

Global Garbage Problem - Addressing Waste Management Woes in Stadiums

Nguyen Duc Thanh

The Center of Physical and Defense Education, Ho Chi Minh City University of Technology and Education, Ho Chi Minh City, Vietnam

Email address:

thanhnhd@hcmute.edu.vn

To cite this article:

Nguyen Duc Thanh. Global Garbage Problem - Addressing Waste Management Woes in Stadiums. *International Journal of Sports Science and Physical Education*. Vol. 4, No. 1, 2019, pp. 1-8. doi: 10.11648/j.ijsspe.20190401.11

Received: December 23, 2018; **Accepted:** January 22, 2019; **Published:** February 21, 2019

Abstract: Sporting events regularly take place in stadiums. To serve thousands of spectators' entertainment needs, in addition to meeting a range of sports activities such as lighting yards, showing scoreboards on screen, watering and mowing grass, the managers also have to spend a huge budget for the collection and disposal after each event. Mixed trash after games is very terrible and could rise up to tens of tons. It takes thousands of hours of work by hundreds of sanitation workers and volunteers to clean them. This situation is a waste and not a few headaches managers. Many solutions have been in place. The most viable one of them is that instead of dealing with garbage passively, it was classified, recycling, reusing, significantly saving money but also protecting the environment. This paper has synthesised efficient solutions for handling waste from the stadium in the world.

Keywords: Environment, Recycling, Saving, Solutions, Stadium, Waste

1. Introduction

All over the world, sports have lured towards fans. There are approximately tens of thousands to hundreds of thousands of people who gather in stadiums to watch and cheer with all their best for every sports game. That is a beautiful culture and a source of endless encouragement to help athletes show their talent. At stadiums, audiences are not only watching, screaming and then sublimating with their happy and sad emotions towards each happening of the game, but also have some legitimate requirements such as eating, drinking and... littering.

Generally, sports industry emits a vast amount of garbage every year. From 2013 to 2014, there were more than 170 million fans filled full stadiums to watch and litter at the major leagues of football, baseball, hockey and international basketball games at venues in the US and Canada. Visitors and fans of those major league discharge more than 1,000 tons of garbage every season and only a small percentage of waste recently is brought out of the landfill. From 2014, the top 200 stadiums, just in the US, draw nearly 181 million visitors each year to the four major professional leagues (NFL, MLB, NBA, NHL), and still, just a small amount of waste after games is recycled

or disposed. [1]

Thereby, it is not difficult to realize that stadiums themselves are the main factor in the weakening of overall local energy and also have impacted the environment severely with their terrible waste. With the explosion of the popularity of sports, many new stadiums have been built, and Waste Management (WM) estimates that the major leagues generate approximately 35,000 metric tons of carbon dioxide (CO₂) each year from their fans' waste activities alone [2]. Therefore, the cost-saving initiatives for a lot of crucial issues consisting of energy, water, especially waste management to apply in activities in stadiums should be considered seriously.

2. Methodology

This study has been collected secondary data from different sources like reports of various organization (such as World Bank, FIFA, LEED), various books, journals, research articles as well as vast data from many web links. Through analyzing those data in different ways for finding garbage problem in stadiums and proposing handling solutions.

3. Results

3.1. Overview of Waste

Waste products are generated from various processes such as human activities, industrial production, agriculture, trade, tourism, transport, restaurants and hotels ... In other words, wastes are things that consumers no longer want to use and reject them. Waste in the stadium is synthetic waste including plastic bags, cans, aluminium cans, glass bottles, cigarette paper box, phone batteries, CDs, packaging baked goods, excessive or discarded food and drinks.

Waste can be classified in many ways following:

- (a) The origins of waste (garbage, office trash, construction waste, medical waste, industrial waste, agricultural waste).
- (b) The state of waste (solid waste, liquid waste; gas waste).
- (c) The chemical properties of waste (inorganic garbage and organic waste).
- (d) The composition of waste consists of biodegradable waste (food, dead animals and plants); hard decomposed garbage (building materials, metal, glass, plastic, nylon).
- (e) The toxic level of waste: can be divided into hazardous waste and non-hazardous waste. In particular, hazardous waste including hazardous items in the treatment of patients in hospitals; heavy metal containing some elements such as lead (Pb), mercury (Hg), Cadmium (Cd) is the germ that causes cancer; radioactive materials generated from the processing of plant breeding, food preservation, mining, energy [3].

