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Development of a Kitchen Sink-Integrated Plate Waste Collector for Minimizing Clogging and Waste Accumulation

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Abstract - *Purpose - This study was conducted in response to the growing environmental and plumbing problems caused by improper kitchen waste disposal, particularly food scraps and cooking oil, which often lead to pipe clogging, bad odors, pest infestation, andincreasedpollution. In areassuchas a subdivision in Jagobiao, Mandaue City, Cebu, householdsfound manual waste segregation inconvenient and time-consuming due to strict waste monitoring policies, resulting in daily challenges in proper disposal. Similar issues have also been observed in other parts of the Philippines, where improper disposal of grease and oil into drainage systems contributes to blockages and environmental damage, mainly due to limited awareness of correct waste management practices. To address these concerns, the researchers designed and evaluated an integrated kitchen sink system that automatically separates solid waste and oil during regular dishwashing, eliminating the need for manual segregation. The system showed excellent technical performance, achieving 100% oil removal efficiency and 93%–99% solid waste separation efficiency, while user evaluation based on the Technology Acceptance Model indicated high satisfaction in terms of reliability, safety, ease of use, and usefulness. Overall, the study highlights the importance of integrating waste separation into kitchen systems as a practical solution that improves household convenience, prevents clogging, enhances wastewater flow, and supports cleaner and more sustainable environmental management.*
Keywords - *clogging, effluent, food waste, grease trap, mechanism, oil waste*

I. INTRODUCTION

Sorting kitchen waste is important for keeping the environment clean and protecting people's health. It helps cut down the amount of trash going to landfills and lowers harmful gas release into the air. When food scraps are kept apart from other garbage, it becomes easier to recycle or turn them into compost. This saves resources and lessens pollution. Proper waste separation also stops pests and germs from spreading, making the surroundings cleaner and safer. In addition, it can also minimize clogging problems, a kitchen main problem that can possibly occur due to blockages in pipes.

The kitchen systems require an efficient management system for their waste. In particular, the scraps of food and grease bring many problems. Plumbing blockage might occur with unpleasant smells and increased loads in water treatment plants in case of inappropriate disposal of food residues. Similarly, an accumulation of grease inside water treatment pipes often causes a blockage, bad smell, and costly repairs to the plumbing system, contaminating the environment through sewage systems. These problems underscore the need for effective solutions that minimize the adverse impact of kitchen waste on plumbing infrastructure and the environment.

In a subdivision located at Jagobiao, Mandaue City Cebu, manual segregation of waste is a very hassle and inconvenient process for them to do every day. Since their area is somehow a private area, their wastes are strictly monitored by the maintenance of their subdivision if it is properly decomposed or not. With this, they need to manually segregate it and throw it in the proper area intended for their wastes which they considered inconvenient for them especially that they have to do it every night.

Moreover, the researchers tend to solve that kind of problem by designing an integrated kitchen-sink where the homeowners can conveniently use whenever they wash their used kitchen utensils without manually segregating any wastes that could possibly cause clogging problems.

To add up, the study investigated the disposal practices of households in Cabanatuan City, Philippines, focusing on how cooking oil and grease residues from their operations are managed. It revealed that many establishments and households improperly dispose of liquid waste by flushing it through the city's drainage system, leading to potential canal blockages. Furthermore, the findings showed a lack of awareness among food operators regarding proper liquid waste disposal methods and the environmental harm caused by their actions (Balaria, 2021).

According to Parfitt et al., (2010), the study examined the differences between pre-consumer and post-consumer food waste, emphasizing the unique challenges and opportunities in managing each type. Pre-consumer food waste, which includes preparatory food scraps and unused raw materials is easier to compost because it is typically free from contamination and already separated from other waste. On the other hand, post-consumer food waste, consisting of table scraps, is more difficult to manage due to contamination and the need for separation from other waste materials. The city's sanitation office highlighted that grease and fat in drains create a significant sanitation and infrastructure problem, severely affecting the drainage system. When fat and grease mix with water, they solidify and over time, harden like mortar when combined with sludge and debris. These blockages lead to severe obstructions, causing drain backups and exacerbating flooding issues, particularly during heavy rainfall, making the situation unhygienic and hazardous. (Rebollido., 2023)

The aim of this project was to provide households with more

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convenience and help to lessen food and oil waste clogging, resulting in a better wastewater flow rate.

II. STATEMENT OF THE PROBLEM

This study aimed to design, develop and evaluate a Kitchen Sink-Integrated Plate Waste Collector for Minimizing Clogging and Waste Accumulation.

