



Long Paper
**A Survey in Identifying Environmental Problems in
Valenzuela City**

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Abstract

The study's main objective is to identify key environmental problems in the City of Valenzuela and recommend feasible technology that can determine the quality of air and water being released by the companies. A survey was conducted with 127 industries in Valenzuela City aimed at knowing the city's plastic production and recycling, wastewater management, solid waste management, air pollution reduction as well as its governance to the problems being encountered by the city. The study revealed that about 55% of the industries' wastes are plastics which is quite alarming as plastics are one of the biggest polluters on earth. It also shows that most of the company representatives who answered the survey admitted that they (about 46%) barely knew if plastic neutrality is practiced in their place. Interestingly, about 86% of the participating industries claimed that they did not produce air emissions yet have no available records of their air emissions inventory. With this, the researchers recommend a strict implementation of the Republic Act 9003 also known as Ecological Solid Waste Management Act of 2000 in Valenzuela City. It is interesting to note that, about 56.10% expressed their willingness to collaborate with the Scoping team to conduct studies on possible technology that would be able to resolve Valenzuela City's problems on waste.

Keywords – Industrial wastes, plastics, Valenzuela City, technology

INTRODUCTION

Waste management is one of the greatest challenges that the Philippines faces. Valenzuela City is likewise experiencing this problem as one of the key cities in Metro Manila with regards to business and industry that accumulates industry wastes (Magalang, 2013). Technologies that are needed to help the city with its problem of waste disposal should be given importance to aid the city's problem of waste.

Many businesses were built in the city due to the openness of the government to innovation, promote science and technology, and are always ready to give a helping hand to business owners (Castro, 2017). Valenzuela City launched in 2013 the 3S (Simple Processes, Speed in Delivery, and Service Excellence) Plus Program for their clients.

Dubbed as the plastic city of the Philippines having more than 300 plastic and rubber companies, the city has about 100 recycling plants of plastic and about 250 junk shops. There were about 324 plastic and rubber manufacturing companies in Valenzuela in 2011 producing an employment of 175,000 factory workers (Lopez, 2013). Aside from the problem in water pollutants, studies from 2004-2009 of the Philippine Nuclear Institute (PNRI) air sampling stations reveal that Valenzuela leads in having higher particulate and lead levels among other places in Metro Manila. The hazardous waste generated can pose serious health problems to the community and its adjacent town. Not all companies can afford state-of-the-art facilities.

Some of the industrial wastewater in the Philippines is disposed of without treatment. The National Capital Region (NCR) is one of the highest contributors to industrial waste. Plastic manufacturing and recycling is one of the largest industries in Metro Manila. This is due to the increasing demand for single-use plastics and low prices. Local recycling and small-scale industry to produce recycled plastics is increasing. The Philippine government has always been vigilant in reducing pollution in major bodies of water. The government has been focusing on cleaning up Manila Bay. Valenzuela City rivers are part of the many tributaries of Manila Bay.

OVERVIEW OF VALENZUELA CITY

Valenzuela City used to be an agricultural and fishing town before urbanization when it was still part of Quezon City and Bulacan (Valenzuela.gov.ph). In 1975, Valenzuela City was separated from Bulacan through Presidential Decree 824. From then on, Valenzuela City started to urbanize and was passed as a highly urbanized city through RA 8526 in 1998 (Philippine Statistics Office, 2002). Valenzuela City has 32 Barangays divided into two districts wherein Barangay Heneral T. de Leon and Barangay Poblacion were the highly populated and least populated, respectively. Disiplina Village is the biggest in-city relocation project in the Philippines located in Valenzuela City (Cities Development Initiatives [CDIA], 2019). It has housed 4,800 informal settlers since 2011. Some of the residents are street waste collectors.

Valenzuela City's Environment

With the booming economy of Valenzuela City, its industries also need appropriate technologies to resolve the waste that the city produces. The report of the World Bank in 2001 as mentioned by Magalang (2013) states that Metro Manila cities are generating 25% of the Philippines' total waste.

