] Available at [http://onlinepubs.trb.org/onlinepubs/archive/NotesDocs/25-25\(50\)_FR.pdf](http://onlinepubs.trb.org/onlinepubs/archive/NotesDocs/25-25(50)_FR.pdf)
- Verespej, M., (2008). RecycleBank success may be boon to industry, *Plastics News*, 20, 12, p. 18, Business Source Complete, EBSCOhost, [Accessed 5th January 2012]
- Viscusi, W. K., Huber, J., Bell, J., Cecot, C., (2009). Discontinuous Behavioral Responses to Recycling Laws and Plastic Water Bottle Deposits, National Bureau of Economic Research, USA, [Accessed 7th February 2012] Available at <http://www.nber.org/papers/w15585>
- Visvanathan, C., Glawe,U., (2006). Domestic solid waste management in South Asian countries—A comparative analysis, Synthesis Report of the 3R South Asia Expert Workshop,Nepal, [Accessed 12th November 2011] Available at <http://www.faculty.ait.ac.th/visu/Prof%20Visu's%20CV/Conferance/25/3R-MSWM.%20Visu.pdf>
- Vining, J., Ebreo, A., (1992). Predicting Recycling Behavior from Global and Specific Environmental Attitudes and Changes in Recycling Opportunities, *Journal of Applied Social Psychology*, 22, pp1580–1607,Wiley Online Library doi: 10.1111/j.1559-1816.1992.tb01758.x, [Accessed 1st February 2012]
- Wang, J., (2006). All in One: Do Single-Stream Curbside Recycling Programs Increase Recycling Rates?' Academic Paper , Berkley University of California ,[Accessed 11th November 2011] Available at <http://nature.berkeley.edu/classes/es196/projects/2006final/wang.pdf>
- WasteOnline.org.uk, (2004). History of Waste and Recycling Information Sheet, [Accessed 15th October 2011] available at <http://dl.dropbox.com/u/21130258/resources/InformationSheets/HistoryofWaste.htm>
- White, L., (2002). ZeroWaste, Extended Producer Responsibility: Container Deposit Legislation Report , ZeroWaste NewZealand ,pp 12, [Accessed 15th January 2012] Available at <http://www.zerowaste.co.nz/assets/Reports/Beveragecontainers.pdf>
- Woodard, R., Harder, M. K., Bench, M., (2006). Participation in curbside recycling schemes and its variation with material types, *Waste Management*, 26, 18, pp 914-919, ScienceDirect, ISSN 0956-053X, 10.1016/j.wasman.2005.08.009, [Accessed 20th January 2012]
- Woodbury, K.P, Mariani, M., (2008). Recent advances in the waste and recycling industry: Electronic bin tagging and weighing systems, *Journal of Public Works & Infrastructure*, 1, 2, pp195-203,EBSCOhost, [Accessed 12th November 2011]
- Wollner ,D., (1999). What's next for nonprofit recyclers?, BioCycle. J.G. Press, Inc. Main Account. HighBeam Research, [Accessed 22nd January 2012]
- WRAP, (2006). Recycling for flats : planning, monitoring, evaluating and the communication of recycling schemes for flats with case studies from the UK and abroad, [Accessed 30th January 2012] Available at

http://www.wrap.org.uk/downloads/Recycling_for_flats_March_2006_WW_Defra.5431f997.9124.pdf

WRAP, (2008). Promoting recycling to residents of high and low rise flats, 3783 BCLF Case Study: Bexley, [Accessed 8th February 2012] available at http://www.wrap.org.uk/downloads/BCLF_Bexley_15.09.08.75fb2890.5864.pdf

WRAP, (2010). Recycling Collections for flats, [Accessed 28th January 2012] Available at http://www.wrap.org.uk/local_authorities/research_guidance/collections_recycling/recycling_collections_for_flats/

Yau ,Y., (2010). Domestic waste recycling, collective action and economic incentive: The case in Hong Kong, *Waste Management*, 30, 12, pp 2440-2447, ScienceDirect, ISSN 0956-053X, 10.1016/j.wasman.2010.06.009 [Accessed 15th January 2012]

Yau, Y., (2010). Stakeholder engagement in waste recycling in a high-rise setting, *Sustainable Development*, Wiley Online Library , doi: 10.1002/sd.468, [Accessed 29th January 2012]

Zerbock, O., (2003). Urban Solid Waste Management: Waste Reduction in Developing Nations, Masters International Program Paper, Michigan Technological University, [Accessed 18th September 2011] Available at http://www.cee.mtu.edu/sustainable_engineering/resources/technical/Waste_reduction_and_incineration_FINAL.pdf