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The Factors and Challenges Influencing WEEE Management in Thailand: A Case Study of The Bangkok Metropolitan Administration (BMA)

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Abstract

This research aims to 1) analyze the factors that contributed to the BMA's WEEE management and 2) discuss the challenges facing the BMA in WEEE management. Additionally, the study emphasizes the importance of shared responsibility between the BMA and private sector stakeholders. Enhancing competencies in legal, financial, human resource, and environmental management aspects is also highlighted. This research employs a qualitative approach to investigate the management of Waste Electrical and Electronic Equipment (WEEE) within the Bangkok Metropolitan Administration (BMA). Interviews were conducted with 15 individuals from the government and private sectors involved in WEEE management to improve the efficiency of WEEE management. The study result indicates two primary objectives: firstly, to identify the factors that influence WEEE management practices, and secondly, to understand the challenges faced in this domain. These recommendations encompass advocating for robust legal frameworks, ensuring adequate allocation of resources, and fostering collaborative ties with private entities. This research contributes to a comprehensive framework catering to policymakers and practitioners. Its aim is to refine and optimize WEEE management practices in the specific context of Bangkok. The study suggests that the BMA should strengthen its cooperation with the private sector, adopt the principle of shared responsibility, and focus on improving its capabilities in legal, budgetary, workforce, and environmental management aspects. The study provides valuable insights for policymakers and practitioners to improve WEEE management in Bangkok.

Introduction:

Waste of Electrical and electronic equipment (WEEE) or e-waste is currently a major issue around the world. Due to the digital revolution and easy access to electronic equipment such as televisions, computers, batteries and cell phones, e-waste is one of the fastest growing waste streams. Recently, The number of WEEE is growing at a rate of 3-5% per year, making it one of the fastest growing wastes in the world (Aboughaly & Gabbar, 2020; Shittu et al., 2021). According to the United Nations College, by 2021, the world has generated 52.2 million tons of e-waste per year (United Nation University, 2020).

Improper WEEE management practices can have serious consequences for human health and the environment because hazardous substances are harmful to human health and the environment. However, solving the WEEE problem requires a skilled workforce, adequate funding, and dedicated processes for the proper and safe recycling of WEEE prior to disposal (Kumar et al., 2017; National Science and Technology Development Agency, 2016). For example, the circular economy, which is considered a model for sustainable economic development, can be used to reduce WEEE and replaces previous EEE models, to ensure resource consumption efficiency (Pan et al., 2022; Shittu et al., 2021).

In Thailand, the expansion of the electronics sector is the root cause of the WEEE problem. About 82% of WEEE is generated in households, 14% in offices, and 3% in hotels or apartments. According to 2015 data from the Pollution Control Department, televisions, air conditioners, refrigerators, washing machines, and computers account for the majority of e -waste in Thailand (Wittaya-anumat, 2017). According to the Pollution Control Department (2020), Thailand communities generates an average of 380,605 tons per year, or an increase of approximately 2.2% per year. According to the Thailand Development Research Institute (TDRI), there will be 13.42 million cell phones and about 3.65 million portable audio and video players (Pollution Control Department, 2020; Kiddee & Bunmak, 2016; Wittaya-anumat, 2017).

Local governments are responsible for managing e-waste within their boundaries. However. They face a number of important barriers, such as the lack of technical skills, poor infrastructure, inadequate funding, and insufficient community participation (Rautela et al., 2021). For example, Bangkok, the capital of Thailand, is the economic center of the country with a population more than 5 million people (Central Registration Office, 2021). The Bangkok Metropolitan Administration (BMA), as a special authority in Bangkok, has regularly established rules for the collection of hazardous waste in the municipality, including WEEE. Bangkok alone has generated the largest amount of waste in Thailand every day, and the amount of waste in Bangkok is increasing year by year. In 2020, it was 9,520 tons of garbage per day, 8,675 tons in 2021, and 9,000 tons in 2022 (Manatsanitwong, 2022).

Therefore, WEEE management is a complex and urgent issue in Bangkok. As the Bangkok Metropolitan Administration (BMA) lacks essential expertise and procedures for effective WEEE disposal, management practices are of primary concern. This circumstance results in incorrect WEEE disposal rather than recycling due to lower remuneration for BMA cleaners and rubbish pickers compared to their colleagues in other local administrations. The BMA's efforts are further hindered by legislative restrictions, financial constraints, and a lack of qualified staff for efficient WEEE handling.

