Leveraging Predictive Analytics and the Sustainable Livelihood Framework for Rural Enterprise: The Case of Coconut Coir Bags Production in the Philippines

REMEGIA C. JACOB[1,2] ID **, RICHELLE D. MAYLAD[1,2]** ID **,
MAYLEN G. EROA[1]** ID

[1]Batangas State University – The National Engineering University, Batangas City, Philippines
[2]Technological University of the Philippines – Manila

Corresponding author: 24-07096@g.batstate-u.edu.ph

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ABSTRACT

This study examines the potential opportunities for coconut coir bags as sustainable livelihood products in some rural regions of the Philippines. The research employs a quantitative methodology based on the Sustainable Livelihood Framework (SLF) and the Technology Acceptance Model (TAM), utilizing Microsoft Power BI as the primary tool for predictive data analytics and visualization. The study noted that agricultural waste, such as coconut coir, recognized as abundant and sustainable, is critical for production due to its low cost and environmental benefits. A profit of 60% per unit sold is estimated based on data analysis. As reflected in the responses of domestic

tourists, there is an apparent inclination towards purchasing products with a moderate to high spending appetite and a clearly defined perception of value related to such environmentally friendly products. Power BI is utilized for data visualization and to predict the company's future needs, which helps identify the required production level. Visual analysis from dashboards enables better strategic decision-making since the economic logic of product development using coir to promote entrepreneurship in rural areas is viable. Furthermore, this analysis supports Sustainable Development Goals (SDGs) 12 and 13 by promoting eco-sensitive consumption, circular economy strategies, innovative design approaches, and environmental accountability in product development.

INTRODUCTION

Implementing advanced technologies improves profit margins for traditional sectors. Maximization of profit and sustainable growth can be achieved through technology implementation in natural source product analytics. There is growing interest in coir, a by-product of coconut, derived from the husk as it is a natural alternative to synthetic materials (Reddy, 2019). Everyone from entrepreneurs to industrialists is increasingly aware of the environment and issues related to plastic overuse. Such concerns are driving renewable and biodegradable materials like the coir which fulfill the demands of plastic replacements sought by consumers. These environmentally friendly alternatives not only support rural economies but also provide social advantages, especially coconut coir bags (Food and Agriculture Organization of the United Nations [FAO], 2021).

The Philippines is one of the world's top producers of coconut along with a remarkable yearly haul of coconut husks. Nevertheless, most of this husk's potential to create value-added products remains unused. Coconut husks can aid towards achieving green product goals which help stimulate the local economy if rural areas transform agricultural waste into coir bags. Entrepreneurs can discover marketable trends and assess profitability through tools such as Power BI which offers forecasting alongside dashboard integration (Philippine Coconut Authority, 2022).

Adeel et al. (2021) showcased the sustainable use of coconut coir waste by employing it as a natural dye for silk, highlighting the innovative possibilities of coconut waste in developing eco-friendly products. This study demonstrates the need to utilize natural fiber secondary materials within coir-based livelihood enterprises aimed at greener manufacturing in the Philippines.

This study explores the production cycle decision-making processes of coir bag production using Power BI. As a result, it seeks to forecast estimated sales

alongside the financial performance for the operations first year to monetize and assess market value and profitability within Power BI's visualization and forecasting parameter boundaries. Business intelligence tools such as Power BI help transform raw business data into refined useful information that stakeholders can act on with precise, fact-based evaluations (Orji et al., 2023).

The scope of research in Southeast Asia remains sparse when looking at regional studies on coir innovation and rural entrepreneurship. In contrast, Malaysia has been very open about sharing their findings regarding the impact digital innovations have in transforming rural areas. A systematic review by Nipo et al. (2024) illustrates how innovations such as mobile applications and e-commerce contribute to more effective rural business operations while deepening their access to markets and finance alongside enhanced inclusion. The analysis also highlights ongoing issues such as a lack of sufficient infrastructure and low levels of digital literacy in the education gap infrastructure. Louis has done extensive work addressing these issues for ASEAN but is yet to explore incorporating predictive analytics models like Power BI into coir grassroots development models. By looking at how Power BI can aid data driven decision making for rural coir producers in the Philippines this study anchors a template on sustainable enterprise model across low GDP ASEAN countries.

