

Sustainable Solid Waste Management in Sports Events: A Case Study of Football Matches in Thailand

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The International Olympic Committee has adopted Agenda 21 as a countermeasure to the environmental impact caused by sports events. This research addresses its lack of a concrete solid waste management framework by investigating solid waste generated, collected and sorted by the football stadiums in the Thai Premier League. The participation behaviors of spectators were examined by means of a structured questionnaire along with in-depth interviews with key stakeholders in solid waste management. In addition, relevant policies were reviewed. Results suggest that due to the lack of waste separation, less than 15% of the recyclable waste at stadiums proceed to recycling, with the rest going to landfills in the form of commingled solid waste. Carbon dioxide emissions corresponding to the waste produced was estimated by the IPCC's first-order decay method. Field observations suggest that recycling can be increased by means of a prior-sorting behavior, and this was confirmed by the spectator survey. In-depth interviews with key stakeholders underlined the lack of proper incentives, regulations and environmental awareness to support proper solid waste management. We propose a sustainable solid waste management framework comprised of responsive policies, incentives and public participation focusing on the current deficiencies of solid waste management and increasing opportunities for resource recovery and recycling at sporting events.

Keywords: Sustainable solid waste management; GHG emission; sports events; Thailand

Introduction

Solid waste is the inevitable rubbish created by human activities (Moeller, 2005). According to the code of federal regulations of the U.S. government, solid waste is any material that is discarded by being abandoned, inherently waste-like, discarded military munitions and recycled in certain ways (United States Environmental Protection Agency [EPA], 2014). One activity that generates large quantities of solid waste is sporting events in which waste increases as the number of spectators increases.

Mega sporting events with a great number of spectators tend to generate larger amounts of solid waste. Woods (1993) estimated that spectators generated 74.1 tons of solid waste during five days of the 27th Super Bowl in California in 1993. He also estimated that an average of 50,000 spectators per game at the Skydome baseball stadium in Toronto in 1992 generated 2,552.04 tons of solid waste.

Without management, solid waste can adversely affect living species by contaminating soil and underground water. Its degradation also affects the climate via greenhouse gas emission

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(EPA, 2017). The primary international policy regulating this field of study is Agenda 21, a United Nations action plan guiding sustainable development. It addresses current problems and prepares countries for forthcoming challenges. The program areas of Agenda 21 are described in terms of the basis for action, objectives, activities and means of implementation covering four sections: (a) social and economic dimensions; (b) conservation and management of resource for development that includes environmentally sound management of solid wastes and sewage-related issues; (c) strengthening the role of major groups; and (d) means of implementation. Regarding sports events, the International Olympic Committee (IOC) recently expressed their concern over environmental impacts made by sports events by adding solid waste management (SWM) in the recently revised “Sustainability Through Sport” report (IOC, 2012). According to the report, proper solid waste management should not only send solid waste to the landfill, but also include the sequence of waste minimization, prior sorting, collection, recycling, composting, energy recovery, treatment and finally disposal.

Football has been the most watched sport in Thailand since the establishment of the Thai Premier League (TPL) in 2009. The number Thailand’s football league spectators increased approximately 23% between 2010 and 2012 (Football Association of Thailand [FAT], 2013). Due to the ever-increasing number of football matches, spectators and their activities, the amount of solid waste has been increasing. Nevertheless, this study showed that the current solid waste management in sports events in Thailand is still far from ideal.

To achieve sustainable solid waste management, the process should eliminate unsustainable patterns of production and consumption according to Agenda 21 (United Nations Conference on Environment and Development [UNCED], 1992). It is important to study solid waste generated and managed in football matches to obtain the solid waste generation rate and understand the deficiencies of the current process. In addition, relevant national and international solid waste management policy reviews are imperative to obtaining sustainable solid waste management framework in sports events.

This research examines the current situation of solid waste generation, its management in football matches and its greenhouse gas emission to raise awareness among related stakeholders and organizations. Due to the currently limited availability of studies in the field of solid waste management in sports events, the current stakeholders in football matches can also benefit from our proposed framework.