This study aims to examine the WEEE management challenges that the BMA is currently dealing with and the factors that contributed to the BMA's WEEE management. A comprehensive approach that bridges knowledge gaps, ensures equitable compensation, navigates legal complexities, and secures sufficient funding is needed to address these issues. Bangkok can only pave the way for responsible and sustainable WEEE management through such an all-encompassing strategy.

Research Objectives:

This study aims to

1) analyze the factors that contributed to the BMA's WEEE management.

2) discuss the challenges of the BMA in WEEE management.

Concept and Theory:

The Concept of Garbage Politics

Garbage politics is the use of garbage or waste management as a tool to gain political power. This phenomenon can manifest itself in a variety of ways, such as when politicians promise to improve waste management infrastructure or when citizen movements demand better waste management.

Waste management issues can also be used for political campaigns or to control local communities as the waste problem is pressing and can damage people's livelihoods (Mansell, 2023). Consequently, waste management is a major challenge for policy and urban planning, especially at the local level.

In developing countries, inadequate waste management infrastructure often leads to serious public health and environmental problems, making waste management a critical issue. Inefficient waste management influences voters, especially at the local level (Pongsawat, 2019). Moreover, politicians use the issue of waste management in their election campaigns. An important case study is the Bangkok governor's election in 2022, in which many candidates showcased their policies on public services, energy, and the environment. Most of them focuses on increasing green space and addressing waste issues, including waste segregation and revenue generation (PPTV, 2565; Bangkok Business, 2022).

Political Structure of The Bangkok Metropolitan Administration (BMA)

Bangkok was governed as a special local government organization, namely, the Bangkok Metropolitan Administration (BMA). This unique characteristics or elements of local government body differs from those of other local government organizations (Smith, 2019). A special local government organization is typically located in an economically prosperous area, such as a densely populated urban area or a popular tourist destination.

Bangkok is a metropolitan area which is characterized by economic prosperity, function as a hub of government agencies, and high population density, which includes a large number of migrants (Briffault, 1995). Consequently, local government organizations in the capital city must adopt a unique organizational structure compared to other forms of local government (Wilson & Game, 2011). The governor of Bangkok is acting in accordance with government policy, Cabinet decisions, and the directives of the Prime Minister and the Minister of the Interior. According to the Revolutionary Council Announcement No.218 and the Provincial Administration Statute, the Bangkok Governor has the powers and duties under the Municipal Law, Sanitary Law and other laws. As the superior of all Bangkok officials and employees, the governor supervises the four deputy governors who act as deputy governors in carrying out the administration of Bangkok on behalf of the governor (Kokphon, 2004).

The Principle of Environmental Management

Environmental management is the methodical and strategic approach used by businesses, governments, and people to address and reduce the environmental effects of their operations, goods, or services. It includes a variety of methods for reducing pollution, preserving ecosystems, and making the most effective use of resources. In Environmental management, Chris Barrow (2018) examines concepts and ethics pertaining to the environment and human well-being as well as environmental issues in development and the emergence of environmental management are all given a brief overview (Barrow, 2018).

In terms of WEEE management, the Extended Producer Responsibility (EPR) principle includes designing products considering environmental impact (Eco-Design), ensuring financial responsibility for end-of-life management, developing policies for effective collection and recycling, promoting consumer awareness and education, and enforcing compliance through regulatory means (Walls, 2006). These policies promote efficiency, encourage responsible use, provide simple disposal methods, educate the public, and align with federal regulations to better manage electronic waste (Manomaivibool & Vassanadumrongdee, 2011).

Moreover, the concept of shared responsibility (SR) emphasizes the group and collaborative efforts of numerous stakeholders, including governments, businesses, consumers, and civil society, in addressing complicated and urgent issues, particularly those related to the environment and sustainability. Jacobs and Subramanian (2011) investigate the effects of mandates for product recovery and shared accountability along a supply chain on the economy and environment.

The findings are important for businesses that anticipate or are already subject to product recovery legislation as well as for social planners who aim to balance the negative effects of such legislation on the economy and the environment and ensure its fairness (Jacobs & Subramanian, 2012). Using EPR or SR for the WEEE system helps reduce the environmental impact of electronic waste, improves conservation, and creates a more circular economy by encouraging people to consider the life cycle of WEEE.

