

Managing the Urban Environment of Bangkok, Thailand

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How to cite this paper: Edelman, D. J. (2022). Managing the Urban Environment of Bangkok, Thailand. *Current Urban Studies*, 10, 73-92.

<https://doi.org/10.4236/cus.2022.101005>

Received: January 20, 2022

Accepted: March 8, 2022

Published: March 11, 2022

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Abstract

This article brings the contemporary thinking and practice of Urban Environmental Management (UEM) to the solution of current environmental problems in Bangkok, Thailand. With a fast-growing population of 17 million, Bangkok is the political, economic and commercial capital, as well as the largest city, of Thailand. It is also one of the most important and polluted cities in Southeast Asia. Such cities face more immediate problems than those in the developed world and have fewer resources to deal with them. The article first considers the context of Bangkok, and then reviews issues of poverty alleviation, industry, transportation, energy, water, sewage and sanitation, and finance. Finally, it proposes a 5-year plan to help alleviate the urban environmental problems of this fascinating city utilizing a real-world database and a limited budget.

Keywords

Urban Environmental Management, UEM, City and Regional Planning

1. Introduction

Urban Environmental Management (UEM) has been receiving increasing attention since 1970 in both developed countries, where it has emerged as a subject of academic research and professional interest, and in developing countries, where it has become increasingly an area of donor concern as well. As a field, it is more like planning or engineering rather than geography, economics or sociology; and it represents an integrated view of environmental problems at city, and increasingly, regional level. Such problems are multi-sectoral (e.g., manufacturing, services, household, etc.), multi-system (e.g., water supply, sanitation, transport, etc.), multi-level (central, regional, local and community) and multi-actor (e.g., government, NGO, CBO and private). They require solutions of enormous complexity,

and those professionals who coordinate the planning, implementation and management of the process must be able to communicate with specialists from many disciplines and professions (e.g., biology, chemistry, engineering, city planning, public administration, social sciences and law) (Edelman, Schuster, & Said, 2017).

This article focuses on the practice of Urban Environmental Management in developing countries which face more immediate problems than the developed world and have fewer resources to cope with them in a comprehensive manner. The current study, then, is the report of a graduate-studio that took place at the School of Planning, College of Design, Architecture, Art and Planning, University of Cincinnati, USA from August through December 2021. The objective of the studio was to prepare students to work overseas in data-poor environments as professional consulting planners. Several lectures were given to set the framework of the mixed class of seventeen domestic and international students to operate in seven collaborative sector-level teams (Poverty Alleviation, Industry, Transportation, Energy, Water, Sewage and Sanitation, and Finance) preparing a 5-year Environmental Plan for Bangkok, Thailand utilizing a real-world database and a limited budget (Edelman, 2022).

Bangkok is the political, economic and commercial capital, as well as the largest city, of Thailand. It is located on the delta of the Chao Phraya River, about 25 miles (40 km) from the Gulf of Thailand. It was formerly divided into two municipalities—Krung Thep on the east bank and Thon Buri on the west—connected by several bridges. In 1971, the two were united as a city-province with a single municipal government. In 1972, the city and the two surrounding provinces were merged into one province, called Krung Thep Maha Nakhon (Bangkok Metropolis) governed by the Bangkok Metropolitan Administration or BMA (Wikipedia, n.d.) (<https://en.wikipedia.org/wiki/Bangkok>). The metropolis is a bustling, crowded city, with temples, factories, shops and homes juxtaposed along its roads and canals. While it is also a major tourist destination, noted for fabulous cultural attractions and nightlife with a flourishing sex trade, it has severe environmental problems, which include air pollution from vehicle emissions, water pollution from organic and factory wastes, water scarcity, and hazardous waste disposal.

Furthermore, Bangkok's rapid growth coupled with little urban planning has resulted in a haphazard cityscape and inadequate infrastructure. Despite an extensive expressway network, an inadequate road network and substantial private car usage have led to chronic and crippling traffic congestion, which caused severe air pollution in the 1990s. The city has since turned to public transport in an attempt to solve the problem, operating five rapid transit lines and building other public transit, but congestion still remains a widespread issue in that limited space, a persistent increase in the number of vehicles, inconsistent traffic flow, and uncertain travel time are all dominant factors of daily life in Bangkok. Bangkok also faces long-term environmental threats such as sea level rise due to climate change and subsidence, the latter of which is a major concern (Wikipedia, n.d.) (<http://www.en.wikipedia.org/wiki/Bangkok>).

2. Poverty Alleviation

In Thailand, the effects of the economy have drastically changed the way of life for all of those who reside there. The steady reduction of poverty in the country from the 1960s until 1997 was primarily gained through economic growth led by industrialization, the emergence of export growth and increased foreign investment. This led Thailand to create high interest and fixed currency exchange rates to continue to attract outside investors and their “hot” money. This kind of money is frequently transferred between financial institutions to obtain the most capital gain, and this foreign investment and potential for profits piqued the interest of countries such as the United States. This sudden rush of money to and investment in Thailand created a boom for the economy, but soon that all came crashing down. With the appreciation of the US dollar, hot money flowed into the US economy. This action hurt export growth and, in turn, panicked foreign investors. The withdrawal created a massive shift in foreign currencies, especially in Asia. With the depletion of their own foreign currency, the Thai baht was forced to float (World Bank Group, 2020).

