Solid Waste Management Inventory: Development and Psychometric Testing of an Instrument for Public Integrated Schools

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Abstract

Solid waste management is one way to assess the solid waste practices of the public integrated school to maximize the amount of waste from generation to disposal. However, after a thorough review of published literature using various databases, the researcher was not able to find any psychometrically-sound instrument that measures solid waste management. Therefore, the researcher aimed to fill this gap by developing a reliable and valid instrument that measures solid waste management in the Philippine context. Methodological research design was used in this study. A total of 222 public integrated schools teachers in North District Division of City of San Fernando Pampanga voluntarily participated in this study. Internal consistency of the inventory was examined through the calculation of Cronbach's alpha. The results of the Cronbach's alpha range from .741 to .916, which indicates excellent reliability. On the one hand, the 57-item Solid Waste Management Inventory was factor analyzed and examination of variance revealed that the 9-factor solution explained 68.23% of the total variance (factor loadings were fairly high ranging from .429 to .935).

Keywords: solid waste management, psychometric assessment

1. Introduction

Waste management is a controversial issue that is not only faced by the Philippines but even more by industrialized and progressive countries. Kirunda (2009) believed that waste management is not included in any organizational strategic plan and ignored as important composition of organizational operation. Since it was not economically rewarding and it requires much attention and even resources, waste management is in the last list. In this modern time, where everything seems to be in a snap of a finger and progress is on its own way, remedy on solid waste management should be prioritized before it could get even worse more than what one could imagine.

Nowadays, government units, non-government organizations and even concerned individuals take part in resolving the issues by minimizing if not eradicating the problem. Seeing the problem in its broader context, it is too hard to resolve it for it includes cultural practices, budgetary requirements and willingness to implement schemes for proper waste management. Innovations such as waste segregation and recycling materials in exchange of monetary rewards were already introduced by different government agencies like the Department of Environment and Natural Resources (DENR), Department of Health (DOH) and Department of Education (DEPED). Books were also written to localize the concept of waste management down to the students' level. The National Disaster Risk Reduction Management Council (NDRRMC) associated the occurrence of flash floods out from irresponsible waste management. Local government units initiated "Clean and Green" projects to advocate 4Rs or also known as Reduce, Reuse, Recycle and Recover. The city council of City of San Fernando, Pampanga initiated an ordinance "Plastic Free Ordinance" in order to minimize the accumulation of plastic materials which are proven to be detrimental to our environment (City of San Fernando Pampanga-City Information Officer and City of San Fernando Pampanga-City Environment and Natural Resource Office, 2014).

In 2005, Miriam College – Environmental Studies Institute and the Environmental Management Bureau-DENR headed by then Secretary Michael T. Defensor created the Solid Waste Management Module for Schools. The module is a step by step guide for the schools to manage solid waste properly with the participation of children and adults as well. According to Secretary Defensor, the schools instill values among youth that will be of great help in molding the kind of community that the Philippines we will have. Much of pupils' time is being spent in school, fostering core values particularly taking good care of Mother Earth as a worthwhile advocacy.

Calamities were being brought by irresponsible waste management, one of which is the Payatas Tragedy in the year 2000. Mountains of waste devastated the residential area and even killed many lives. This brought the enactment of the Republic Act of 9003 or also known as Ecological Solid Waste Management Act of 2000. It encourages community-based initiative to construct functional Material Recovery Facilities that we have today ranging from composting and recycling facilities. The segregation scheme is composed of recyclables, compostable and residuals. In such case, the government saw the need to educate the community and start off with the youngsters. Start it in school, the cradle of values formation. Through this module, schools were obliged to educate the students on the rationale, theories and practice of solid waste management, structured implementation of Solid Waste Management and school community involvement (Miriam College, 2005).