Categorization of WEEE

According to the EU Directive (2012/19/EU), electronic waste, or e-waste, refers to discarded electrical and electronic devices, including a wide range of items such as computers, refrigerators, and mobile phones, when they reach the end of their usable lifespan (European Commission, 2012). In the EU Directive, Waste Electrical and Electronic Equipment (WEEE) was classified into the 10 following categories:

1) Large Household Appliances: This includes major appliances such as refrigerators, washing machines, ovens, and air conditioners.

2) Small Household Appliances: It covers smaller appliances used in households, such as toasters, coffee makers, irons, and vacuum cleaners.

3) IT and Telecommunications Equipment: This category comprises items like computers, laptops, printers, telephones, and communication equipment.

4) Consumer Equipment: It includes electronic devices used for entertainment, like televisions, radios, cameras, and musical instruments.

5) Lighting Equipment: This category encompasses all types of lighting products, including lamps and luminaires.

6) Electrical and Electronic Tools: It covers tools and equipment used for various purposes, such as drills, saws, and sewing machines.

7) Toys, Leisure, and Sports Equipment: This category includes electronic toys, gaming consoles, sports equipment, and other leisure items.

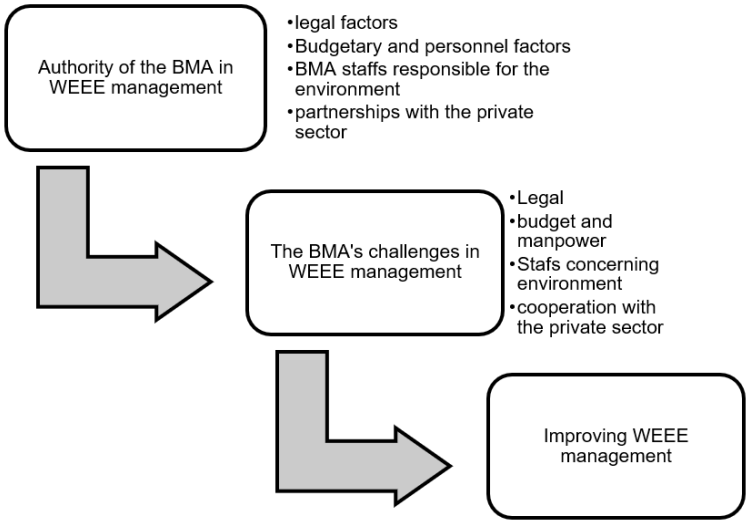
8) Medical Devices: It covers electronic medical devices like medical monitoring equipment and laboratory instruments.

9) Monitoring and Control Instruments: This category includes devices used for measuring and controlling purposes, such as thermostats and smoke detectors.

10) Automatic Dispensers: It includes automatic machines like vending machines and cash dispensers.

Figure 1

Conceptual framework



Source: Researcher, 2022

Research Methodology:

In this study, research employed a qualitative research design using a case study for a comprehensive and detailed understanding of social issues (Creswell, 2018; Neuman, 2014). The qualitative approach also provides opportunity for researcher to explore the experiences and events in the study area, understand the perspectives of those living in the area, and interpret the social reality under study. Semi-structured interview was used to allow the researcher to directly observe the local community, engage in discussions, and inquire about participants' everyday actions (Neuman, 2014).

The sample group

The researcher conducted a semi - structured interview with 15 representatives from both the government and private sectors. A purposive sampling method was used to select five participants from three government agencies: the Bangkok Environment Department, the Provincial Electricity Authority at Headquarters, and Advanced Info Service, the largest GSM mobile phone operation and digital service provider in Thailand. The selection criteria were intended to ensure that the characteristics of the participants matched the target population and that they were willing to participate in the survey.

Research Method

The researcher used a qualitative research approach by using semi - structured interviews for data collection. Moreover, the researcher strategically utilized the triangulation method, specifically employing the data triangulation technique, which involved the integration of multiple data sources to enhance the validity and comprehensiveness of the study's findings (Abdullah, 2019; Strijker et al., 2020). In this case, the researcher conducted interviews with a total of 15 participants, ensuring a diverse range of perspectives and insights. The semi - structured interview with open - ended questions was conducted with five representatives from each agency involved in WEEE management. Each interview lasted about 45 minutes and was divided into three parts.

