

Solid waste generation in the urban centers of Bhutan and measures to minimize the problem through education

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Chapter 1.

1.1 Background

Bhutan is a small Himalayan nation, it remained isolated over past decades owing to its geographical location, and it has high and cold foothills in the north and dense forest in the south. The formal developmental activities in Bhutan started with the implementation of first five-year Plan in 1961. And with the developmental activities taking place in the country, numerous environmental issues such as climate change, pollution and deforestation started arising and solid waste management is one of them. Quick urbanization and accelerated economic development contribute in the generation of community solid waste (Khajuria et.al. 2010). Solid waste management is one of the major urban issues encountered by municipalities all through the world (Larochelle et al. 2012). Similarly, the generation of the solid waste is a major issue in the urban centers of Bhutan (Norbu 2010). Ana et.al. 2011, states that inappropriate solid waste management practices, particularly in the urban communities of developing countries is a major issue. Like any other countries around the globe, solid waste production is one of the fundamental difficulties faced by Bhutanese government.

The production of the solid waste in the city centers of Bhutan has increased over the past century due to urbanization, (Phuntsho et al. 2009). Which is the result of development. The ordinary assessed amount of Municipal Solid Waste (MSW) created is 1.7 to 1.9 billion metric tons for each day (UNEP 2010). Thimphu and Phuentsholing the two biggest urban centers of Bhutan collects 36.7 and 24.7 tons of MSW in a day respectively at the landfill sites, (Phuntsho et al. 2009). Compared to the towns of bordering countries the hassle of waste in Bhutan is not worse, for instance a survey conducted in 2008 located out that Thimphu generates was 0.53 kg of waste per capita per day (Phuntsho et al. 2010) compared to 0.66 kg per capital per day in Kathmandu, Nepal (Dangi et al. 2011). However, due to massive urban population, the government is facing challenge in educating the public the significance of reduction and management of solid waste. Very little awareness to the Bhutanese public is one of the major factors causing extended waste generation (NEC 2009).

However, with proper policies and recognized setup in place Bhutan's solid wastes can be manageable. There is no need of sophisticated technologies, but the generation of the solid waste

can be minimized by creating awareness through educating the youths. As stated by Sales et.al. (2006), education plays a vital role in encouraging sustainable development and it also improves the capacity of the human to address environment matters. Educating school going children with regards to the importance of environmental issues will instill the right behavior in school going children will have positive impacts on the behavior of their families, (Rada et.al. 2016). Thereby, students can act as a bridge, which transmits the knowledge and actions of waste management learned in school to the people in their community.

Therefore, this study aims to examine the solid waste problem and explores some of the policies to minimize the issues of solid waste through educating the youths by referring research and publications about solid waste education. Furthermore, I will also refer the peer reviewed research on waste management in Bhutan such as “Studying municipal solid waste generation and composition in the urban areas of Bhutan”. In addition, this study will explore the MSW categorization and its compositions in other developing countries and review its social, environment and economic impacts by reviewing different peer reviewed academic journals and compare it with Bhutan.

1.2 Research Aims

How can education help in reduction and managing of solid waste to minimize its social, environment and economic impacts?

To achieve the aim, this research will;

1. Identify the sources, scale and composition of community solid waste generated in the urban centers of Bhutan as related to other developing countries and review its social, environment and economic impacts.
2. Identify areas where education can contribute in tackling the problem of urban solid waste.

1.3 Approach

The research is also literature based. To access and identify the categories of the solid waste and its impacts, I will be using the information that are available from recent reports and surveys on waste that are published through government website or other relevant sites such as; Municipal Co-operation of Bhutan, National Environment Commission, National Statistical Bureau, Royal Society Protection Nature. Furthermore, I will also refer the peer reviewed research on waste management in Bhutan such as “Studying municipal solid waste generation and composition in the urban areas of Bhutan”. Moreover, in order to examine the generation and composition of solid waste in city centers of Bhutan with different developing countries, I will also investigate published studies and papers various developing countries. Furthermore, I will be referring to key information sources from different peer reviewed academic journals and articles that are based on generation of solid waste in Bhutan or any other countries published reports on waste, research and statistics from government organizations and agencies that deals with waste to study the impacts of solid waste and identify strategies to minimize the problem of solid waste through educating the youths.

