



Proposal of a Combined Environmental Management Solution for Municipal Solid Waste (MSW) Separation in a Developing Country: For Pilot Realization in Hanoi, Vietnam

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DOI: <https://doi.org/10.30880/ijie.2020.12.03.002>

Received 20 May 2018; Accepted 20 September 2018; Available online 27 February 2020

Abstract: Municipal solid waste (MSW), thousands of tons of which increasingly generated daily in human life by the rapid urbanization, population migration and industrialization not only in Vietnam, but in all developing countries are causing many serious problems in Environmental management for the authorities of these issues. In Vietnam, various approaches, solutions and programs were studied, suggested and deployed over the last decades, but the most of them have stopped at the level of pilot-programs and have generally not been replicable, so not been applied in wide scale. The most challenging issue of MSW management systems is non-applied or not fully - done waste separation practice at sources, caused by not only limited collection equipment, staff and working efficiency, but also lack of investment in infrastructure and limited public awareness. These circumstances raised the real need of a combined Environmental Management solution for municipal solid waste (MSW) separation at sources, especially in urban residential households. This paper proposes a combined management solution for municipal solid waste (MSW) separation at sources, based on applying and combining 4 main environmental management instruments: 1- Legislation, 2- Economic, 3- Analysis, assessment and technology, 4- Education and Communication. A pilot realization in Hanoi, Vietnam is proposed with detail description of the solution and reasonable argumentation. The solution effectiveness, judged on the basis of the collected data is presented.

Keywords: Vietnam, Environmental Management, municipal solid waste (MSW), separation at sources.

1. Introduction

Vietnam, as many developing countries are facing various common challenges in municipal solid waste (MSW) management. Improper treatment and disposal caused by inappropriate management of MSW lead to serious impacts [1]. The mentioned in [2] environmental impacts are the accumulation of MSW in residential areas causing the odor problem; MSW is thrown to the channels, lakes, rivers which results in the degradation of water quality; the landfill leachate is the other important source of water pollution as well as soil pollution; and estimated about 40-50% of MSW transported to open dumping sites are uncontrolled burnt. The community health impact can be listed as people living near the open dumping sites, and unsanitary landfills are being exposed to the adverse impacts with the symptoms of dermatological disease, respiratory diseases, and diarrhea, and the most vulnerable groups are scavengers in which most of them are women and children. The obvious social-economic impacts due to significantly increasing MSW quantity are the expenses used for collection, transportation, treatment and disposal have been increasing, environmental conflicts associated with MSW seen are arisen between pollution causing companies/enterprises and suffered community, social groups in handicraft villages, small-scale industry activities and agricultural activities, and production activities and landscape as well as culture. As well as different methods for the disposal and treatment of MSW being applied, for example in Vietnam like open dumping and landfill, composting, incineration and recycling, but it is proved that the

significant increase of MSW generation is putting a huge strain on the existing MSW management systems, mainly caused by no separation activity at source of compostable waste from the other non-biodegradable and recyclable waste [2]. So this work [2] assured that proper implementation of source separation would lead to better options and opportunities for scientific disposal of waste. My work is focused on the combined Environmental Management solution for municipal solid waste (MSW) separation in a developing country with a proposal for pilot realization in Hanoi, Vietnam.

2. Methodology and Proposal

As we know, environmental management is realized through many instruments with four big main groups: 1- Legislation, 2- Economic, 3- Analysis, assessment and technology, 4- Education and Communication. Our proposed methodology based firstly on the economic instrument, the study result of which is originated from the factors influencing waste separation intention of residential households [4]. Some of the facts on municipal solid waste generation in Vietnam, requiring the combined solution for the separation of waste at source as a fundamental condition in closing the loop of materials, which is expected to reverse the negative impacts of solid waste on the environment and the scarcity of natural resources, leading to sustainable waste management programs.

