ALTERNATIVE TECHNOLOGY AS SOLID WASTE MANAGEMENT TECHNIQUE FOR THE MUNICIPALITY OF TAGUDIN, ILOCOS SUR

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Abstract- In this study, the status of the Alternative Technology on Solid Waste Management (SWM) of Tagudin, Ilocos Sur was determined utilizing descriptive-evaluative research design and using a survey questionnaire triangulated with observations and interviews. As deduced from the study, alternative technology is important for the reduction of volume of waste, maximization of waste recycling and reduction, and conversion of residual materials into recyclable materials. This prolongs the life span of the waste disposal facility. The level of implementation of the SWM Program of the LGU in terms of segregation at source and segregated collection is highly attained. However, the creation of MRF and Composting Facility is very highly attained. The problems encountered in the utilization of Alternative Technology were rated as slightly serious and as to the quality and marketability of the byproducts of the alternative technology, a strategic plan was formulated and recommended.

Keywords- Alternative Technology, disposal, Recycle, Reduction, Waste Management

INTRODUCTION

Population increases in developing countries are of social, political, and economic concern. Such an increase has a direct impact on available resources and contributes to waste generation (Ahsan et al., 2014). As the population increases, consumption of different resources also increases; thus, waste is generated (Chabuk, Al-Ansari, Hussain, Knutsson, & Pusch, 2015). Inevitably, the byproduct of production and consumption is waste. Waste in this case comes in different forms, and among such waste is solid waste. Food waste, cloth, garden trimmings, paper, construction debris (brick, concrete, sand, and dirt), wood, leaves and branches, ferrous and non-ferrous metal, glass, shredded skins, and leather, hospital waste, slag, animal waste, industrial waste, old appliances, and miscellaneous waste are some of the many generated solid wastes (Manjarekar, 2017), (SREENIVASA REDDY PERLA AND S PADMANABHAN, 2019).

Over the last thirty years, however, the focus of waste management has shifted to reducing the impact of waste on the environment and recovering resources from waste materials (Lamba, Kaur, Raj, & Sorout, 2021). Hence, this study assessed the status of the alternative technology being used by the Local Government Unit (LGU) of the municipality of Tagudin, Ilocos Sur to reduce plastic waste disposal. The alternative technology product of the LGU, which uses clean residuals (plastics) turned into bricks, contributes to waste reduction through recovery and recycling. Alternative Technology is a technology capable of processing municipal solid waste, such as conversion technology, transformation, or other emerging technology, in place of land disposal (Saleem, 2018). The LGU will benefit from it in terms of waste volume reduction that is collected and dumped at the waste disposal facility. The LGU benefits from it environmentally; it also provides social benefits, among others in uplifting quality of life through employment generation within their constituents. Integration and inclusion of alternative technology in their solid waste management program could be a win-win situation in economic, societal, and environmental aspects.

METHODOLOGY

The descriptive-evaluative design coupled with natural observation (qualitative method) was used in this study. The researchers used actual observation of actual processes and events taking place and conducted structured interviews with authorities

to gather additional information or data. A set of questionnaires were also utilized to gather data.

The respondents of this study were the Municipal Solid Waste Management Officer (MSWMO), Municipal Environment and Natural Resources Officer (MENRO), and 86 Barangay officials handling solid waste management in the Municipality of Tagudin.

Weighted mean and percentages were the statistical tools used to treat data.

RESULTS AND DISCUSSIONS

LEVEL OF ATTAINMENT IN THE IMPLEMENTATION OF SWM PROGRAM

The level of attainment in the implementation of the SWM program covers its Segregation at Source, Segregated Collection, Material Recovery Facilities (MRF), and Composting.

The result reveals that the elements of the implementation of a solid waste management program are very highly attained with a composite mean equal to 4.25. This implies that the LGU had implemented segregation at source and segregated collection. The moral recovery facility has been established and composting is practiced

In the study of (Molina & Catan, 2021), senior high school students were knowledgeable about solid waste management. Thus, a high level of awareness of SWM is attaining a high level of implementation (Lalamonan, Comighud, & Mae, 2020).