Aside from having clean surrounding as one of the objectives of solid waste management, human health is also a major concern. The Department of Health (DOH) informed the public that epidemic diseases were primarily caused by irresponsible garbage disposal. The media has always been active in advertising the advantages of responsible waste disposal. The conventional way of disposing garbage such as burning and dumping on dumpsites caused chain problems. Burning of garbage caused air pollution while dumping on dump sites caused landslides, cradle of diseases and even soil pollution. Burning chlorine content material produces harmful chemicals which is hazardous to human health and contributes much too global warming (Miriam College, 2005).

The elements of school waste management are generation, segregation, collection, final disposal and evaluation. Generation refers to the size of the schools dictates the volume of garbage and the type of waste. These data are important on how to minimize or how to manage the waste. Segregation is basically based on nature and destination of waste. Availability of trash bins indicating the type of waste could help people to determine where to put what was supposed to be in the trash. Schools practice this scheme in order to systematically segregate their waste. Either biodegradable or non-biodegradable. Biodegradable can be pig feed and composted for organic fertilizers while non-biodegradable can be factory recyclable. Efforts were also done in order to re-use non-biodegradable materials into fancy bags and decorations while shredded tetra packs can be turned into pillows. On the positive side of increasing tons of garbage, is also an increasing opportunity to turn waste into livelihood and generate income and slow down the depletion of earth's resources. Hazardous objects such as batteries, broken glass, paints. Broken thermometers are called special waste. These can be sent to factories that extract chemicals out from these materials. Styrofoam and paper cups can be surrendered to Polystyrene Company of the Philippines. Collection talks about the scheme and who collects the garbage form school premise. It may junk dealer truck or simply "kareton" or in some cases, city government provides landfill or dumpsite. Compostable waste can be composted by the school itself for gardening purposes or can be collected by composters. Final disposal can either be in factories, compost pit, dumpsite or landfill and as pig or animals feed. Lastly, evaluation entails examination of objectives if they were met or requires improvement of the other elements. These five elements of solid waste management will be the theoretical framework of the development of researcher-made questionnaire.

School has been an effective vehicle to educate not only the students but also the entire community. The school community is also a wide producer of garbage. Might as well proper waste management should start in the school itself.

The objectives of the study are on the premise of developing a pool of items which could represent the constructs of solid waste management; to assess the internal consistency of the proposed inventory and the construct validity of the proposed inventory. The findings of this study will yield a structured, reliable and valid solid waste management inventory that will be of used for

other schools in assessing the internal consistency of their solid waste management inventory. The Division of City of San Fernando advocates functional Material Recovery Facilities (MRF) in each school as part of school operation. Science department promotes ways on how to manage waste. The researcher is a High School TLE teacher who sees the current problem on waste management and believes that waste management will lead to the provision of healthy and conducive environment for learning.

1.1. Statement of the Problem

The researcher aimed to develop and assess the psychometric properties of the Solid Waste Management Inventory for Public Integrated Schools. Specifically, the researcher sought to answer the following questions:

1. How may the internal consistency of the Solid Waste Management Inventory be assessed using Cronbach's alpha?
2. How may the construct validity of the Solid Waste Management Inventory be tested using principal component analysis?

2. Method

2.1. Research Design

The researcher used a design known as methodological research design which is very appropriate in instrument development. Methodological research is a design used to develop the validity and reliability of an instrument to be used as variable in the research (Miller-Keane Encyclopedia and Dictionary, 2003). The study developed and assessed the psychometric quality of the proposed solid waste management inventory. For such objective, the research design fitted in methodological research.

2.2. Respondents

The respondents of this study were the teachers from the six integrated schools in the North District of the Division of City of San Fernando, Pampanga. The said schools are as follows: Baliti Integrated School, Calulut Integrated School, Maimpis Integrated School, Panipuan Integrated School, Saguin Integrated School, San Isidro Integrated School and Telabastagan Integrated School.

A total of 222 teachers were asked to join the study. In instrument development, the researcher needs to count the number of items in the proposed inventory then multiply it by 5 in order to come up with the minimum sample size.

