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Hybrid Seaweed Mechanized Chopper-Extractor in San Jose, Occidental Mindoro: Basis for an Enhanced Technology

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A R T I C L E I N F O

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A B S T R A C T

This quantitative- descriptive study assessed the level of acceptance of the Hybrid Mechanized Seaweed Chopper-Extractor among the seaweed farmers in San Jose, Occidental Mindoro. Through field testing and face to face interview with thirty (30) respondents, the findings of this study reveal a notably high acceptance rate of the Hybrid Mechanized Seaweed Chopper-Extractor among local farmers, which aligns with similar studies on agricultural technology adoption in coastal communities. With its key benefits of chopping efficiency (85.66%), extraction efficiency (4.06%), and electrical energy consumption ((0.02 kWh/kg), the technology presented promising advantages to the local community. This denotes that farmers who believe the machine will significantly improve their work efficiency, find it easy to operate, and hold positive attitudes toward its use are much more likely to intend to adopt the technology. Patenting process for the Hybrid Mechanized Chopper-Extractor to secure intellectual property rights is hereby highly recommended to support innovation and advance technology transfer in seaweed farming.

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INTRODUCTION

Seaweed farming is an essential aspect of the Philippine aquaculture industry as it contributes significantly to rural development and increasing livelihoods among the coastal communities. The country is one of the world's leading producers of *Kappaphycus* and *Eucheuma* that valued for their high carrageenan content that is widely applied in the food, cosmetic, and pharmaceutical industry (Bureau of Fisheries and Aquatic Resources, 2023). In 2023, the Philippines produced approximately 1.6 million metric tons of fresh seaweed, underscoring its prominent role in global seaweed production .Coastal provinces such as Palawan, Romblon and Mindoro are some of the province's biggest producers, while San Jose, Occidental Mindoro has become a significant production area due to its conducive marine environment.

In spite of the good prospects of the sector, there are also problems of post-harvest processing challenges facing seaweed farming in the area. The conventional ways are still inefficient, tedious, and labor-intensive, especially at the chopping and extraction stages. Such practices are outdated and usually lead to uneven processing, low yield of bioactive compounds and increased production costs—variables that inhibit scalability and profitability of the small scale farmers. The absence of accessible and affordable mechanized tools aggravates the disparity between the technological progress and the local farming methods (Kadam et al., 2015).

To solve this problem, a new machine named Hybrid mechanized Seaweed Chopper-Extractor was developed by Occidental Mindoro State College. This low-energy machine combines chopping process and extraction and is dual-powered and it provides a sustainable solution for enhancing the efficiency of seaweed post-harvest handling. As an innovation invented by students, the machine offered a transformative approach that can bring optimum extraction yields and reasonable cost (Sunga et. al, 2024). However, the innovation is still underutilized as it has not been introduced, tested and commercialized for local seaweed farmers.

Consequently, this study assessed the level of acceptance of the Hybrid Mechanized Seaweed Chopper-Extractor among the seaweed farmers in San Jose, Occidental Mindoro. It filled an important gap between development of technology and its adoption by end user, with the goal of facilitating future initiatives for technology adoption, patent application and sustainable seaweed industry expansion.

THEORETICAL REVIEW

Related Literature

This section examines prior research and scholarly discussions related to the objectives of the study. Cost of Hybrid Mechanized Chopper-Extractor The feasibility assessment for seaweed farming strongly relies on understanding the expenses that will be needed to purchase processing equipment. Hauke et al. (2022) reveals that big seaweed production facilities need between $200 and $300 to make one dry ton of product yet this implies substantial investment for equipment. IMARC Group report (2025) provides detailed technical information

on creating a seaweed oil processing facility but investors need complete financial evaluation before starting any project.

Locally made equipment is 35–50% less expensive than imported alternatives while still having similar functionality, according to a 2023 World Bank report on agricultural mechanization in developing nations (World Bank, 2023). This bolsters the Hybrid Chopper-Extractor's economical strategy. Through streamlined manufacturing procedures, modular designs can lower production costs by 20–30%, according to additional research by the Asian Development Bank (2022).

The survey results from Philippine Council for Agriculture, Aquatic and Natural Resources Research and Development (PCAARRD, 2021) show that 78% of small-scale farmers consider equipment under ₱100,000 affordable for purchase. Our prototype design structure adjusted its costs based on this reference p oint.