Specifically, this study seeks to give focus on the following objectives:

1. Identify the limitations and challenges associated with existing kitchen sink anti-clogging systems, congregate relative studies and theories that will support and help the study's structure and determine which materials will be used.
2. Design and develop a prototype of Kitchen Sink-Integrated Plate Waste Collector that will enrich solace of the effective waste segregation, minimize clogging in pipes due to oil build up and food residue, filter food particles from water prior to entering the septic tanks.
3. Evaluate and test the developed Kitchen Sink-Integrated Plate Waste Collector in terms of:
   - 3.1 Effectiveness of Segregation of Food Waste from Wastewater
   - 3.2 Effectiveness of Oil Separation
   - 3.3 Effectiveness of Notifying the Users
4. Implementing user acceptance testing of the innovative Kitchen Sink-Integrated Plate Waste Collector to evaluate its performance and user satisfaction in terms of:
   - 4.1 Reliability
   - 4.2 Safety
   - 4.3 Performance
   - 4.4 Serviceability
   - 4.5 Perceived Usefulness
   - 4.6 Perceived Ease of Use
   - 4.7 Behavioral Intention

III. METHODOLOGY

A. Research Design

This study employed the quantitative design where researchers determined the problem they want to solve in this study, the key concepts and variables of the study, and then outlined the relationship between them. In this phase, researchers were able to define the possible questions they used to gather the data they needed, created the conceptual framework, and also prepared for the factual stage of the study. This study also incorporates and follows a structured approach of the quantitative method through survey questionnaires made by the researchers and data gathering methods.

B. Research Environment

This study was conducted at Deca Homes Mandaue Prime Jagobiao, a subdivision located at Mandaue City, Cebu.

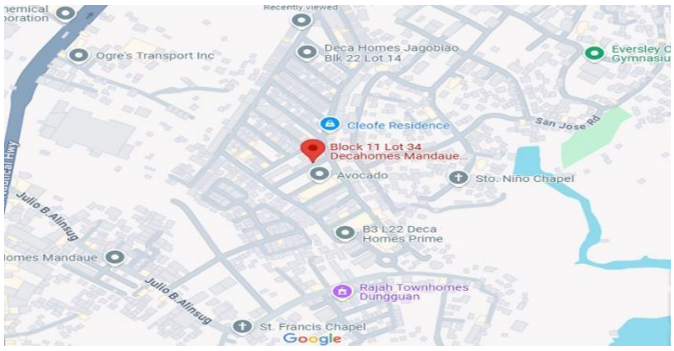

Figure I. Research Setting

C. Research Respondents

The researchers used purposive sampling, a non-random type of sampling that selects the right participants based on their knowledge and experience in clogging. The study was conducted on the homeowners that serves as the environment of this thesis study. There were 20 respondents in this study as the researchers were able to show their testing videos to the other homeowners.

D. Research Instrument

Survey questionnaires was the main tool used for gathering data on this study. An initial survey questionnaire and a post-evaluation survey questionnaire was prepared by the researchers. The post-evaluation form has the questions that are needed to find out how satisfied the interviewees were with the project.

E. Research Procedure

For this project, researchers checked all related studies, literature, and other sources that serves as help to them in making and planning the project. Theories, principles, and processes that helped and supported the study were also found by the researchers. The researchers used these to come up with plans and strategies that were used to make an easier and more efficient way of washing dishes without having to separate manually the wastes from the plates.

F. Treatment of data

The data was processed by organizing the survey responses and interview notes into categories based on common themes and opinions. Statistical analysis was used to identify patterns in the responses, such as the frequency of particular preferences or issues. The responses were compared to determine if the system is more efficient and preferred by users. The results were interpreted to highlight the strengths and weaknesses of the integrated kitchen sink waste separator. Finally, the findings were presented to draw conclusions on the device's potential for improving the minimizing of clogging efficiency and user satisfaction.

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IV. RESULTS AND FINDINGS

Table 1
Overall efficiency of Oil-Wastewater Separation

Trial #	Oil to Water Ratio	Average Efficiency (%)	Overall Efficiency (%)
1-7	1:1	100	100
8-13	1:2	100	
14-19	1:3	100	
20-22	1:4	100	

Table 1 summarizes the overall oil–wastewater separation efficiency across all tested oil-to-water ratios. The results show that the system achieved an average removal efficiency of 100% for each ratio (1:1 to 1:4), with no measurable oil detected in the wastewater effluent in any trial.

