

Development and Assessment of Improvised Shredding Machine of Kitchen Waste for Food Technology Laboratory

Fajardo, Christine B.¹, Pasion, Billie Jack DR.^{2*}, Manuzon, Eminiano P.³

^{1,2,3}*Nueva Ecija University of Science and Technology, Gen. Tinio St., Quezon District, Cabanatuan City, Nueva Ecija, 3100 Philippines*

*Corresponding author's email: cadworkz.bojtech@gmail.com

Abstract. This research focused on the development and assessment of an Improvised Shredding Machine of Kitchen Waste for the Food Technology Laboratory. It is a shredding machine designed to reduce waste generated in food labs, small businesses, and community households. Developmental research is thought to be especially essential in the field of instructional technology. This study employed developmental research, specifically one of the most popular forms of developmental research design, namely product development, in which the generated product is studied, explained, and finally assessed. The product was developed based on the following phases of the Hannafin and Peck model, such as: Needs Assessment, Design, and Development and Implementation. Moreover, it was assessed by four (4) sets of respondents, namely: Electrical Experts, Food Technology Teachers, Small Business Enterprises and Community Households in the city of Cabanatuan and Municipality of Santo Domingo, Nueva Ecija. They were asked to assess the technical descriptions and characteristics of the developed shredding machine such as Functional Suitability, Performance Efficiency, Reliability, Usability, Maintainability and Portability. The researchers utilized weighted mean to analyze the data gathered. Based on the result of the study, the respondents rated and approved this particular niche. The electrical expert respondents rated the shredding machine very effective, very functional, very usable and very maintainable. Likewise, the food technology teacher, small business enterprise and community household respondents rated it very functional, very efficient, very maintainable, very usable, very maintainable and very portable. In lieu with this, the product was effective to utilize into its target end-users.

Keywords: Community household; Food technology laboratory; Kitchen waste; Shredding machine; Small business enterprise

1. Introduction

Parallel with the advancements in industries and continuous increase in world population, the amount of food waste being generated also increases. Waste

generation rates are generally related to modern conveniences and changing lifestyles, increasing population, rapid urbanization, improper waste disposal, and public insensitivity. Based on the 2019 report of the Food and Agriculture Organization of the United Nations, it is estimated that roughly 1.3 billion tons of food waste is generated annually which is about one-third of the food being manufactured for human consumption. This poses serious effects on public health, safety, productivity and economy.

Consequently, food production does not only involve economics resources to deplete, but also the exhaustion of large portion of the earth's resources leading to biodiversity loss. This environmental effect is coupled with the emission of methane by food waste which contributes greatly to global warming. This global scenario implies that there is an urgent need to address the generation of food waste with the increase in the demand of food production.

In the Philippines, the problem on food waste is a persistent scenario due to rapid growth in population, inadequate government policies, lack of knowledge on proper disposal, insufficiency or lack of recycling resources and services and most importantly, the lack of interest and willingness of households (Schanes et.al, 2018). In relation, the Local Government Units (LGUs) holds primary responsible for the effective and efficient solid waste management in the Philippines. Ecological Solid-Waste Management Act of 2000 prohibits new open dump sites for disposal and encourages the conversion of open dumps into controlled dump sites within three years.

Problems of waste are generated from human activity. Day-to-day activities in the home, school, commercial establishments and industries produce many kinds of waste (Anitha, 2017). Hygiene starts from home and household waste accounts for major amount of rubbish some can be reusable and others are non-reusable (Google Books, n.d.). It consists of fruits and vegetable peels, seeds, bad vegetables and rotting food materials and others. All of these constitute to a huge number of municipal wastes once it is not properly disposed of and the consequences are dangerous.

According to Risse (2017), food waste is divided into two categories: pre-consumer and post-consumer. Pre-consumer food waste is simply the preparatory food refuse and diminished quality bulk, raw material food that is never seen by the consumer while post-consumer food waste is simply the table scrap food refuse. Any of these wastes contribute to damage and inconvenience

when improperly disposed of, which include foul smells, additional dredging costs of waterways, silting up of reservoirs, decrease in plant productivity, corrosion of structures and structural foundations, and depreciation of land value (Anitha, 2017).