There are three major rivers in the Valenzuela City. These are the Tullahan, Polo, and Meycauayan rivers (CDKN Global, 2015). The source of water in the Tullahan River is the La Mesa Dam. The Tullahan River is connected to various rivers such as the Pasig River in the south and Rio Grande de Pampanga in the north. The name of the Polo River came

from the City's former name. This river connects the Tullahan and the Meycauayan rivers. The Polo River also drains its water to the Marilao River. The Meycauayan River, formally known as the Meycauayan-Marilao-Obando River, runs from Brgy. 169, North Caloocan on the east to Manila Bay on the west, passes the Northern Caloocan and Northern Valenzuela from Manila, and the Southern Meycauayan and Obando from Bulacan, and empties into the Manila Bay.

The Philippine government is serious with its Manila Bay cleanliness drive thus nearby rivers contributing to pollution in the bay should be cleaned as well. Two rivers of Valenzuela City contribute to Manila Bay's pollutants. In 2014, "Bantay Ilog" or "River Watchers" was launched by the government of Valenzuela City aimed to control water pollution and enforce the Clean Water Act. Bantay Ilog is under Ordinance Number 133, Series of 2013 (Melican, 2014). Despite this, Valenzuela rivers remain polluted.

SIGNIFICANCE OF THE STUDY

Residents of Valenzuela City

This study may be significant to the residents of Valenzuela City as this study may bring attention to the authorities to solve the problem of pollution in the city.

General Public

This study may benefit the General Public as the solution in solving the pollution in Valenzuela City may also be adapted to the whole country.

Department of Science and Technology

This study may be significant to DOST because through this study appropriate technologies needed to solve the problem of air, water, and soil pollution may be created and funded by the agency.

Academe

The Academe may benefit from this study as this will inspire them to participate in research that benefits the General public.

LITERATURE REVIEW

The data collected supported the conducted survey. The problems in Valenzuela City remain unsolved due to several reasons. Pollutants are seen as threats in the city as this can cause health problems amongst the residents of the city.

Industrial Wastes

Categorized into three forms, industrial wastes are identified as solid, liquid, and gas which can be hazardous or non-hazardous. While nonhazardous wastes can be recycled and put into good use (Roy & Ahmaruzzaman, 2022), hazardous wastes pose a danger to people's health. The article published by the United States Environmental Protection Agency (2023), states that hazardous wastes may result in different illnesses such as difficulty in breathing, irritation of the skin or eyes, nausea and headaches, and other illnesses like birth defects, behavioral abnormalities, cancer, physiological malfunctions, and physical deformation.

Evidence on the Effects of Non-recycled Waste on the Environment, Animals, and Human Health

Based on the key facts provided by Plastic Oceans International, there is approximately more than 380 million tons of plastic waste being produced every year 50 percent of which is intended for single-use purpose only. Only less than 9% of this plastic waste is being recycled, the rest is ending up in landfills and such. These processed single-use plastic goods can only be used for a very short period, but it can take hundreds of years until they are completely decomposed. Due to improper solid waste disposal and negligence, about 10 million tons of this single-use plastic ends up in the oceans yearly which is equivalent to more than a truckload of garbage for every passing minute. These plastic wastes ended up killing about one million marine animals and humans unknowingly have been consuming an average of 40 pounds of plastic in their lifetime since cooked marine animal is one of their favorite foods.

Plastic Production: Benefits and Disadvantages of Recycled Plastic in Comparison with Virgin Materials

Plastics are cheap, lightweight efficient, and extended that can be easily molded into a wide range of items that are used in a variety of uses. As a result, over the past 60 years, plastic production has increased considerably. However, present levels of their use and disposal create many environmental challenges. Approximately 4% of the world's oil and gas production, a non-renewable resource, is being used as raw material for plastics, and another 3-4% is spent on generating electricity. A large portion of the plastic manufactured annually is used to manufacture disposable packaging or other short-lived

items that are wasted within a year after production. These two results also prove that plastics' present use is not acceptable. Moreover, large amounts of wasted end-of-life plastics are collected as waste materials and in natural environments worldwide due to the polymers' extreme toughness (Hopewell et al., 2009).