Waste management includes activities like collection, sorting and processing of waste. The target is to reduce the adverse effects of litter on the environment and society.

Garbage disposal is to use technical measures to handle waste without leaving adverse effects on the environment, recycling several products which bring social benefits, and promoting economic efficiency. According to the current trend, waste treatment often follows the 3R principle (Reduce - Reuse - Recycle).

Overall, the waste management and disposal in stadiums requires a lot of time, efforts and consumes a huge budget of fund annually. However, if there is a solution to recycle garbage efficiently, it would be a worthy resource serving for many social benefits.

3.2. Waste Situation

3.2.1. Waste - A global Problem

Today, environment protection, including the disposal of waste, is a global problem. In 2012, the World Bank (WB) warned of a garbage crisis which was becoming more severe and created enormous financial and environmental burdens to the governments over the world. In 2013, as estimated by the Blacksmith Institute, an environmental watchdog based in the US, there were over 200 million people in developing countries who are at risk of health damage caused by

pollution.

Regarding electronic waste, in 2013, the United Nations issued a report saying that the amount of eliminated electronic products will rise to 65.4 million tons per year globally.



Figure 1. Scavengers collect valuable waste at Sidoarjo garbage dump in East Java, on June 5, 2018. CREDIT: JUNI KRISWANTO [4].



Figure 2. Children collect plastic water bottles among the garbage washed ashore at the Manila Bay. According to the United Nations Environment Programme, at current rates of pollution, there will likely be more plastic in the sea than fish by 2050 [5].

Regarding plastic waste, according to the research data from 24 expeditions on the oceans for over six years (announced on 12.10.2014) noted that there are about 27,000 tons of plastic waste, including types of bottle jars, bags or old toys floating and polluting the ocean surface worldwide [6].

A study in 2010 said that there are about 8 million tons of plastic garbage deposited in the oceans from coastal states, higher than the total amount of garbage floating on the surface of the ocean [7].

In 2013, the volunteers of Ocean Conservancy's International Coastal Cleanup already collected more than 11 million products (second highest amount collected throughout 27 years of the event). Here are the various types of waste which were found the most:

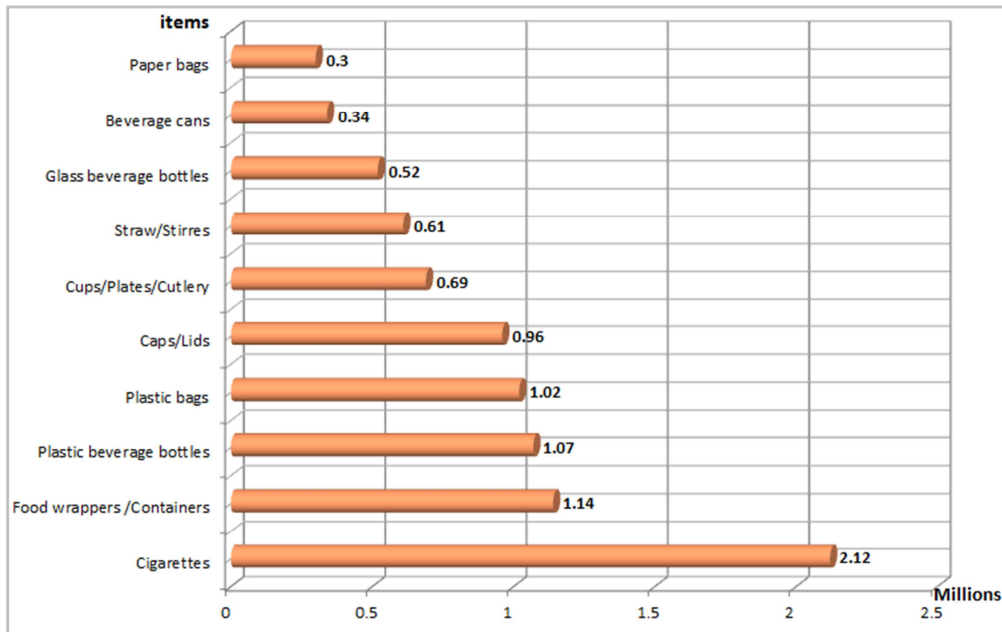


Figure 3. Ten most common types of waste on beaches in the world [8].

