

A Mini Review On Differences In Solid Waste Generation And Management Scenarios In Two High Income Countries—Saudi Arabia And USA

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Abstract— An in-depth review of land area, population and waste generation (both total and per capita) of two high income countries, namely, Saudi Arabia and USA was conducted to assess the critical factors influencing the rate of waste generation and the status of waste management. This is investigated with reference to the above countries by examining the composition of municipal solid waste (MSW) and the methods of waste management employed, including recycling, landfilling, dumping, waste-to-energy, incineration and composting. Due to the increasing population size connected to greater land area, an association between land area and generation of waste may be expected; however land area or the economic status of the country are not the only important factors. In fact, this study points out that critical factors include government and environmental policies, lifestyle and attitudes, the level of development, the amount invested in waste solutions and the priorities of each nation.

Index Terms— Municipal solid waste, waste management, USA, Saudi Arabia, recycling.

I. INTRODUCTION

Each day, inhabitants in every country produce waste. Nations throughout the world are struggling to deal with overwhelming quantities of waste and the environmental, health and social problems it creates. Economic growth and wealth have been linked to the growth of waste generation (Productivity Commission 2006). However, different countries have populations of different sizes as well as different land areas that may have additional influence on the amount and types of waste produced. Government regulations as well as the values, structure of governments and providers, economy, environments and many other individual factors govern the characteristics of waste that are exhibited in different countries. Differences in characteristics and generation of wastewarrants separate systems for waste management. Historically, landfill has been an integral part of management systems and it remains a primary method for the management of municipal solid waste. However, due to environmental concerns alternatives are now considered important. Recycling and waste-to-energy in particular are now

key processes practised in many countries around the world. There is potential for the international research community to work together with the solid waste industry in separate countries to increase and improve alternatives for integrated solid waste management programs that meet economic and environmental criteria (Barlaz et al., 2003). This study makes a comparative analysis of two high income nations, namely, Saudi Arabia and USA, which are located in two different continents, to critically assess the factors, in addition to economic status, that govern solid waste generation and management activities.

II. POPULATION AND LAND AREA

The USA has a greater land area as well as a larger population (Fig. 1.).(World Bank - Countries and Economies, 2012). The land area of a country may be a deciding factor in the way waste is disposed. Countries with a smaller land area are less likely to employ dumping and landfilling as methods of final waste disposal, due to the land area these practices demand. It is therefore more likely that smaller land area countries will seek alternative solutions to manage waste, such as incineration or waste-to-energy. However, this study explores, in reference to the selected countries, whether such expectations are always true.

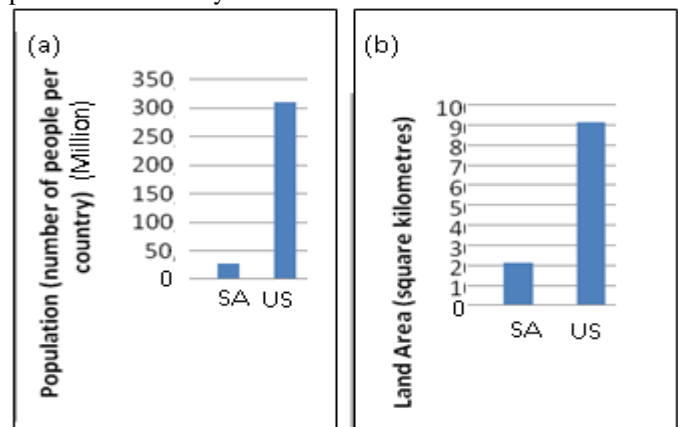


Fig. 1a. The total population of each country

Fig. 1b. The total land area of each country (World Bank, 2012)

III. TOTAL AND PER CAPITA WASTE GENERATION

It is logical to expect that countries with the greatest population would generate greater amounts of waste, as is evidenced by the USA. The United States have a much larger generation rates at 250 million tonnes (EPA, 2011), due largely to the fact that it has the largest population, thus there are more people to create waste. Saudi Arabia, in comparison, generates 12 million tonnes (Abou-Elseoud, 2008).

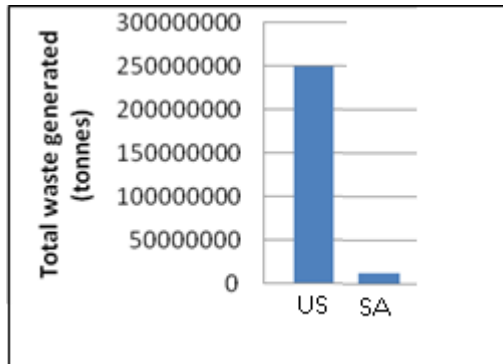


Fig. 2. Total waste generation in tonnes for each country.

As both Saudi Arabia and USA have been classified as 'high income', it could be assumed that per capita waste generation rates would be similar. In fact Fig. 3. shows that although the total waste generation is much higher in case of USA (due to the larger population), the per capita waste generation rate of Saudi Arabia is closer to that of USA (Fig. 3).