Part 1 general information about the organization.

Part 2 the role of the organization in dealing with WEEE management.

Part 3 the process of WEEE disposal concerning the organization's responsibility.

Participants were purposively selected based on their knowledge, skills, and experience related to the research topic, as well as their willingness to cooperate in the interview process (Bouma, 2000; Neuman, 2014). The sampling criteria aimed to meet the research objectives and ensure that participants were free to express their opinions. The data obtained from the study are securely stored on the researcher's computer, with numerical codes assigned to access the information to ensure information security. In order to conceal the identity of informants, study reports do not include the real names or locations of participants.

Research Results:

The results of this study show that there are several factors that contributed to the management of WEEE in Bangkok. These include (1) legal factors, (2) Budgetary and personnel factors, (3) the BMA staff responsible for the environment, and (4) partnerships with the private sector.

Legal factor

The Bangkok Metropolitan Administration (BMA) exercises administrative control over Bangkok as a legal entity, as stipulated in the Bangkok Metropolitan Administration Act (No. 6) B.E. 2562 (2019). Under its mandate, the BMA is empowered to regulate waste management in accordance with four different laws and regulations.

1. Cleanliness and Orderliness Act B.E. 2535 (1992).

2. Bangkok Metropolitan Ordinance on Service Rates and Criteria, Procedures and Conditions for Exemption or Reduction of Service Fee B.E. 2544 (2001).

3. Bangkok Metropolitan Regulations on Criteria for Manure and Sewage Management of Premises and Public Health Services B.E. 2545 (2002)

4. Public Health Act B.E. 2550 (2007)

The complexity and antiquity of laws have made the WEEE management and regulation a challenge. In the absence of specific legislation on WEEE management in Thailand and Bangkok, the BMA has resorted to enforcement of numerous existing regulations in the national level. However, the effectiveness of these measures to successfully manage and contain WEEE remains limited.

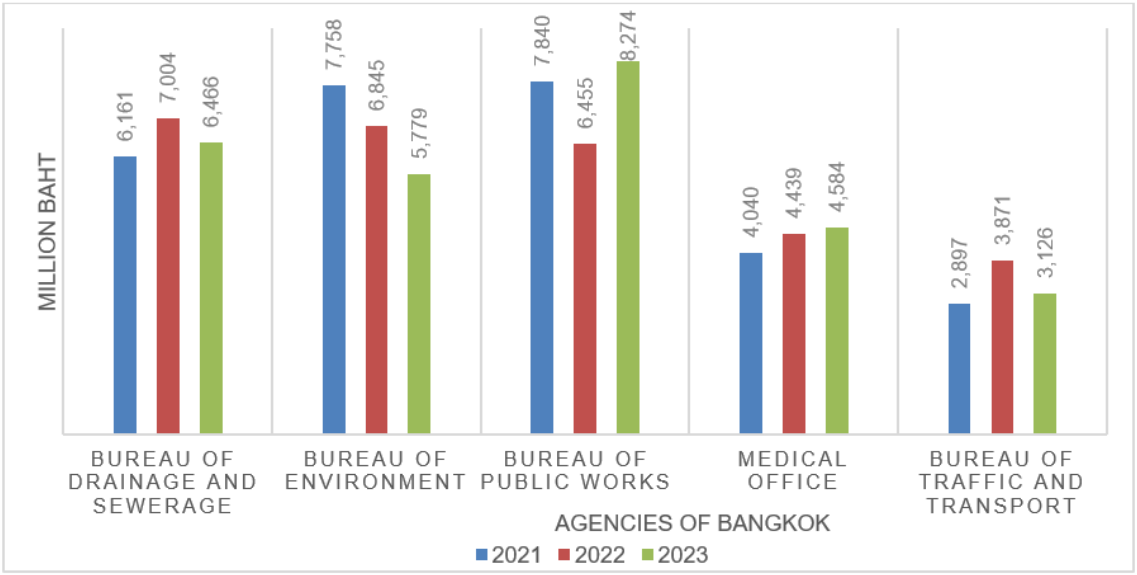
Besides the legal challenges, this study also examines the capabilities of the BMA, a special local government organization, to respond to environmental management at the local level. This assessment focused on three critical aspects, namely the potentials of the BMA in terms of budget and staff allocation, the BMA staffs responsible for the garbage collection, and BMA's ability to partner with the private sector.