The effect of these currency movements was the Asian Financial Crisis. This economic decline affected a multitude of Asian countries. Thailand, though, had its exchange rates plummet, and the Thai currency (baht) lost much of its value. Before the crisis, the baht had an exchange rate of 1 dollar = 25 baht. After the crash, however, one dollar was the equivalent of 54 baht. Such a drastic drop in value caused the poverty rate to increase to 65% after the crash and brought about a time of hardship (Ibid.).

Between 2015 and 2018, the poverty rate fluctuated. In 2015, the poverty rate was 7.2% (5.2 million), and, approaching 2018, the rate rose to 9.8% (6.8 million) (<https://www.macrotrends.net/countries/THA/thailand/poverty-rate>, Thailand Poverty Rate 1981-2021 (2021)). The amount of people living below the poverty line before 2018 decreased drastically due to Thailand’s economic growth and government aid programs. However, an economic slowdown, technological problems, and a trade war resulted in a considerable number of people residing below the poverty line once again. This widespread poverty increase spread over the entirety of Thailand, and 61 out of 77 provinces were thrown into impoverished situations (Limited, 2020).

In Bangkok, specifically, the poverty line is defined as a daily income of 165 baht (US\$5.50) per person. In 2019, the average number of people earning this amount of money was 4.3 million. In 2019, with a 2.20% decrease in the poverty rate, economic shifts were starting to improve. Nevertheless, several severe droughts, a low GDP rate (2.7%) and, among all else, the global Covid-19 pandemic, caused complications for Bangkok (Ibid.). Covid-19 hit Thailand during an era of financial crisis. With an already struggling population, having to shut down businesses, bring about a curfew, and ensure social distancing, those who were struggling struggled even more once the virus came about.

Most cases in Bangkok are within the slums. There are a total of 579,630 people living in Bangkok's slums, accounting for 29% of the city's population. The slums are subject to "socio-economic vulnerability, limited access to social welfare and public facilities, poor housing, unsafe and overcrowded neighborhoods, risky and/or polluted environments (Global Times, 2021)." These areas are tight quarters of housing that are filled with people, and there is little to no social distancing. This makes the spread of Covid-19 almost impossible to prevent.

Bangkok's slums contain both the highest number of Covid-19 cases and the largest poverty-stricken areas. A study done on the impact of Covid-19 in Thai slums shows that, "Out of 900 participants, 25.9% lost their jobs during the lockdown and 52.7% lost their income. The job and income loss increased the poverty rate within the participants from 51.6% to 91.7% (Pongutta et al., 2021)." Such a high decrease in income and jobs has pushed the residents of the slums into an even further impoverished state.

Khlong Toey is the largest populated slum in Bangkok and also the most destitute. With a population of over 100,000, the people that live there are struggling, even more so since they are being hit with a third wave of Covid. Khlong Toey is a highly overpopulated area that consists of families of up to 10 living in one small living space. Within such a small space, no chance of social distancing is possible, and it turns this area into sort of a brewing pot for the next wave of Covid. A resident stated that, "...living with 10 people in a house...of maybe 20 square meters, which means if one has COVID[-19], the rest have it (Global Times, 2021)."

Since the third Covid wave hit Bangkok, 1.3 million people have been affected. Most of the cases are from these close quarters of Khlong Toey. With such a high number of new cases, precautions are being taken to try and help prevent and protect those in and out of these slums. Covid-19 tests would be a proficient means of help, but many residents of Khlong Toey are unable to afford to get a test. With Khlong Toey residents living on 150 baht a month (US\$5) and a Covid test being 1000 baht each, the possibility often slips away (Global Times, 2021).

With little ability to support themselves in these troubling times, the residents of slums get help from CSO's (Civil Society Organizations), which provide food and services as non-profit organizations. One CSO, the Bangkok Community Health Organization, is working to prevent the spread of Covid-19, and it has volunteered to provide Khlong Toey with free Covid-19 tests. These tests offer to those in the community confidence that the spread of the disease can be slowed and potentially stopped (Global Times, 2021).

As of December 2, 2021, 41.5 million people in Thailand have been fully vaccinated, equivalent to 59.4% of the population (Ritchie et al., 2021), the majority of those being citizens living in Bangkok. The current goal set by the government is to have 70% of the population fully vaccinated by the end of 2021 (Beech & Suhartono, 2021). However, this goal has been challenging to reach as there

has been a national shortage of vaccine doses to distribute to those who want it. Unlike other countries, there is not a political debate about the effects of the vaccine, but rather a desire from the public to become fully vaccinated and return to normality. There is an overwhelming abundance of the Chinese produced and manufactured Sinovac vaccine, which has been found not to be the most effective vaccine as it prevented symptomatic disease in only 51% of individuals, although it prevented severe Covid-19 and hospitalizations in 100% of the studied population (WHO, 2021).