In USA, as has been described by the EPA (2011), waste generation per capita was lower in 2010, than 10 years before in 1990. The USA has a per capita waste production of 2 kg per day, while Saudi Arabia is following with a value of 1.4 kg per capita per day

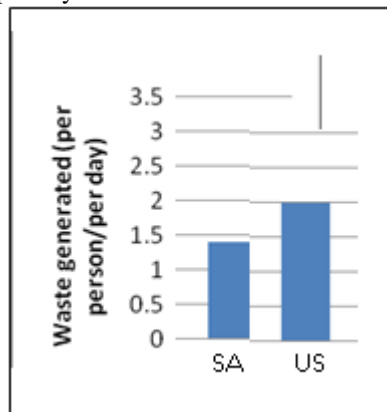


Fig. 3. Graph showing the per capita waste generation values for each country in terms of kg generated per person per day. Values are calculated by dividing total waste generation by the total population.

After analysing the generation of waste in terms of total and per capita rates, no proportionate relationship between land area size and the amount of waste could be found: Saudi Arabia showed similar waste generation rate per capita

although it has a much smaller land area. This observation indicates the importance of other factors such as governmental and environmental policies in place in each country.

IV. WASTE CHARACTERISTICS

Food wastes and paper/cardboard wastes were highest in Saudi Arabia (Table 1). The majority of municipal waste generated is compostable or recyclable, which greatly reduces the amount of waste that requires landfilling, incineration or dumping. Organic food waste represents a large proportion of the waste generated, and with proper management in the home this waste could be composted and would not require disposal. There is an absence of yard trimmings in the organic waste division, and this is due to Saudi Arabia's geographic location. The land mass is dominated by the Arabian Desert, and encompasses a number of deserts with a distinct lack of vegetation.

TABLE 1
MSW COMPOSITION IN THE COUNTRIES

| Component | Saudi Arabia ^a , % | USA ^b , % |
|---------------|-------------------------------|----------------------|
| Food Organics | 37 | 15 |
| Paper | 29 | 30 |
| Plastic | 5 | 13 |
| Textile | 6 | 9 |
| Glass | 5 | 5 |
| Mineral/metal | 8 | 10 |
| Garden | -- | 14 |
| Other | 10 | 4 |

^a(Abou-Elseoud, 2008), ^b(EPA, 2011)

In USA, on the other hand, it was found that organic materials are the largest component. Paper and paperboard account for 29 per cent, while yard trimmings and food scraps account for another 27 per cent. Further, plastics make up 12.4 %. Paper and paperboard is likely to remain the largest due to the use of office paper and disposable items such as newspapers (Table 1). Of the 250 million tons of waste generated it was found that in 2010 the majority of this was derived from containers and packaging (30.3%), followed by nondurable goods at 21.3%. Durable goods, the third largest portion makes up approximately 20 % (EPA, 2011). The fact that packaging makes up the majority of waste may be attributed to the fact that USA is an increasingly consumerist society, and packaged goods provide a convenient solution (Phillips, 1998). As Americans now also have more money to spend, increases in disposable items are also observable (Phillips, 1998).

V. WASTE MANAGEMENT

Rapid development coupled with expanding population in the Arab region in the last few decades has created a mass expansion in the amount of municipal waste generated, which has led to many issues surrounding the disposal of this waste. In many Arab countries, legislation is a major barrier to waste management, as poor legislation and little implementation of existing legislation has resulted in poor management of

municipal waste. A lack of centralisation and control in the waste sector has further exacerbated this (Al-Ahmad et al 2011). In response to this, in 2008 the Saudi Government invested heavily in strategies to manage the large amounts of waste generated. Funding has been allocated to municipal waste disposal and drainage of municipal waste waters, in addition to funds that are being invested in agriculture and infrastructure (Middle East Company News 2009).

Within the United States, all separate local solid waste management systems consist of the same basic elements, these being collection, hauling, recycling, combustion, and landfilling (Phillips, 1998). Well-designed landfills and waste to energy plants have replaced open dumps and polluting incinerators over the past few decades. Recycling has also become a central part in the management of solid waste within communities (Phillips, 1998). Local Governments are in charge for collecting and managing solid waste (Phillips, 1998). State governments and their state solid waste agencies have enacted laws to regulate practices and often encourage local governments to implement waste reduction, recycling, and one or more specific disposal methods (Phillips, 1998). Major federal government acts and legislation influence the way waste is managed, including the Clean Air Act of 1963, the Solid Waste Disposal act of 1965 and the Resource Recovery Act (1970) (Phillips, 1998). Additionally, there are also guidelines and regulations for emissions, and for the location and operation of landfills.

