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Research paper

Melaka Moving Forward To Incineration Technology Management to Overcome Municipal Solid Waste (MSW) Problem

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Abstract

Exponential population growth in cities have generated huge amounts of municipal solid waste (MSW). This includes Melaka which in addition has experienced a rising number of tourists over recent years. The two factors combined have brought to the production of approximately 1200 tonnes of waste per day. Landfilling is the general method of disposal but has brought with it challenges of insufficient territory. To address the issue, this study suggests the use of incineration technology as an alternative method. Experts' opinions are generated regarding the suitability of implementing the technology in Melaka. A qualitative method is used by interviewing top management of the secretariat of Melaka Green Technology Council and Melaka Green Technology Corporation. PESTLE analysis approach is incorporated as an explorative research tool. The findings showed that Melaka has the capabilities of implementing the incineration technology on a large scale.

Keywords: *incineration; municipal solid waste; sustainable; spatial socioeconomic inequality.*

1. Introduction

Melaka represents one of the 13 states in Malaysia, occupying a total area of 1658 square kilometers [1] and population of approximately 931,210 with a density of 493 per km² [2]. As of 2010, Melaka was recognized and declared as a developed state and has since become the center of technology particularly green technology as it works towards a sustainable future [1]. The Melaka Green City Action Plan was formed in 2014 as a guideline and strategy in creating a sustainable city. One of the key issues discussed is the management of waste. Municipal solid waste is one of the major contributors to the total waste generated. The increase in population over time and growth as a popular tourist destination has assuredly contributed to the recorded 1200 tonnes of municipal solid waste (MSW) generated per day [3]. Consequently, cost of disposing the waste has rocketed to RM 90,000 per day [4] and ultimately increased cost of managing MSW. It is also important to understand that MSW spreads diseases, leading it to be a serious threat to both health and social development. In [5] discussed the detrimental effects on health with indiscriminate disposal of MSW. A study in Sri Lanka also exposed the outbreaks of disease caused by poor management of waste [6]. As this waste directly affects the environmental conditions, the need for better disposal alternatives arise.

As the Melaka State Government seeks for more effective ways of MSW disposal, this paper proposes the use of incineration technology to manage municipal solid waste. The call for this technology also arises due to other problems being faced such as rising levels of greenhouse gas emissions by mobile units especially in cities [7-8]. Previous research has shown that approximately 99% of MSW in Melaka is disposed through landfilling whereas incineration is only used on a small-scale for medical waste. When landfills such as the one located in Krubong has reached maximum capacity, new ones are opened. This creates a never-ending cycle of filling and opening up new landfill spots that continue to pollute and damage the environment. The incineration technology as discussed by [8] is a harmless alternative and is essential in building a resource-saving and environment-friendly society, reducing pollution, improving living standards and ultimately developing a sustainable green city. In comparison to other MSW treatment technologies, waste incineration performs the best [9] and is a better waste management option [10].

The use of incineration technology to dispose MSW not only reduces environmental pollution but also decreases the cost of management as a whole. The reduction in this cost directly affects the socioeconomics of Melaka as financial resources can then be used for developmental activities. Looking beyond, this technology has the potential to be applied in other states and regions nationwide, particularly those in Peninsular Malaysia. According to [11-16], there is spatial inequality of socioeconomics among administrative districts in Peninsular Malaysia based on decennial censuses data 1980 to 2010. Therefore, in [17] discuss the link between socioeconomics and inequality, with improvement of the former reducing the gap of inequality.

1.1. Generation of MSW

In Malaysia, the average components of MSW are quite similar with the largest categories consisting of food waste (45%), plastic (24%) followed by paper (7%), iron (6%) and lastly 3% for glass and others. Information and understanding on generation of MSW is fundamental to almost every aspect of its management. Multiple research have discussed the relationship of the growing human population and the amount of MSW generated [18-19]. In 2000, the population of Melaka was 365 261 which generated an approximate 515 tons of waste [18]. Melaka ranked fourth in Peninsular Malaysia which produced 1.2 kg/capita/day of MSW generation [20]. According to [21], MSW is generated by humans' activities which are household, commercial activities and other sources such as offices, hotels, supermarkets, shops, schools, institutions and from municipal services such as street cleaning and maintenance of recreational areas. Table 1 displays the population and number of tourists in the state of Melaka from year 2014 to 2016. Studies and research on MSW generation in Malaysia has begun since the early 1980s and an average annual increase of 2% is observed [22]. In comparison with the population in 2000, it is evident that the current population brings with it a massive amount of waste.