Materials and Methods

The study area was comprised of three stadiums hosting football clubs in the Thai Premier League, namely the SCG Muangthong United (MTUTD), the Bangkok Glass FC (BGFC) and the Chiangrai United (CRUTD). These stadiums, besides representing different football clubs, are of small, medium and large size and are located in a provincial area, a suburban area and the capital city respectively.

The respondents of the study were classified into two groups:

- 1) A sample of 1,155 spectators were selected by random sampling methods (Creswell, 2007) from three study matches held at each study stadium. The random sampling method relies on selecting subjects so that all members of a population have an equal and independent chance of being selected. Because the number of spectators reached 10,000 according to the

statistical record of the Thai Premier League, Taro Yamane's formula was used for a number of sample size (Yamane, 1967). A sample size of 385 spectators in each study match was required at confidence interval of 95%, as detailed in the following formula.

$$n = \frac{N}{1 + Ne^2}$$

where

n = sample size.

N = population size. (i.e. number of spectator in the football match)

e = precision of random sampling.

2) Nine key stakeholders involved in solid waste management at each study clubs were selected by purposive sampling method (Bernard, 2012). A purposive sampling method relies on the researcher's judgment when choosing members of population to participate in the study. It is a non-probability sampling method. The criterion for the purposive sampling was based on the role of selected respondents in solid waste managed activities, which are source reduction, storage, handling, collection and disposal. The respondents consisted of three clubs' presidents or managers, three clubs' waste collectors and three independent waste collectors.

Data Collection

Data collection included the following activities.

1) Field observation and solid waste collection and separation: For each team, three matches out of 18 home matches in 2012 in which the home team play against small, medium and large opposing teams were selected as study matches, allowing for analysis of waste generations in all combinations of team sizes. These nine matches aimed to represent every kind of match that could occur during a league competition: small vs. small, small vs. medium, small vs. large, medium vs. medium, medium vs. large and large vs. large at different locations. Thus, the solid waste generated and managed was observed during the nine study matches allowed for generalization. Solid waste generated was collected after the matches were over to separate and sort into types and amount to obtain the solid waste generation rate of the football match and greenhouse gas emissions from the waste.

2) Questionnaire to spectators: A structured questionnaire was developed to study spectators' opinion and behavior on solid waste generated and managed at the stadiums. The questionnaire was administered to 1,155 spectators from three study matches during the 2012 Thai Premier League (TPL) season, between July and December 2012.

3) In-depth interviews with key stakeholders who involved with solid waste management of each of the study clubs: A semi-structured questionnaire was used to conduct in-depth interviews with football club management staff. Topics covered by the questionnaire included the key stakeholders' opinion on the environmental, social and economic issues of solid waste, as well as their opinions on solid waste managed at the stadium and their own personal views on sustainable solid waste management. The face-to-face interviews were conducted between September and December 2012 at their stadiums. Our hypothesis is – that collaboration of the clubs with the TPL's solid waste management-related regulations and an effective

incentive structure for the club's to implement would translate to more sustainable solid waste management policies – was tested.

4) Policy review: We reviewed international and national sustainable solid waste management policies that applied to football matches. The reviewed policies belong to the International Olympic Committee (IOC), Federation Internationale de Football Association (FIFA), Asian Football Confederation (AFC), Football Association of Thailand (FAT), Thai Premier League (TPL), Ministry of Tourism and Sports and the Department of Pollution Control.

The frameworks of integrated solid waste management planning of the EPA (2002) and the United Nations Environment Program [UNEP] (2009) were applied to the data collected from the study stadiums to develop a sustainable solid waste management framework for sports events.

Data Analysis

All data collected were analyzed to develop a sustainable solid waste management framework in sports events using the following methods.

1) Field observation and solid waste generated collection and separation

The solid waste generated in the study matches was collected and sent to the separation site, operating in full compliance with the International Organization for Standardization (ISO) 14001 standard (ISO, 2004). The different types of waste were separated into waste for disposal and waste for recycling. The types and amount of separated solid waste data from three study matches were recorded and analyzed.