Through finding the missing plane (MH370) recently, a horrifying amount of waste was accidentally discovered, which warned of environmental pollution and required some necessary measures to protect marine life.

Plastic waste is most concentrated in the north Atlantic, which receives waste from the US, Canada, Mexico and Europe. According to scientists' estimation, the landfill in the Indian Ocean may have 5 million km² in size, but it has no clear boundaries and can even change with the seasons. [9]

The recent study also identified the top 20 countries the waste dumped into the ocean. The result is that China ranked first, the United States ranks 20th, the rest are on the list include: 11 different Asian countries, Turkey, five African countries and Brazil.



Figure 4. Top 10 sources of ocean's plastic waste [10].

The experts of the World Bank (WB) estimates that by 2025, the total amount of garbage discharged urban residents will be 2.2 billion tonnes/year - an increase of 70% compared to the current 1.3 billion tonnes, while the cost of solid waste disposal is expected to reach \$ 375 billion/year, compared to 205 billion at present. [11] It is an enormous rate of growth!

With an increase in urbanization and size of population in the world, global waste may grow by 70 per cent by 2050,

says a World Bank Report in 2018 [12]

3.2.2. Waste at Stadiums

Many sporting events such as the Olympics, World Cup, World Championships, ... is an opportunity for spectators coming to stadiums to gather and lively enjoy the world sporting talented masters. After the fun is over, dozens of battlefields strewn with garbage everywhere is what the cooperation have struggled to cope with. The culprit is none other but the "God" from all over the seating and sidelines of stadiums.

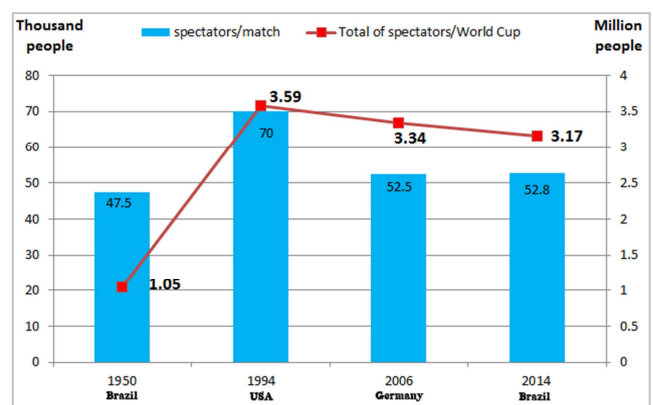


Figure 5. Number of spectators, the protagonist of waste, through World Cups.

It had been recorded that an average of about 5 tons of garbage scattered in and around the stadium after each game in the 2014 World Cup. To deal with this situation, the host country, Brazil, had trained about 850 workers just to make hygiene for 12 stadiums serving World Cup.

According to statista.com, the statistic depicts the average per game attendance of the five major sports leagues in North America (NFL, MLB, NBA, NHL and MLS). The average

per game attendance at National Football League games was 67,042 during the 2018 season. [13]

A study at 25 locations and various events in California in 2006 showed that, on average per day, every guest who attended the event discharged approximately 2.44 pounds of waste (1 pound = 0.45 kg). [14]

According to the statistics from some stadiums in the US, there are about 40 tons of various waste collected in the field and the areas around Beaver Stadium in Park University Campus of Pennsylvania after each game of the host. This figure of the University of Michigan Stadium is approximately 400m³/match, equivalent to 2.400 m³/season. Additionally, Sanford Stadium, the campus of the University of Georgia, transported an average of 34 tons of waste to the local landfill (2008).

This situation is wasted because it consumes a huge budget for the clean-up process and makes many troubles to the managers. Many solutions are presented, instead of dealing with garbage passively, it is classified, recycled, reused; saving considerable money and also protecting the environment.

3.3. The Solutions and Recycling at Stadiums

Most of the waste at stadiums is often buried in dumps (sanitary landfill). That is the form of the most rudimentary and economical in all, but it left many disadvantages such as requiring the broad areas of land, affecting residential areas with stench which may cause diseases, affecting the environment seriously and especially not making uses of the recyclable raw material.

Besides, some waste landfilled need much time to decompose. Leachate will soak freely down into the ground and cause water pollution, adversely impact to human life.