The total cost of the Hybrid Mechanized Chopper-Extractor is ₱146,144.00, divided into direct materials and direct labor costs. The materials cost ₱118,489.00, covering essential components like stainless steel for durability, mechanical parts such as gears and motors, and a solar power system worth ₱79,000.00 for off-grid use (Sunga et. al, 2024). The production cost for direct labor amounts to ₱27,655.00 for local fabrication services. Solar system installation offers flexible configuration which allows the machine to work with both grid power and no grid power types. (See appendix E)

This economically feasible prototyping method enables rural seaweed processors to gain easier access to resources. Through the local utilization of materials and workforce the fabrication of equipment becomes more affordable and accessible to rural demographic communities. Those initiatives led by the Department of Trade and Industry maintain sustainable drying facilities for seaweed-producing firms in MIMAROPA and other regions specifically to support local industrial development of micro, small and medium enterprises (MSMEs) (DTI, 2024).

The use of standardized mechanical parts including pillow blocks as well as gears and pulleys in design leads to effortless maintenance that shortens equipment downtime while producing extended equipment longevity. The Philippine agricultural mechanization initiatives widely promote this design approach for gaining rural accessibility and sustainability (MinDA, 2024).

The combination of solar power systems within seaweed processing technology allows sustainable operation in coastal areas that lack centralized power generation. The Renewable Energy Technology to Increase the Value-Added of Seaweeds (RETS) project in Tawi-Tawi provides a model that demonstrates such integration through EU support and UNIDO implementation. The hybrid solar plants constructed under this project allowed farmers to run their processing facilities during any period including harsh weather (BIMP-EAGA, 2024; Philippine News Agency, 2024; Mindanao Development Authority, 2024). Operational efficiency of the machine extends from processing hubs linked to other facilities all the way to remote rural barangays throughout different environmental conditions.

Benefits of Hybrid Mechanized Chopper-Extractor
Chopping Efficiency

Multiple investigations demonstrate why sufficient crushing and chopping systems are vital for agricultural processing operations. The mechanized forage chopper automated the cutting process so it became more efficient but also demonstrated the extensive time required for manual forage chopping (Balayo, 2017). Gbabo et al. (2013) together with Kumar (2018) and Tyagi et al. (2022) conducted investigations to evaluate juice extraction crusher effectiveness. The process research indicated that roller arrangement directly affected product output because horizontal rollers extracted 55–60% efficiency yet vertical rollers reached 50–55% extraction rates. The current design of these machines left substantial portion of juice trapped in the bagasse despite these new improvements.

Extraction Efficiency

Studies in mechanical extraction technology during recent years have demonstrated superior outcomes of dual-roller systems. Researchers Chen and colleagues released a paper in 2023 to Journal of Food Engineering which demonstrated dual-roller devices achieve extraction outcomes as high as 15 to 20 percent above single-roller methods. The alteration stems from improved cell wall disruption and better pressure distribution achieved through processing.
Food and Agriculture Organization (FAO, 2022) established perfect operational parameters for mechanical extraction. The technical report of their organization indicates that optimal juice yield and fiber maintenance occurs when roller pressure is set between 2-3 kg/cm². The extraction of polysaccharides from seaweed depends on subtle pressure regulation to avoid product damage from excessive pressure because insufficient pressure can lead to lost extractable compounds.

Electrical Energy Consumption

Energy efficiency directly determines the sustainability level of seaweed processing. Renewable energy technologies with photovoltaic (solar) systems incorporated into post-harvest operations decrease power dependency through traditional energy sources thus minimizing operational running costs while also lowering environmental impact (Gupta et al., 2020). Studied research demonstrates that both low-power motors and hybrid power options within energy-efficient processing equipment increase operational efficiency in regions with restricted power access (Nguyen & Le, 2021). Hadjipaschalis et al. (2022) emphasized that processing equipment with hybrid power backup reduces carbon footprint effectively while ensuring continuous operation when power grids fail. Emerging technologies highlight the necessity to create seaweed processing equipment which delivers optimal performance while maintaining accountable energy utilization for the Hybrid Mechanized Chopper-Extractor focused on rural and remote locations.

Expected Return on Investment

A thorough comprehension of expected Return on Investment (RoI) helps people decide the financial sense of seaweed processing equipment investment. The Food and Agriculture Organization (FAO) conducted feasibility studies that demonstrated seaweed farming becomes profitable through proper technological assistance for cooperative operations. Proper farming management will produce strong profitability from the FAO's one-hectare farm business model and initial investments yield acceptable returns.