In summary, the consistent efficiency across varying mixture conditions indicates that the prototype effectively prevents oil from entering the drainage system and maintains stable separation performance.

Table 2.
Actual Data and Efficiency Results for Solid Waste Separation

Solid Waste Added per Trial Attempt (kg)	Trial #	Total Mass of Solid Waste Added (kg)	Accumulated Mass of Solid Waste in Solid Bin (kg)	Sensor Percentage (%)	Efficiency (%)
0.5	1	0.5	0.48	10	96
	2	1	0.936	20	94
	3	1.5	1.404	40	94
	4	2	1.942	50	97
	5	2.5	2.474	60	99
1	6	1	0.98	30	98
	7	2	1.87	50	94
	8	3	2.8	70	93
	9	1	0.97	30	97
	10	2	1.856	50	93
	11	3	2.794	70	93
1.5	12	1	0.957	30	96
	13	2	1.932	50	97
	14	3	2.906	70	97
	15	4	3.9	100	98
	16	1.5	1.46	40	97
	17	3	2.8	70	93
	18	4.5	4.39	100	98
2	19	2	1.88	50	94
	20	4	3.914	100	83

Table 2 summarizes the actual mass measurements and corresponding efficiency results for solid waste separation across varying solid waste input levels. The results show consistently high separation efficiencies, ranging from 93% to 99%, across all trial attempts and loading conditions. This indicates that the prototype effectively separates the majority of solid waste introduced into the system. Minor variations in efficiency observed at higher loading levels did not indicate a decline in performance, suggesting that the system maintains reliable separation efficiency over a wide range of operating conditions. Overall, the high and stable efficiency values demonstrate the prototype's effectiveness in solid waste capture and its suitability for preventing solid waste from entering the drainage system.

Table 3
Survey results: overall mean score and interpretation

Overall Mean Score	Verbal Interpretation
3.93	Highly Satisfied

Table 3 presents the overall mean score across all categories of the survey questions. With an overall mean score of 3.93, users were highly satisfied with the overall performance of the product. Users consistently described the device as reliable, safe, effective, and easy to operate. These positive impressions fit well with the theoretical foundations of the study—especially TAM, which emphasizes the importance of perceived usefulness and ease of use in shaping user acceptance. The strong score also reflects the principles of sustainable waste behavior, showing that users appreciate a tool that supports cleaner and more responsible waste disposal.

Overall, the feedback suggests that the device meets its intended purpose: it functions effectively, is convenient to maintain, and encourages users to adopt it as part of their daily routine. This combination of good performance and positive user perception indicates a strong potential for real-world application.

V. CONCLUSION

Based on the findings, the waste separation system effectively prevented both oil and solid waste from entering the drainage system. The oil–water separator maintained complete oil removal throughout all trials, indicating stable and repeatable performance regardless of changes in oil-to-water ratios. At the same time, the solid waste separation

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mechanism consistently collected the majority of solid materials, reducing the risk of pipe clogging and maintenance issues. Overall, the results confirmed that the system functioned as intended and was suitable for household or similar applicatio ns where efficient waste separation is needed to support cleaner wastewater flow and improved drainage performance.

AUTHOR CONTRIBUTIONS

Author 1: Conceptualization, Methodology; **Author 2**: Data curation, Writing-Original draft preparation, Writing-Reviewing; **Author 3**: Investigation, Validation, Visualization, Writing- Reviewing, **Author 4:** Validation, Visualization; **Author 5:** draft preparation, Writing- Reviewing

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GENERATIVE AI STATEMENT

The authors used ChatGPT (Open AI) solely as a language-support tool to improve the clarity, coherence, and grammatical accuracy of the manuscript. All AI-assisted outputs were critically reviewed, revised, and validated by the authors to ensure the accuracy, integrity, and originality of the content. The authors accept full responsibility for the final version of the manuscript and its published content.

ETHICAL CONSIDERATIONS

Prior to the data gathering, ethical approval was obtained from the University of Cebu Academic Research Ethics Committee (UCAREC). The approved protocol ensured adherence to the principles of respect for persons, beneficence, justice, voluntary participation, informed consent, confidentiality, and anonymity, and compliance with the Data Privacy Act throughout the research process.

DECLARATION OF INTEREST

The authors declare that they have no competing financial, professional, or personal interests that could have influenced the conduct, findings, or publication of this study.

DATA AVAILABILITY

Data will be made available by the corresponding author on request.

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