In order to solve this situation, a series of questions are listed to how to dispose of waste sparingly, effectively without adversely affecting the environment. How to re-use things were thrown away, even how to turn trash into treasure? Many environmentalists and managers of waste disposal at the stadium all over the world have applied various solutions effectively to this problem.

3.3.1. Using Recycling Bins and Solar-Powered Self-Compacting Trash Bins

Rather than leaving the garbage disorganizedly, the managers have used the recycling bins located throughout the stadium with three different colors: green for normal waste, magenta for the plastic bottles, aluminium cans and glass bottles and grey for compostable items (such as food, napkins, paper products and pizza boxes). It has substantially reduced the time to sort trash, and it is also very convenient for recycling in the next steps.

Specifically, at the Gillette (Massachusetts), many recycled bags are located in the parking lots and compactors used to collect bottles, plastic cans are available throughout the stadium. Fenway Park (Boston) has 100 new recycling bins placed throughout the yard, recycling more than 24 tons of bottles and cans each season. Qualcomm Field (California)

offers 350 recycling barrels (94 gallons area; 1 gallon = 3.78 liters) in the waste disposal area. Folsom Field (Colorado) replaced all outdoor trash with recycling and composting bins. Recycling is also one of the greatest success stories at the University of Maryland. The campus institutional proportion increased from 17 percent in 2003 to an impressive 89 percent in 2014.

Installation a series of bins throughout the stadiums is, of course, necessary, but they often have limited capacity. Furthermore, the bins usually contain many different types of waste so that they should be easy to be full quickly, and garbage spilled out which causes unsanitary and offensiveness. In order to solve this situation, self-compacting trash bins use 100% solar power called BigBelly Solar Compactor is a perfect solution.

With many outstanding features, for example, they just occupied the space of a normal garbage container (800 liters), but thanks to the ability of cutting and compressing garbage so its capacity increases by 5 times; therefore, they increase the ability to contain garbage, reduce garbage collection trips and cut fuel use down to 80%.

Throughout the solution above, a large amount of money that has been spent on labor wage rate, fuel and maintenance cost can be saved, as well as the environmental benefits from reducing Greenhouse effect and other pollutants. This kind of trash bins is very safe, easy to use in all weather conditions and is designed to evade insects, cattle, and is suitable for public, especially stadiums.

3.3.2. Construction Unburied Solid Waste Treatment Areas

Nowadays, stadiums all around the world are attempting to obtain “non-waste”, which means that 90% of garbage should be recycled instead of being brought to landfills. Specifically, many of the solid waste treatment plants are constructed within the area of the stadium. These factories are invested with technological chains to treat unburied solid waste thoroughly without landfills or emissions of secondary pollutants into the environment, and produce renewable energy products from solid waste. These plants are invested in the technological line for processing unburied solid wastes thoroughly. They are not polluting to the environment and creating of renewable energy products from solid waste.

Pioneering for this, Washington Nationals Stadium (Washington, D.C) has earned the LEED Certification (Leadership in Energy and Environmental Design) for using energy efficiently thanks to a center of waste recycling inside the campus. Also, Cardinals Stadium (Arizona) can recycle about 120 tons of waste each year.

In Vietnam, Chi Lang Stadium (Da Nang) with a capacity of 30,000 seats, discharge a sizable amount of garbage annually. To solve the problem, Da Nang inaugurated the solid waste treatment complex in January 2015. The complex has a total area up to 10 ha with the 900 billion invested capital. The factory was equipped with technological chains to treat the solid waste thoroughly without landfills or emissions of secondary pollutants into the environment and produce renewable energy products from solid waste. [15]

3.3.3. Waste Separation and Recycling (the Solution of Sorting and Mechanical Treatment)

The artisanal of persistent components in solid waste has lots of meanings, contributes to reducing landfilling and minimizes pollution from waste as well as regenerating and saving areas for landfills.

With this method, organic waste will be brought into anaerobic firing lines to produce biochar; glass bottles and debris will be heated to get rid of polluted components and comminuted, mixed with additives to produce unfired bricks which are used for public and civil construction. All of these products will have to be verified to make sure they meet the requirements in quality according to the industry standards. To prepare for the 2018 world cup in Russia, the organizers have prepared well for garbage collection by posting instruction labels on trash bins. This makes the sorting and recycling process happen quickly and efficiently.



Figure 6. Labels used on top of bins at the FCC Draw in Kazan [16].