According to Fitriana and Ahmadi (2021) seaweed farming in Indonesia presents an economic opportunity through sustainable farming and improved processing techniques because mechanization enhances yield levels and profitability. The experimental data supports the notion that hybrid mechanical tools like the Chopper-Extractor can abate seaweed farming expenses and boost productivity thus improving regional farming operations in San Jose, Occidental Mindoro and local territories.

Perceived Usefulness

A person evaluates system usefulness based on their belief that the system would enhance their performance (Davis, 1989). PU stands as a vital factor for technological advances including the Hybrid Mechanized Chopper-Extractor since users need to determine the machine's potential to boost their operational performance and manufacturing output and generate income streams. Users tend to adopt technologies because Venkatesh and Bala (2018) demonstrated that they choose systems that either boost output levels or deliver cost advantages to their work operations.

In the Philippine context, the Department of Agriculture (2022) found that 82% of farmers would adopt equipment that saves at least 2 hours of labor daily. These findings align with the International Rice Research Institute's (2021) observation that technologies offering 15% or greater efficiency gains achieve widespread acceptance. For seaweed farming, perceived usefulness is intimately related to the technology's capacity to enhance the harvesting process, lower labor expenses, and raise production, so farmers must view the chopper-extractor as a useful tool in their operations.

Perceived Ease of Use

According to Davis (1989), PEOU represents how users evaluate the system's use requirements to be effortless. PEOU determines both the operation simplicity and the capability for farmers to master the Hybrid Mechanized Chopper-Extractor without encountering substantial difficulties. This study conducted by Venkatesh et al. (2016) demonstrates user acceptance of technology exists primarily because of how easy the system is to operate and which requires minimum technical skills.

The adoption process depends heavily on simple operation protocols and simplified maintenance procedure. According to research the implementation of intuitive designs shortens learning periods to between 40-50% of original time

(Smith et al., 2022) and equipment with less than three maintenance points generates higher adoption levels (PhilMech, 2023).

Attitude toward Use

Among the psychological factors is Attitude toward use (ATU) which represents personal evaluations concerning technology use (Fishbein & Ajzen, 1975). Previous technological exposure and personal ideas regarding technology impact and value influence how farmers decide to accept new agricultural technology choices. Studies by Al-Busaidi et al. (2019) showed that positive regard toward agricultural technologies results in higher likely acceptance of changes by farmers.

The Hybrid Mechanized Chopper-Extractor receives its reception from farmers directly through personal experience and peer interaction. Research conducted by the Agricultural Training Institute (ATI, 2022) demonstrates that farmers develop favorable perspectives toward new tools only after obtaining successful outcomes with their technology during three to five cycles of use with direct experience as the key factor in developing trust in new equipment. Brown et al. (2023) discovered that peer suggestions have a fundamental role in molding farmer perspectives based on the fact that 68% of farmers seek guidance from their colleagues before adopting new technology.

Behavioral Intention to Use (BIU)

BIU describes the future technology use behavior of individuals who base their decisions on PU, PEOU, and ATU evaluation. The research conducted by Ajzen (1991) showed that user attitudes along with suspected benefits and ease of use influenced their decision to utilize technology. The seaweed farmers' perceptions of Hybrid Mechanized Chopper-Extractor value along with their views on its ease of operation will collectively determine their behavioral intention to use the equipment. According to Davis (1989) as well as Taylor & Todd (1995) people who view new technologies as advantageous and seamless for existing farming practices adopt them more frequently.

Synthesis

Several ideas can be highlighted through the literature review that affect feasibility and the potential success of the Hybrid Mechanized Chopper-Extractor for seaweed farming in San Jose, Occidental Mindoro. In terms of cost, locally produced equipment is more economical relative to imports with a 35-50% decrease in the cost as per the report. This reduced cost on the equipment elevates the accessibility of the equipment for small scale farmers which show that farmers consider equipment costed below ₱100,000 as affordable.

Regarding operational efficiency, the value of mechanized systems to reduce time for labor and enhance productivity has been proven. Dual-roller extraction systems demonstrate how automation can increase efficiency and improve product quality. This is especially applicable to the Hybrid Mechanized Chopper-Extractor, which is created to maximize seaweed processing due to the enhanced efficiency of seaweed extraction.