In addition, the greenhouse gas emissions from the solid waste were calculated by providing the weight of solid waste sorted by the degradability to the greenhouse gas emission using calculating software developed by the Public Health and Environmental Technology Services Center, Khonkaen University, funded by the Environmental Research and Training Center (ERTC) and the revised 1996 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories Worksheet developed by the IPCC. The software utilizes a first-order decay method² to calculate greenhouse gas emission with Thailand-specific parameters based on the revised 1996 version. Thus, it was recommended to use the revised 1996 version instead of the revised 2006 version for the purpose of benchmarking.

² The First Order Decay [FOD] method can be expressed equivalently by equation as follows:

$$Q_{T,X} = kR_xL_0e^{-k(T-X)}$$

Where

$Q_{T,X}$ = The amount of methane generated in year T by the waste R_x (Gg)

k = Methane generation rate constant (1/yr)

X = The year of waste input

R_x = The amount of waste disposed in year x (Gg)

L_0 = Methane generation potential (m^3/Gg of refuse)

= $MCF \times DOC \times DOC_F \times F \times 16/12$

(16/12 is molecular weight ratio CH_4/C)

T = Current year

The methane emissions obtained from the IPCC method were converted to greenhouse gas emissions in CO₂ equivalent units. This research utilized the software for the sake of simplicity and replicability. Its consistent algorithm converts the weight of waste into a CO₂ equivalent of emission with Thailand-specific parameters. The software was developed as an open-source resource and is made available for free by Khonkaen University.

2) Spectator survey

The data from a structured questionnaire were in the form of Likert scales ranging from 1 to 5 to give the degree of the agreement in each point of the questionnaire, allowing numeration of subjective quantities such as opinions. A frequency distribution table was used to analyze the opinion and behavior of spectators regarding solid waste generated at the stadium.

3) In-depth interviews

The data from in-depth interviews were analyzed by using a method developed by McCracken (1988) for long interviews, starting from familiarization with data, generating initial codes from keywords based on in-depth interviews, searching for themes among codes, reviewing themes, defining and naming themes, and then presenting and reporting.

4) Policy review

Relevant international and national sport policies were studied and applied to propose a sustainable solid waste management framework for sports events. This step involves listing policies and regulations initiated by the IOC, the FIFA, the AFC, the FAT and the TPL that involve solid waste management. The reviewing process also listed the applicable aspects of solid waste management to identify what was missing and what can be improved.

Results and Discussion

Solid waste generated at the stadium

The net solid waste of every match was calculated to find the average solid waste generated rate of each stadium. The average solid waste generated at the MTUTD, the BGFC and the CRUTD were 1111.3 kg, 963.3 kg and 887.4 kg respectively as shown in Table 1. The solid waste generation rate of the football matches was 0.097 kg per person per match.

Over 85% of the solid waste generated at the study matches was commingled and could not be economically sorted and recycled due to its mixture with food waste in waste bins. The commingled solid wastes at the MTUTD, the BGFC and the CRUTD were 957.6 kg (86.17%), 851.1 kg (88.35%) and 806.7 kg (90.90%) respectively. The amount of solid waste that could have been sorted if it was prevented from mixing with non-recyclable waste was 153.7 kg (13.83%), 112.2 kg (11.65%) and 80.6 kg (9.10%). Based on observation, implementation of a sorting strategy separating recyclable and non-recyclable waste prior to commingling, known as prior sorting, could enhance the recycling process and avoid mixing solid waste. Football clubs should be responsible for this by providing staff to separate the recyclable solid waste (e.g., plastic and glass bottles and cans) at the entrances before spectators enter the stadiums.