Table 1
Population according to school

School	Total Population
Public Integrated School A	41
Public Integrated School B	32
Public Integrated School C	47
Public Integrated School D	17
Public Integrated School E	55
Public Integrated School E	30

2.3. Instruments

The Solid Waste Management Inventory was the main instrument used in this study. It composed of the principal elements found in solid waste management such as School Community Involvement on Waste Management, Curricular Integration, Generation of Waste materials, Segregation Scheme, Collection Scheme, Final Disposal and Evaluation. The prime basis of the construction of the said inventory was the School Module on Solid Waste Management Inventory designed by the Miriam College-Environmental Studies Institute and the Environmental Management Bureau or Department of Environment and Natural Resources. Delphi technique used in gathering expert opinion from appropriate government agencies. Instruments rating scale to be used.

2.4. Data Collection

Permission to administer the survey questionnaire for data gathering purposes from school administrators was secured by the researcher. With the permission to administer the questionnaire, the researcher administered the first draft of the inventory and collected the responses in each school.

2.5. Ethical Considerations

The approval of this proposal was obtained from the Graduate School Office of Don Honorio Ventura Technological State University. Prior to data collection, the researcher personally explained the entire nature of the study including the potential uses and benefits in joining the study. More so, the rights of the participants in any research undertaking presented to them such as their right to self- determination, right to withdraw at any stage of the study without any prejudice, and the right to privacy and confidentiality of data. After having explained all these, the researcher served as informed consent from each participant who opted to voluntarily join the study.

2.6. Statistical Treatment of Data

Data analysis came out using the Statistical Packages for the Social Sciences (SPSS). To determine the internal consistency of the instrument, the Cronbach's alpha was used. On the one hand, principal component analysis with promax rotation was used to determine the construct validity of the instrument. In order to achieve the best fitting structure and correct number of factors, criteria such as eigenvalues higher than 1.0 and factor loadings higher than 0.40 was used.

However, before conducting principal component analysis the researcher run Kaiser-Meyer-Olkin (KMO) quantity of sampling and Baitlett's Test was utilized to evaluate whether the sample size is adequate enough to execute a satisfactory analysis. A KMO Value greater than 0.5 was used as a criterion for sample size adequacy.

3. Results and Discussion

3.1. Reliability Analysis

Internal consistency of each dimension of the inventory was examined through the calculation of the Cronbach's alpha. Results range from .700 to .916. The first dimension has a Cronbach's alpha coefficient of .916, while the second dimension has .897. The third dimension has an alpha coefficient of .912, while the fourth dimension has .790. The fifth dimension has an alpha coefficient of .868, while the sixth dimension has .829. The seventh dimension has an alpha

coefficient of .856, the eight dimensions has .854, and the ninth dimension has .700. These values indicated high reliability of the inventory.

3.2. Factor Analysis

The 57-item Solid Waste Management Inventory for Public Integrated Schools was factor analyzed with a sample of 222 public school teachers to see if the measure scale was multidimensional using confirmatory factor analysis. However, 15 items were removed due to low factor loadings. Factor analysis allowed the identification of subscales and the construction of the independent factors of the measured items. Tables 2 to 10 described the factor items and their corresponding factor loadings.

Preliminary analysis indicated high factorability-Bartlett's test was significant at $p<.001$ and sampling adequacy was good (Kaiser-Meyer-Olkin test=0.927). Principal component analysis with Promax rotation using a minimum eigenvalue of 1.0 as the extraction criterion for factors was examined for total variance. Examination of variance revealed that the nine-factor solution explained 68.23% of the variance; factor loadings were fairly high ranging from .429 to .935.

Factor 1 described 40.29% of the variation. It had five (5) items with loadings exceeding the criterion 0.40. This factor appeared to capture how the school evaluates its practices as regards solid waste management. The item "*The person –in-charge evaluates school personnel's ability to implement waste management practices"*, was the clear-cut marker variable for Factor 1 which is named *Evaluation of Solid Waste Practices,* because of its high loading (.860).