Energy efficiency is another important factor to take into consideration especially in the rural areas where access to energy may not be easily available. The incorporation of renewable energy sources like solar power is indicated to reduce cost of operations and environmental damage. Hybrid power solutions also maintain uninterrupted supply of power when there are power blackouts and this is crucial especially in the regions with poor energy grids.

Theoretical Framework

The Technology Acceptance Model (TAM) proposed by Davis (1989) guided the researcher in the conduct of this study. The model explains behavior of user adoption through two constructs, namely Perceived Usefulness (PU) and Perceived Ease of Use (PEOU). According to TAM, people will be more likely to use a technology if they perceive that it will increase their performance (PU) and it is easy to use with limited effort (PEOU). Such perceptions define the individual's Attitude toward Use (ATU) to determine their Behavioral Intention to Use (BIU) the technology.

The Hybrid Mechanized Chopper-Extractor, within the scope of this study, is analyzed with these behavioral constructs in mind, with focus on its possible role in advancing the processing activities for seaweed. To enhance the knowledge of user acceptance, the framework also contains supporting economic and technical constructs drawn from cost-benefit theory and agricultural mechanization principles.

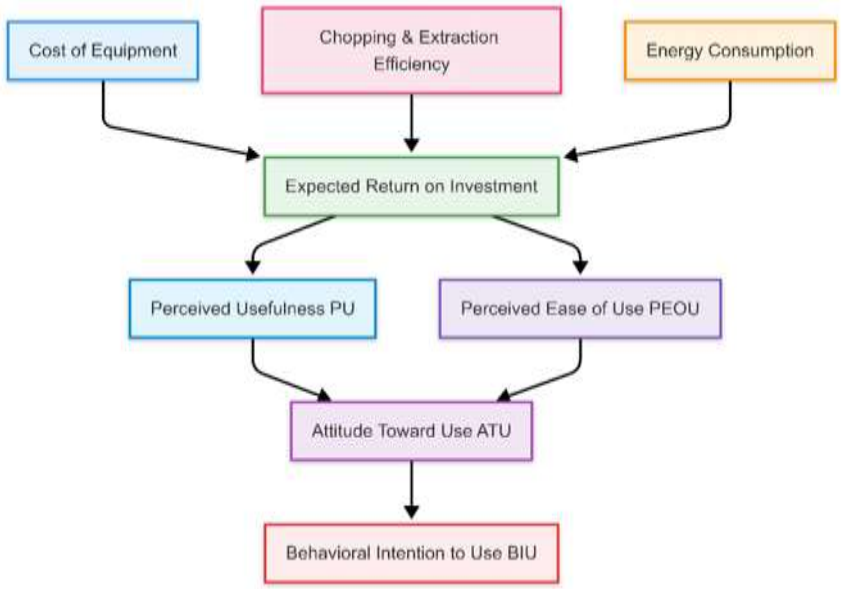

Figure 1. Theoretical framework of the study

METHODOLOGY

Research Design

The research utilized quantitative-descriptive-correlational design in seeking the answers to the statement of the problem.

The researcher employed descriptive methods to determine the benefits of the Hybrid Mechanized Chopper- Extractor in terms of chopping efficiency and

extraction efficiency, and electrical energy consumption, along with the Return on Investment.

Similarly, descriptive research was also used in assessing the level of acceptance among seaweed farmers in terms of perceived usefulness, perceived ease of use, attitude toward use, and behavioral intention to use.

On the other hand, correlational design or multiple linear regression analysis was used to identify the significant relationship between respondents' perceived usefulness, perceived ease of use, attitude toward use, and their behavioral intention to use the technology.

Locale of the Study

The study was conducted at of San Jose, Occidental Mindoro. Specifically, it was conducted in coastal barangays of the municipality where seaweed farming is one of the primary sources of livelihood.

Figure 2. Locale of the study

Respondents of the Study

The study included thirty (30) seaweed farmers engaged in farming and/or post-harvest processing, residing at San Jose, Occidental Mindoro. Respondents had experience with the Hybrid Mechanized Chopper-Extractor during the researchers' orientation and demonstration sessions. This exposure allowed the participants to give knowledgeable comments on the machine's performance and their acceptance.