VI. COMPARISON OF WASTE MANAGEMENT METHODS

A. Landfill

Landfilling is a method of solid municipal waste disposal in which waste is buried between layers of dirt so that low lying ground can be reclaimed. Historically, landfills have been one of the most common methods of organized waste disposal and are used today in many countries. In Saudi Arabia, landfilling is the predominant form of disposal of municipal solid waste (Middle East Company News 2009). Landfills receive waste from municipal services, industrial and agricultural industries, commercial and construction and demolition sources. By contrast, in USA 54.3% of the waste is disposed in landfill, this is a large reduction by the US as in 1960 the percentage of waste disposed of in landfill was 94% (EPA 2010). This can be attribute to the distinct policies on waste disposal.

B. Recycling

Recycling is the process of recovering waste materials to produce new products, reducing the use of raw materials and reducing the amount of waste sent to final disposal. It is a key component of modern waste management and reduces pollution, emissions and waste. Recycling practices vary in different countries, and this can be attributed to a number of factors. A major push for recycling has occurred worldwide, as governments recognise the need for sustainable waste management in societies with a growing demand for waste solutions. This is evident in Saudi Arabia; over 77% of municipal waste can be recycled, and companies are being

encouraged to investment in the recycling industry (Riyadh Exhibitions Company, 2009). Despite this, waste recovery processes are uncommon in this region, and much of the waste generated is disposed of in an uncontrolled manner and waste facilities are developing (Abou-Elseoud, 2008).

The rate of recycling in the USA is significantly high, at 34% in 2010. This rate is also increasing (EPA 2011). The high rate of recycling in the USA can be attributed to the fact that it has been highly promoted by government and environmental bodies. Curb side collection of recyclables is available to 70% of the population, which makes recycling from the home both easy and accessible (EPA, 2010). In addition to this, deposit systems are available in eleven states to enable large-scale recyclable collection..

C. Composting

Organic waste can be recycled and decomposed in the process of composting to produce matter that can be used for the benefit of soils and the environment. In Saudi Arabia, composting is only partially practised in some cities while in the USA yard trimmings composting facilities handled approximately 54 500 tons per day in 2009 (EPA, 2010). In total in 2009, 20.8 million tonnes of waste including yard trimmings, food scraps and other MSW organic material were recovered for composting in USA (EPA, 2010). This difference between USA and Saudi Arabia can be attributed to the fact that Saudi Arabia produces little to no yard trimmings due to the nature of its arid environment. Also, the material recovered for composting (7.1% in 2000, increased to 8.6% in 2009) in USA is primarily yard waste (Barlaz et al., 2003). Although currently an uncommon practice, as the waste industry develops composting is given increasingly greater importance Saudi Arabia (Abou-Elseoud 2008).

D. Waste-to-Energy and Incineration

Waste to energy is an effective and environmentally viable method for producing energy by incinerating waste (Avfall Sverige, 2011). The incineration process converts municipal solid waste into ash, flue gas and heat by the addition of high temperatures, making this waste disposal method most suited for waste which cannot be treated by any other disposal method (Avfall Sverige, 2011). In 2009, the USA had a total of 94,721 tons of municipal solid waste ending up at energy-recovery facilities every day (McGlinn, 2000; Merrild et al., 2012). This accounts for only 11.9% recovery rate. The small amount of waste being diverted to incineration in the USA can be due to public perception that these facilities create CO₂ and other pollutants that are released into the atmosphere (Centre for Sustainable Systems, 2011) which is not the case if executed correctly. Saudi Arabia has minimal waste recovery facilities established as the technology is yet to be introduced there.

E. Dumping

Illegal waste dumping refers to the process of unlawful deposition of waste larger than litter. This includes large waste materials which have been dumped, tipped or deposited onto public or private land without a licence or approval. The

USA has the highest dumping rate, with 1 458 150 tonnes dumped illegally in 2011. In 1960, open air dumps were closed in the US and replaced by landfills designed to protect the environment from air and water pollution. Ocean dumping has also decreased considerably (Phillips, 1998). While the USA does have the highest dumping rate, one must consider the vast size and population of the USA.

Dumping is a common form of waste disposal in Saudi Arabia, with 223 582 tonnes of waste dumped in 2011, due to the high population and the general absence of efficient waste collection in the country. Disposal of waste is often uncontrolled and random, which results in large amounts of waste being dumped in an unregulated manner (Akash et al 2011). This may increase health risks for those living in regions with a high rate of dumping.

VII. CONCLUSION

Despite the fact that both Saudi Arabia and USA are high income countries, waste management practices vary. Efforts are being made in both countries to reduce waste generation and find sustainable waste management practices to counteract the waste production associated with increasing populations. Recycling and waste-to-energy are increasingly being used to manage waste, as they provide an environmentally sustainable solution for waste disposal when compared with landfilling and dumping. Due to the increasing population size connected to greater land area, an association between land area and generation of waste may be expected; however land area or the economic status of the country are not the only important factors. In fact, this study points out that critical factors include government and environmental policies, lifestyle and attitudes, the level of development, the amount invested in waste solutions and the priorities of each nation.

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