As shown in a report of the Institute of Science for Environmental Management (ISEM), Vietnam the municipal solid waste in Vietnam has been generated in average 15 million tonnes per year, from which 80% is domestic, 18% - industrial and 2% - hazardous. The population of large cities makes up 25% of the national population but produces more than 50% total solid waste. They produce about 0.7 kg/person/day in urban areas in comparison with 0.3 kg/person/day in rural areas. The MSW collection rate in Vietnam is still limited, only 70% in big cities and 20% in rural areas with the following treatment percentages: few sanitary landfills -15%, limited recycling - 10-12% (while 30% waste is recyclable) and composting only 2% in all. Hanoi, the capital of Vietnam, produces more than 6500 tons of solid waste per day, and the average amount of MSW generated daily per capita is 0.9 kg. It is estimated that this figure will reach 1.4 kg/day by 2020 (Ministry of Natural Resource and Environment, MONRE, 2011) and currently, solid waste is not segregated at the source [3].

According to the survey results in the study [3], of the 180 households surveyed, 130 households stated that they were willing to pay (WTP) a monetary fine as a commitment for every time they violated the regulation of the waste separation program, whereas 50 households were unwilling to pay. The mean of the WTP was 73,400 VND (*), with 40.7% of them agreeing with the monetary fine of 50,000 VND. The Hanoi authorities currently have no mechanism in place for dealing with violations of waste separation at source, although a fine of 100,000 VND is imposed each time any household fails to dump their waste properly in terms of time and place. Based on this reference data with some households' daily living and personal character manner analysis, the main idea of the economic instrument of this study is paying the households for well separated waste during the MSW collection at source instead of fining for violations of waste separation. This motivating methodology will positively influence the intentions to separate waste at the source of residential households. The payment rate will be suggested and reasonably analyzed in the following discussion part.

For legislation application, the trust of individuals plays a decisive factor in their waste separation intentions. So, policies and initiatives centering on building trust of economic benefits are crucial to an increased participation of residential households in waste separation. Measures to boost the residents' trust include issuing effective laws and detailed regulations for the motivation (not only enforcement as normally suggested) of waste separation at the household level, making community awareness in coordinating and exchanging information among municipality agencies and local communities and improving the involvement of all relevant stakeholders.

As the Education and Communication instrument, a community-based management should be a principal recommendation to overcome social dilemmas in waste separation, in which an appeal to the feelings of personal conscience might be beneficial in encouraging environmentally-friendly actions. Interventions focusing on communication strategies to increase the awareness of and responsibility for collective benefits are suggested to strengthen the personal norms of the residents, including young generation education. The approach can be using the environmental communication (EC) as an integration instrument to integrate environmental management into municipal development, establishing a complementary set of policy instruments, what might be enabled by wise use of all EC components in their interactivity. The complementarity of EC instruments and stakeholder group efforts forms synergy and enhances better environmental policy integration.

Finally, this proposed methodology has analysis, assessment basis and technology solution for pilot realization. The data and information analysis gave opportunity to assess the economic efficiency, to suggest the routing - scheduling for waste collection, to increase the environmental and economic benefits by introducing composting municipal organic waste recovery and to propose a technology adjustment model of collecting vehicles and handcarts to support 3R separation at source. The combined environmental management solution for municipal solid waste (MSW) separation is simultaneous realization of all 04 described instruments in the proposed methodology.