1.4 Research structure

Chapter 2: literature review.

This chapter will explore and introduce MSW sources and composition in in the urban centers of Bhutan and investigate the cause of generation of high volume of solid waste in the urban centers of Bhutan. In addition, this chapter will explore the MSW categorization and its compositions in developing countries. Furthermore, will examine the social, economic and environmental impacts of the solid waste through reviewing and analyzing the case studies.

Chapter 3. Experiences of tackling the problem of solid waste and the role of education in tackling environmental issues including waste.

Will identify educational strategies for waste management strategies through analyzing selected case studies conducted in Bhutan as well as in other developing countries. Moreover, this chapter will explore on how generation of solid waste can be minimized through educating the youths.

Chapter 4

Summarize the findings from the previous chapters and make recommendations to minimizing the issue of solid waste generation through education in the urban centers of Bhutan. Furthermore, this chapter will also identify the limitations of the research and recommendation future

Chapter 2 Literature Review

2.1 Sources, scale and composition of municipal solid waste.

The increasing quantities of municipal solid waste generated is one of the most daunting challenges that municipalities have been facing, (Aleluia 2016). On average the developed international locations normally generate 521.95–759.2 kg per person per year and the developing countries generates 109.5–525.6 kg per individual per year, (Karak 2012). Globally the estimated quantity of wastes era was once 12 billion tones in the year 2002. It was estimated that about 19 billion tons of solid wastes will be generated annually by the year 2025. Globally municipal solid waste generation exceeds 2 billion tons per year, which is a primary threat to the environment. That is why, MSW management is one of the fundamental topics for environmental protection in existing days and in the future, (Karak 2012).

Though Bhutan is known to be one of the least developed countries in the world, its budget and capital city has developed significantly over the years, thereby causing solid waste production beyond the management capacity, Allison (2014). MSW refers to the things that are littered in urban areas. It mainly comprises of household wastes and commercial wastes that are collected and disposed by the municipal authorities, (Zakir 2014). The major types of MSW are food wastes, papers, plastics, metals, glasses, including electric powered bulbs, batteries, discarded medicines and parts of automobile, (Magutu et al. 2010). The MSW production rates in the urban centers of Bhutan were 0.53 kg per capita per day, which consists mainly of organic waste (58%). Paper and paperboard formed the second highest (17%) fraction of the MSW and plastic waste formed up to 13%. 47% of the waste consist of domestic waste from the households, followed by non-household waste from the commercial sources which constituted on average 23%, (Norbu 2010).

A study conducted in 2008 revealed that Thimphu alone generates around 49% of organic waste, 2 % paper, 14%plastics, 4% glass, 3% textiles, 0.5 % metals, 0.4 % electronic waste, and 4.5 % others, (Partnerships for Effective Municipal Service Delivery Thimphu Thromde). Similarly, Phuntsholing produces over 148 tons per week i.e., 24.76 tons per day associated to around 13 tons per day in 2002 (RSPN 2006). However, by 2009 Thimphu and Phuentsholing the two biggest urban centers of Bhutan collects 36.7 and 24.7 tons of MSW in a day individually at the landfill sites, (Phuntsho et al. 2009).

2.2 Why high generation of solid waste?

2.2.1 Rise in population

As per the Bhutan National Statistics Bureau, 2017, the population of Bhutan was 757,042, it increased to 768,577 in the following year and in 2017 it rose to 779,666. Human populations in Bhutan are unevenly distributed and concentrated in a few urban centers, Allison 2014. In 2017, urban population for Bhutan was 40.2 %. Between 1968 and 2017, urban population of Bhutan grew substantially from 5.5 to 40.2 % rising at an increasing annual rate. The city's challenges are compounded by a rapid urbanization process in Bhutan, with annual growth rates of 13.5 Partnerships for Effective Municipal Service Delivery Thimphu Thromde, Bhutan. The Bhutanese news (2016), reported that, as greater and extra people move into the urban areas it becomes hard for the municipal corporation to educate the people on waste management moreover, increase in migration from rural to urban areas has led to an increase in share of population in urban region who are unaware of the existing waste management policies.