Kitchen waste and its accumulation are increasingly acknowledged as a critical problem among governments, businesses, academics, and the general public. The exponential growth in food waste due to the increasing world population imposes serious threats to our society like environmental pollution, health risk, and scarcity of dumping land. (Paritosh et.al, 2017). Food waste has been projected to increase in the next 25 years due to economic and population growth, mainly in Asian countries. It has been reported that the annual amount of urban food waste in Asian countries could rise from 278 to 416 million tonnes from 2005 to 2025 (Melikoglu et.al, 2013).

However, the most common and often practice by household and some communities is to store waste in plastics, drum can, bins or in any receptacles. Wastes collection is done once or twice a week. Kitchen leftovers, such as food peels and trimmings, decompose quickly. If left in a garbage container, it will quickly disintegrate under anaerobic environment, producing a foul odour and creating a shelter for flies, cockroaches, and germs.

With this problem, utilizing the waste grinder in handing food waste is a very timely endeavour, especially for a developing country like the Philippines since waste management in the country is in dire need of change to streamline young minds to the environmental problems and concerns. However, waste grinder available in the commerce are for indoor purposes only. In lieu with this, the researchers shredding machine that can be utilized both in indoor and outdoor activities which makes it portable and with the same functionality. Furthermore, the developed shredding machine addresses the global problem on food waste generation by aiding the first step in the food waste management system. The reduction of wastes disposal pointed out that the use of garbage grinders leads to valuable benefits.

2. Methodology

This research utilized a developmental research design. According to Richey & Nelson (2001) as cited by Pasion (2022), it is the systematic study of designing,

developing and evaluating instructional programs, processes, and products that must meet the criteria of internal consistency and effectiveness. This study also makes use of one of the most popular kinds of developmental research design: the product–development approach, in which the generated product is examined, explained, and then assessed. In this study, the developed product is the Improvised Shredding Machine.

The assessment of the developed machine was done by fifty–five respondents. The distribution was as follows: 5 electrical experts, 15 food technology teachers, 15 small food enterprise and 20 community households from the city of Cabanatuan and municipality of Santo Domingo, Nueva Ecija, Philippines.

The questionnaire utilized to assess the developed improvised shredding machine was self–made by the researchers. It was personally administered pilot testing to gather data, information and comments for the improvement of the questionnaires, and all data gathered were treated and tested using Cronbach Alpha. The test–retest method was employed after the final copy was done and finalized. The internal consistency method was employed. The results from the test are effectiveness = 0.76, functional suitability = 0.75, performance efficiency = 0.73, reliability = 0.72, usability = 0.76, maintainability = 0.72 and portability = 0.74. The reliability coefficient of the test was 0.74, which was deemed acceptable. This implies a high degree of consistency, meaning that the instrument accurately measured what it was designed to measure.

3. Results and Discussion

3.1. Development of the Improvised Shredding Machine of Kitchen Waste for Food Technology Laboratory

The development of the improvised shredding machine followed the phases of the Hannafin and Peck model, such as Needs Assessment, Design, and Development and Implementation.

3.1.1. Needs Assessment

In this phase, the researchers identified the proper disposal of kitchen waste in school food laboratories, small food enterprises and community household in the chosen localities of the study. Moreover, the benefits of proper

disposal of kitchen waste were also assessed. Likewise, the researchers conceptualized the design of their improvised shredding machine based on its intended functionality in this phase.

3.1.2. Design

The design phase is focus in describing the draft plan, electrical diagram, hardware and materials, and the cost and benefit analysis of the developed shredding machine as shown in the following figures below.