Table 1: The amount of solid waste generated in the study matches

Study matches No.	Club	Number of spectators	Solid waste for recycling		Solid waste for disposal		Net solid waste (kg)
			(kg)	Percentage	(kg)	Percentage	
1	SCG	11,453	111.1	12.65	767.5	87.35	878.6
2	Muang-thong United	11,755	140.9	12.74	965.6	87.26	1106.5
3	(MTUTD)	13,548	209.1	15.50	1139.6	84.50	1348.7
Average			153.7	13.83	957.6	86.17	1111.3
4	Bangkok glass FC	5,933	70.9	9.94	642.7	90.06	713.6
5	(BGFC)	5,653	103.1	11.22	815.9	88.78	919.0
6		10,050	162.6	12.94	1094.8	87.06	1257.4
Average			112.2	11.65	851.1	88.35	963.3
7	Chiangrai United FC	5,933	54.6	7.36	687.0	92.64	741.6
8	(CRUTD)	5,653	65.9	9.38	636.9	90.62	702.8
9		10,050	121.4	9.97	1096.3	90.03	1217.7
Average			80.6	9.10	806.7	90.90	887.4

Source: The Thai Premier League, 2013

Solid waste generating, disposing and sorting behaviors

In all study matches, 60%-75% of the spectators were men, 38%-53% of them were ages 15-25 with 38%-60% of the spectators holding a bachelor's degree. Approximately 29%-54% of them were in secondary school.

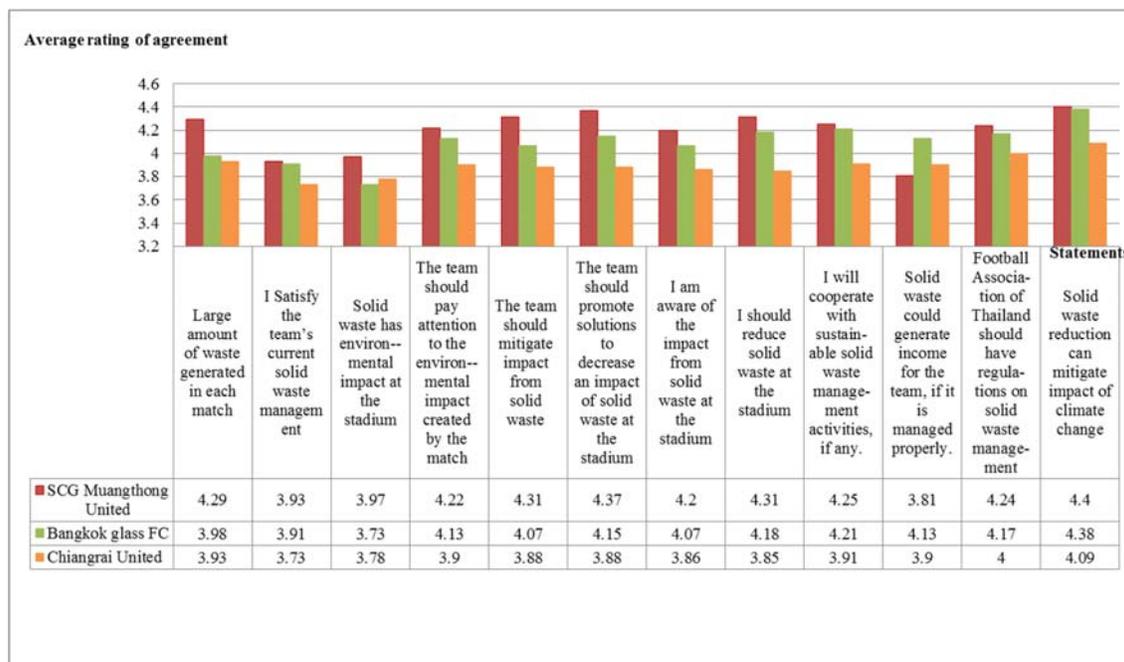
Regarding opinion on solid waste generated at the stadiums, the spectators mentioned that they generated plastic bags (22%-27%), food packaging (9%-18%), glass bottles (6%-8%), plastic bottles (11%-26%), cans (5%-12%), plastic cups (11%-23%), plastic boxes (2%-6%), paper (4%-7%), hazardous waste (1%-2%) and other waste (1%-3%). The type of solid waste found at the study matches relatively similar to that identified in the study of Stahl and Hochfeld (2003) and the solid waste found at the London Olympic games in 2012 and the NFL Super Bowl XXVII in 1992 (Bardelline, 2012; Woods, 1993).