Budget allocation

There are budgetary hurdles in hazardous waste and WEEE management that require significant financial commitment. The BMA has a steady revenue stream from taxes, fees, real estate, utilities, commercial activities, and other sources. Additional revenue, consisting of accrued payments and loans taken out by the BMA and other government agencies, is another source of income (Kokphon, 2004).

Figure 2

The top 5 offices in the BMA with the most budget allocations between 2021-2023



Source: (Royal Gazette, 2021; Congressional Budget Office, 2022; Draft Municipal Ordinance of Bangkok on Expenditure Budget for the Fiscal Year 2023)

The first challenge relates to budget allocation and the organization's workforce potential in Bangkok. The budget allocated for the Bureau of Environmental in 2021 is 7,758 million baht. This budget decreases in 2022 and in 2023 respectively, making it the third largest budget recipient after the Bureau of Public works and the Bureau of Drainage and Sewerage as shown in Figure 1 above.

For the cost breakdown, the BMA allocated more than 11,980 baht/ton for hazardous waste management in 2017. However, it generates revenue of 535 million baht and 527 million baht from waste collection fees in 2019 and 2020, respectively. Therefore, budget allocation is an important factor for waste management, especially WEEE in Bangkok.

BMA staffs responsible for the garbage collection

The BMA garbage collectors are responsible for cleaning and sweeping a particular area. They play a critical role in maintaining public safety in the area. In contrast, waste collection and disposal activities also pose significant risks to their life and property, particularly garbage collection along roadways. These activities are considered dangerous, as traffic accidents occur frequently, especially during nighttime operations. Only in 2022, three accidents involving waste pickers occurred in Bangkok. The career's environment poses significant hazards and carries a high risk of property damage and loss of life.

In addition, the BMA cleaners and waste pickers are inadequately equipped with protective equipment for the nature of their work. Moreover, the quantity of this equipment is insufficient for WEEE. Importantly, the wages and benefits for these workers are lower than those for general cleaning personnel and workers in other areas of local government. The BMA personnel whose work involves collecting sewage or solid waste receive salary which ranges from 8,690 to 9,400 baht per month. This rate is comparatively lower than the salary of general employees (building cleaning) and employees of other local governments, who receive salaries ranging from 9,000 to 18,000 baht. The latter also receive additional compensation for health risks from the Ministry of the Interior (Interview, 20 November 2022). Their salary is inconsistent with the hazardous nature of their work.

This factor was recognized in the context of the garbage policy, in which Bangkok governor candidates advocated their political campaign for social security of the BMA garbage cleaners. The current Bangkok governor, Dr. Chadchart Sittipunt, emphasized that the BMA cleaning staff must have proper protective equipment, such as duty uniforms, protective hoods, hygienic masks, gloves, sturdy and durable garbage baskets, and carts for garbage transportation. In addition, they should receive compensation and benefits commensurate with the hazardous nature of their work, such as wage compensation, social benefits, medical care, health insurance or accident insurance (Sittipunt, 2022).

Partnerships with private sector

According to the principle of Extended Producer Responsibility (EPR), the effectiveness of WEEE management requires partnerships with the private sector. especially the implementation of a sorting system for different types of solid waste. EPR principle requires manufacturers and importers of electronic products to be responsible for the collection and recycling of their products at the end of their life, and other Waste Electrical and Electronic Equipment (WEEE) directives must also be fully implemented. As a result, the BMA has sought collaboration with various sectors to overcome these constraints. In 2017, the Pollution Control Department of the Environment Bureau signed a Memorandum of Understanding (MOU) on a cooperation project between the public and private sectors with department stores, educational institutions, and the Thai Trade Center Association to collect hazardous waste and waste from electrical and electronic products in the community. This cooperation led to the establishment of additional channels for the separation of hazardous waste by setting up drop-off points for five types of waste, including cell phone batteries, cell phone remnants, batteries, fluorescent tubes, and containers contaminated with hazardous substances such as aerosol cans. Drop-off sites were located in 3,815 participating department stores or grocery stores in 43 districts of Bangkok (Ministry of Natural Resources and Environment, 2017; Kongphet, 2017).