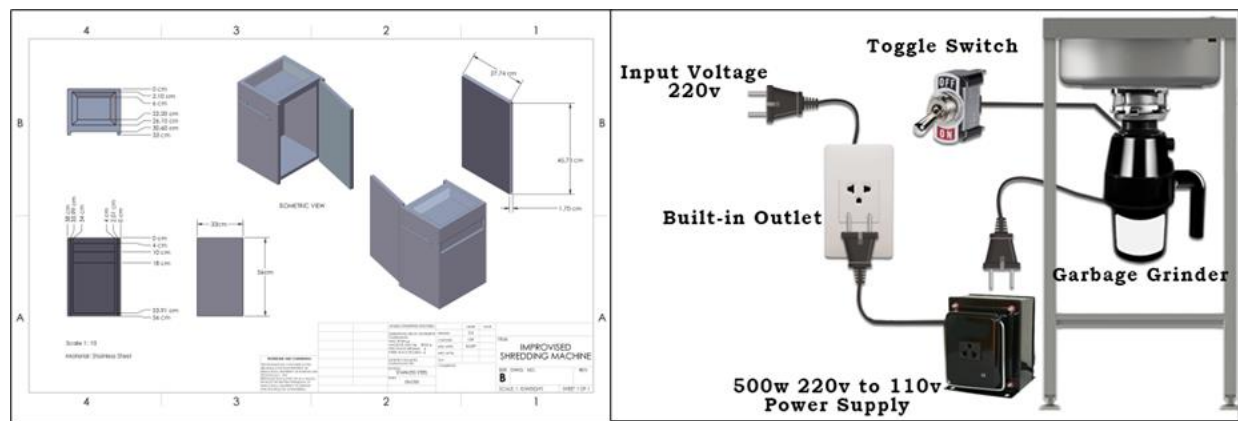


Figure 1 Improved Shredding Machine's Draft Plan and Electrical Diagram

The hardware and materials utilized in the development of the shredding machine was categorized into recycle, electrical, consumable and non-consumable materials. On the other hand, the cost and benefit analysis of the developed device is presented on the table 1. The total expenditure of the researchers during the development phase was ₱8,685.00. This implies that the developed shredding machine is cheaper than the current market price of Food Waste Disposal Kitchen Waste Home Automatic Wet Food Sink Pulverizer Quick Drainage Hole Filter Slag Grinder Food Crusher that is ₱10, 499.00, (source: <https://www.lazada.com.ph>). Further, the researcher' machine is portable which means that it can be utilized in indoor and outdoor activities as long as it was connected to power source.

3.1.3. Development and Implementation

In this phase, the development of the improvised shredding machine followed properly the draft plan of the physical structure of the device and safely installed the electrical components by following the intended electrical diagram.

The available tools, materials and equipment was accurately utilized by the researchers to avoid accidents and mistakes during the construction. The researchers also used Gantt chart to monitor the progress of development.

Series of testing on the operation and functionalities of the developed was correctly performed before deploying the developed device for its implementation to its intended users. With the proper guidance of the researchers, the end-users of this research were perfectly utilized the shredding machine and secured as well. The figures presented below shows the development and implementation of the improvised shredding machine.



Figure 2 Improvised Shredding Machine’s Development



Figure 3 Improvised Shredding Machine’s Implementation and Evaluation

3.2. Assessment of the Improvised Shredding Machine of Kitchen Waste for Food Technology Laboratory

The assessment of the developed improvised shredding machine was done right after the implementation phase. The electrical expert respondents were

asked to evaluate technical descriptions of the device based on its effectiveness, functionality, usability and maintainability. On the other hand, its technical characteristics, such as: functional suitability, performance efficiency, reliability, usability, maintainability and portability were assessed by three groups respondents, namely: food technology teachers, small business enterprises and community households.

3.2.1. Assessment of the Electrical Experts

The assessment of the Improvised Shredding Machine is one of the most important phases of the study, where the developed product was tested by the different set of respondents. The electrical experts assessed the technical descriptions of the developed machine using the research instrument. Table 1 shows the summary of assessment of the electrical experts.

Table 1 Summary of the assessment of Electrical Expert Respondents

Descriptors	Weighted Mean	Verbal Description
Effectiveness	4.00	Very Effective
Functionality	4.00	Very Functional
Usability	4.00	Very Usable
Maintainability	4.00	Very Maintainable

The table shows that the improvised shredding machine systematically shredded kitchen garbage into the appropriate product or output. In addition, it can pulverize a variety of food waste and segregate solid from liquid outputs. Furthermore, it reacts and processes timings and throughput rates as it executes its duties. Likewise, it was very simple to use and manipulate. Broadly speaking, the developed device has a very small number of components, which means that in case the device become malfunction the user can easily identify which part is broken or busted.

3.2.2. Assessment of the Food Technology Teachers

As mentioned above, food technology teachers evaluated the technical characteristics of the developed device. Table 2 shows the synopsis of the evaluation.

Table 2 Synopsis of the evaluation of Food Technology Teacher Respondents

Descriptors	Weighted Mean	Verbal Description
Functional Suitability	3.86	Very Functional
Performance Efficiency	3.78	Very Efficient
Reliability	3.73	Very Reliable
Usability	3.83	Very Usable
Maintainability	3.75	Very Maintainable
Portability	3.75	Very Portable

The table shows that the food technology teacher respondents agreed that the developed device was very functional, very efficient, very reliable, very usable, very maintainable and very portable.