Although several types of solid waste found at the study stadiums could be recycled, it was mixed with food waste resulting in commingled solid waste which cannot be properly separated and recycled. A prior-sorting behavior could have circumvented the unnecessary non-recyclable waste generation. An efficient management by means of 3Rs implementation (reduce, reuse and recycle) and promotion of prior sorting will prevent recyclable and non-degradable waste from ending up in landfills where they cannot be reprocessed and are generating CO₂e values instead of going back to their life cycles.

A range of 73%-93% of spectators believed that football clubs should be responsible for proper solid waste management. In addition, 33%-53% of them suggested that the clubs should separate solid waste before final disposal. This finding suggests spectators may not perceive themselves to be part of the solution. Awareness to contribute to the act of waste separation is still lacking. Approximately 70% of the spectators were not satisfied with current solid waste management and 28%-45% of them would cooperate with a sustainable solid waste

management. In addition, they agreed that recycling could generate income for the football clubs. The interviews showed that despite such awareness, without a policy from the TPL, the clubs would rather spend their money on other projects such as youth development.

Figure 1: The average rating obtained from the Likert scale of the spectators’ opinions on solid waste managed at the study matches and awareness of impact from solid waste



According to Figure 1, the level of awareness of solid waste generated and managed indicated by agreement level of the statements that describe (a) a recognition of solid waste generated at the stadiums and its impact; (b) an understanding related to solid waste management at the stadiums; and (c) an encouragement of participation from the Football Association of Thailand [FAT], the clubs and the spectators to reduce and manage solid waste. A higher level of agreement reflected more awareness on the issues.

Regarding a recognition of solid waste generated at the stadiums, 25.3-50.1% of the spectators absolutely agreed that a large amount of waste was generated in each match, 21.6-27.6% of them absolutely agreed that solid waste has environmental impacts at the stadium, 28.0-38.7% of them absolutely agreed that the club should pay attention to the environmental impact created by the match, and 26.1-45.0% of them absolutely agreed that the club should mitigate impact from solid waste. In addition, 25.3-48.3% of the spectators absolutely agreed that the club should promote solutions to decrease an impact of solid waste at the stadium. Meanwhile, 24.8-39.9% of them absolutely agreed that they are aware of the impact from solid waste at the stadium.

Regarding an understanding related to solid waste management at the stadiums, 15.7-29.5% of the spectators absolutely agreed that they are satisfied with the club’s current solid waste management and 27.5-46.8% of them absolutely agreed that they should reduce solid waste at the stadium. Meanwhile, 27.5-45.1% of the spectators absolutely agreed that they would cooperate with sustainable solid waste management activities, if any were imposed. A range

of 29.0-40.7% of the spectators absolutely agreed that solid waste could generate income for the club, if it is managed properly.

In conclusion, the spectators recognized that a large amount of waste was generated during each match and agreed that it caused an environmental impact. In addition, they viewed that the football club should concentrate on mitigating the impact. The survey results also reflect that around 70% of the spectators still were not absolutely satisfied with current solid waste management and 27.5-45.1% would cooperate with the sustainable solid waste management. In addition, they viewed that the sorted solid waste could generate income for the football clubs.

Regarding an encouragement of participation to reduce and manage solid waste, 31.5-42.8% of the spectators absolutely agreed that the Football Association of Thailand should have regulations on solid waste management and 39.2-61.8% of them absolutely agreed that solid waste reduction can mitigate the impact on climate change.

Lastly, 75%-96% of the spectators mentioned that they were aware of the positive impact of proper solid waste management. Sixty nine to 96% of them were also aware of greenhouse gas emissions caused by solid waste. This shows that the spectators are not satisfied by the current solid waste management.

Solid waste managed at the stadium

The current solid waste management in the Thai Premier League needs to be improved in terms of waste minimization and prior sorting, collection, recycling, composting, energy recovery, treatment and disposal.

1) Waste minimization, prior sorting and reuse

Though the football clubs provided different colors of waste bins for recycling, there is still a need to build awareness about prior sorting and waste minimization in order to encourage spectators to adopt a role in mitigating such problems. Prior sorting was being implemented at only one football club. Other football clubs did not execute prior sorting due to the limited budget on solid waste management and a shortage of staff. Thus solid waste management was not fully utilized. The CRUTD's club president (2012) stated that, "We would love to conform with TPL's regulations on waste management, if they were any. But currently without an incentive, we will have no choice but to spend our budget on the more urgent matters."