The selection criteria guaranteed that only those with practical knowledge and experience in seaweed farming were included in order to ensure that replies accurately reflected the possible actual use of the technology.

Sampling Procedure

For respondent selection the study applied purposive sampling method. This research included thirty (30) seaweed farmers based in San Jose, Occidental Mindoro. A trial usage opportunity of the Hybrid Mechanized Chopper-

Extractor was provided to respondents for them to gain sufficient understanding before engaging with the research instrument.

Identifying qualified participants involved observing the following inclusion criteria:

1. Actively engaged in seaweed farming and/or post-harvest processing.
2. Has at least one (1) year of experience in seaweed operations.
3. Willing to participate in the hands-on demonstration or trial of the Hybrid Mechanized Chopper-Extractor.
4. Resides in or operates within San Jose, Occidental Mindoro.

Research Instrument

This research adopted questionnaire questions from TAM to evaluate Hybrid Mechanized Chopper-Extractor acceptance by measuring four key elements of perceived usefulness and perceived ease of use together with attitude toward use and behavioral intention to use. The survey consisted of forty (40) questions that were grouped into four parameters with ten (10) questions per parameter. The survey provided 4-point Likert scale questions that let participants indicate their agreement intensity across four levels. The adopted survey instrument focused on identifying how respondents accepted the technology.

RESULTS AND DISCUSSION

Chopping Efficiency of Hybrid Mechanized Chopper- Extractor

Table 1. Chopping Efficiency of Hybrid Mechanized Chopper-Extractor

Description	Trial 1	Trial 2	Average
Average length of plant (mm)	217.4	141.5	179.5
Operating time (h)	0.58	0.33	0.46
Weight of output (kg)	11.1	9.8	10.5
Output capacity (kg/h)	19.14	29.7	22.72
Chopping efficiency (%)	**90.9**	**80.33**	**85.66**

Legend: *Excellent 90-100; Very Good 90-89; Good 70-79; Fair 60-69; Poor below 60*
Based on Philippine Agricultural Engineering Standards 245:2008

The Hybrid Mechanized Chopper-Extractor showed very good chopping efficiency, with average chopping efficiency of 85.66% and an output capacity of 22.72 kg/h. Such results are an indication that the machine can process seaweed much faster and more efficiently as compared to manual based methods (Sunga et al., 2024). The level of performance implies high potential of lowering labor and time requirements of small- to medium-scale seaweed farming activities.

This performance is especially important in reference to effects on the rural and small-scale operations. The average efficiency of 85.66% of the machine is at the level of industry standards for agricultural manually-fed choppers as identified by Mrema et al. (2008). This establishes the suitability of the machine for field deployment particularly in a resource-constrained community.

Extraction Efficiency of Hybrid Mechanized Chopper- Extractor

Table 2. Extraction Efficiency of Hybrid Mechanized Chopper-Extractor.

Description	Trial 1	Trial 2	Average
Weight of input (kg)	12.2	12.2	12.2
Input capacity (kg/h)	16.33	24.43	20.38
Operating time (h)	0.75	0.5	0.62
Extracted liquid (mL)	460	583	522
Juice collected (kg)	0.44	0.55	0.5
Juice recovery (%)	3.58	4.54	4.06
Extraction loss (%)	96.42	95.46	95.94
Extraction rate (kg/h)	0.58	1.11	0.85

Legend: *Excellent 90-100; Very Good 90-89; Good 70-79; Fair 60-69; Poor below 60*
Based on Philippine Agricultural Engineering Standards (PAES) - PAES 245:2010

As shown in Table 2, the Hybrid Mechanized Chopper-Extractor obtained 522 mL of juice by processing 12.2 kg of raw seaweed, corresponding to a poor juice recovery rate of 4.06%. This is quite low compared to international standards for mechanical extractors which normally average from 40-70% (Sharma et al., 2019). Average weight of the juice content retained within the seaweed was 95.94%, meaning that the machine was still not efficient in juice extraction.

The findings mean that though the prototype is able to do the basic extractions, it requires a lot of design improvement. Low juice recovery indicates that there is a necessity for improved compression processes, perhaps by increasing the force of pressing or redesigning the press. According to FAO (2024), poor efficiency is typical of the early-stage which underlines the value of incremental development. The integration of secondary filtration or re-pressing capabilities might enable the recovery of greater amount of juice and to bring the machine's performance in line with the standards that are acceptable.