Solid Waste

Waste management has been challenging not only in the Philippines but all over the world. While different policies have been developed to resolve these issues, there are several fundamental issues concerning their efficient implementation, such as the leadership's political will and capacity, effective waste management technologies, and awareness. Community members' ability to work as a group can achieve more sustainable waste management practices. Cities, municipalities, and barangays have the primary responsibility for disposing of solid waste under RA 7160 (Local Government Code of 1991). In its attempts to implement changes to the existing solid waste management (SWM) scheme, the government adopted Republic Act No. 90033 (Ecological Solid Waste Management Act of 2000). Solid Waste Management (SWM) has been described as one of the Philippines' big urban environmental problems (Aguinaldo, 2008). A Filipino produces about 0.3-0.7 kilograms (kg) of waste per day, and in 2000 the annual production of waste was estimated at 10 million tons, with a projected increase of 30 percent in 2010 and continuously increasing to 2020 40% more (World Bank, 2001).

According to Subido (2019), it is estimated that 163,000,000 plastic sachet packets, 48,000,000 shopping bags, and 45,000,000 thin film bags are being thrown daily. A controversial dumping of waste materials to the Philippines from the United States of America in 2018 with approximately 3,000,000 kilos of recycled plastics was reported (Fonbuena, 2019). In May 2019, shipments of trash arrived in Mindanao International Container Airport which reportedly came from Australia and Hongkong (Mogato, 2019).

One of the best ways to reduce plastic waste in Valenzuela is to recycle them. Recycling reduces the use of fresh raw materials and reduces energy use (Nemerow, 2005). Reducing the need for “conventional” waste management and reducing water and air pollution from landfills reduces greenhouse emissions. The non-biodegradable waste consists of 50 percent equivalent plastic, tetra pack, styrofoam, and rubber. The biodegradable waste consists of 70% food scraps, 20% agricultural waste, and 10% livestock manure.

Air Pollution

The 2016 WHO Global Urban Ambient Air Pollution Database shows that 80% of the people living in urban areas are exposed to air quality levels that exceed the WHO limits (WHO, 2016). The trend is alarming due to the clear linkage of air pollution and its effects on health such as respiratory diseases, pulmonary insufficiency, and mental disorders

(Manisalidis et al., 2020). The Philippines had not been an exemption as the reported primary causes of morbidity and mortality in 2010 were mostly respiratory infections (DOH, 2010). The ambient air quality in Metro Manila is not excluded from the world's list of problems with air pollution as records on the presence of air pollutants such as total suspended solids (TSP) and PM₁₀ are higher than the set standard by the regulating government agencies (Regmi, 2017;). In Metro Manila, the identified sources of air pollution are the power plants, industries, and the transport sector with PM₁₀, PM_{2.5}, SO_x, NO_x, CO, and VOCs the primary contributors to air emissions (ADB, 2018).

The rapid urbanization of Metro Manila is correlated with the environmental issues it is facing and Valenzuela City is not an exception. In a study that determined the difference in the presence of black carbon and elemental carbon between urban and rural areas, a comparatively significant difference in the concentrations of the mentioned air pollutants was noted with urban Valenzuela significantly higher than that of those collected from rural Bulacan (Valdez et al., 2020).