Table 1: Population and tourists in Melaka from 2014 to 2016 [23-25]

Year	Population	Tourists Visit Melaka
2014	881400	12 000 000
2015	895100	12 200 000
2016	908300	12 740 000

1.2. MSW Management

Solid waste management covers all activities starting from generation up to the final disposal. It is commonly known as the control, generation, storage, collection, transfer and transport, processing and ultimately disposal of solid waste in line with best practices of public health, economics and finance, engineering, administration, legal and environmental considerations [21]. Previous studies carried out by multiple researchers have shown that solid waste management in Malaysia consists of mainly dumping and landfilling [26-27]. However, this method is becoming less favored as individuals protest the implementation of new landfill sites in close proximity due to concerns regarding smell, litter, pollution, pests and the value reduction of homes in the area [19]. Besides, waste is also commonly disposed in makeshift containers that have no protection against regular rainfall which occurs in the tropical climate of Malaysia [16]. The government has privatized the management of solid waste in Malaysia in an effort to ensure and enhance quality of service. Alam Flora Sdn. Bhd., SW Environment Sdn. Bhd., E - Idaman Company and Eastern Waste Management Sdn. Bhd are the four concessionaries that were granted contract and are responsible for waste management nationwide [28].

In Melaka, the management of solid waste is managed by Solid Waste Corporation (SWCorp). MSW is managed through landfilling and Waste-to-Energy (WtE) through combustion of waste using incineration technology. Approximately, 99% of MSW is disposed through landfilling whereas incineration is being used on a very small scale such as for clinical waste disposal at Bukit Rambai, Melaka. The Krubong landfill commissioned since the 1980s has reached maximum capacity with almost a billion tonnes of accumulated solid waste [29]. To overcome this problem, the local authorities had opened a new landfill in Sungai Udang, Melaka in April 2015. This then creates a never-ending cycle of closing and opening of new landfills. Ultimately, it is a poor method that will not be feasible in the long term. Therefore, incineration technology comes into play as a better alternative. The harmless disposal of MSW is important to build a resource saving and environmentally friendly society, reduce pollution, improve living conditions as well as the level of ecological civilization, and achieve scientific urban development [8]. In comparison to other MSW treatment technologies, the waste incineration performs best [8] and it is a better waste management option [10]. The application of large scale incineration technologies is inevitable as landfill areas would ultimately cease [30].

2. Methodology

This study uses a qualitative method by semi-structured interview, which consists of several key questions regarding the research scope that is prepared before the interview sessions. According to [31], the qualitative method is often associated with an interpretive philosophy as researchers have to make sense of the subjectivity and socially constructed meanings expressed and interpreted by the informants about the phenomenon that is being studied. On the other hand, the informal semi-structured interviews need researcher's effort to explore a general area in depth by asking related questions from related professionals in the relevant field. Therefore, Melaka Green Technology Corporation (PTHM) is chosen as the sample because this company used to deal with matters related to MSW management in Melaka and acts as the lead agency in the development of green technology in Melaka in order to achieve the zero waste theme which is stated in Green City Action Plan for Melaka. Three respondents were selected to be interviewed who consisted of two respondents from top management who are Manager of operation division and Head of Green Awareness and Training Unit, while another one is assistant engineer from Project Development Unit PTHM is the secretariat for Melaka Green Technology Council which deal with matters related to municipal solid waste management in achieving the theme zero waste in Green City Action Plan for Melaka. The interview contains questions on suitability to implement large scale incineration technology in Melaka by adapting the PESTLE (Political, Economic, Social, Technology, Environmental and Legal) framework. PESTLE is an important tool used for market and environmental analysis and to support strategic decision making [32]. There have been no prior research that has adapted PESTLE analysis framework to generate experts' opinions on the suitability in implementing new technology management such as incineration technology to overcome the current landfill MSW disposal problems in depth. The benefit of PESTLE analysis is the result of which later can be used in collaboration with other analytical tools like the SWOT analysis and Porter's Five Forces to give a clear understanding of a situation and related internal and external factors. The last two analytical tools will not be discussed in this paper.

In this paper, PESTLE framework is applied to analyze the capability of Melaka in implementing the incineration technology. Each alphabet in the PESTLE stand for a factor which are Political, Economical, Social, Technology, Legal and Environmental respectively. PESTLE analysis is a concept in marketing principles and a tool for business analysis [33]. Commonly, this concept is used as a tool by companies to track the environment they are operating in or are planning to launch a new project, product or service. PESTLE analysis gives a bird's eye view of the whole environment from many different angles that one wants to check and keep a track of while contemplating on a certain idea and plan. Hence, PESTLE analysis is suitable for this research.