Electrical Energy Consumption

Table 3. Electrical Energy Consumption of Hybrid Mechanized Chopper-Extractor.

Description	Trial 1	Trial 2	Average
Machine Operating Time (h)	0.58	0.33	0.46
Power (kW)			
– Without load	0.63	0.59	0.61
– With load	0.67	0.64	0.66
Electrical Energy Consumption (kWh/kg)			
– Without load	0.03	0.02	0.02
– With load	0.03	0.02	0.02

With an average machine operating time of 0.46 hours, the power consumption findings from the prototype show moderate energy use. Under load, the machine needed an average power of 0.66 kW, somewhat more than the 0.61 kW noted without load. Although small, the variation shows the predicted rise in power need caused by mechanical resistance when processing plant material.

Such low energy consumption dictates that the machine is energy efficient hence appropriate for small to medium level agriculture, particularly in rural areas where electricity may not be sufficient or too expensive. These findings are in line with Adekomaya et al. (2016) in that efficient agricultural machines tend to have energy consumptions in between 0.02 and 0.10 kWh/kg. In a similar manner, FAO (2016) states that in order to make rural applications practical there is need to have low power consumption to make it affordable and sustainable.

Return on Investment Analysis of Hybrid Mechanized Chopper-Extractor

This section includes a comparative analysis of income to determine the financial advantage of the using the Hybrid Mechanized Chopper-Extractor. It is a comparison of the annual income of seaweed farmers before and after the use of the machine to show how profitable mechanized processing is.

Income without the Hybrid Mechanized Chopper-Extractor

Table 4. Income without the Hybrid Mechanized Chopper-Extractor

Income Without the Machine	**Amount**
Total Revenue	₱137,500
Operating Expenses	₱10,000
Net Income	**₱127,500**

In the traditional method, farmers only depend on selling dried seaweeds. Farmers harvest an average of 500 kg per harvest. With five (5) harvests per year, the total annual yield amounts to 2,500 kg. With a market price of ₱55 per kilogram, the total revenues is ₱137,500. Operating costs include only the cost of planting materials at an estimated amount of ₱10,000 per year. Maintenance and electricity costs are not incurred as processing is done manually. Thus, net income without the machine is calculate at ₱127,500.

The results implies that while traditional seaweed farming offers a low-risk and cost-efficient model for small-scale farmers, it inherently limits growth and innovation. The absence of technology and processing capabilities not only caps potential income but also hinders farmers from participating in higher segments of the value chain. These implications underscore the need for the introduction of enhanced technologies to improve operational efficiency, increase product value, and ultimately uplift the socioeconomic conditions of seaweed farming communities.

Income with the Hybrid Mechanized Chopper-Extractor

Table 5. Income with the Hybrid Mechanized Chopper-Extractor

Income With the Machine	**Amount**
Revenue from Chopped Seaweed	₱137,500
Revenue from Seaweed Juice	₱23,017.55
Total Revenue	**₱161,517.55**
Maintenance	₱5,000
Planting Materials	₱10,000
Electricity (Electric-powered)	₱629.96

Total Operating Expenses	**₱15,629.96**
Net Income	**₱145,887.59**

By adopting the Hybrid Mechanized Chopper-Extractor, the farmers now have two revenue streams. Farmers may also earn from the extracted juice. With an extraction average of 42.79 ml of juice for every kilogram of seaweed, the total juice extracted for 2,500 kg of seaweed in a year is 106.98liters. At an average price of ₱225 per liter of seaweed juice, the revenue from the juice amounts to ₱24,017.55. Adding this to the revenue from chopped seaweed, the total annual revenue with the machine is ₱161,517.55.

The annual operating cost for the Hybrid Mechanized Chopper-Extractor is ₱15,629.96, inclusive of ₱5,000 maintenance, ₱10,000 planting materials and, ₱629.96 electricity in the electric-powered setup.

The total revenue amount to ₱161,517.55 to give net income of ₱145,887.59 after the deduction of expenses. This means that there is a major expected improvement in terms of profitability; considering the dual output of extract and chopped seaweed, with an operating cost that can be managed.

Comparison of Income With and Without the Hybrid Mechanized Chopper-Extractor

Table 6. Comparison of Income With and Without the Hybrid Mechanized Chopper-Extractor

Income Comparison	**Without Machine**	**With Machine**
Total Revenue	₱137,500	₱161,517.55
Operating Expenses	₱10,000	₱15,629.96
Net Income	**₱127,500**	**₱145,887.59**

In order to estimate the financial benefit in adopting the Hybrid Mechanized Chopper-Extractor, the seaweed farming income with and without the machine were compared.