With this, Valenzuela City, being an industrial district in the northwestern part of Metro Manila gained much attention for environmental research. It is where one of the 13 air quality monitoring stations operated by the Environmental Management Bureau is located (Gonzales, 2017; Espinoza, et al., 2018). Some research on air emissions was done in Valenzuela City. These were the selected areas along MacArthur Highway, Valenzuela City with the recorded presence of carbon dioxide at about 400+ ppm at the maximum during rush hours or 4:00 PM to 8:00 PM (Torres, 2018). The study shows how mobile sources from the transport sector contribute to the city's air pollution system.

While the transport sector is considered the greatest contributor to particulate matter pollution in Metro Manila, industries have their part (ADB, 2018). The presence of air particulate lead pollution in Valenzuela City was recorded and was seen to be in association with battery recycling activities in the area (Pabroa et al., 2011). Valenzuela City industries were also part of those that were studied for the modeling of particulate matter dispersion in Metro Manila (Cruz et al., 2018).

However, the presence of air pollutants in Valenzuela City is not only evident in the recorded data coming from analytical instruments installed in the area. The burning of plastics in recycling plants is also a growing concern as it results in pungent smells that cause the nearby residents discomfort and claim as a cause of respiratory illnesses (Fonbuena, 2019). These imported and local plastics when recycled without proper air filters cause a very strong burning odor that can travel across the neighborhood. For instance, Canumay West suffered more than months of pungent air due to plastic recycling in 2019. Air from plastics may include toxic substances such as trichloroethane, acetone, methylene chloride, methyl ethyl ketone, styrene, toluene, benzene, 1,1,1 trichloroethane, sulfur oxides, nitrous oxides, methanol, ethylene oxide, and volatile organic compounds. There was no reported data on these substances in Valenzuela City.

However, it is estimated to be 14% of the air of a plastic recycling neighborhood in the United States (Ecology Center, n.d.).

Inefficient Recycling

A 2008 study by the Ex Corporation identified key issues of scrap plastic recycling in the Philippines as (a) a Low ratio (less than 10%) of the use and utilization of scrap plastics (b) Strong dependence on foreign procurement of plastic resins and products to meet the domestic demand and (c) Difficulty in collecting high-quality scrap plastic materials due to mixed discharge with other waste at generation sources. These problems are also the basis for questioning the effectiveness of recycling in managing plastic waste.

Water

A February 2019 GMA news report showed a creek in Bulacan as contaminated and identified Valenzuela City as the main source indicating recurring problems in the wastewater disposal in Valenzuela City Industrial Plants. Residents have also seen color changes to the Valenzuela City creeks. A YouTube video on water pollution at the Brgy. Isla was also uploaded providing insights into the negative changes happening to one of the Valenzuela City rivers (GMA News Online, 2020).

Barangay Isla in Valenzuela City has a river that has become a dumping site for a large amount of trash where plastics and other wastes are directly thrown into the river (Tagle, 2019). Despite being an area of interest, there were only a few data published in scientific journals on the technology used by the industries in Metro Manila.

Types of Waste Being Recycled

Two major recycling industries in the Philippines are importers and exporters and domestic end users (Japan International Cooperation Agency [JICA], 2008). However, in 2019, the exportation of plastic waste has been banned (Teves, 2019). The solid waste in the Philippines is collected from various stakeholders. There are three types of solid waste collectors in the Philippines - street collectors, collection workers, and disposal site collectors. Most of the waste collected is waste/scrap papers, scrap metals (iron and aluminum), scrap glass, scrap plastic, and used electric and electronic home appliances (cellular phone batteries, personal computers, TV sets, and refrigerators). Collection workers are part of the Department of Public Service (DPS), city administrators, engineering offices, or private haulers (Castillo & Otama, 2013).

Plastics such as HDPE, LDPE, PP, PS, PET, HIPS, PVC, and others are being collected. Papers (newsprint, office paper, other white grades, corrugated cartons, paper boxes, etc.), car batteries, computer electronics, tin cans, metals, container glass, flat glass, tetra pak, and tires are among the wastes that can be sold separately to specialized recyclers.