The government is starting to increase doses of the AstraZeneca vaccine, which is produced by a company owned by the country's king. As of November 2021, AstraZeneca Plc. has given an additional 10.5 million doses of the vaccine to Thailand. This will allow for the factories in Thailand to no longer put on hold their additional exports (Reuters, 2021b). This halt on vaccine exports began in June 2021 and prevented the country from making additional profits from their manufacture.

Civil Society Organizations, or CSO's are one the few resources found to be helpful during the pandemic. Due to economic growth from 1977-1997, non-governmental organizations (NGOs) were created, and, by the year 1989, there were over 12,000 NGOs operating in Thailand, with 44% dedicating their work to social/economic development and welfare (Asian Development Bank, 2011). These non-governmental organizations then gave way to civil society organizations in the 1990s due to the economic growth Thailand was experiencing. These Civil Society Organizations grew to meet the many needs of the poor who weren't located in the city center (Ibid.).

In order to expand government social and economic safety nets to include everyone, a 4-phase plan can be implemented (Edelman, 2022).

- Phase 1: As previously mentioned, the first step in extending a government safety net starts with registering those living in slums on government websites, so every person is accounted for by the government.
- Phase 2: Here, labor protection is extended to those who are in the informal sector and don't have a contractual obligation to a company. This can be broken down into further sub phases:
 - Phase 2.2: Subcontracted workers.
 - Phase 2.3: Self-employed/small businesses.
 - Phase 2.4: Daily hires.
- Phase 3: Informal and contracted hires must have a legal system and contractual paperwork that considers them as working members of society so government health policies can then apply to them.
- Phase 4: This phase includes the implementation of a public works program where informal workers can aid in the construction of new housing in slum communities.

Nevertheless, as cities adapt to the new realities that they are faced with, one constant that is present is the need for continued economic growth. This is also

true for Bangkok in that continued economic expansion offers a means of relative improvement for the overall general economy. It also offers opportunities for the economic advancement of citizens who live in and reside around Khlong Toey. Nevertheless, similar to other communities, there are costs associated with new development, with one of them being the gentrification of a community due to the new development. With the process in its current form, substantial amounts of housing units will be vacated and require residents to find alternative housing opportunities or take cash compensation to move elsewhere (Chandran, 2021). While economic growth must continue for an urban environment to succeed and grow, it must work in tandem with the protection of the existing residents' interests in the community.

3. Industry

Bangkok is the location of the main port of Thailand, making it an integral part of the economy of the country. Wholesale and retail trade is the largest sector in Bangkok's economy, accounting for 24% of Bangkok's gross provincial product. It is followed by manufacturing (14.3%); real estate, renting and business activities (12.4%); transport and communications (11%); and financial intermediation (11.1%). Tourism is also a major source of revenue in Bangkok (The World Bank, n.d.).

Bangkok alone accounts for 48.4% of Thailand's service sector, which in turn constitutes 49% of Thailand's GDP (Ministry of Information and Communication Technology, 2017). The service sector is defined as anything having to do with retail trade, tourism, education, social services, government, etc. Bangkok's service sector accounts for roughly half of the 2.3 million establishments in Thailand, as of 2012. This means that there are approximately 480,000 establishments in Bangkok devoted to the service industry (Ibid.). As of 2012 roughly 1.7 million people were employed in the service industry in Bangkok.

The manufacturing industry in Bangkok is made up of the production of building materials, food processing, textiles, the assembly of electronic equipment, and automotive assembly (Ibid.). Thailand's textile industry consists of over 2000 businesses, most of which are in or around Bangkok (Mordor Intelligence, 2021). The country is known all over the world for its silk production. It is also doing well in eco-friendly dyeing and printing services. The textile industry employs over 200,000 people. Overall, the manufacturing industry in Bangkok is a crucial part of Thailand's economy.

In the last 40 years, Thailand has made great strides in economic development, becoming an upper middle-income country. According to the World Bank, Thailand's economy grew at an average yearly rate of 7.5% from 1960 to 1996. The economy grew at a rate of 5% per year from 1999 to 2005 after the Asian Financial Crisis. Millions of new jobs were created from this economic growth. Even more recently, economic growth has slowed from 4.2% in 2018 to 2.4% in 2019. The root cause of slowing economic growth was less demand for exports due to

US-China trade tensions and a drought which impacted agricultural production. The Covid-19 pandemic has only exacerbated the economic growth problems of Thailand. Economic growth went down 6.1% in 2020 due to changes in trade and tourism, supply chain issues, and less domestic consumption.

The World Bank says that the export of goods has provided substantial support to the economy, driven by recovering global demand for automotive parts, electronics, machinery, and agricultural products. The recovery is expected to ramp up in 2022, with the annual GDP growth rate forecasted to rise 5.1% depending on solid progress on Thai vaccination rates, an improvement in the global trajectory of Covid-19 good enough to allow international tourism to recover somewhat, and the Covid fiscal response package (World Bank Group, 2021).