This implies that the improvised shredding machine: crushes the kitchen trash very well, responds and processes times and throughput rates when performing its purposes, meets needs for consistency under normal operation, is easy to use and control, electrical components are replaceable, and can be installed and uninstalled easily.

3.2.3. Assessment of the Small Business Enterprises

As previously said, small business enterprises assessed the technical characteristics of the manufactured product. The evaluation's overview is shown in Table 3.

Table 3 Assessment’s Overview of Small Business Enterprise Respondents

Descriptors	Weighted Mean	Verbal Description
Functional Suitability	3.80	Very Functional
Performance Efficiency	3.71	Very Efficient
Reliability	3.75	Very Reliable
Usability	3.80	Very Usable
Maintainability	3.77	Very Maintainable
Portability	3.75	Very Portable

According to the table, small business enterprise respondents rated the developed shredding machine very functional, very effective, very reliable, very usable, very maintainable, and very portable.

This indicates that the improvised shredding machine: facilitates the accomplishment of specified tasks and objectives, meets the amount and types of resources when performing its functions, is operational and accessible when required for use, is easy to learn by specified users and it meets their satisfaction, can be easily diagnosed for deficiencies, and can be moved from one place to another effortlessly.

3.2.4. Assessment of the Community Households

The technical characteristics of the developed machine were assessed by community household, as it was already described in previous pages. The examination’s summary is displayed in Table 4.

Table 4 Summary of the examination of Community Household Respondents

Descriptors	Weighted Mean	Verbal Description
Functional Suitability	3.86	Very Functional
Performance Efficiency	3.79	Very Efficient
Reliability	3.75	Very Reliable
Usability	3.76	Very Usable
Maintainability	3.65	Very Maintainable
Portability	3.76	Very Portable

The developed machine received high marks from community household respondents for being very functional, very effective, very reliable, very usable, very maintainable, and very portable.

This entails that the improvised shredding machine functions cover all the specified tasks and user objectives, cost is sufficiently affordable compared to existing ones, operates as intended despite the presence of technical faults, users are safeguarded while using it, can be tested without hesitation from risk and hazards, and can be used at indoor and outdoor chores which can be carried out by single person.

4. Conclusions

Based on the phases of the Hannafin and Peck model, the Improvised Shredding Machine was developed successfully. Its technical descriptions were assessed very effective, very functional, very usable and very portable by the electrical expert respondents. Likewise, its technical characteristics were assessed as very functional, very efficient, very reliable, very usable, very maintainable and very portable by the food technology teacher, small business enterprise and community household respondents. Therefore, the developed improvised shredding machine is a solution for kitchen waste problems and conforms to the standards of food waste management system.

Acknowledgements

The researchers would like to acknowledge all the electrical expert, food technology teacher, small business enterprise and community household respondents from the city of Cabanatuan and municipality of Santo Domingo, Nueva Ecija, Philippines who participated in this research.

References

- Anitha, M. (2017). Problems of waste are generated from human activity. *IOSR Journal of Environmental Science, Toxicology and Food Technology*, pp 43–48.
- Google Books. (n.d.). Retrieved July 12, 2021, from <https://books.google.com.ph/?hl=en>
- Kunwar Paritosh, Sandeep K. Kushwaha, Monika Yadav, Nidhi Pareek, Aakash Chawade, Vivekanand Vivekanand, "Food Waste to Energy: An Overview of Sustainable Approaches for Food Waste Management and Nutrient Recycling", *BioMed Research International*, vol. 2017, Article ID 2370927, 19 pages, 2017. <https://doi.org/10.1155/2017/2370927>
- Melikoglu, M., Lin, C. & Webb, C. (2013). Analysing global food waste problem: pinpointing the facts and estimating the energy content. *Open Engineering*, 3(2), 157–164. <https://doi.org/10.2478/s13531-012-0058-5>
- Pasion, B. J. (2022). Development and Assessment of Web Application for Industrial Technological Education. *The QUEST: Journal of Multidisciplinary Research and Development*, 1(1). Retrieved from <https://neust.journalintellect.com/quest/article/view/9>
- Risse (2017) Food Waste Composting: Institutional and Industrial Applications. *Secure*. https://secure.caes.uga.edu/extension/publications/files/pdf/B%201189_4.PDF
- Schanes, K., Dobernig, K., & Gözet, B. (2018). Food waste matters – A systematic review of household food waste practices and their policy implications. *Journal of cleaner production*, Volume 182, 978–991. <https://doi.org/10.1016/j.jclepro.2018.02.030>