Valenzuela as Plastic City

Known as the Northern Gateway to Metropolitan Manila because of the major highways traveling it—the North Luzon Expressway and the McArthur Highway. As an urban city, Valenzuela also became home to different manufacturing companies, including recycling plants that emit a pungent smell to its neighborhood (Waste360, 2019).

With more than 200 plastic and rubber manufacturing companies, Valenzuela City has remained the plastic capital of the country since 2012 (Braganza, 2017). The reported disposal site for Valenzuela City is at the Barangay Lingunan facilitated by the city administration (Asian Development Bank [ADB], 2004). It consists of a seven-hectare landfill area out of the 13-15 hectares total area surrounded by green grasses and small trees (ncr.emb.denr.gov.ph). There are an estimated 80 waste pickers at the dumpsite with 180 Tonnes daily importation. It opened in 1999 and operated exclusively for Valenzuela City after the formulation of DAO 98-49 and DAO 98-50 and the enactment of the Clean Air Act (ADB, 2003). One of the disadvantages is that it is located in a flood-prone area (Mateo & Lagdameo, 2005; Cities Development for Asia, 2020). The landfill is also surrounded by industrial and residential development. It is also adjacent to the Maysan creek. Ground and surface water contamination from waste may also occur.

According to the ADB report, there was possible access to unauthorized waste pickers thereby prompting the administration to build walls. These are a few of the risks of the landfill. Mitigating measures suggested by the ADB for water contamination were (i) detailed groundwater evaluation (a) to further ascertain the level and extent of groundwater contamination; (b) design and installation of a leachate collection, recovery, and treatment system; and (c) design and installation of a groundwater “barrier” system to attempt to contain the extent of contamination, (d) installation of an “industry standard” cover system; (e) improved surface drainage; (f) installation of surface water diversion, containment, extraction, and treatment systems; and (g) an enhanced monitoring program. For landfill gas (LFG) emissions, ADB suggested (a) installation of an “industry standard” cover system (b) installation of an LFG collection and treatment system; and (c) ongoing surface and sub-surface monitoring and testing.

Plastic Neutrality: Efforts of the Industries and the Government

Nestle Philippines emphasized plastic neutrality in 2019 along with Republic Cement, CEMEX Holdings Philippines, Plastic Credit Exchange, and Pure Oceans (Nestle, 2020). Nestle collected a similar amount of plastic waste to what they produced and converted it to cement kilns as an alternative fuel. It was estimated that the plastics collected were 2,400 metric tons in just a month. They also coordinated with local government units including Valenzuela City.

San Miguel Corporation (SMC) along with North Cement Corporation (NCC) are also converting plastic wastes to energy (SMC, 2020; Philippine News Agency, 2020). They coordinated with LGUs for collection and were given an Environmental Verification Certificate by the Dept. of Science and Technology's (DOST) Industrial Technology Development Institute that verified the high biodegradability of the polyethylene product they produced compared to non-biodegradable plastics. In October 2020 alone, approximately 48,000 metric tons of silt and garbage were dredged at the Tullahan River.

Policies

The Republic Act No. 9003 (RA 9003), known as the Ecological Solid Waste Management Act of 2000, is an act declaring the policies of the State to adopt a systematic, comprehensive, and ecological solid waste management program that shall ensure the protection of the public health and environment (Sugimoto, 2008). This act provides for an ecological solid waste management program that creates the necessary institutional mechanisms and incentives, declaring certain acts prohibited and providing penalties, appropriating funds, and other purposes.

Solid Waste Management (SWM) corresponds to a systematic system for the regulation of generation, management of the storage, collection, transfer, and transport of solid waste, processing, and disposal in a manner compatible with best practices in the fields of public health, engineering, conservation, aesthetics, economics, and other environmental considerations.