3. Discussion and Pilot Realization Model

In using economic instrument to regulate, we suggested instead of monetary fine of 100,000 VND for dealing with violations of waste separation at source [3], the Hanoi authorities could have mechanism to pay every household in MSW collection place with rate 500 VND/kg for right-separated MSW quantity and fine of 500 VND/kg for no separated or improperly separated at source MSW quantity. This mechanism will motivate people see that collecting and separating MSW at sources can be a special way to earn more money and help municipal units in easing and accelerating their work. According to our data and cost-benefit analysis, everyday a 4-people family in urban area generates 0.7-0.9 kg/person/day x 4 = 2.8 - 3.6 kg/family/day in medium, which means the household can get about 1,500 VND - 2,000 VND/day more if the waste is sorted properly. This approach also gives the choice to the households not to dump their waste on roads or unpermitted places, but also the willing to collect others' waste and separate it to make more money themselves. In terms of economic benefits, households, violated the waste separation at source (who should pay fines for that) pay households, choosing the waste separation at source as the right thing to do. In this plan, a household can receive about 2,000 VND * 30 days/month = 60,000 VND/month in minimum for their good dealing with MSW. The sum is raised much higher if household uses this way as an earning money job by collecting and sorting MSW of others, estimated as 30-60kg/day x 500 VND/kg = 15,000 - 30,000 VND/day or 450,000 - 900,000VND/month. This mechanism encourage people participate in MSW cleaning up and separating programs. Based on the data about MSW composition Fig. 1a, 1b [4], the at source separation can be instructed and organized so that MSW is sorted out into compostable organic waste (green-colored bin/handcart), plastic + paper (white-colored bin/handcart) and textile + glass + others (orange-colored bin/handcart). Metal is usually collected and easily sold as well-known recyclable solid waste, so its rate in MSW is the lowest, only 0.4-1.0 %.

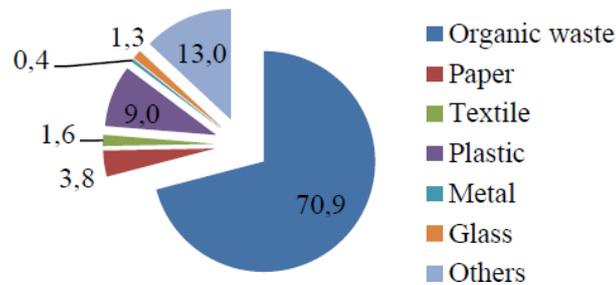


Fig. 1a - Composition of household waste in Hanoi (%)

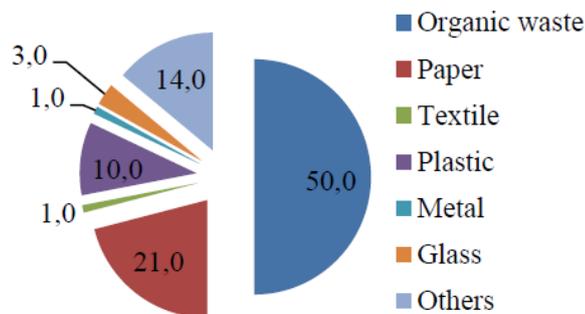


Fig. 1b - Composition of commercial waste in Hanoi (%)

(*) 1 USD = 22,500 VND (approximately).

In case of proper source separation, as studied and shown in [4], composting of all organic waste is the possible ideal practice, which brings the great results, raising the utilization by composting from 2% of total collected MWS amount to about 10% (estimated 218.650 tons/year from whole generated 2.372.500 tons/year in 2011 reported by URENCO). This scenario could reduce significantly the amount of waste sent to landfill, extending the landfill life almost 15 years longer than in the current management model (only 6.2 years) and make the net GHG emission (Thousand tons CO₂-eq) minimized to 2% compared to current situation. One ton of compost product can supply soil nutrients of 7.1 kg of nitrogen, 4.1 kg of phosphorus, and 5.4 kg of potassium, so all compost products could be used for agricultural and gardening purposes.

Legislation authorities could issue policies and initiatives to encourage MSW separation at source by legalized financial support to households, municipality agencies, local communities and relevant stakeholders for the involvement.

The preference of reciprocity was a factor facilitating the level of commitment in waste separation. Thus, appropriate attention should be accorded to the enhancement of reciprocity norms when policies for household waste management are designed and implemented. It is totally fair to apply willing to pay 500 VND/kg for no separated or improperly separated MSW amount as a suggested collative monetary fine in the explicit sanction scheme, considered to enhance the level of cooperation and at the same time prevent violations. Policies could not be accepted and applied without Education and Communication instrument. The education on MSW management procedures should be included in school programs and activities, not excluding the kindergarten early age level. The environmental communication (EC) can be realized through giving exemplary to young residents in every household, family and community, propagating the environmentally friendly manners with clear action plans and creating necessary facilities and equipment, supporting smart MSW separation. The monitoring and supervising systems should be built up at the municipal local units to closely deploy and deal with perceived difficulties.