2.2.2 Development of the country

Bhutan's Economic Development Policy (2010), states "in the last 50 years of planned socio-economic development, the country has progressed from the traditional stage to the precondition for economic take-off". The introduction of five years-plans brought about an amazing development throughout the most recent thirty years and the nation moved from being in the low-income category to the lower middle income one, (Santos, 2013). As per the National Accounts Statistics report (2017), "the economy continued perform better in 2016 with the Gross Domestic Product (GDP) growth of 7.99 percent. This was up by 1.39 percentage points from 6.60 percent growth in the year 2015. The GDP per capita in 2016 had increased to Nu. 193,447.02 (US \$ 2,879.07) from Nu. 174,479.33 (US\$2,720.34) in 2015. In real terms, it grew by 6.36 percent, an increase of 1.46 percentage points from 4.91 percent in 2015". Income of an individual determines what, where and how frequent they purchase things. As the income of an individual gets higher, they will probably purchase extravagance and unnecessary things, (Bandara et al. 2006). As stated by Khor (1986) that, the consumption pattern does not remain the same as one, but it keeps on changing with the change in individual's income. To meet the demand of the customer many production and manufacturing industries are being set up. The number of production and

manufacturing industries increased from 1,389 in 2008 to 2,125 in 2007 (National Statistics Bureau 2017). Bhutan witnessed growth of manufacturing industries, thus, diversifying the industrial product base and activities, (Ministry of Economic Affairs). Rapid industrialization pattern can decline the situation by putting increasing weight on our current MSW (Chen, et al. 2016). Thus, the growing per capita consumption and increasing technologies not only deplete the earth of its resources but produces unassimilated waste poisoning the air, water and land and generating climate change, (UNDP 2013.).

2.2.3 Lack of awareness

The primary problem involving waste management in Delhi is a lack of segregation at the source. This is inevitable, as most residents isn't responsive to the difference between biodegradable and non-biodegradable waste, (Mukherji 2016). Similar is that the case of Bhutan. People throw their wastes whenever and wherever convenient. Wastebaskets are emptied from the third-story windows of a house onto the streets and also the passersby below. The ever-increasing waste generation compounded by lack of awareness has led to negligent and causal littering of rivers and moreover along the roads by residents, Allison (2014). Major challenge that leads to unsustainable waste disposal like careless littering in open space is as a result of lack of awareness, (Applied Research Institute 2009). According to the Waste Prevention and Management Act of Bhutan, 2009, the principle of the act targets to scale back the generation of waste at source; promote segregation, reuse and recycle; disposal in an environmentally pleasant manner; and lastly, to foster coordination and collaboration among various implementing agencies. However, due to the fact of inadequate consciousness on waste problems, there was no public participation and personal initiatives to regulate the waste management issues until 2010 when few man or woman entrepreneurs came up with initiatives of systematic recycling of wastes and established their respective enterprise (UNDP 2014). Aside from than small cleaning campaigns organized by agencies and institutions has no longer been any sustained advocacy program on waste management in Bhutan (UNDP 2014).

Community participation in solid waste management is that the key to sustain any task associated with management of solid waste as success of waste management initiatives need to be adopted by citizens (Joshi and Ahmed 2016). MSW infrastructures and improving citizens' awareness about SW supply separation and recycling to push SW recycling programs maintain great promise for creating effective public campaigns and behavior-changing interventions, (Fernando 2019).

2.2.4 Financial Barrier

Some of the challenges faced by least developed countries include lack of funding, infrastructure, legislation, knowledge, and recognition on solid waste issues, (Bundhoo 2018). The challenges are especially extremely good in developing and transitional nations reflected normally in inappropriate management, underdeveloped technology, damaging financial situation and the lack of environmental awareness, inflicting a very high environmental impact, Topić et.al (2015). Many developing countries and Bhutan without an exception is restrained with limited funds to effectively manage solid waste (RGoB 2014).