In addition, (Twumasi, 2017) stated that the sustainability of waste development programs can be attained through community efforts and the creation of more SWM activities that involve collaborative efforts between all stakeholders.

Segregation at Source

The result reveals that attainment of implementing segregation at source is highly attained with a mean of 4.01. The result implies that the local government unit has complied with Rule IX Section I of RA 9003.

The Implementing Rules and Regulations (IRR) of RA 9003 under Rule IX section I states that volume reduction at source shall be the priority of the ecological SWM system (DENR, 2000). All LGUs shall actively promote among its constituents the reduction and minimization of wastes generated at source; responsibility for sorting and segregation of biodegradable and non-biodegradable wastes shall be at the household level, business, commercial, industrial and institutional centers, and in all other point sources of solid wastes (Paz, Domingo, & Roxas, 2020).

Table 1

Level of Attainment in the implementation of the SWM program of the LGU.

A. Segregation at Source	**Mean**	**DER**
1. The Barangay is practicing segregation at the source.	**4.01**	**HA**
B. Segregated Collection		
1. Waste collected is segregated properly according to types.	**4.06**	**HA**
C. Materials Recovery Facility		
1. The LGU has a Central MRF	4.49	VHA
2. The Barangay has already established its MRF	4.40	VHA
3. All the households in the barangay are being served by the MRF	3.68	HA
Sub-mean	**4.19**	**HA**
D. Composting		
1. The LGU has a functional composting facility	4.55	VHA
2. The compost (final product) is used by the residents/farmers as a soil enhancer.	4.32	VHA
3. The composting facility of the LGU is still operational and sustained.	4.49	VHA
Sub-mean	**4.45**	**VHA**
Composite Mean	**4.25**	**VHA**

Legend: HA - Highly Attained VHA – Very Highly Attained

Segregated Collection

The segregated collection has a mean of 4.06, which means that the segregation is highly attained. This implies that the LGU complied with Rule X section (f) of RA 9003, which provides that for every type of waste, there must be a specific vehicle to collect and there are organized compartments with a proper cover to ensure the containment of waste during transportation.

Material Recovery Facility (MRF)

The material recovery facility of the LGU has a sub-mean of 4.19 described as "highly attained". This implies that the barangays are compliant with section 1 of RA 9003, which states

the proper ways to collect, segregate, recycle, compost, and reuse solid wastes. Moreover, MRFs will be established in every barangay or cluster of barangays (Salillas, Sy, Bustamante, Salmingo, & Padilla, 2017). Further, composting of biodegradable and mixed non-biodegradable will be placed in the MRF for proper segregation, re-used, and recycling. If each type of waste is properly segregated in a container, the resulting residuals collected from different sources shall then be disposed to a sanitary landfill.

To implement satisfactorily solid waste management, (Tiwari, Mishra, Mishra, & Tiwari, 2014) revealed that community participation help ensures that programs will be sustained and that development must have to be integrated with efforts and resources of local people with the government to accomplish things. The involvement of the people will help them appreciate the difficulty of the program's work and dispel suspicion as to its motives (Lema, Mesfun, Eshete, & Abdeta, 2019).

Composting

The composting of the LGU has a mean of 4.45 described as "very highly attained". The result denotes that the LGU has a very effective composting facility. The final product, (compost) was used by the residents/farmers as a soil enhancer. Thus, the composting facility of the local government unit is still operational and sustained. Moreover, composting is one effective method to reduce garbage in the municipal landfill (Ayilara, Olanrewaju, Babalola, & Odeyemi, 2020)

LEVEL OF IMPORTANCE OF ALTERNATIVE TECHNOLOGY

As shown in Table 2, the respondents observed that the elements of alternative technology were very highly important with a composite mean of 4.24. This implies that alternative technology is important as to the reduction of volume of waste, maximization of waste recycling and reduction, conversion of residual materials into recyclable material, employment generation, and finished product.