Without the machine, the farmers only earn from selling dried seaweed at ₱55 per kilogram. With five harvests at 500 kg each, income throughout the year amounts to ₱137,500. With no major operating cost incurred other than planting materials which is ₱10,000, net income is ₱127,500.

With the use of the machine, farmers earns money from chopped seaweed as well as seaweed extract. The total revenue increases to ₱161,517.55, and with total operating costs at ₱15,629.96, the net income amounts to ₱145,887.59. This comparison shows that mechanization increases net income by ₱18,387.59 annually, demonstrating clear financial benefits for small-scale seaweed farmers.

Return on Investment (ROI) for the Hybrid Mechanized Chopper-Extractor

The Return on Investment (ROI) was conducted by contrasting the net income from seaweed farming with and without the use of the Hybrid Mechanized Chopper-Extractor to assess its financial viability.

As previously discussed, the annual net income without using the machine is ₱127,500. With the machine, which enables the production and sale of both chopped seaweed and seaweed extract, net income increases to ₱145,887.59.

This results in an additional income of ₱18,387.59 per year. Using the actual cost of the machine, which is ₱146,144.00, the ROI is computed as follows:

$$\text{RoI} = \left(\frac{₱18{,}387.59}{₱146{,}144.00}\right) x\ 100 = 12.58\%$$

This ROI of 12.58% indicates that the machine generates a modest but positive return within the first year. The implication is that while the initial investment is relatively high, the machine begins to pay off within a short period through increased productivity and additional revenue streams. Over time, continued use will allow farmers to recover the full cost and earn a substantial net gain, making the Hybrid Mechanized Chopper-Extractor a worthwhile long-term investment for small-scale seaweed farmers.

Level of Acceptance of Hybrid Mechanized Chopper-Extractor

Table 7. Level of Acceptance of Hybrid Mechanized Chopper-Extractor

Parameter	**Overall Mean**	**Interpretation**
Perceived Usefulness	3.84	Very High
Perceived Ease of Use	3.82	Very High
Attitude Toward Use	3.82	Very High
Behavioral Intention to Use	3.85	Very High
Grand Mean	**3.83**	**Very High**

Legend: 3.26–4.00 Very High, 2.51–3.25 High, 1.76–2.50 Moderate, 1.00–1.75 Low

The findings of the study show that the seaweed farmers' acceptance of the Hybrid Mechanized Chopper-Extractor was very high with a grand mean of 3.83. The Technology Acceptance Model (TAM) parameters, namely Perceived Usefulness, Perceived Ease of Use, Attitude toward Use, and Behavioral Intention to Use, all demonstrated very high results. The results imply that farmers understand the value of the machine and are likely to continue to use it in the future which is a good indication of acceptance of the technology.

Relationship between Levels of Perceived Usefulness, Perceived Ease of Use, Attitude toward Use, and Behavioral Intention to Use the Hybrid-Mechanized Extactor

Table 8. Relationship between TAM Variables

Variables	**Correlation Coefficient (ρ)**	**Decision on Ho**	**Interpretation**
Perceived Usefulness and BIU	0.989**	Reject Ho	Very Strong, Significant
Perceived Ease of Use and BIU	0.789**	Reject Ho	Strong, Significant
Attitude Toward Use and BIU	0.994**	Reject Ho	Very Strong, Significant

Legend: 0.90–1.00 Very Strong, 0.70–0.89 Strong, 0.50–0.69 Moderate, 0.30–0.49 Weak, 0.00–0.29 Very Weak or No Correlation.
Correlation is significant at the 0.01 level (2-tailed), BIU = Behavioral Intention to Use.

Table 8 presents the relationship between Perceived Usefulness (PU), Perceived Ease of Use (PEU), and Attitude toward Use (ATU) with Behavioral Intent to Use (BIU) Hybrid Mechanized Chopper-Extractor.