An integrated solid waste management system strategy which considers all steps of the Solid Waste Management (SWM) cycle and all factors of sustainability is at the current lacking mostly due to scarce capacity in terms of institutional set-up, trained human resources, and funds, National Integrated Solid Waste Management Strategy (2014).

2.2.5 Comparison with other developing countries.

Compared to the cities of neighboring countries the matter of waste in Bhutan is also not worse, for instance Kathmandu, Nepal generates 0.66 kg per capital per day (Dangi et al. 2011). The composition analysis of institutional wastes revealed 41% paper and paper products, 33% plastics, 13% organic wastes and 13% inert. The study found that commercial waste comprised 59% paper and paper products, 21% plastics, 17% organic and 3% inert. In aggregate, MSW is consists of 56% organic waste, 21% paper and paper products, 19% plastics, and 3% inert, (Dahal et.al 2018).

Stated approximations of solid waste generation in Dhaka city vary widely starting from a minimum of 1,040 tons/day to a maximum of 5,000 tons/day. However, Bangladesh generates 0.43 kg/capita/day and 0.47 kg/capita/ day during the year 2012 and 2015, respectively. Moreover, it has been estimated to achieve up to 0.75 kg/capita/day in the year 2025. Bangladesh generates 22,400 tons of MSW per day, (Mourshed 2017). SW in Bangladesh contains relatively high proportion of organic matter (74.6%) than paper (9.1%) and plastic (3.5%), (Zakir 2014).

Urban Kolkata city generates approximately 2920 tons per day that is equal to 0.632 kg per person per day. MSW in Kolkata consist 34.20% of household waste, 22.80% of Street sweeping, 6.32% of Institutional waste and 36.37% of Commercial and market waste, (Hazara 2009). India alone generates about 48 million ton of municipal solid waste (MSW) annually, (Yadav 2018).

Chapter 3. Impacts of the waste

3.1 Environmental impacts.

Appropriate management of municipal solid waste (MSW) is a very challenging in many countries that are still developing. The inappropriate management of the solid waste can pose risks not only to the humans and animals but also to the water, soil and plants, (Rezapour et.al 2018). The waste has become a major problem in many parts of the Asian and Pacific Region cities over the past 10 to 15 years, mainly due to economic development and urbanization (UNEP 2010). In recent times, there has not only been an increase in waste generated but also a transition from biodegradable to non-degradable wastes (NEC 2016). Bhutan has seen an increase in hazardous and electronic waste from urban households such as cosmetics, household cleaning items, and electronic waste.

On May 1993, Thimphu established a waste disposal site at Memelakha, developed by the Thimphu City Corporation (TCC) with assistance from the Danish government (DANIDA). And it is currently the only landfill site in Bhutan. About 51 metric tonnes (MT) of wet and dry waste from the Thimphu area is dumped every day at the Memelakha landfill, located 12 kilometers from the city, (Kuensel July 27, 2017). For Thimphu alone, solid waste generation is expected to reach around 124 metric tons per day by 2027 with the projected population increase to around 200,000 people. The increased generation rate of solid waste has significant impacts on the quantity of land that is and will be needed for disposal, sales 2006. Hoornweg and Bhada (2012), states that the open dumping ends up in degradation of treasured land resources and creates negative influence on surrounding environmental problems.