2) Collection

Usually, solid waste was scattered around bins and full waste bags were not replaced due to a lack of waste collectors. In general, the club's waste collectors gather waste and clean the stadium after the game is finished. The commingled solid waste typically was put in a temporary garbage room or storage unit where it would sit until transferred to municipality's dumping site.

The MTUTD's general manager (2012) stated as follows:

Normally, independent waste collectors will come to pick up used bottles after a match. We let them do this without us making any profit. We placed (non-separating) trash bins all over the stadium. The waste in these bins are not accepted by the waste collectors as the recyclable containers will have food and drink spilled all over making it too dirty to be sorted.

3) Recycling, composting and energy recovery

At the study stadiums, municipal officers collected the commingled solid waste without any process of recycling, composting or energy recovery. According to the BGFC's general manager (2012), "The bottles and cans already sorted at the gate (due to the stadium's enforced security policy) are always easy to be sold to waste collectors making some money back to the club."

4) Treatment and disposal

At the dumping site, the solid waste was disposed in a landfill without any treatment.

Greenhouse gas emission from solid waste generated at the stadium

Calculated from the weight of degradable solid waste, the average GHG emission from the solid waste per match was 9.73 kg CO₂e³. Without a prior study of GHG emissions from sports events, this number could serve as a good starting point and a benchmark for further studies on the larger scale. The non-recyclable fraction of the waste could be highly reduced by means of the 3Rs concept with along with solid waste prior sorting.

Solid waste management policy

In Thailand, there are three main acts regarding solid waste management: the National Environmental Quality Act B.E. 2535, the City's Cleanness and Orderliness Act B.E. 2503 and the Public Health Act B.E. 2535. At the time of the study, they were outdated and few people know about them—especially considering that the latest one, the Public Health Act, was updated in B.E. 2535. Since then, there have been many technological advancements in the field of waste management and new ideas developed related to the environmental consequences of waste disposal. The lack of incentive to raise awareness and increase public participation in waste management has led to the failure to change behavior and collaboration to mitigate such problems. Reviewing these policies revealed that policy relevant to solid waste management was lacking in the AFC and the TPL. Nevertheless, we discovered that some policies formulated by the government and the IOC's Agenda 21 could be adopted to develop sustainable solid waste management for football matches in Thailand such as the promotion of 3Rs, energy recovery from solid waste and the enhancement of public participation in waste mitigation. Due to the IOC's Agenda 21, while not suggesting a certain process of sustainable solid waste management, it emphasized the importance of environmental impact of sports events, which was a good starting point for the FAT to concern itself with this issue.

The sustainable solid waste management framework

This study found that proper solid waste management is still lacking in the TPL. To achieve proper management, we developed a sustainable solid waste management framework for football matches to include the aspects of institution, policy, techniques, knowledge, economic, financing and public participation based on the EPA's significant factors for integrated solid waste management planning as shown in Figure 2.

In the framework, relevant national and international institutions have important roles to formulate and disseminate responsive policies, laws and acts on solid waste management.

³ Greenhouse gas emission per match came from solid waste data collected from the study stadiums that was calculated by the revised 1996 IPCC's method. 9.73 kg CO₂e is an average number of greenhouse gas emission rate per match.

The TPL should seek guidance from resources such as the “Sustainability Through Sports” report and reach out for further research on frameworks of solid waste management. It should develop concordant policies that emphasize the supportive 3Rs concept, empower SWM staff, support spectator participation, create incentives for the 3Rs, create 3Rs-inspired packaging development, encourage the waste to energy concept, reinforce recycling as a profitable business, develop resource recovery, support public-private partnership in SWM, and develop public education and awareness programs to promote prior sorting and the 3Rs. Football clubs would be required by the TPL to implement the policies and adopt them to their solid waste management from source reduction, waste separation, waste reusing and waste disposal processes to enhancing the 3Rs and resource recovery.