Political factors determine the extent to which a government may influence the economy or a certain industry. Political factors include tax policies, Fiscal policy, trade tariffs etc. that a government may levy around the fiscal year and it may affect the business economic environment to a great extent. Economic factors on the other hand are determinants of an economy's performance that directly impact a company and have resonated long term effect. These include inflation rates, interest rates, foreign exchange rates, economic growth patterns etc. It also accounts for FDIs (foreign direct investment) depending on certain specific industries that are undergoing this analysis. Social factors are those that scrutinize the social environment of the market and gauge determinants like cultural trends, demographics, population analytics etc. Aside from that, technological factors pertain to innovations in technology that may affect the operations of the industry and the market

favorably or unfavorably. This refers to automation, research and development and the amount of technological awareness that a market possesses. Legal factors have both external and internal aspects. There are certain laws that affect the business environment in a certain country while there are certain policies that companies maintain for themselves. Legal analysis takes into account both of these angles and then charts out the strategies in light of these legislations. For example, consumer laws, safety standards, labor laws etc. Lastly, environmental factors include all those that influence or are determined by the surrounding environment. This aspect of the PESTLE analysis is crucial for certain industries particularly for those such as tourism, farming, agriculture etc. Factors of a business environmental analysis include but are not limited to climate, weather, geographical location, global changes in climate, environmental offsets etc.

3. Results and Discussion

The results from the interview are analyzed using the PESTLE analysis with arguments from the researcher supported by literature reviews, while following with the contributions that support incineration, and contrasted with the challenges that resist the implementation of incineration technology from according to factor.

3.1. Political Factors

The 12th Five-Year Plan (2011-2015) of the Chinese government has clearly stated the goals of WtE incineration industry, proving that governing bodies have a role in paving the development of the industry [34]. The past few years, Melaka has implemented the Melaka 21 Green Action Policy. The policies have expressed the attempts of the government to achieve zero waste on landfills by 2030. "If the incineration technology is used as a disposal method for MSW, it will be able to reach out toward the zero waste policies in Melaka…" explained the manager. The manager believes that, by implementing the incineration technology to replace current MSW disposal methods, the zero waste goals can be realized because the incineration technology is able to solve the problems of limited infrastructure in managing the increased volume of MSW. "Not just the current Chief Minister of Melaka, Datuk Seri Idris Haron expressed his desire to use this technology to solve the MSW problem, the former Chief Minister of Melaka, Senator Tan Sri Haji Mohd Ali Rustam also expressed the same thing in 2010…" Commented the manager, and assistant engineer.

At the same time, the implementation of incineration is desired by the previous and current Chief Minister who want to solve the problems of scarcity of land and MSW management problems simultaneously. "We admit that Chief Minister of Melaka has been asking of the federal government for the use of incineration technology as a disposal method for MSW but it is up to the federal government because they have the full authority on how they want to manage the MSW…" Explained the head, manager and assistant engineer. However, the final decision of implementation falls in the hands of the Ministry of Urban Wellbeing, Housing and Local Government (UHLG) which is enforced by federal government. However, UHLG has privatized the waste management in Melaka to SWCorp.

3.2. Economical

In [31] discusses how economic factors such as markets, capitals and financing modes are important in analyzing feasibility of incineration technology application. "I admit that from the incineration technology, it can be used to generate electricity to the nearby local area and the ash can be reused by the construction industry…" Stated the manager. From the economic angle, incineration technology has high potential to convert MSW into electrical energy through the Waste-to-Energy process, while the ash produced after the incineration process can be used by the construction industry. This is a new technology to the state of Melaka; thus, this industry still has high growth prospects in supporting the low harmless garbage disposal rate in Melaka. The waste-incineration facility may also provide jobs in the new industry. "Incineration technology is not very economical in Melaka because 60% of MSW being produced is organic waste with high moisture content…" Pointed out by the manager. On the other hand, cost of implementation; "Incineration facilities may be very costly to be developed…These facilities also require skilled staff to run and maintain them…", affirmed the assistant engineer. Furthermore, "MSW disposal method via incineration technology is costlier than via landfilling practices. Maybe when using the incineration technology, it may cost up to more than RM70 for self-assessment rather than use land-filling only RM30 for self-assessment…" Explained the manager and assistant engineer.