The illogical disposal of wastes can leak into the environment, which contaminate the environment. As stated by Samadder et al. (2017), Adamcová et al., 2017 in Rezapour et.al (2018), the plastic, food waste, inorganic salts, glass, paper, building and electronic wastes, metals, and organic fractions leads to pollution in soil and water mainly through leachates. When the gas and leachate flow away from the landfill boundaries and when they are released into the surrounding environment, it causes severe environmental concerns such as; fires and explosions, vegetation damage, unpleasant odors, landfill settlement, ground water pollution, air pollution and global warming,(El-Fadel 1997). Also, when the leachate is released in an uncontrolled manner it pollutes the groundwater, surface waters, agriculture and natural ecosystems. It was reported in the national newspaper,(Kuensel 2017), With the current wastes from the city's municipality being

collected and disposed of at Memeylakh landfill, the site has remained an open uncontrolled facility with its effects not only towards the nearby residential areas but also reaching into the Thimphu stream below. The people living in the vicinity of Memelakha filed a complaint stating that the stream beside the landfill is being affected as there are excess growth of lichens thereby contaminating the water sources nearby. The Global Water keeper Alliance and Clean Bhutan initiated a water quality monitoring program in 2017 across the rivers in Bhutan (Gyelmo 2018). The result of the program indicated that the rivers contained higher levels of *E. coli* bacteria, which if left uncontrolled, could increase in toxicity in the next ten years.

Thus, improper waste management contributes to extend in water and air pollution in urban areas (MoWHS 2007). Further, MSW impact some global environment, such as increase of greenhouse gas (GHG) emissions in the atmosphere (Hoornweg and Bhada, 2012).

3.2 Economic impact of the waste

Since, environmental conservation has been a top priority in Bhutan since the start of development planning in the 1960s (CBS, 2004). For a country whose developmental policies are guided by the philosophy of Gross National Happiness (GNH) promoting a balanced economic growth and environmental sustainability, waste should be dealt with a major threat.

Effective management of solid waste has become environmentally and economically mandatory due to the amplify of environmental problems Ghinea et.al 2016. Solid waste management has become so important due to the fact if now not managed properly, it has an unfavorable impact on the environment. Waste is by-product of economic activities and management of waste has economic implication. Regarding the development of MSW management systems, in most international locations the municipalities take up the duty to collect, sort, transport, recycle, and treat the generated MSW, (Weng et.al 2011). As stated by Fobi et.al (2008), Urban waste series device is a pivotal component of all waste management schemes around the world however, the process of waste collection is related with considerable investment and operating costs.

The generation of large quantity of solid waste not only requires a system of collection, transportation and disposal but also requires experts with the knowledge of what the wastes are

comprised of, and how they need to be collected and disposed, (Narayana et.al 2009). Thus, management of the solid waste requires investment. Thimphu City Corporation alone spends about Nu.10 million yearly solely for waste management in the town of which more than 50% of this amount is spent on waste collection and transportation alone (TCC). The NSB (2017) estimated that four urban centers have spent Nu 4 to manage a kilogram of waste. This is only considering the operational value of managing solid waste and landfills through the salary, fuel price and maintenance of trucks and tractors, landfill management cost and different day-to-day operational costs. The four urban centers incur an expenditure of Nu 53.61M for collection and disposition of 14,490 tons of waste to landfills, annually.

3.3 Social impact

Solid waste management is a daunting task for the municipal authorities throughout the world, (Li and Huang 2006). The gas emissions at landfills mostly consist of methane, carbon dioxide, water vapor and non-methane organic compounds and its danger to the human health cannot be neglected as people who works as a waste collector as well as the people residing near the landfill are exposed to the smell and the harmful compounds from the landfill and they inhale the harmful air. (Liu et al., 2016). Liu et al., 2016 also states that Long-term exposure to such harmful air is associated with health risks, such as respiration problem and cancer. Several types of cancer have been reported in people living near landfills where landfill gas migrates through the soil, (Narayana et.al 2009). Wu et al, 2015, also states that continued exposure to filthy odors from the landfill can result in stress development, anxiety, headaches, vomiting and eye irritation

Chapter 4

How can education help in reduction and management of the generation of solid waste and its social, environment and economic impacts?

With the continual increase and alter in consumption pattern of the people has resulted in numerous social and environmental collapses in municipal areas and developing countries are the foremost affected, (Fagnani et.al 2017). The rise in environmental problems makes educators see environmental education as a response to fight against the environmental crisis, (Winnie 2018).