Concerning the efficiency of the waste management sectors in the Philippines, a study conducted by Pagunsan and Shimada (2012) seeks to evaluate how efficient the LGUs are in their implementation of Republic Act No. 9003 or Ecological Solid Waste Management of 2000 using a two-stage approach. The researchers state that the cost efficiency and economic effectiveness in providing solid waste services were triggered by budget restrictions, increasing cost of solid waste, and the growing importance of the said services in the economic development of a country.

First, the study concluded that LGUs with higher income and good environmental governance can obtain better performance, and having a rapid case of population growth can worsen the LGUs' performance. Second, strengthening the community-based solid waste management system at the barangay level can improve LGUs' performance. Lastly, the implications of the mixed influence of land area, poverty incidence, and ownership of disposal facilities are case-to-case basis. For instance, the greater land area will provide for the establishment of disposal facilities for the nationwide case except in Metro Manila wherein the establishment of disposal facilities for some LGUs is no longer possible. In the case of poverty, integration of the informal sector into the formal solid waste management system can contribute to the efficiency of LGUs.

The Future of the Industry-Government-Academe Collaborations

One of the first manufacturing companies built in Valenzuela was a baby food company that aimed to improve child nutrition in the country (Castro, 2017). It is one of the examples of a government-industry-academe partnership as the company was located at the Valenzuela City Polytechnic College, developed by the Philippine Chamber of Commerce and Industry's (PCCI) Valenzuela chapter, in collaboration with the Department of Science and Technology and the local government. The products were distributed to children of Valenzuela City as part of the feeding program. This project established a good relationship between the Valenzuela City government and manufacturing firms.

METHODOLOGY

Research Design

The study used a quantitative method by surveying the selected Barangays in Valenzuela City. According to Creswell (2017), quantitative research explains a phenomenon by getting data in numerical form which is analyzed mathematically. Jeffrey's Amazing Statistics Program (JASP) was utilized to analyze the data gathered by the researchers.

Selected people of Valenzuela City from its Barangays were surveyed by the four groups of the Surveying team composed of educators, engineers, and scientists from the Metro Manila Industry Energy and Emerging Industry Research (MMIEERDC) spearheaded by the Polytechnic University of the Philippines (PUP) in collaboration with Trinity University of Asia (TUA), Adamson University (AdU), Technological University of the Philippines (TUP) and the Department of Environment and Natural Resources-Ecosystems Research and Development Bureau (DENR-ERDB). They were also interviewed regarding their waste disposal and if they were willing to be of help in attaining technologies suitable to resolve the city's waste problem.

To get pertinent information on the project, the team formulated survey questionnaires before starting to e-mail the companies but due to the pandemic, limited manpower was assigned to operate the companies. It was also difficult for the team to manage to get an appointment with the companies since most were not cooperative with the idea of getting surveyed or interviewed specifically on waste management. Addresses and contact numbers were searched from the internet and some were provided by the staff of the scoping group.

Google mapping of the Valenzuela area was also done by the group to assign people to survey the city. Four groups were created. Penetrating a certain area would be difficult thus, the team coordinated with the mayor's office, the City Environment and

Natural Resources, and Liga Ng Mga Barangay to get an appropriate permit for the survey and interview. The group then made plant visits.

Face-to-face interviews were also conducted aside from the web interview that was launched by the group to establish a dialogue with key personnel who were important in getting information for the study.

Data Analysis

The Survey Process and Methodology

To get appropriate information related to the survey, the team came up with a survey questionnaire. These were disseminated to different companies through emails. Unfortunately, the emergence of the COVID-19 pandemic hampered the onsite data gathering due to limited manpower. Also, scheduling an appointment for actual interviews with these companies added to the concerns of the project team. This was associated with the idea that most companies were non-cooperative in giving information, particularly in waste management. Addresses and contact numbers were searched from the internet and some were provided by the staff of the Survey group.