More responsive policies, laws and acts on solid waste management from relevant national and international regulations are required. In addition, the TPL should be required to make sure that concordant policies are implemented by their football clubs.

During the source reduction/separation/reuse process, shops and vendors should be required to sell beverages off dispensers instead of directly off of bottles or cans. They need to dispense bulk-packaged beverages in a recyclable plastic cup. A container that can be refunded upon returning it also economically encourages recycling of the plastic cup.

As of now, for security reasons, the TPL already enforces a rule to prevent people from bringing bottles and cans into the stadium. With this rule already in place, bottles and cans can be separated at the entrance by security staff to avoid commingled solid waste.

To reduce solid waste generated from plastic bags and other materials, shops and vendors should be mandated to use only paper packaging for food in the stadium. Thus, the possible solid waste generated at the stadium would be mainly plastic cups, plastic bags, paper packaging, food scraps and less waste of other kinds.

During the collection process, spectators are engaged. Spectators could get points by collecting the solid waste generated at the stadium and could exchange the points with souvenirs, tickets or gifts. For the rest of the waste, the club’s waste collectors could collect, sorted and put in the garbage rooms. In addition, the club’s waste collectors could be required to replace the full waste bags to prevent scattering due to overflow.

As for the recycle/energy recovery process, all sorted solid waste can be sold to the junk shop for recycling. For paper packaging, the municipal officer could transfer it to a waste-to-energy power plant of the area, if there are any nearby. For organic waste from food scraps, the club’s waste collector could compost it and used it as fertilizer. Lastly, during the disposal process, municipal officers could transfer the rest of solid waste to a landfill.