Arrow Ecology - an Ecology Company of Israel (widely deployed all over the US, Australia, Greece, Mexico and UK) has developed the Arrow Bio System towards this method and treated up to 150 tons of waste per day, recycled more than 70% of waste for their stadiums.

Moreover, Safeco Field Stadium is the most successful one which has saved around 1 million USD in the past three years by recycling 80% of waste from sports competitions.

3.3.4. Recycling of Nylon, Discarded Plastic Bottles into Industrial Fuel Oil and Useful Widgets

Plastic items are getting more and more common, but its persistent attributes are a severe problem for the environment. Besides, used nylon bags being thrown out everywhere in and outside campuses of stadiums is also one of the causes that create sewer system blockage. According to statistics, India currently has the severest plastic waste pollution in the world.

At the stadiums, after the solid waste is classified (into 3 main components: nylon, organic debris, rocks - debris - glass bottles), nylon will be brought into cracking pyrolysis chain (chemical reactions process in order to break the long hydrocarbons chain into short hydrocarbons) to produce PO, RO and FO oil (Fuel oil or Mazut oil). Chemical biowaste is filtered out from garbages can also turn into biodiesel for

vehicles in circulation, internal combustion engines of the ship or being used as fuel in industrial furnace boilers, furnaces, incinerators volatile type, a chimney type, ...

In Vietnam, the technology of converted solid waste (nylon) to PO and RO oil was first applied in 2012 by Vietnam Environment Joint Stock Company (Hai Chau District, Da Nang City). With the proportion of 8% nylon contained in 650 tons of domestic waste within Da Nang City, the factory can produce about 17 tons of PO and RO oil per day.

Besides, garbage is recycled in order to produce a lot of other useful items. Non-governmental Organization Converse (since 1999) found out how to recycle plastic by using high temperature to melt, shape and then turn it into household items, shoes, handbag and colorful jewelry. In 2014, Nike – one of the leading producers of sports products built a store made complete from garbage called “X-158 Hyper Nature” in Shanghai (China). The store was designed by Miniwiz Designer Company (Taiwan) and built from 5500 aluminium cans, 2000 PET bottles and 50000 old CDs and DVDs. [17]

In addition, Janguito Malucelli Stadium (the first biology stadium of Brazil) quipped 6000 seats within the green grass field. The designers also used recycled wood to build this stadium. At New Meadowlands Stadium (New Jersey), the seats in the grandstand area are made from recycled plastic, and the Environmental Protection Agency was consulted for the construction of this stadium.

3.3.5. Turning Garbage into Clean Energy

Lagos (Nigeria) have adopted this technology effectively. The city is attempting to turn environmental problems from the urban areas, the stadiums into its advantage by transforming trash into methane gas to generate electricity.

The process is conducted as follows: First of all, the food of plant origin and damaged fruit are put in a chamber. Then, after crushed into powder, they are put into a tank with 20m³ volume and are fermented to produce gas. Next, the gas is pumped to an upper chamber else. After that, waste is taken out and used as agricultural fertilizer. Finally, gas is filtered and put up generators to produce electricity.

3.3.6. Using Recycled Paper and Water Cups from Cornstarch Material

The idea of using corn sugar to help reduce solid waste from catering services for fans was implemented by the cooperation of multi-national Company Cargill and Nature Works, LLC (biggest polylactic acid polymer manufacturer in the world)

In Target Field of US, the Minnesota Twins baseball team's hometown, located only 21 kilometers away from Cargill, this baseball team had signed a 3-year contract with a catering service manufacturer to supply thousands of cups, spoons, trays, eating utensils and straws made of Ingeo materials. With that, all of these items can be mixed with crumbs to make organic waste.

Progressive Field (Ohio) has made a green campaign at their stadium through recycling all the paper, cartons, aluminium, metal scrap, battery..., whilst using recycled

paper on the grandstand and water cups from cornstarch material in the franchised areas.

3.3.7. Waste Treatment by Packet Compression Techniques and Hydromex

Packet compression is performed by the whole waste of the stadium collected and gathered to the plant. First, waste is assorted manually, things that can be recycled are categorized, the others are being moved to the hydraulic compression system with the purpose to maximize the volume that forms the packet. These packages are used with different aims such as dike, groin, flattening the lowlands after having covered layers of sand and soil.