Table 2
Factor 1 items and their corresponding factor loadings

Factor 1 Items	Factor Loadings
The person-in-charge evaluates school personnel's ability to implement waste management practices.	.860
The school evaluates the effectiveness of waste management practices through survey or educational research.	.859
The school monitors the volume and classification of school wastes	.777
The school includes evaluation of waste management practices on quarterly basis.	.692
The school welcomes suggestions and recommendations from the academic community to improve solid waste management.	.522

Factor two, which represents 5.60% of the total variance, had seven (7) items with loadings more than 0.40. The theme of this factor involves how the academic community properly segregates its waste materials. The marker variable for this factor is "*The students segregate their waste properly"* which has a loading of .784; hence, it is named *Proper Segregation of Solid Waste Materials.*

Table 3
Factor 2 items and their corresponding factor loadings

Factor 2 Items	Factor Loadings
The students segregate their waste properly.	.784
Proper segregation of solid waste materials is being .	.763
The nature of waste is posted in each classroom for segregation purposes practiced in the school.	.760
Trash bins are available in each classroom.	.760
The visitors segregate their wastes properly.	.725
The parents segregate their wastes properly.	.710
The teachers segregate the wastes properly.	.618

Factor three has a percentage variance of 4.997 and has five (5) items with loadings more than 0.40. The theme of this factor involves how school implements solid waste management. *"The school strictly implements proper solid waste management to teachers"* is the item that has the highest loading (.920) and considered as the marker variable for this factor (*Implementation of Solid Waste Management*).

Table 4
Factor 3 items and their corresponding factor loadings

Factor 3 Items	Factor Loadings
The school strictly implements proper solid waste management to teachers.	.920
The school strictly implements proper solid waste management to students.	.844
The school strictly implements proper solid waste management to parents.	.814
The school strictly implements proper solid waste management to other school personnel.	.769
The school strictly implements proper solid waste management to visitors.	.681

The fourth factor with a percentage variance of 3.668 has three (3) items with loadings more than 0.40. This factor is about how teachers integrate solid waste management principles in the school curriculum. The item with the highest loading of 0.671 is the *"The school conducts seminars on the solid waste management to the academic community";* this is the clear marker variable for this factor named as *"Integration of Solid Waste Management Principles in the Curriculum"*.

Table 5
Factor 4 items and their corresponding factor loadings

Factor 4 Items	Factor Loadings
The school conducts seminars on the solid waste management to the academic community.	.671
The school conducts educational film viewing on solid waste management to the academic community.	.532
The school conducts regular interschool competitions on classroom waste management practices.	.429

Factor five describes 3.468% of the total variance. It has five (5) items with loadings greater than 0.40. The factor presents how personnel collect solid waste materials and the item with the highest loadings (.893) is *"Garbage trucks regularly collect waste materials*". This factor is named *"Collection of Solid Waste Materials"*.

Table 6
Factor 5 items and their corresponding factor loadings

Factor 5 Items	Factor Loadings
Garbage trucks regularly collect waste materials.	.893
Maintenance personnel collect waste materials.	.851
Wastes are being collected daily.	.692
Collected wastes are segregated.	.621
The local government unit helps in monitoring the volume of garbage collected by the schools.	.459

The sixth factor, with a percentage variance of 2.996, has seven (7) items with loadings more than the criteria of 0.40. Under the factor *"Promotion of Solid Waste Management Principles"*,the item*"The school fosters solid waste management by promoting clean and green campaign"*, has the highest loading (.935). This factor shows how the school promotes solid waste management.