Recognizing the problem, policymakers in Thailand decided it was necessary to digitize Thailand in order to propel the country to the next level. Thailand 4.0 is the plan for the future that policymakers came up with (Ministry of Foreign Affairs Thailand, n.d.).

Thailand 4.0 is a 20-year plan for Thailand that was launched in 2016. According to a statement from the Royal Thai Embassy in Washington D.C., “Thailand 4.0 is designed to promote and support innovation, creativity, research and development, higher technologies and green technologies.” The goal is to digitize the country and graduate from middle income to a high-income country (Ibid.). Thailand 4.0 refers to a method to generate a transformation from primarily machine manufacturing to digital manufacturing (Puriwat & Tripopsakul, 2020). To aid in implementing the Thailand 4.0 policy, policies focus on the semiconductor and automotive production industries within this plan.

4. Energy

Well over 15 million people live and work in Bangkok (Pakarnseree, 2018). As the capital of Thailand and centrally located, Bangkok is the heart of the country’s industry, commerce, manufacturing, construction, and economy (Arifwidodo & Chandrasiri, 2015). These factors have led to rapid industrialization and urbanization due to the influx of people coming to the capital city. The people of Bangkok place a major significance on entertainment. The city has a high concentration of recreational establishments, neon lighting, and flashy displays. This increases energy consumption and pollution. Energy efficiency is a major concern that needs to be addressed. More sustainable housing and adaptations to the planning of the city can help to mitigate Bangkok’s energy needs (Ibid.).

Urbanization has had a huge impact on the environment in Bangkok. The development of the city’s roads and buildings has reduced the number of trees and amount of vegetation in the area. Temperatures in Bangkok have risen as a result of urbanization. The tall buildings trap heat, lights are used at all hours of the day, and motor vehicles are the most common form of transportation. Air conditioning and fuel use have increased because of this. Air conditioning, used to make high temperatures more comfortable, makes up the largest percentage of

energy use (60%) in Bangkok. Each of these factors, along with industry, manufacturing, and population growth have had a negative impact on the environment in Bangkok. Air pollution, water pollution, and land subsidence have increased along with a temperature difference of seven degrees Celsius higher than that of rural areas (Arifwidodo & Chandrasiri, 2015).

In order for a country to develop and flourish, it requires adequate energy resources. Thailand has scarce conventional energy resources; therefore, it looks to imports as an alternative. Thailand as a whole requires energy to supply and meet its domestic demand, which is at odds with its population growth, urban growth and economic expansion (Ministry of Energy, 2015). Energy utilization climbs every year with a large portion consisting of imported energy. Since 1995, the overall import of commercial energy has accounted for over 50% of the combined supply. It is also foreseen to grow since nonrenewable resources such as gas and oil reserves are being depleted at alarming rates. Therefore, since the majority of energy consumption and imports are fossil-based, an issue arises with environmental protection because there is a surge of greenhouse gas emissions (GHG). Residents of Thailand have a negative view of the use of fossil fuels such as coal, which has sparked protests across the country at coal-fired power plants. To address these concerns, Thailand set a renewable energy goal of 30% of total energy use by 2036 in the Alternative Energy Development Plan or AEDP 2015. The intentions are to vary energy sources and diminish environmental pollution rates.

According to Open Gov Asia, Thailand currently generates around 12% of its energy from sustainable sources, and Thailand's government hopes to increase this to 37% by 2036. There are different methods that can be used to help reach this goal, but most of the research conducted on energy solutions for Bangkok consists of investing in renewable energy and overall moving to more environmentally friendly ways to bring energy to the city.

Solar Power is an energy solution that is renewable and environmentally friendly. It is obtained through the energy of the sun's rays and can be as simple as a single panel on a residence or an entire energy farm of dozens, or even hundreds, of panels. Thailand as a whole already leads East Asia in solar power development and so expanding this further in Bangkok makes sense.

Another solution is the creation of more waste-to-energy plants in Bangkok. Waste-to-energy plants focus on burning municipal solid waste to produce steam that is used for the production of electricity, which is fed to the power grid, and heat. This solution not only produces renewable energy, but also helps dispose of Bangkok's overflowing waste by repurposing much of the waste currently sitting on the streets of the city.

The high costs of creating plants like this one are not the only potential drawback of this solution. A large factor in whether or not the process will work as imagined is the state of the waste being incinerated. There needs to be a certain level of consistency and quality that is hard to receive when it is coming from

different people and businesses. With this solution, knowledge and information about what waste can and cannot be disposed of with the intent of creating energy would need to be thoroughly understood across the city. Distributing this information is a major communication task. Furthermore, it would be wise to create positions in which people or machines sort the waste before it goes to the dump, thereby ensuring it meets the quality needed.