Hydromex is a new technology and first applied in America. It is actually a trash grinder, and then the trash is polymerized and used an enormous pressure to compress the products into shape. With this technology, waste from the stadiums will be processed and made into materials, products to serve construction and useful agricultural products.

3.3.8. Decomposing Grass Clippings, Then Brewing Till Fermenting to Make Compost

The most important professional request for the performances of the athletes in a match is that the sports industry must be at the standard size. According to the sports features, the competing process takes place indoor or outdoor, and many different materials will be covered on the field surface to serve the activities. There are varieties of sports fields, from wooden, rubber mats, bakelite, cinder tracks to artificial grass..., but the most popular, oldest and most suitable for all the team competition games at the stadium (football, baseball, rugby) is the natural grass field. The grass must be well-taken care and weekly evenly cut at a fixed length.

The campus with its acreage of thousands m²/field, the amount of waste after every cut is enormous, and it will waste a lot of time, money and effort to collect and dispose of the garbage. Lincoln Financial field (South Philadelphia) has a practical solution is that grass clippings are collected from decomposing, after that they will become compost which helps reduce the amount of fertilizer and water necessary to maintain a green field.

In 2004, SBC Park (California) - San Francisco Giants baseball team's ground (42.000 seats) ran the recycling program - brewing waste. In progress, the managers, suppliers, and contractors actively retrieved: papers, cartons, grass, leftovers. Every match they collected around 12 masses of organic compounds, after which they will be mixed by the waste treatment system called Norcal Waste Systems. At the end of every match, SBC Park collected more than 1.760 tons of raw materials and saved more than \$100.000. [18]

Folsom Field of Colorado University in Boulder and its stadium in Ohio (America) were typical proofs for this issue when they announced that: There's no need to have trash bins because everything which is sold inside those stadiums when the matches take place can be recycled or composted.

3.3.9. Recycle Vegetable Oil and Grease into Organic Diesel

When cooking oil is being re-boiled times to times at a high temperature, it will be oxidized, polymerized so it lost all the nutrition, especially when food is burnt in grease environment it will become carbon residue, which is a cause for cancer, cardiovascular disease, Parkinson, amnesia, and liver connected diseases.

Besides causing harmful effects to human's health, directly eliminating vegetable oil into the environment will also pollute the water, soil, air seriously. Meanwhile, the sacked vegetable oil has the same ingredients as the vegetable oil, which is very fit to apply as biomass sources to produce organic material.

In order to tackle this problem, in 2008, the Kobe University in Japan cooperated with industrial firms to present a method which allows transferring used oil to biological fuel (Biodiesel) by using genetic changes in viruses. The managers of Lincoln Financial Stadium also applied this method to convert used vegetable oil and grease (after cooking for a huge amount spectators) into biodiesel, and then it is used to provide energy for lawn mowers of the stadium.

On the Scheme on the Development of Biofuels up to 2015, with a vision to 2025 was compiled by the Minister of Industry and Trade and approved by the Prime Minister of the Government in 20th November 2015, up to 2015, Vietnam produces 250 thousand tons of ethanol and vegetable oil. It can be mixed to produce 5 million tons of E5 (a mixture of 5% biodiesel and 95% gasoline) to supply 1% of the national requirement. [19].

3.3.10. Dispose Rubbish by Burning and Using Output Energy

Burning the rubbish will reduce minimum waste for the final step which has a profoundly positive effect on protecting the environment. The energy output can be used for boilers, fireplaces or traditional energy industry and electrical power industry. However, this solution is often applied in developed countries because it is more expensive than buried rubbish.

On the other hand, the use of energy from cremation is quite common in Europe, especially Sweden. After burning the body of dead people, cremation is transferred to the atmosphere up to 8000°C. It is wasted that this energy is evaporated uselessly and pollute the atmosphere. Therefore, Redditch Borough Council in England revealed an idea which uses waste heat from a crematorium to heat Abbey swimming pool in local centers; it is considered to save £14,560 a year.

Similarly, Le Manh Ha, the Vice Chairwoman of the People's Committee, evaluated that 80% of countries around the world dispose of garbage by burning for electricity, Singapore accounted for burning 100% rubbish. Every day, Ho Chi Minh City discard about 7- 8 thousand tons of garbage, organic waste occupied for nearly 82%. Ho Chi Minh City will build the first factory that will burn rubbish to gather energy in Vietnam. They invested about 180 million

dollars in the factory and estimated to refund in 14 years if the capacity is a thousand tons a day. [20].