Volume of Waste

The volume of waste has a sub-mean of 4.07 described as "very important". This implies that the respondents agreed that alternative technology has reduced the volume of wastes that are disposed of in the waste disposal facility. The results of the study confirm the conclusion of (Saleem, 2018) which stated that the adoption of new technologies is efficient to solve municipal waste.

Waste Diversion

The waste diversion has an overall mean of 4.24 described as very important. This implies that alternative technology maximizes recycling. Moreover, the products produced from the technology contributed to waste reduction.

Table 2

Level of Importance of Alternative Technology

A. Volume of Waste	**Mean**	**DER**
1. The Alternative Technology has reduced the full volume of wastes that are disposed of in the waste disposal facility	4.07	VI
Sub-mean	**4.07**	**VI**
B. Waste Diversion		
1. The Alternative Technology maximizes recycling	4.14	VI
2. Alternative Technology processes all waste into a serviceable product.	4.00	VI
Sub – mean	**4.07**	**VI**
C. Residual Material		
1. All recovered cellophane/plastics are well shredded and mixed into bricks.	4.07	VI
2. All recovered glass bottles are well pulverized and mixed into hollow blocks.	4.07	VI
Sub-mean	**4.07**	**VI**
D. Employment Generation		
1. It has generated employment from the locality.	4.29	VHI
2. It offers additional income to the residents.	4.29	VHI
3. It offers a sideline job.	4.29	VHI
Sub-mean	**4.29**	**VI**
E. Finished Product		
1. The finished products of Alternative Technology are donated for public use.	4.50	VHI
2. The finished products of Alternative Technology are used for LGU projects.	4.71	VHI
Sub-mean	**4.61**	**VHI**
Composite mean	**4.24**	**VHI**

Legend: VI – Very Important VHI – Very Highly Important

This approach is based on the concept of adapting the best practicable environmental option for individual waste streams

and dealing with waste as a byproduct (Goutam Mukherjee et al., 2021).

Residual Material

The residual material has a sub-mean of 4.07 described as very important. This implies that the residual materials were recovered and used as raw material in the manufacture of a recycled product such as tables, decorative blocks, bricks, and hollow blocks.

(Antonio, 2009) expound that recycling is separating out and reusing the components of the waste stream that may have some economic value. It returns various materials to the production cycle and saves natural resources along the way.

This further implies that residual materials are very highly important in manufacturing recycled products (Ahluwalia & Patel, 2018).

Employment Generation

Employment generation has a sub-mean of 4.29 described as very important. This implies that alternative technology has generated employment from the locality; it offers additional income to the residents, and it offers a sideline job.

This further implies that residual materials are very important for employment generation.

Finished Product

The sub-mean for the finished product is equal to 4.61, which means that the finished product is of high importance. This implies that the finished products of alternative technology are either donated for public use or for LGU projects.

The final report of (Corporation, 2008) discusses the empowerment of LGUs to develop mechanisms for addressing SWM problems. Some technologies transform plastic waste into a product that is beneficial to the community because it is cost-efficient and environment-friendly (Kognole, Shipkule, & Survase, 2019).

LEVEL OF QUALITY OF THE FINISHED PRODUCT

Table 3 shows the level of quality of the finished product with a sub- mean of 3.93 described as good quality.

Based on interviews and observations made by the researchers, five (5) kilos of recovered plastic, one (1) bag of cement, and three and a half (3 ½) wheelbarrow load of sand were used as raw materials to produce ninety-five (95) pieces of bricks. Five (5) kilos of recovered plastic were shredded for an hour and were mixed into a dry mixture of cement and sand. After which, it was poured into a molder and air-dried for a day. A total of eleven (11) hours were spent to produce ninety-five (95) pieces of bricks in a day.