Education and knowledge is regarded to be one of the most effective driver for sustainable development, (Zorpas 2017). Desa (2012), states that Waste management education ought to start with school children. Waste management is one of the most important environmental elements that needs to be in-cooperated in academic institutions, (Ioja et.al 2012). Since the educational institutions performs an vital role in promoting sustainability in the society. Ioja et.al (2012). Sustainable waste management education in school will make a positive contribution to the education of future generations, (Kayihan 2012). That is why Many countries pay interest to educating younger generations on waste management in schools, to promote focus of environmental maintenance when those generations reach adulthood, (Pimpuang et.al 2018).

Educational projects associated with waste management is vital steps for promoting the sustainability concept. If Waste management plans are put in place in educational institutions it could lead on to success of sustainable development strategies, (Iota et.al 2012). Integrating the environmental education into the programme curricula and non-formal activities in schools such as students' associations and orientation weeks could create a deeper understanding about solid waste management practices. The skills and the knowledge gained through such formal and semi-formal educational interventions would help in increasing their awareness levels and changing negative disposition of students, (Ifegbesan et.al 2017). The presence of a Waste Management Plan

The presence of a Waste Management Plan (WMP) in educational establishments can lead to decrease in generation of waste and promoting income generation for people involved with recycling chain, (Fagnani et.al 2017). Waste education can be carried out as section of institutionalized activities addressing art and creativity. Imaginative cities and futuristic cars are created through the usage of waste materials collected from local companies and private homes or those found at the beach or elsewhere in the local community. Artistic activities become the entry factor for dealing with waste materials and consequently for learning techniques on waste and reuse, (Jørgensen et.al 2018). The waste environmental education programme. What every Student Should Know about Waste was developed in the form of an educational set and was introduced in school by a panel of experts in Poland. As per the parents' reports, the 70% of the students had discussed the programme with their parents, and 34% of the students had made suggestions to their parents regarding improving waste management practices at home, (Malgorzata et.al 2003).

The future of society are going to be determined by the faculties where everyone are advised on the most effective ideas (Dewey 2008). Providing waste education to children is that the foremost step in creating citizens with life-long commitment to environmental protection, (Hasan 2004). Developing waste education and awareness strategy can change students' habits and behavior, Grodzinska et.al 2003. When the scholars are taught about waste in schools, their knowledge on waste management increases and that they also develop skills for addressing problems like a way to prevent litter; a way to conserve nutrients through composting and way to conserve material resources by recycling and reuse, (Williams 2014). Thus, educating the youth isn't only part of the answer to current environmental problems but in doing so their parents and other household members can also be educated/influenced, (Maddox 2011). Rakotomamonjy (2015), also states that environmental education focused on children not only benefits the youngsters, but the benefits may be passed from children to adults.

Moreover, since Bhutan has financial shortage in MSW management, compositing would be most suitable option of waste management to adopt because it requires low operational cost. If Composting is allotted properly, it can become practical method for organic waste management in developing countries, since it has low operational cost with low environmental impact, (Jara-Samaniego et.al 2017). Furthermore, composting transforms organic matter into a product that

improves soil quality, (Diamond 2017). Thus, such waste management system turns a waste into a resource by creating a recycled product made up of stabilized organic matter, carbon rich and free of most pathogens and weed seeds, (Pergola 2018).

Saeed 2009, states that Waste should be either be reused or recycled. Though, 100% of the MSW cannot be reused or replaced. However, some component of the MSW are often recycled and reused. 17% of MSW in Bhutan consist of Paper and paperboard and 13% plastic (Norbu 2010). Teaching the methods of recycling waste in schools will have a proper and greater impact. Recycling program in school will not only shape current waste management, but also has the potential to influence and improve waste reduction in future. Ward et.al 2014. Moreover, household recycling behavior can be positively impacted by a school-based waste education model, Williams 2014. Students deliver the knowledge acquired in school to their family. And sharing the messages learned at school with parents at their respective residence will have implications for both the students' and parents' learning processes, (Maddox 2011).

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