3.3.11. Waterless Urinal

It is estimated that in World Cup 2010, South Africa spectators consumed over 2.4 million liters of beer and approximately 400 thousand sausages. Thus, the demand for public toilets increased significantly. In order to limit liquid waste and save water, traditional toilets for man are replaced by waterless urinals in schools, offices, libraries, public transportation and especially in stadiums. Those require lower setting fees and service security. Each one costs from 200 to 350 USD, but it is calculated to save about 40 thousand gallons of water per year (around 200 USD). The principle is used a slight piece of liquid which undergo waste from human but avoid the smell. As a result, the amount of water for flushing toilets is reduced and also save money paid for electric bills.

In America, Staples Center received ISO 14001 Certificate form Environmental Management System because of saving 7 million liters of water a year from this toilet (2010). Besides, Meadowlands Stadium is the first stadium in American Rugby League that operated 600 Kohler Steward waterless toilets (model K- 4918). By using those, they saved 2.7 million liters of water a year, cut down the flow to sewers and decreased the demand of water use around 20% to 25%; it also declined 20% of power uses in matches and 1 million

gallons of consumption water each year.

3.3.12. Establish Group of Volunteers to Collect Rubbish and Educate Community Concious

Stadiums staffs are not only facing with garbage alone but are also assembling teams with hundreds of volunteer members to collect rubbish and educate consciousness to the community about putting garbage in the right places according to its classifications, banning food from the outside of stadiums, and just using recyclable products from the stadiums.

Japanese is the most excellent example of environmental consciousness in stadiums. Every time they attend a festival or a sports event, they always keep their stands clean. This habit is obeyed by all Japanese spectators even when they are not in their country. In the history of World Cup, Japanese spectators always set a good impression to others; they also energetic cheer the host and politely behave whenever they win or lose. Moreover, they nicely impress worldwide soccer fans by collecting garbage after the match or clean the stand. Similarly, Brazil, China, and Vietnam spectators join in cleaning stadiums after matches.

There are many practical solutions for disposing garbage around the world which can be applied to the sports industry, especially in stadium campus with the purpose of achieving highly conservative value and significantly reduce pollution.



Figure 7. Japanese spectators gave a good impression in World Cups (2014 and 2018) because of their enviromantal conciousness and made people admire [21].

4. Conclusion

Many valuable inventions were applied to many stadiums worldwide such as: using solar power, withdrawing rainwater to serve irrigation, especially this article has summed up 12 types of solutions for recycling and disposing of waste.

This applying has brought many practical benefits: saving energy, cost, cutting down pollutants that cause Greenhouse effect and raise people's awareness of environmental protection.

There are many solutions to solve the waste problem at the stadiums worldwide efficiently. It depends on the specific conditions of each area, country, local, different types of

solutions will be flexibly performed. If these solutions can be deployed simultaneously, hope there will be a new expectation of the worldwide green stadium models.

References

- [1] Readymag.com (2018), LEED in Motion Venues. Retrieved from Readymag.com website (<https://readymag.com/usgbc/venues/leed/>).
- [2] WM.com (2013). Sustainable Stadiums & Arenas. Retrieved from WM.com website (<https://www.wm.com/sustainability-services/documents/insights/Stadiums%20and%20Arenas%20Insight.pdf>).