The bricks mixed with cement and sand were not compacted, resulting in a quality of just a good product. This implies that the recovered plastics were not shredded and appeared; and that the bricks as output were not firm.

Table 3

Level of Quality of the Finished Product

Bricks made from shredded plastic	Mean	DER
1. Plastics are well shredded and not appearing	3.79	Good
2. Bricks are firm	4.07	Good
Over-all mean	**3.93**	**Good**

However, (Lmf & Ams, 2017), concluded that eco-bricks are an effective means to decrease plastic waste and good material for building construction.

PROBLEMS ENCOUNTERED ON THE UTILIZATION OF THE ALTERNATIVE TECHNOLOGY

As shown in Table 4, the problems encountered on the utilization of alternative technology have an overall mean of 2.57, which means that there are slightly serious problems encountered on the utilization of the alternative technology for bricks products.

Table 4

Problems encountered on the utilization of alternative technology

Indicators	Mean	DER
1. Lack of trained/skilled personnel.	2.71	MS
2. Raw materials for the alternative technology are not readily available	2.57	SS
3. Lack of designated personnel to manage the Alternative Technology	2.57	SS
4. Efficiency of the machines and equipment to produce the finished products.	2.64	MS
5. Difficulty marketing the finished product.	2.57	SS
6. Poor quality of the product.	2.36	SS
Over-all Mean	2.57	SS

Legend: SS - Slightly Serious MS – Moderately Serious

Lack of trained/skilled personnel has a mean 2.71 described as moderately serious. This implies that there are trained personnel, but still they do not have enough seminars/trainings attended when it comes to the utilization of the alternative technology.

Raw materials for the alternative technology that is not readily available have a mean of 2.57 (Slightly Serious) which may also imply that the materials used in the alternative technology were readily available through segregation at source and segregated collection scheme and policy of the local government units.

Lack of designated personnel to manage alternative technology is slightly serious with a mean equal to 2.57. The result implies that the lack of designated personnel who will manage the utilization of alternative technology is not a very serious problem among local government units.

The efficiency of the machines and equipment to produce the finished products has a mean of 2.64 (moderately serious). The result implies that the machines and equipment were capable of producing a certain number of finished products during the allotted processing period.

Difficulty to market the finished product has a mean of 2.57 described as slightly serious. The result may imply that the finished product, despite not being available in the marketing industry, was still used either by donation or used in LGU projects among the cities and municipalities.

Quality of product is also a slightly serious problem among local government units, with a mean of 2.36 described as slightly serious. This may imply that the finished product is of good or quality product.

ALTERNATIVE TECHNOLOGY STRATEGIC PLAN FOR TAGUDIN, ILOCOS SUR

Rationale

As gathered from the study, alternative technology is very highly important along the volume of waste, waste diversion, residual material, employment generation, and finished product. The finished product of the alternative technology on bricks made from shredded plastic is not of high quality due to adhesion problems since they are made from plastics and sand. Bricks proved to be unstable due to difficulty maintaining adhesion because of water absorption. The local government units have highly attained the implementation of segregation at source and segregated collection in their respective jurisdictions; however, the establishment of Material Recovery Facility (MRF) and composting were very highly attained. Problems encountered on the utilization of Alternative Technology by the local government were slightly serious.

This research looks into the status of the alternative technology on solid waste diversion in the municipality of Tagudin, Ilocos Sur. Furthermore, the study shows that Alternative Technology is significant concerning the reduction of solid waste dumped in waste disposal facilities, maximizes recycling; and maximizes waste diversion.

Objectives:

1. To strengthen public information within the municipality utilizing Alternative Technology.
2. To enhance the quality of the finished product of the Alternative Technology.
3. To promote the marketability of the finished product of the Alternative Technology.

The proposed strategic plan for the alternative technology on solid waste diversion is anchored on Rule XXI (Research and Public Information), Rule XII (Implementing a Recycling Program), and Rule XXII (Access to Records) of the Implementing Rules and Regulations (IRR) of the Republic Act 9003.