A third solution is hydropower. Currently, hydropower is the largest form of renewable energy in Thailand, where there are 26 hydroelectric dams and plans for more. An advantage of hydropower as a form of renewable energy is that power is produced without using much land. The Electricity Generation Authority of Thailand (EGAT) is currently working on what will be one of the world's largest hydro-solar plants when it is completed. EGAT then plans to replicate this project with eight other dams (Reuters, 2021a). After researching and studying different approaches to clean and renewable energy sources in Bangkok, solar power was found to be one of the most viable options based on available land, resources, and budget constraints. All of the solutions studied have their own pros and cons; however, solar power was eventually chosen as the best method via investment and implementation of a new solar farm project as part of a 5-year plan to benefit Bangkok. The waste-to-energy method, although a viable option and useful in the sense that it also starts to tackle a waste issue in Bangkok, was too costly and came with too many outside factors that may hinder the process. The extra steps needed to educate the general public on proper waste disposal methods and the need to motivate an entire population to do so make this a less desirable option. Hydropower, on the other hand, also proves itself a viable option, but comes with environmental concerns regarding the amount of carbon dioxide and methane that would be released. Hydropower also comes with concerns regarding water levels as it runs the risk of starting droughts, as well as harming the fish and other life existing in the bodies of water in which these plants are located (Conserve Energy Future <http://www.conserve-energy-future.com>). Ultimately solar power stands out as the most logical as it does not rely on external factors such as waste disposal, education, and water levels, as well as requiring lower costs than the other options studied.

5. Transportation

What was once a quiet and relatively small community has grown to be the complete opposite. During the year 1782 when Bangkok became the capital of Thailand, the city had a population of approximately 400,000. The city was once solely based on water travel, and canal systems existed for some time, until they later declined due to the creation of roads necessary for automobiles.

Today, the six districts of Bangkok encompass 7785 square kilometers (Oxford Business Group, 2017) with a population of 17.5 million. The city's population has increased immensely over time and, with this, so has the need for transit, both public and private, leading to the enormous increase in vehicles. Li-

mitted space, inconsistent traffic flow, uncertain travel time, high congestion levels, and air pollution are all associated with the transportation in Bangkok.

Citizens are influenced by the quality of the environment they live in on a daily basis. A major problem with transportation is the fact that vehicles are the main source of air pollutants. With more automobiles than ever, according to WHO, Bangkok's air pollution is more than double the amount that is recommended or expected (IQAir, 2021). In 2020, Thailand was ranked 34th in the world for poor air quality. Although people can still get around and carry on with their daily activities, the city has consistently stayed near the top of the list of cities with polluted air. Although some measures have been taken to improve this situation, more action needs to be taken. More than just day-to-day life has been impacted for the citizens of Bangkok by problems of air pollution and congestion. Bangkok's pollution has also resulted in roughly 8000 deaths and US\$3,100,000,000 of damage to the economy in 2021 alone. Public health and the overall quality of life have been impacted tremendously by transportation as well. The more that the city's inhabitants can make the environment in which they live in more eco-friendly, the closer Bangkok will be to solving its overall transit problems.

Congestion levels are closely related to pollution levels, and air pollution and congestion within Bangkok remain extreme problems that need continual attention. Congestion in this city has started to improve slowly in recent years but remains a problem that has a long way to go before it will be solved as well. Increased travel time results from this congestion in Bangkok.

The evolution of this city over the years has led to a strong need for improvements in transportation. Not only is travel a fundamental aspect of living in Bangkok, but the resources for the different modes of transportation are just as essential. Bangkok faces inconsistent and problematic traffic flow daily. In the past, tactics such as building more roads have attempted to improve the transportation in Bangkok. However, as elsewhere, this has only brought more vehicles to the streets, thereby eventually worsening traffic congestion and air pollution. Thus, all groups within Thailand should continue to work at responding to the transit issues at hand as the unresolved issues of transportation have influenced the emotional, physical, and mental well-being of Bangkok's citizens. Sustaining transit systems throughout the area is important in keeping the city stable and healthy.

Bangkok has been working to eliminate the issues of air pollution and congestion in transportation in numerous ways over the past few years, including a high-speed rail project, The Gold Line, Bang Sue Grand Station and electric vehicles. As Thailand moves in a more transportation-friendly direction, plans to not only build a third international airport, but also make a switch from the Euro IV to Euro V petrol standard by 2023 are in the works.

6. Sewage and Sanitation

With 2604 km of canals weaving through the city (Wancharoen, 2019), the Gulf of Thailand to the southwest border, and a densely populated cityscape, Bangkok

is a vibrant city surrounded by natural beauty. The expansive waterways and dense population, however, create a challenging situation for sewage and sanitation management. Inadequate wastewater management for the population of Bangkok results in much of the wastewater being untreated (Pollution Control Department, 2022). In addition, people living in areas that do not receive adequate municipal solid waste collection, or simply reside near the waterways, use the canals as a dump for their solid waste (Johnson & Trang, 2019). This improper dumping leads to environmental pollution that is harmful to residents of Bangkok and the environment. Though the Bangkok city government, sometimes in partnership with the private sector, has intervened to confront these challenges with expanded wastewater treatment and municipal solid waste collection, further intervention is necessary to address fully the needs of Bangkok's residents and the natural environment.