For real implementation, this paper proposes the technology pilot realization model for Hanoi, Vietnam as a typical city of a developing country. According to Hanoi URENCO's report, MSW generation was 2,372,500 tons/year, 85% of MSW derived from households and 15% from commercial sources. This amount accounted for about 11% of total MSW generation for the whole country. The amount of MSW is predicted to increase by 15% annually. The waste collection rate was estimated to be 95% in the inner city and 60% in suburban areas. Overall, collection of MSW was 85% for the whole city utilizing a curbside collection system [4]. The city currently does not apply source separation, so first of all, legislation is called for formulating the policies, encouraging effective waste separation and providing the general public with better understanding and more sufficient information to change their biases towards the difficulties. The suggested economic motivation will work as a preference of reciprocity, guaranteeing the level of commitment in waste separation from residents. The pay and fine sum are not significant and affordable for both residents, following or violating waste separation procedure, but survey showed that 72% households stated that they were willing to make a commitment to participate in waste separation at home without any encouraging payment for the sort out MSW amount, because in fact more than 60% of them often sort recyclables for sale, among that 23% of those people voluntarily saved recyclable waste and then gave it to others (the poor or waste collectors). They did not discard them into a mixed waste bin. So with money motivation the involvement percentage could be intensively raised higher. Not only the regulations on the collection of separated wastes need to be promulgated, but also the infrastructure needs to be upgraded to facilitate waste separation through the provision and management of necessary separation facilities, means of transportation, and equipment such as weight balances, waste bins and plastic bags to ease the actual difficulties confronted by residents and waste collecting teams. The government policy should promote the steady improvement approach for solid waste management system, including standard/guideline on collection, source separation and organic recovery for environmentally sustainable cities.

We suggest that collection system with specially equipped handcarts would go for waste collection in teams. Each team has in minimum 3 handcarts: green-colored for compostable organic waste (50-70% in weight), white-colored for plastic + paper (13- 30% in weight) and orange-colored for textile + glass + others (17-20 % in weight). All handcarts have electronic balance for weighting and vehicle routing - scheduling detecting device, which allows to optimize the collection - separation process in number of gather sites to be visited, required vehicle quantity to operate and balanced the workload over different time periods (day and night shifts). The case study of vehicle routing-scheduling for waste collection in Hanoi was researched and proposed in [5] for the reference.

Finally, resident awareness and responsibility for collective benefits of environmentally sustainable cities play key role in the municipal solid waste (MSW) separation at source. Households are supposed each time to dump their waste properly in terms of collection time and place, not throwing the generated waste freely on curbsides any time as still practiced nowadays in Hanoi, causing unpleasant impression about culture and beauty for all. The fine should be applied to the household, who can't afford the waste clearance in the pavement area or surrounding of his house or rented place. Awareness on 3R and source separation should be increased in private sector and educated for community participation through appropriate mechanism of management and education programs with all ages and knowledge levels, using Environmental Communication instruments for environmental policy integration. Four components of the EC model (environmental information, environmental education, public participation in environmental decision making and behavior in environmentally friendly manner) applied complementary become indispensable elements of environmental management processes in all environmental subsectors (water, waste, air, nature etc.) and spheres of life: at work, home and study [6].

4. Conclusions

Our study affirmed that cities and urban areas, especially in developing countries need a combined environmental management solution for municipal solid waste (MSW) separation at source, which is the synergy and integration of many instruments: Legislation; Economic; Analysis, assessment and technology; Education and Environmental Communication. The proposal for pilot realization model of Hanoi, Vietnam was presented in this paper by improving management efficiency through willing to pay (WTP) analysis with pay and fine mechanism, suggested technology solution for collecting and separation processes and environmental integration through education programs for various resident sectors and EC instruments. This combined solution could bring the economic benefits to cooperating

stakeholders and enhance environmental policy and sustainable development prerequisites, namely public environmental awareness, a shift in the environmental thinking of society, and change of consumer society behavior, production and consumption models. In the results, cities are going to be environmentally sustainable and economically successful.

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