Public Information

Strengthening public information within the municipality utilizing the Alternative Technology as provided by Rule XXI Section 1 (c) of the IRR of RA 9003, which states that the DOST, in coordination with the concerned agencies and institutions, shall: 1) conduct a research study on other ways to re-use non-recyclable and non-reusable materials; 2) programs such as environmental technology verification (ETV) shall be formed to assessed new develop technologies; 3) assistance program shall be rendered to a developed clean technology (CT) or clean production (CP) which will be implemented by the concerned agency; 4) recovers materials and energy from the solid waste by introducing new technologies of waste management; 5) sources of fertilizers and biofuels must be maximized from the many types of organic materials; 6) uses of newly recovered resources must be properly scrutinized and studied.

Quality of Finished Product of the Alternative Technology

Enhancing the quality of the finished product of the Alternative Technology as provided by Rule XII Section 3 of the IRR of RA 9003, which states that it shall be the responsibility of the DTI to conduct a study into product standards for recyclable and recycled materials. Such a study shall consider and include, but not be limited to, any existing standards on recycled and recyclable products and existing international practices. The conduct of the study shall be based on a thorough investigation from affected industries and concerned agencies to formulate standard guidelines, and shall be submitted to the National Ecology Center (NEC) database for easy access.

Marketability of the Finished Product of the Alternative Technology

Rule XII section 1 of the IRR of RA 9003 states that the DTI, in cooperation with the Department of DILG/LGUs, and other related agencies, shall conduct research on existing market processes and purchase of recyclable markets to promote the marketability of alternative products. Moreover, strategies to further expand the marketability of products shall be explored. In addition, investigation on recyclable material should be conducted which is defined in the act, by the Commission, DTI, DOF, and the NEC. It should include: a) Identifying potential purchasers of the recovered material through standard market research techniques; b) Directly contacting buyers and determining the buyers' quality specifications, potential transportation agreements, and any minimum quantity criteria. Results of investigation on the marketability of the products, including a list of all persons involved, product information, and everything needed to strategically market a product, shall be easily accessible by the public, through the solid waste management information database, formulated by the National Ecology Center.

Further, as mandated in RA 9003, section 2, national, local agencies and government organizations should encourage and promote to the public to purchase eco-products and services. All government employees shall help in the reduction of environmental problems by patronizing environmentally friendly products and services to the extent feasible, consistent with price, performance, availability, and safety considerations. Responsibility for environmentally preferable purchasing shall be shared among the program, acquisition, and procurement personnel of government agencies. This is in consideration to the principles of pollution prevention, life cycle perspective/multiple environmental attributes, comparison of environmental impacts – recovery time and geographic scale, differences among competing products environmental performance, and human health

Furthermore, in the same act, congruous incentives and other tax incentives shall be encouraged to the commercial and industrial establishment. First, to spearhead, involve and invest in integrated ecological solid waste management projects; Second, to manufacture environmental – friendly products, to introduce, develop and adopt innovative processes that shall recycle and re-use materials, conserve raw materials and energy, reduce waste and prevent pollution; and finally, to undertake community

activities to promote and propagate effective solid waste management practices.

CONCLUSIONS

Based on the findings, the following conclusions were drawn: 1.) The level of attainment in the implementation of the SWM Program of the LGU is very highly attained.2.) The level of importance of Alternative Technology is very highly important as to the volume of waste, waste diversion, residual material, employment generation, and finished product.3.) The quality of the bricks product of the alternative technology is good. 4.) The problems encountered in the utilization of Alternative Technology are rated slightly serious. 5.) A strategic plan which can be adopted by the LGU was formulated to enhance the utilization of Alternative Technology.

RECOMMENDATIONS

Based on the findings of the study, the following are recommended:1. The improvement of Alternative Technology can be very highly attained by emphasizing its quality and marketability. 2. The proposed strategic plan is recommended for adoption by other LGUs and NGOs for the improvement of Alternative Technology.

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