The indiscriminate disposal of wastewater has been and continues to create huge problems in Bangkok. The increasing population and rising industrialization have outstripped the pace of environmental protection and preservation in the city. Wastewater generation is largely from households, commercial and industrial activities, as well as agricultural practices, which have significantly led to a decline in the quality of the environment (Pollution Control Department, 2022). The majority of the wastes generated are untreated and are usually disposed of through sewers that are directly connected with canals and rivers and, as a result, create issues of pollution, contraction of diseases, and, consequently, deteriorate the quality of life of the people of Bangkok.

The rising rates of wastewater generated and its uncontrolled disposal have resulted in the contamination of rivers and the deterioration of the quality of groundwater with salinity, coliform bacteria, and other organic compounds, which both serve as water sources to some households in Bangkok as well as other surrounding communities (Polprasert, 2007).

This high population and busy tourist culture produce significant solid waste. In 2020, The Bangkok Metropolitan Administration (BMA) collected 3.34 tons of household hazardous waste, 43.24 tons of infectious waste, and 9519 tons of municipal solid waste (MSW) per day (The Department of Environment, 2021). Industrial waste is required by law to be managed separately by the industries responsible for the waste production, according to the Notification of Ministry of Industry Re: Industrial Waste Disposal B.E. 2548 (Thailand Ministry of Industry, 2005).

Waste production declined overall during the Covid-19 pandemic, resulting in fewer total tons collected from 2019 to 2020. Infectious waste decreased by 11.65% during the height of the pandemic in February-May 2020 compared to 2019 due to fewer residents seeking medical care outside of Covid-19 complications (Ibid.). MSW declined by 1045 tons per day compared to 2019 due to significantly fewer tourists and many unregistered residents moving back to their hometowns outside of Bangkok. Plastic waste, however, notably increased as

residents used more takeout containers and home deliveries as a result of Covid-19 prevention measures. In April of 2020, the proportion of plastic waste increased to 36.6% of the total waste, a 16.59% increase from 2019. This proportion fell by 15% after the relaxation of Covid prevention measures but remained notably higher than 2019 levels. Food waste remained the highest proportion of MSW in 2020, totaling 45.41% (The Department of Environment, 2021). Solid waste collection in Bangkok involves stakeholders from the formal public and private sectors, as well as an essential contribution from the informal sector. The Department of the Environment of the BMA is the primary public entity in charge of solid waste collection.

The informal sector plays an essential role in Bangkok's waste management. Only 8% of the population separates their waste, and there is no formal recycling system (Archer & Adelina, 2021). All waste separation and recycling are sorted by informal waste collectors and sold to waste dealers, commonly referred to as junk shops. BMA garbage collectors serve as formal/informal workers hired by the BMA, but they also sort the waste they collect from households and sell valuable recyclables to waste dealers for an extra 150 - 200 baht in profit (Johnson & Trang, 2019).

The population of Bangkok is estimated to grow rapidly by 2050, as would the growth of the wastewater that would be generated. An increasing population would lead to a significant rise in the volume of wastewater as well as the demand for quality water. A needs assessment conducted revealed that the current treatment capacity in Bangkok is stagnating and, as a result, contributes to the poor management of wastewater generated. In this respect, it is crucial to address the capacity and coverage needs of the city of Bangkok to meet the rising rate of wastewater generation. Feasibility studies are required to determine the viability and efficiency of projects to inform operational, technical, legal, and resource allocation decisions. In the final year of the plan period, a feasibility study would be conducted to assess the current and future situations of wastewater generation and management in Bangkok.

The current low source separation rate of 8% in Bangkok results in challenges in the Bangkok MSW stream (Archer & Adelina, 2021). Low waste separation rates lead to unnecessary disposal costs and environmental pollution (Sukholthaman & Sharp, 2016). Furthermore, a lack of source separation contaminates valuable recyclables that can otherwise be kept out of the waste stream and generate income for informal waste collectors who sell them to waste dealers (Nguyen & Nitivattananon, 2019).

Given the challenges that result from the lack of waste separation and the benefits that result from it for the environment, the BMA's spending, and the increase in informal waste collector income, a city-wide source separation program is needed. Furthermore, Thailand is in the top five countries for marine plastic pollution (WOIMA Corporation, 2021) and has named plastic reduction as a priority in its 3R strategy and Roadmap on Plastic Waste Management (2018-2030) (The Department of Environment, Bangkok Metropolitan Adminis-

tration, 2021).

Finally, there are numerous businesses developing plastic alternatives (Stone, 2018). A particularly promising option for Bangkok is packaging made from seaweed. An Indonesian company called Evoware uses locally produced seaweed to create biodegradable packaging at lower costs than plastic (Ibid.). A similar business model or other plastic alternatives could be developed in Bangkok. Local businesses developing alternative packaging to plastics would have the dual benefit of reducing plastic waste and providing employment directly through the business and through work in seaweed agriculture.

7. Water

In contrast to a lot of cities, Bangkok did not initially have paved roads and walkways, and the. Main means of transportation were waterways. “The river, (Chao Phraya), helped the city of Ayutthaya become an international trading hub, and the country started to build relationships with the merchants from around the world who visited (Iverson, 2017).” Most of these merchants came from China, Spain, the Netherlands and France. The waterways in Bangkok have been the heart of Bangkok’s needs and history. Bangkok’s earliest settlers chose to settle here because of its location. The river made the land fertile for farming and it was filled with fish. Due to this, Bangkok expanded into what it is today, with “more than 50,000 people still [using] its ferries every day”, (Bangkok River) with the Chao Phraya River being the most important waterway (Ibid.).