Google mapping of the Valenzuela area was also done by the group to assign people to survey the city. The Survey team was composed of educators, engineers, and scientists from the Metro Manila Industry Energy and Emerging Industry Research (MMIEERDC) spearheaded by the Polytechnic University of the Philippines (PUP) in collaboration with Trinity University of Asia (TUA), Adamson University (AdU) in collaboration with Bicol State College of Applied Sciences and Technology (BISCAST), Technological University of the Philippines (TUP), the Department of Environment and Natural Resources- Ecosystems Research and Development Bureau (DENR-ERDB), Lithos Manufacturing and University of the Philippines (UP). Four groups were created. The first was a group of researchers from the PUP; the second group was from TUA and DENR-ERDB; a third group was from TUP, Lithos, and UP; and the fourth group was from PUP, BISCAST, and AdU. Penetrating a certain area would be difficult thus, the team coordinated with the mayor's office the City Environment and Natural Resources (DENR), and Liga ng mga Barangay to get appropriate permits for the survey and interview.

The group then made plant visits. Face-to-face interviews were also conducted aside from the web interview that was launched by the group to establish a dialogue with key personnel who were important in getting information for the study. The team also conducted a three-day webinar on selected topics relevant to the needs of the attending companies. The purpose of this event was to have initial data for the survey project. The webinar was responded to with positive feedback from the attendees.

The Survey Schedule

The survey was conducted by selecting respondents from different Barangays in Valenzuela City. This was facilitated by four groups coming from the members of the Survey team from September 2020 to March 2021. The respondents were interviewed regarding their waste disposal. Also, they were asked if they were willing to be of help in attaining technologies suitable to resolve the city's waste problem. The project started in May 2020 but due to the pandemic and other hindrances, it was officially commenced in September 2020 and ended in August 2021.

RESULTS

Key environmental problems were identified by the researchers after getting the results of the survey. These were pollutants coming from the plastic and manufacturing industries surveyed by the researchers, lack of data on air emissions, and lack of knowledge on plastic neutrality. There were 127 industries in Valenzuela City that participated in the survey, the majority belonged to the plastic and rubber manufacturing industries, food manufacturing (15%), textile and paper industries, and metal manufacturing. The result of the survey is in parallel with the list of industries that belonged to the primary contributors to air emissions of PM₁₀, PM_{2.5}, SO_x, NO_x, CO, and VOCs in Metro Manila which included power plants, food manufacturing, paper, and packaging products manufacturing, and small-scale chemical manufacturing (ADB, 2018). More than half of the industries that participated in the survey were small-scale with less than 50 employees each.

In the conducted survey, only 14% of the participating industries mentioned that they had gas emissions which comprised both mobile (54%) and stationary (46%) sources. Many of the mobile sources (94%) belonged to the vehicles that were used for materials transport. Stationary sources comprised of equipment being used in their manufacturing processes such as compressors, grinders, mixers, blenders, and extruders. The remaining 86% of the participating industries claimed that they did not produce air emissions yet had no available records of their air emissions inventory. The survey shows an agreement with the previous research stating that the development of applicable emission inventories in developing countries is challenging due to the lack of data (Cornet, 2017).

With regards to air emissions, among the industries that participated in the survey, 83% claimed that they did not produce air emissions and 17% claimed that their operations emit gas or particulate matter into the air. The air emissions that were mentioned in the survey were particulate matter, total organic carbon (as gaseous vapor), sulfur dioxide, nitrogen monoxide, nitrogen dioxide, ammonia, and carbon monoxide.

Although the energy source is more electricity, some also use fuels to run their process equipment. Included in the fuels that were being utilized were diesel, liquefied petroleum gas, bunker fuel oil, coal, kerosene, wood wastes, foundry coke, and special fuel oil. But no one mentioned carbon dioxide emission even though the industries undergo combustion processes as evident from the presence of various kinds of fuels that they use in their processes and vehicle operations. Moreover, few industries have records of their air emission inventory. This is an indication of the presence of a gap between the result of the survey and the expected output. With this, more detailed research works are needed to come up with a comprehensive air emission inventory of Valenzuela industries that will be used as a baseline for the development of appropriate and sustainable technology that will be used to combat air pollution that is being contributed by the industries.