Table 7
Factor 6 items and their corresponding factor loadings

Factor 6 Items	Factor Loadings
The school fosters solid waste management by promoting clean and green campaign.	.935
The school promotes solid waste management by posting relevant information on the bulletin boards.	.742

The school provides enough space in the school paper for solid waste management.	.709
The school posts solid waste management advocacy campaigns in each classroom.	.659
The school develops local instructional materials explaining what solid waste management.	.537
The school allocates enough budget for the implementation of solid waste management.	.536
The school includes solid waste management in its strategic plans.	.437

Factor seven has a percentage variance of 2.861. This factor had six (5) items with loadings of more than 0.40. Factor 7 describes how schools generate waste materials. The item, "*Waste generated includes recyclable materials such as plastic bottles, cans, and glasses*" was considered the marker variable with the highest loading of .857. This factor is named "*Promotion of Solid Waste Management Principles"*.

Table 8
Factor 7 items and their corresponding factor loadings

Factor 7 Items	Factor Loadings
Waste generated includes recyclable materials such as plastic bottles, cans, and glasses.	.857
The school finds ways on how to minimize the volume of generated garbage.	.677
Waste generated includes compostable materials such as agricultural materials and left over food.	.660
Volumes of paper comprise school wastes.	.652
Generation of waste is a school concern.	.648

The eight factor has a percentage variance 2.239 with loadings greater than 0.40. The marker variable (with a loading of .771) is the item "*Yes-O officers and the adviser monitor proper segregation of solid waste*". This factor had three (3) items and is known as "*Support of Student Organization in Solid Waste Management*".

Table 9
Factor 8 items and their corresponding factor loadings

Factor 8 Items	Factor Loadings
YES-O officers and the adviser monitor proper segregation of solid waste.	.771
YES-O Club initiates projects to motivate proper segregation and other recyclable materials.	.749
The Yes-O Club regularly conducts seminars on proper solid waste management.	.432

The factor nine had two (2) items with a percentage variance of 2.112, with the loadings of more than the criteria 0.40. This factor indicates how schools dispose solid waste materials. The item, *"The school has a functional material recovery facility"* is the marker variable with a loading of .877. This factor is known as the *"Final Disposal of Solid Waste Materials"*.

Table 10
Factor 9 items and their corresponding factor loadings

Factor 9 Items	Factor Loadings
The school has a functional material recovery facility.	.877
The school follows up the final disposal of school waste..	.538

3.3. Conclusions

1. Internal consistency of each dimension of the inventory was examined through the calculation of the Cronbach's alpha. Results range from .700 to .916.
2. The 57-item Solid Waste Management Inventory for Public Integrated School was factor analyzed and only 42 items were considered due to high factor loading. 10 items were excluded because of item low factor loading. Factor 1 is named *Evaluation of Solid Waste Practices*. Factor 2 is named *Proper Segregation of Solid Waste Materials* Factor 3 is named *Implementation of Solid Waste Management*. Factor 4 is named *Integration of Solid Waste Management*. Factor 5 is named *Collection of Solid Waste Materials*. Factor 6 is named *Promotion of Solid Waste Management Principles*. Factor 7 is named *Promotion of Solid Waste Management Principles*. Factor 8 is named *Support of Student Organization in Solid Waste Management*. Factor 9 is named *Final Disposal of Solid Waste Materials*.

3.4. Limitations and Directions for Future Research

On the basis of the foregoing findings and conclusions of the study, the following recommendations are offered:

1. The proposed number of respondents which were numerated as 253 was not materialized and resulted to 222 participants due to some problems. Problems such as unavailability of the participants, school head's hesitation to permit their teachers to participate in the conduct of the study and the accessibility of schools were met. Future researchers may want to venture on recruiting a larger sample size to represent the entire target population.

2. The researcher only assessed the reliability and validity of the Solid Waste Management Inventory by means of using Cronbach's alpha and construct validity. Further psychometric testing needs to be done in national level to contextualize Filipino aspects of Solid Waste Management.
3. Since this study showed that the Solid Waste Management Inventory is a psychometrically-sound instrument, future researchers may want to utilize the Inventory in assessing the solid waste practices of public integrated schools.

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