The results showed that there is a very strong and significant correlation between Perceived Usefulness and Behavioral Intention to Use ($\rho = 0.989$). This means that farmers who feel the machine can be useful in improving their farming performance are more likely to use the machine. This coincides with the findings of Davis's (1989) that users will primarily judge technology acceptance based upon their belief in whether or not its use will improve their job performance. In addition, Venkatesh and Bala (2018) state that adoption is more likely given that anticipating an operational or an economic advantage from a system is more likely. In the context of Philippines, this goes hand-in-hand with Department of Agriculture's (2022) results that equipment that saves labor time is more readily adopted alongside the observation of the importance of efficiency gains made by the International Rice Research Institute (2021).

CONCLUSIONS AND RECOMMENDATIONS

Based on the analysis and findings of the study, various conclusions were drawn regarding the benefits, Return on Investment, and acceptance among seaweed farmers of the Hybrid Mechanized Chopper-Extractor in San Jose, Occidental Mindoro.

The machine demonstrated effective performance in both chopping and extraction functions. The chopping component showed high efficiency in breaking down the seaweed, while the extraction shows areas for improvement. Additionally, the machine operates with low electrical energy consumption, both under load and idle conditions. This energy efficiency enhances the suitability of the machine for rural coastal communities where electricity supply may be inconsistent or expensive, contributing to the sustainable use of technological resources.

The High Return on Investment indicates that the technology is financially viable and offers high returns for seaweed farmers in San Jose, Occidental Mindoro. Despite an initial investment, the machine yields a positive return, demonstrating that it can recover its cost over time while contributing to increased profitability. This makes the technology a financially sound and sustainable investment for small-scale seaweed farmers.

The Hybrid Mechanized Chopper-Extractor demonstrated strong acceptance among seaweed farmers across all parameters of the Technology Acceptance Model (TAM). Farmers perceived the machine as highly useful in boosting productivity, minimizing manual labor, and improving the quality and consistency of processed seaweed. It was also regarded as user-friendly, easy to learn, operate, and maintain which lowers typical barriers to adopting new technology. Their positive attitudes and satisfaction with its performance, coupled with a strong intention to continue using, advocating for, and upgrading the machine, suggest a high potential for sustained adoption both individually and within farming communities.

The Perceived Usefulness, Perceived Ease of Use, and Attitude toward Use are all positively and strongly related to the Behavioral Intention to Use the Hybrid Mechanized Chopper-Extractor. This means that farmers who believe the machine will significantly improve their work efficiency, find it easy to operate, and hold positive attitudes toward its use are much more likely to intend to adopt the technology. The strong correlations suggest that these factors are key drivers of acceptance, highlighting the importance of emphasizing practical benefits, ensuring user-friendly design, and fostering favorable perceptions to promote successful adoption of agricultural innovations.

Recommendations

The researcher formulated various recommendations based on the findings of this study. The recommendations were addressed to the entities who are included in the significance of the study.

First, seaweed farmers are encouraged to adopt the Hybrid Mechanized Chopper-Extractor as it has proven to enhance processing efficiency and increase income through dual-product output. Seaweed farmers should be encouraged to view the machine as a long-term investment that enhances both productivity and profitability. Additionally, farmers should collaborate through cooperatives or associations to share resources and reduce the individual burden of investment.

Moreover, technology developers and engineers should focus on enhancing the extraction mechanism of the machine to increase juice yield while maintaining efficiency. Customization of the design for portability, energy flexibility (e.g., solar-powered options), and ease of maintenance should also be considered.

In addition, Local Government of San Jose, Occidental Mindoro may facilitate programs to promote the adoption of the technology and provide programs geared toward its adoption by local seaweed farmers.

More importantly, student innovators are encouraged to pursue formal intellectual property (IP) protection for their inventions, such as through utility models or patents, in coordination with the college's IP Office. This not only safeguards their creative work but also opens opportunities for collaboration, funding, and responsible commercialization, ensuring that locally developed technologies can make a lasting impact in their communities and beyond.

Lastly, the Occidental Mindoro State College should pursue the patenting process for the Hybrid Mechanized Chopper-Extractor to secure intellectual property rights and support its innovation goals and technology transfer to the community. This will strengthen the college's role in advancing technology transfer in agriculture. At the same time, this could open a path for inventions of student innovators to be commercialized.

FURTHER STUDY

Furthermore, in order to increase the perceived ease of use of the Hybrid Mechanized Chopper-Extractor, technology developers and engineers need to make its design easier so as to minimize the operational complexity and the extension services need to train farmers practically and give them more accessible material where they could learn.

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