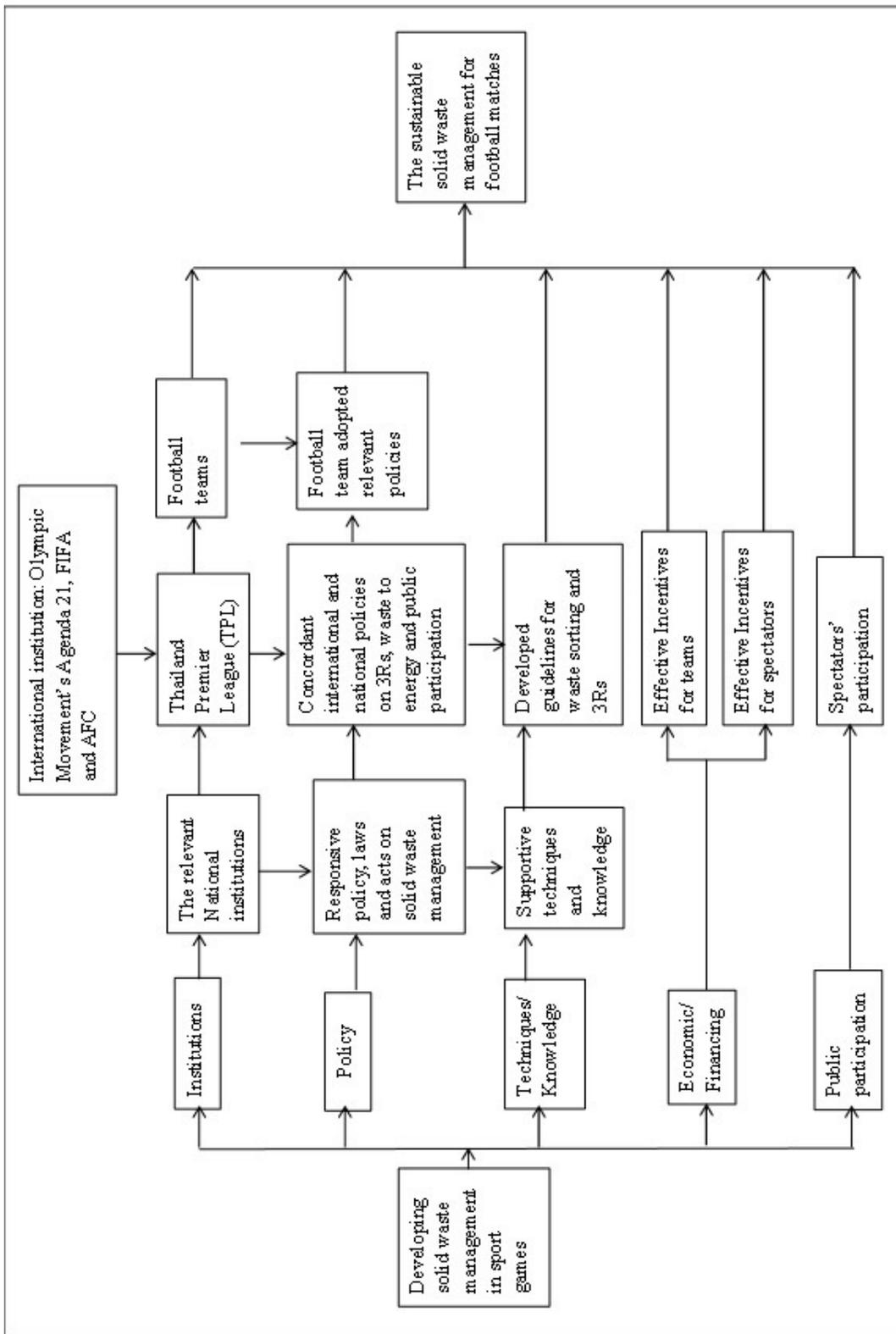


Figure 2: Sustainable solid waste management framework for football matches

Relevant national institutions should provide supportive techniques and knowledge regarding waste prior to separation and incorporating the 3Rs concept in order for the TPL to develop guidelines for football clubs. Thus, football clubs could use this guideline to raise awareness and encourage spectators' participation in the club's sustainable solid waste management process.

With spectators currently feeling dissatisfied about waste management, football clubs can increase public participation by providing opportunities for their fans to have their voices in the way waste should be managed. By gamifying the process, awarding points to the team with less waste or the team with higher recyclability, teams and their fans could share the rewards in keeping the stadium tidy and the waste sorted.

The proposed sustainable solid waste management framework would improve the deficiencies of the current management process and increase the opportunity of resource recovery and recycling at the match. Besides, the framework could be applied to all sports events in Thailand.

Conclusion

This study found that less than 15% of solid waste generated at football stadiums made it to the recycling process. The rest of the commingled solid waste went to landfill and generated unnecessary greenhouse gas emissions. Despite a sign of awareness regarding environmental impacts caused by disposing waste, spectators paid very little attention to waste sorting. Interviews revealed that despite such awareness, without a policy from the TPL, the clubs would rather spend their money on other projects such as youth development. The lack of sorting behavior at every study stadium correlates to the very low recycling ratio found in the solid waste collection study. The in-depth interviews with key stakeholders underlined that it was due to a lack of prior sorting at the study clubs.

Despite Thailand's laws, acts and policies related to solid waste management during sporting events, current policies still lack proper incentives, rules, regulations and environmental awareness of solid waste management among the related institutions, especially by the Football Association of Thailand and the Thai Premier League. Lack of awareness and public participation are important problems to address in pursuing desirable waste handling behavior and collaboration to mitigate the effects from solid waste-related problems.

The current solid waste management process by the football clubs in the Thai Premier League still lacks proper management. To achieve it, we developed a sustainable solid waste management framework for football matches that includes the aspects of institution, policy, techniques, knowledge, economic, financing and public participation. Economics and financing are about building effective incentives, such as point redemption on penalties for the clubs⁴ or souvenirs, tickets or gifts for the spectators. Additionally, public participation could be encouraged by the clubs providing an opportunity for their fans to share and propose ideas of preferred solid waste management. The proposed sustainable solid waste

⁴ Normally, the TPL deducts points from the clubs when they break the rules. When the points accumulate to a certain level, the clubs need to pay a fee to the TPL. If clubs with good practice in waste management could have redemption on the penalties, it could help save money and improve the reputation of the club.

management framework comprised of responsive policies, laws and acts formulated techniques, knowledge, forceful incentives and public participation. The framework has the potential to improve the current management and increases the opportunity of resource recovery and recycling at the sports events.

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