Bangkok is a port city located in the north of the Gulf of Thailand. Water is a huge part of what makes Bangkok the bustling and successful city it is today. The location of the city is ideal for trade and transportation, being on the Gulf of Thailand and located on a major river, the Chao Phraya. The river flows south into the Gulf of Thailand and is over 225 miles long. The canals, or *khlongs*, use the river as a source of water. The river is very important in the transportation of goods such as teak and rice.

The primary source of drinking water comes from surface and ground water. The water in Bangkok is cleaned and purified in plants and, in theory, should be safe to drink. The problem comes when it leaves the treatment plants and goes into aging lead water pipes. This then affects the quality of the tap water and causes a strong chlorine smell. It is recommended for citizens and tourists to drink only from bottled water. The basin of the Chao Phraya is the largest in Thailand, it drains roughly 30% of the country. The water has been polluted and is no longer drinkable for many reasons. Chemicals used in farming and agriculture, industrial waste, and untreated sewage flow are just a few factors that pollute the waterways of Bangkok (Thelwell, 2019).

For years the canals have been used as a source for drainage, and because of that they are now filled with wastewater. A Greenpeace study shows high levels of toxic chemicals in the canals. There is evidence of heavy metals, hormone disrupting chemicals, and human carcinogens in the water. The wildlife is dying, and the

fish caught must be cleaned and tested for disease before being cooked (Ibid.).

Bangkok is very exposed to the elements with no natural protection. The city's location is at a perfect spot for flooding. It is located close to the Gulf of Thailand and is on top of the Chao Phraya River. The sinking of the city is happening fast due to the marshy land and the weight of the urbanization along with the uncontrolled use of groundwater. Bangkok is slowly sinking at a steady rate of 10 cm annually. Due to raising seas levels and climate change some experts say that Bangkok is at risk of sinking in 15 - 20 years (The ASEAN Post Team, 2019).

The city of Bangkok, and most cities around the world, use lead piping as their main means of distribution from the water treatment center to the tap water from peoples sinks at home. Most residents and tourists are aware of Bangkok's water situation, which can affect tourists' desire to travel there, and can be fearful for the residents. However, "Thailand has been verified as clean by World Health Organization standards since 1999. That means the water is just as clean as water coming out of the valve in Los Angeles, London or Stockholm" (Tap Safe and Tap Source <https://mytapscore.com>). If the water is clean when it leaves the water treatment center, but not clean when it gets to the population, there could only be one reason why the water gets contaminated: the lead piping (Water Doctor, 2020).

Since it is now well known that lead piping is harmful, people stopped installing it. Now, plumbers install PVC piping. PVC piping is lightweight, flexible, safe, flame resistant, and has a high design versatility (Think Pipes, n.d.; PVC4Pipes, 2021). PVC is made up of a thermoplastic polymer (plastic and vinyl) and is inexpensive. Countries across the world are turning to PVC piping to allow for consumers to have safe drinking water. PVC piping is easier to work with and easier to install than lead piping (Adarsh, 2021). Due to this, it is proposed here to replace all the lead piping in Bangkok with PVC to eliminate consumers' risk of illness and contamination. Using PVC piping instead of lead is better for the environment as well.

All the districts in Bangkok, except Pathumthani, Samutprakarn, and Nonthaburi, contain lead piping. The challenge is to replace these lead pipes with PVC piping efficiently without disrupting the history, community, or tourism within the city. Replacing all the lead pipes will not just cost a lot, but it will also take a long time. One must consider and evaluate all districts and distinguish which ones should go first and how long each district would take. As a result, a district that has elements found throughout Bangkok has been chosen for the pilot study to determine the unknowns of replacing piping and help to develop a system to do so.

8. Finance

The City of Bangkok is the thriving economic and commercial hub of Thailand. Over the 20th century, Thailand's capital has developed to become a central trade and manufacturing hub for the country. The highly developed system of canals,

roadways, and port facilities has allowed for the concentration of economic activity that has only accelerated with globalization and the technological advancements of the 21st century. Thailand has set an ambitious goal of becoming a high-income country by 2037 through its Vision 4.0 outlined in the 20-year national strategy (Organization for Economic Cooperation and Development, 2021). Thailand, and Bangkok in particular, have been focusing on green development strategies, and have put green growth as a priority for new and future development projects (Ibid.). This focus on green growth, along with the need to meet the United Nations Sustainable Development Goals (United Nations, 2015) informs the direction of the project proposals outlined above.

The finance team researched the available funding sources for development projects in Thailand, with a focus on Bangkok. The team evaluated the Bangkok budget, multilateral investment banks, Official Development Assistance (ODA), and Foreign Direct Investment (FDI) to locate the key domestic and international sources of funding. It also looked at ongoing projects in each sector to understand better which sectors Thailand and international banks are prioritizing for development funding. The finance team used this research to inform each project sector of funding availability and funding sources. It collaborated with the following sector teams on a 5-year funding plan (2022-2026): Poverty Alleviation, Industry, Energy, Transportation, Sewage and Sanitation, and Water. Through collaboration, the team developed a budget for each project that would be feasible to implement for Bangkok.