Hence, with majority of MSW produced in Melaka being organic wastes with high moisture content, it is not suitable for the processes involved with incineration technology. Subsequently, incineration plants are categorized as large investments compared to landfilling. The incineration plant is expensive to build, following with high operating and maintenance costs. The incineration technology also requires skilled labour to carry out operations.

3.3. Social

Implementation and development of incineration technology relies on the acceptance of the public [30]. "The promotion of a new solid waste management plan in Melaka not only enhances social, economic and environmental efficiency and promotes sustainable development but it also resolves the dual crisis of non-renewable resource depletion and environmental degradation.", said the head and assistant engineer. The State Government of Melaka is concerned on developing Melaka into a sustainable city. By implementation of novel technology to handle the disposal problems in Melaka, the lifestyle of citizens can be improved by this green technology. Support from the public is crucial as it affects the rate of success. "The public did not fully participate in the recycling for maximum effort, this causes items that can still be considered recyclable to be dumped in landfills...", said the head. Meanwhile, "the public isn't really getting exposed for what they need to know about incineration technology and causes them to not realize that it is a good technology to solve the MSW problem. In this case, it is up to the government and the mass media to play an important role in explaining the benefits using incineration technology to citizens…" added the manager.

The lack of awareness by the public in taking responsibility of classifying MSW has made waste collection a costly and complicated task. The problem that arises is the increase of MSW volume. Moreover, the public often misunderstand the concept of incineration technology due to insufficient exposure and education. The public believes that the incineration plants built close to residential areas are unreasonable as the emissions from the combustion will threaten the general health and lifestyle of the community. Secondly, the public mistrusts the emission standards from the combustion of the incinerators due to lack of supervision and information in this industry.

3.4. Technological

Technology brings with it both advantages and challenges. Aspects such as generation capacity, wear and tear of equipment, the elimination of toxic and hazardous substances are important discussions [34]. "Incineration technology has proven to impact the MSW disposal method. For example, Japan relies 100% on incineration technology to dispose of MSW. Neighbouring country, Singapore has also implemented this technology…", emphasized the manager and assistant engineer. The developed countries rely on the incineration technology in managing their MSW. Japan is one of the country, which has successfully adopted incineration technology.

Incineration technology has proven to achieve substantial volume reduction, through stabilization, well sanitation, as well as useful

energy generating and recovery [28]. “Although incineration technology has proven applicable for MSW disposal, this technology is currently only used for small-scale disposal of clinical waste at Bukit Rambai. Clinical waste and MSW are both different type of wastes and may give different results…” commented the manager. Melaka only applies the incineration technology in small scale only for the disposal of clinical waste which are unable to generate energy.

3.5. Legal

Landfilling, composting and incineration are the three primary MSW disposal methods. Incineration technology has successfully been implemented in countries such as Japan and Germany as a result of clearly stated legal precautions [34]. Laws and safety standards must be taken into account in analyzing the adoption of incineration technology. “Technically, incineration technology can be implemented in Malaysia but legislation in Malaysia stated that the ash form from the incineration considered as toxic... Nobody in Malaysia has expertise about the engineering law, while technically it can be implemented. Actually, the ash produced can be used by the construction industry…” said the manager

The incineration technology is accepted legally. However, the ash that produce from the incineration combustion is known as toxic that band by Malaysia which is a barrier for the implantation of incineration.

3.6. Environmental

Environmental factors include the surrounding environment in Melaka to make consideration of implementation of incineration technology. Include climate, weather, and geographical location. “Incineration plants have huge environmental benefits and remarkable external benefit and they have great impacts on society and environment…” Incineration technology nowadays is modified to environmental friendly. The incinerator plays important role in waste recycling, reduction of greenhouse emissions, conservation of land resources and control of environmental pollution [35].

In [36] state that there is two ways to reduce the greenhouse emissions to atmosphere, one way is to reduce the landfill gas caused by landfill disposal while another way is to use residual heat incineration instead of fossil fuels incineration. “It is no doubt that incineration technology produces a variety of toxic, but the toxic can be eliminated if they successfully managing and filtered the production of toxic systematically...” added the head.

The by-products, toxic, which is ash containing heavy metals, dioxins and other pollutants that may threat the environment and human health is undoubtly generated. But, the level can be controlled through supervision.

4. Conclusion

This research indicates that implementation of incineration technology in Melaka can overcome the problem such as the limitation of insufficient land resource and environmental issues brought by landfills disposal method. On top of that, with the improvement of heat recovery after incineration, this system makes it possible to efficiently generate clean electricity. This enabled Malaysia's incineration plants, especially in Melaka to become safe and sound while generating electricity efficiently like other developed country such as Japan.

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