Moreover, Bangkok has proposed a plan for the private sector to take over garbage collection and disposal for a period of 2-3 years under a 5-year contract. However, due to a budget of 1,000 million, the plan is currently under consideration by the Bangkok City Council. The private sector is allowed to operate waste disposal facilities such as On Nut Waste Management Center, Nong Khaem Garbage Disposal Center, and Sai Mai Waste Disposal Center for the purpose of waste disposal (Interview, 20 November 2022; Manatsanitwong, 2022).

In addition, the BMA has authorized the private sector to collect waste and construct two new waste incinerators and waste-to-energy plants under the private contract project of C & G Environmental Protection (Thailand) Company Limited and New Sky Energy (Thailand) Co. However, the project is currently under review by the National Anti - Corruption Commission (NACC) office (Interview, 20 November 2022; Manatsanitwong, 2022). The building transparent cooperation with the private sector in waste management therefore remains a critical aspect of solving Bangkok's WEEE problem. This includes the need to reduce landfilling to 30% in order to achieve the waste management efficiency target, as well as the pending audit of the waste incineration project by the National Anti - Corruption Commission Office. In order to improve waste separation, the BMA schedule waste collection appointments with its residents by day and by type to achieve better waste segregation.

Regarding to the cooperation with the private sector, the BMA has a cooperation agreement in the form of a Memorandum of Understanding (MOU) with Shell Company of Thailand Limited, an energy company, to implement a service station project to facilitate the collection of hazardous waste. To this end, the points of hazardous waste collection, including WEEE, have been established at all 106 Shell petrol stations around Bangkok. In addition, the District Office has supported this project by providing four types of waste garbage cans, namely hazardous waste bins, recycling bins, food waste bins, and general waste bins. This initiative aims to encourage public participation in solving environmental problems through the collective action of waste separation. Prior to the implementation of this project, hazardous waste was collected by employees for sanitary disposal. Therefore, this project also promotes behavioral change towards proper WEEE management. (Interview, 20 November 2022).

In 2022, a collaboration was initiated between various sectors, including government, business, and civil society, to address the problem of plastic waste and sustainable waste management. Agencies involved in this partnership include the Environmental Protection Agency, the Environmental Research Institute of Chulalongkorn University, the Confederation of Thai Industries, Dow Thailand Group, the Institute of Packaging and Recycling Management for the Environment (TIPMSE), and the Petrochemical and Materials Technology Center of Excellence. This public - private partnership (PPP) aims to solve the plastic waste crisis in a sustainable way (Interview, 25 November 2022).

State - owned enterprises, moreover, have participated in the WEEE management. According to information obtained from interviews with officials at the Provincial Electricity Authority Headquarters (PEA), the PEA has as placed a transparent bin outside the office for the WEEE disposal such as flashlights and unused batteries. The PEA has also installed waste stations in the office and implemented a "Green Office" project that mandates waste separation on each floor and in each building. At PEA headquarters, waste is separated into hazardous waste and recyclable waste before being transported to Bangkok District Office for disposal.

Following the interview with 5 representatives of Advanced Info Service (AIS), the electronic equipment manufacturers have joined the WEEE management efforts as part of the principle of shared responsibility (SR) in practice. AIS, along with other entities such as the Provincial Electricity Authority, the Thai Association of shopping malls, petrol stations, and mobile phone operators, is contributing to the WEEE management efforts in accordance with government policy (Interview, 20 November 2022). In addition, AIS has worked with the Thai Post Office to ensure the proper disposal of WEEE through the "Leave" campaign under the "Thai People without E - Waste" project. AIS properly recycles and disposes of WEEE in accordance with international standards. Between January and March 2022, about 7,600 pieces of WEEE and about 30,700 pieces of postage containing WEEE were collected through AIS. In total AIS collected more than 38,300 pieces of WEEE by March 2022 (Interview, 25 November 2022).

Research Discussion:

The result showed that the WEEE management in Bangkok faces several challenges, namely (1) legal challenges, (2) budget challenges, (3) challenges of the BMA staffs (4) management challenges in terms of promoting collaboration.