- [3] Nguyen Xuan Nguyen, Tran Quang Huy (2004). The technology of solid waste and garbage disposal. Ha Noi: Science and Technology Press.
- [4] Telegraph View (2018), Let's be honest about recycling. Retrieved from Telegraph Media Group website: <https://www.telegraph.co.uk/opinion/2018/10/19/honest-recycling/> [Accessed October 19, 2018].
- [5] Cook Islands News (2018), Plastic swallowing our oceans. Retrieved from dangcongsan website (http://dangcongsan.vn/cpv/Modules/Preview/PrintPreview_E_n.aspx?co_id=30293&cn_id=721096). [Accessed May 28, 2018].
- [6] Audrey McAvoy (2014). Study: 270,000 tons of plastic float in the ocean. The Retrieved from The Jakarta Post website (<https://www.thejakartapost.com/news/2014/12/11/study-270000-tons-plastic-floating-oceans.html>). [Accessed December 11, 2014].
- [7] Laura Parker (2015). Eight million tons of plastic dumped in ocean every year. Retrieved from National Geographic website (<http://news.nationalgeographic.com/news/2015/02/150212-ocean-debris-plastic-garbage-patches-science/>). [Accessed February 13, 2015].
- [8] CBC News (2014), Malaysia Airlines Flight MH370 search shows extent of ocean trash . Retrieved from cbc.ca website (<https://www.cbc.ca/news/technology/malaysia-airlines-flight-mh370-search-shows-extent-of-ocean-trash-1.2594539>). [Accessed Apr 01, 2014].
- [9] Ariel Schwartz (2013). The 10 types of trash that are littering our beaches. Retrieved from Fastcompany website: <http://www.fastcoexist.com/1682053/the-10-types-of-trash-that-are-littering-our-beaches>. [Accessed May 16, 2013].
- [10] Laura Parker (2015). Eight million tons of plastic dumped in ocean every year. Retrieved from National Geographic website (<http://news.nationalgeographic.com/news/2015/02/150212-ocean-debris-plastic-garbage-patches-science/>). [Accessed February 13, 2015].
- [11] Deutsche Welle (2012). World Bank warns of growing global waste mountain. Retrieved from Deutsche Welle website (<http://www.dw.com/en/world-bank-warns-of-growing-global-waste-mountain/a-1600713508/06/2012>). [Accessed June 08, 2012].
- [12] Reuters (2018). Global waste could grow by 70 percent by 2050 as cities boom, warns World Bank. Retrieved from swachhindia.ndtv.com website (<https://swachhindia.ndtv.com/global-waste-management-world-waste-to-grow-as-cities-boom-warns-world-bank-25247/>). [Accessed September 26, 2018].
- [13] Statista.com (2018). Average per game attendance of the five major sports leagues in North America 2017/18. Retrieved from Statista.com website (<https://www.statista.com/statistics/207458/per-game-attendance-of-major-us-sports-leagues/>).
- [14] Calrecycle.ca.go (2018). Venues and Events: Reducing Waste. Retrieved from Calrecycle.ca.go website (<https://www.calrecycle.ca.gov/venues>). [Accessed August 13, 2018].
- [15] Communist Party of Vietnam online newspaper (2015), Solid waste treatment complex inaugurated in Da Nang city. Retrieved from dangcongsan website (<http://en.dangcongsan.vn/science-education/solid-waste-treatment-complex-inaugurated-in-da-nang-city-310333.html>). [Accessed June 30, 2015].
- [16] FIFA (2018). Waste Management Concept 2018 FIFA World Cup™. Retrieved from resources.fifa.com website (<https://resources.fifa.com/image/upload/waste-management-concept-2018-fifa-world-cup-russiatm-2874784.pdf?cloudid=uqrijkjrhtcdz22qqvd>).
- [17] Lidija Grozdanic (2013). Nike's Shanghai concept store is made with 50,000 old cds, 5,500 used soda cans. Retrieved from Inhabitat website (<http://inhabitat.com/new-nike-concept-store-in-shanghai-is-made-entirely-from-trash/>). [Accessed August 29, 2013].
- [18] Christopher Williams and Steven Sherman (2005). Baseball stadium hits home run for recycling and composting. Retrieved from BioCycle website (<http://www.biocycle.net/2005/02/23/baseball-stadium-hits-home-run-for-recycling-and-composting/>). [Accessed February 2005, Vol. 46, No. 2, p. 56].
- [19] The Prime Minister (2007). Decision No. 177/2007/QĐ-TTg of november 20, 2007, approving the scheme on development of biofuel up to 2015, with a vision to 2025. (https://theredddesk.org/sites/default/files/decision_177-2007-ttg_eng_2.pdf).
- [20] Trong Tan (2015). HCMC calling for investment in incinerator generated power projects. Retrieved from Ministry of Industry and Trade website (<http://vneec.gov.vn/tin-tuc/activity-news/t21321/hcmc-calling-for-investment-in-incinerator-generated-power-projects.html>) [Accessed May 08, 2015].
- [21] Andreas Illmer (2018). World Cup: Japan fans impress by cleaning up stadium. Retrieved from bbc.com website (<https://www.bbc.com/news/world-asia-44492611>) [Accessed 20 June, 2018].