The global pandemic has added a layer of uncertainty to the finance team's research of available funding. However, the careful disbursement of stimulus packages, as well as a US\$1.5 billion loan from the Asian Development Bank (ADB Thailand Fact Sheet, 2021), have helped to buffer Thailand from the worst economic effects of the Covid-19 pandemic. While the pandemic hit Thailand's tourism industry hard, there is hope that the economy will begin to rebound with the country having reopened again to vaccinated tourists from 60 countries (Khernamnuoy & Silver, 2021).

The finance team researched all reasonable funding options, including Bangkok budget projections and estimated new funding for each sector, key Foreign Direct Investment partners, multilateral development bank loans, top Official Development Assistance partners, and special funds, trusts, and facilities that provide sector-specific lending. Thailand is considered a middle-income country, with a Gross National Income (GNI) of US\$490 billion, and a GNI per capita of US\$7100 (Foreignassistance.gov, 2021). As a middle-income country, Thailand becomes ineligible for much development assistance in the form of grants; therefore, most international development funding is provided in the form of concessional or non-concessional loans, technical assistance, or joint research partnerships.

Along with funding research, the finance team evaluated the requirements of the various funding sources, as well as the requirements of Thailand's 20-Year

National Strategy, to ensure that each sector's project goals were in alignment with the goals of the strategy. The United Nations Sustainable Development Goals (SDGs) were also considered, as most multilateral development banks and ODA partners require that projects meet SDG requirements. Each project proposal was evaluated for whether the project met several of the UN SDGs, as well as the goals of the 20-Year National Strategy. Research was also conducted to ensure that comparable projects have been funded at a similar scale and at similar cost in Thailand or other middle-income countries (United Nations, 2021).

Aside from the Asian Financial Crisis in the 1990s and the current economic crisis caused by the pandemic, Thailand has long had a strong economy favorable to foreign investment and development, and after a thorough review of proposed projects by each sector for the 5-year environmental management period of 2022-2026, the finance group has concluded that all seven sectors will be funded either at full or partial capacity. The team concludes that there will be sufficient funding sources available through both foreign and direct investment, Multilateral Development Bank sources, top donor countries and sovereign/non-sovereign funds to support implementation of projects proposed by poverty alleviation, transportation, energy, and water sectoral teams. Lastly, the finance team assessed the scale of projects proposed by the sewage/sanitation and industry sectors, advising that these sectors revise the scope of the proposed projects in order to be financially viable in relation to the availability of funding during the 5-year planning period. Therefore, the projects for all seven sectors of this study and presented in this article reflect the analysis of the Finance Team and are projected to be fully funded (World Bank Group, 2021).

9. Conclusion

The intent of this article was to summarize the results of a project to bring the contemporary thinking and practice of Urban Environmental Management to the solution of real problems in Bangkok, Thailand, a large cosmopolitan Southeast Asian metropolis best known outside of the region as a fascinating city for tourists with ornate shrines, a vibrant street life, and fabulous food. The boat-filled Chao Phraya River feeds its network of canals, flowing past the Rattanakosin royal district, home to the opulent Grand Palace and its sacred Wat Phra Kaew Temple. Nearby is Wat Pho Temple with an enormous reclining Buddha and, on the opposite shore, Wat Arun Temple with its steep steps and Khmer-style spire (<https://www.google.com/search/Bangkok>). Despite its breathtaking sites, it is a city plagued by numerous serious environmental problems.

The objective was to replicate as much as possible the conditions under which a team of expatriate consultants would operate in this context so that a class of graduate urban and regional planning students could develop ideas and procedures that fit the circumstances they would likely confront as professional planners working on such projects in developing countries for international development banks, multilateral donors in the United Nations system, as well as the

numerous bilateral donors of the developed countries (Edelman, 2020). Consulting firms operating internationally on projects for these institutions, agencies and countries come not only from the donor countries of the United States, Australia and Europe, but increasingly from countries such as Brazil, India, China and Korea as well, and the staffs of experts they provide often come from a number of the countries named (Edelman, 2014; Edelman, 2018).

In this working environment, it was instructive for the students to formulate a 5-year plan of solutions to the environmental problems and issues they faced rather than be told how to deal with them (Edelman, 2021). This expanded their analytical skills and taught them how to utilize the limited knowledge and resources available to come up with implementable solutions for the benefit of the people of Bangkok. They learned that such skills are transferable to other projects, and they gained a greater appreciation of the skill set that they are developing as planners (Edelman, 2016). Bringing the reality of development to the classroom and asking students to confront it gives them an appreciation of professional practice that the study of theory alone does not (Edelman, 2015). Consequently, the project summarized here has attempted not only to expand the education of graduate students, but also to provide a meaningful contribution to planning pedagogy (Edelman, 2019).

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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