Results of the survey show that the air emission parameters that were usually being checked were particulate matter, presence of carbon monoxide, sulfur dioxide, total organic carbon, nitrogen dioxide, and ammonia in their respective areas. About 76 percent of the surveyed industries said that they had existing air emission treatment facilities and 21 percent said that they did not have one. The specifications of the existing air treatment facilities that the industries operate were not included in the survey.

Having the results of the survey, the creation of technologies that will solve the problems of Valenzuela City pollution is suggested. Dustin and MaCauley (2001) emphasized the role of technology in cleaning up the environment.

DISCUSSION

With many plastics coming from the industries of Valenzuela City, it poses an alarming state as plastics are considered one of the earth's largest polluters. The companies that participated in the survey comprised mostly of small medium scale but already revealed contributions to air emissions emitting PM₁₀, PM_{2.5}, Sox, NO_x, CO, and VOCs, these are considered the biggest pollutants that pose a danger to the public (WHO, n.d.). Interestingly, more than 80% of the companies that said they were not contributory to air emissions had no record to show which is a major concern for a government agency in charge of air pollution control being handled by the Environmental Management Bureau (EMB) in accordance to the Philippine Air Act of 1999.

Maintaining the quality of air in Valenzuela City is one concern that needs to be addressed. Thus, air treatment facilities should be a must in every manufacturing company that emits particulate air. Though a big percentage stated in the survey that they had treatment facilities, more than 20 percent of the surveyed industries admitted that they had no treatment facilities.

The report of the United Nations Environmental Programme (UNEP) states that air pollution could be cut by 80% by 2040 if existing technologies were used. The creation of new technologies to counter pollution being emitted in the city can also be considered.

CONCLUSION

The study strengthened the status of Valenzuela City as the plastic capital of the Philippines as the industries' wastes were more plastics which could raise an alarming state as plastics are considered one of the earth's biggest polluters. With this condition, some of the city's citizens were not knowledgeable of plastic neutrality.

The survey conducted by the team composed of educators, engineers, and scientists also concluded that it is difficult to apply emission inventories in developing countries such as the Philippines due to the scarcity of data. This holds in the air emissions as only a few industries that participated had records of their air emissions. Thus, more studies are encouraged to be done to accurately measure the air emissions in the city of Valenzuela to create technologies necessary for the city. The Republic Act 9003 also known as the Ecological Solid Waste Management Act of 2000 in Valenzuela City should be strictly implemented.

IMPLICATIONS AND RECOMMENDATIONS

The results of the study encourage strong support for Republic Act 9003 also known as Ecological Solid Waste Management Act of 2000 in Valenzuela City. People of the city should be made aware of the importance of plastic neutrality to be practiced in their community to observe proper waste management. This can be done through seminars and training for the residents of Valenzuela City.

Proper checking of the air emissions of the different industries in Valenzuela City should be done regularly to monitor the air quality of the place. Air monitoring can also be done by having technology that can monitor the company's air emissions. Technologies that can help the city in solving its solid waste management, air pollution, and even water pollution caused by improper throwing of garbage or inappropriate chemicals in the city's rivers should be formulated and proposed to the appropriate agency of the government like the Department of Science and Technology (DOST).

Appropriate funding for the launching of technologies to solve the city's problems with waste should be done. In this aspect, the concerned government agency, DOST should support further the research that aims to solve city pollution. Further studies on pollution control and waste management should be covering a bigger number of manufacturing industries to solve the problem of waste being released by manufacturing industries.

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DECLARATIONS

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Informed Consent

An Informed Consent Form was given to the participant/s of the research wherein the investigator/s explained in detail the purpose of the research, explained the procedures of the study, including the risks and confidentiality of the research.

Ethics Approval

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