Legal challenges

The BMA faces challenges related to the creation of laws and regulations relating to WEEE management. The local government were not empowered to create it owns regulation. Thus, it must rely on the Public Health Act B.E. 2535 (1992), which authorizes local authorities to the operation of waste management. Therefore, the BMA continues to face legal limitations. It does not have the authority to issue its own regulations. On March 17, 2015 (2015), the Cabinet approved the Integrated Waste Management Strategy for Electrical and Electronic Equipment 2014-2021, which empowers local authorities to manage WEEE, especially a special local government organization such as the Bangkok Municipality and Pattaya City, which have a system to sort and collect 10 types of WEEE[1] (Wittaya - anumat, 2017).

However, the interview data shows that Bangkok, as a special local government organization, does not have a specific law for WEEE management. In addition, the Thai government has yet to implement laws and regulations for WEEE management, which causes problems in managing WEEE at national level and imported e-waste from abroad. Instead, a number of environmental laws are enforced, leading to difficulties in their implementation and enforcement (Nakornchan & Sopha, 2018). In this regard, the Pollution Control Department of the Ministry of Natural Resources and Environment has been working to promote the (draft) End-of-Life Product Management Act for Electrical Appliances and Electronic Equipment in accordance with the Basel Convention (Nueangnong, 2019). If It is passed, the legislation will be useful in forcing manufacturers and importers of electronic equipment to take responsibility for the proper disposal of their products after they have been used as intended.

In 2020, Thailand attempted to pass a draft of the Waste Management of Electrical and Electronic Equipment and Other Products Act B.E. ... proposed by the Pollution Control Department of the Ministry of Natural Resources. However, the draft has not yet been approved by the Cabinet and is currently under consideration by the Commission (Pollution Control Department, 2021). So that, recently there is no direct WEEE management law in Thailand.

Budget challenges

Financial challenges can impact the effectiveness of WEEE management, as WEEE disposal requires high levels of funding. There are costs associated with creating adequate WEEE collection system and building disposal infrastructure. The cost also involves procuring and maintaining vehicles and equipment for transporting WEEE, and building and operating facilities to treat and dispose of this waste. In addition, proper management of WEEE requires appropriate transportation and disposal processes, systems, and standardized locations to avoid negative health and environmental impacts. However, hazardous waste disposal facilities in Thailand are mainly located in the central and eastern regions, resulting in costly transportation, insufficient disposal of hazardous waste and WEEE, and improper recycling of some electrical and electronic products.

Moreover, the budget includes expenditures on public education campaigns, as well as enforcement costs and penalties for improper or illegal WEEE disposal. In addition, the BMA needs to consider the financial impact on the public and businesses to adequately dispose of WEEE, which may include the cost of recycling fees or other expenses borne by consumers or businesses.

[1] *which are (1) television (2) refrigerator (3) air conditioner (4) personal computer (5) telephone (6) fluorescent lamp (7) video camera (8) printer and fax machine (9) Portable audio/video equipment and (10) dry batteries.*

Challenges for BMA staff responsible for environmental management

In practice, the BMA does not have staff directly in charge for environmental management with knowledge of WEEE separation. The BMA collected WEEE as hazardous waste and disposed of it in only two ways: WEEE is either (1) disposed of by a private company in a secure landfill or (2) sold to an antique shop and shipped to recycling facilities in the country and abroad. The failure to separate WEEE from hazardous waste highlights the limitations of the BMA's environmental potential due to the lack of the system of sorting electronic components and the lack of skilled and knowledge staff to provide adequate sorting, unloading, and retrieval services. As a result, there is no standardized WEEE management system or facility capable of sorting, handling, and disposing of electronic waste in the BMA's waste collecting system (Jarusombat, 2011).

Environmental issues remain the top priority for the BMA, but the budget for contracting private companies concerning waste collection and disposal is limited. With a budget of over 1,000 million baht, the BMA does not have a system for sorting electronic components collected from WEEE in municipality, nor does it have the infrastructure to collect and treat WEEE. Furthermore, there is no recycling market in Bangkok for EEE items, such as batteries and fluorescent tubes. Bangkok residents do not know where to dispose of WEEE or how to dispose of them properly. Although the BMA has a project called #waste-separation to prevent WEEE from being mixed with hazardous waste, those responsible for environmental management in Bangkok still do not know how to dispose of WEEE properly (Khaikham, 2022). Additionally, the salary of the BMA cleaners and waste pickers is comparatively lower than that of employees of other local governments. As a result, Bangkok residents and the BMA staff are not aware of the importance of a proper WEEE management system and the environmental and health risks associated with it. This leads to improper disposal of WEEE instead of proper recycling or treatment.

Challenges in building collaboration with the private sector

Although the BMA has waste collection and disposal centers in Bangkok and surrounding areas, it still faces significant challenges in establishing partnerships with the private sector to collect and transport WEEE from other parts of the country. This can result in WEEE being sent to landfills instead of being properly recycled or treated. Consequently, WEEE management process in Bangkok is not technically proper and is not yet realizing its full potential to solve environmental problems. Therefore, solving the Bangkok waste problem through a private contract project to collect waste and build waste incinerators or waste-to-energy plants is fraught with challenges, including the pending review of the waste incineration project by Thailand's Office of the National Anti-Corruption Commission.

In addition, Thailand lacks a comprehensive national WEEE management system. Bangkok has implemented many projects such as the "3R" (Reduce, Reuse and Recycle) campaign and the #waste-separation project, but WEEE management has not been uniformly regulated or enforced at the national level. This may lead to differences in the handling and disposal of WEEE in different regions of the country.

In addition, the BMA has not implemented the principle of shared responsibility (SR), although the private sector is willing to work with the government. Moreover, Bangkok residents are enthusiastic about not disposing of their WEEE until they are sure it will be properly disposed. There are also initiatives such as cell phone manufacturers and EEE importers paying for the disposal of cell phones and batteries. These companies are required to register waste and unused materials management (such as Factory Types 105 and 106) service providers established between 2015 and 2019.

One such provider is Total Environmental Solutions[2] (TES) Thailand for recycling of all kinds of WEEE and Electronics waste. In addition, the BMA has also established agreements with two mobile network operators, Advanced Info Service Public Company Limited (AIS) and Total Access Communication Public Company Limited (Dtac), to set up collection points for WEEE at various branches in shopping centers around Bangkok before forwarding WEEE to TES (Dtac, 2563; ThaiPublica, 2019; Bangkok Business, 2020).

These collaborations show that the private sector is willing to work with the Bangkok government for WEEE management in a clean and safe manner. However, the practical implementation of WEEE management remains challenged by other factors such as budget limitations, lack of knowledge, and inadequate guidelines for proper WEEE disposal.

Conclusion:

The investigation into WEEE (Waste Electrical and Electronic Equipment) management issues in Bangkok highlights a complex problem that requires urgent attention and purposeful action. The identified problems converge to underscore the need for a comprehensive strategy. Due to the absence of specific legal frameworks tailored to WEEE management, the Bangkok Metropolitan Administration (BMA) relies on broader waste management regulations. This hampers effective processes and sustains improper disposal of electronic waste.

Furthermore, tight financial constraints and a shortage of qualified personnel worsen the situation. Limited funding constrains the BMA's ability to implement effective strategies, and a lack of skilled workers complicates WEEE management. The socio - economic gap between BMA cleaners and waste collectors and their counterparts in other local governments exacerbates this issue, leading to inefficient waste handling practices that compromise the environment.

Building cooperative partnerships with the private sector poses a significant challenge. Concerns arise that electronic waste might end up in landfills instead of being properly recycled due to the BMA's struggles in establishing meaningful collaborations for WEEE collection and transportation from different areas. This undermines efforts towards sustainable waste management and sustains adverse environmental impacts.

This research suggests as follow

1. The BMA still faces challenges in several areas, including (1) legal challenges, (2) budget challenges, (3) challenges for the BMA staff responsible for WEEE management, and (4) challenges in building collaboration with the private sector. Therefore, the BMA should focus on improving its capabilities in these areas to effectively manage waste electrical and electronic equipment (WEEE).

2. The BMA should strengthen its cooperation with various private sectors, such as waste collection companies and towing companies. A specialized WEEE management company can provide a WEEE management system that ensures safety and relies on modern technologies to sort, disassemble, treat, and recycle valuable electronic components in accordance with appropriate WEEE management practices.

3. The BMA should adopt the principle of Extended Producer Responsibility (EPR) or shared responsibility (SR). This involves encouraging manufacturers, importers, distributors, retailers, governments, and consumers to take responsibility for their respective roles in WEEE management.

Conflicts of Interest

The authors declare no conflict of interest. The founding sponsors had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, and in the decision to publish the results.

[2] *The company was only one-stop e-waste management in Thailand that meets standards. It has over 38 factories in 20 countries around the world*

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