In the agriculture of the Philippines, coconuts have served as the linchpin of rural industries. Fujii (2005) outlined the adaptive strategies of smallholder families from Laguna province, detailing how they shifted from a singular coconut monoculture cropping system to more diversified agriculture and integrated livestock, demonstrating flexible resilience common among rural people. Simultaneously, Batocol and Delos Santos (2018) studied husk utilization in 13 leading coconut producing provinces and uncovered sharply underutilized coir husk products which are critical to value-added coir product enterprises. On larger scales Emami et al. (2024) performed a material-flow analysis measuring ASEAN community's shift toward circular economy constructs demonstrating that coir's biomass has been overlooked even though it contributes to sustainability-development- goals. Community wide, Madiclum (2023) applied participatory action research to provide market access for coconut growers advocating for community-based approaches to tackle economic inclusivity gaps towards rural resilience. All these studies contribute towards understanding our emphasis on sustainable data-backed coir enterprise construction in the rural Philippines using resource optimization and market integration alongside circulation economy principles as backbone frameworks of our Power BI and SLF-TAM model.

FRAMEWORK

This study examines the feasibility of manufacturing coconut coir bags in rural areas using the Sustainable Livelihoods Framework (SLF), a key framework for academic research and policy circles (Natarajan et al., 2022), and an adapted version of the Technology Acceptance Model (TAM). In the SLF model, five capitals are defined as natural, human, financial, social, and physical, determining the sustainability of community-based enterprises. In this context, natural capital is derived from the supply of coconut coir as a renewable agro-industrial by-product, human capital through the skills of local artisans, and financial capital through the estimated revenues from producing coir bags. In this instance, social and physical capital is defined as the local cooperatives and the pre-existing tools for bag-making. All these assets demonstrate the community's ability to efficiently unspent resources to achieve sustainable livelihoods (Rosli et al., 2022).

Like any other coir bag producers, the local producers also need to embrace newly available economic tools with proper Power BI adoption, which is business intelligence with data visualization and predictive analytics, and for that, the Technology Acceptance Model (TAM) is best suited here. An older version of it states that an individual's adoption of technology is deeply rooted in two things: their understanding of how useful that technology is and how easy it is to use.

Through the intuitive dashboards, small-scale producers can not only understand but also interact with the data effectively and monitor vital KPIs like sales, production volume, and profit margins. This willingness to retain and accept the system stems greatly from these clean and polished features. Through simple design, Power BI's interface and usability is streamlined, which encourages users to shift from casual to active, goal-oriented engagement with the system. Blending basic local resources with friendly digital helpers such as Power BI proves effective in low-tech rural spots, mainly because straightforward, speedy results attract interest (Ichim et al., 2022). This match aligns with the intention aspect of Technology Acceptance Model, showing grassroots creators the tools worth so they keep using them.

To emphasize Power BI use with coir bag producers, the authors included the following interfaces depicting the artisans' perceived ease of use and usefulness from TAM, the behavioral intention and actual use of Power BI.

Figure 1

Adapted Technology Acceptance Model (TAM) for Power BI Adoption among Coir Artisans
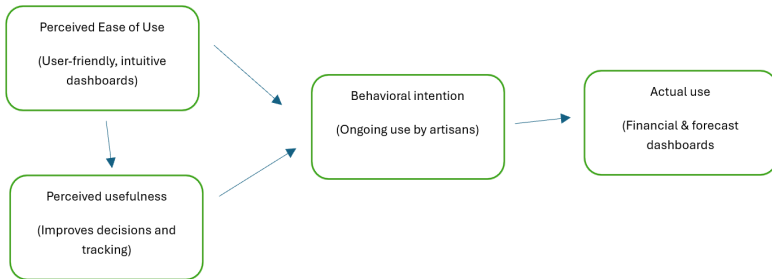
The diagram displays the impact of ease of use and usefulness on behavioral intention and actual use of the system related activities. The craftsmen's provided equipment facilitates self-directed dashboards and advanced decision-making, causing them to develop a powerful intention toward platform persistence. Consequently, Power BI becomes habitually used for financial tracking, sales forecasting, and production strategy optimization which helps in fostering entrepreneurial activities in the countryside.

The framework is based on three critical input variables: resource availability, economic viability, and market demand. Resource availability includes the local inventory of skilled labor and coconut husks, and under economic viability we classify unit costs, selling price, revenue, and net profit. Market demand is measured by tourism surveys which assess sustainable and voracious consumption patterns. Power BI performs these computations to produce descriptive and inferential visuals and predictive insights.

Power BI serves as the primary data processing and business intelligence application, fulfilling the role of an analytical layer. Monthly performance is tracked using descriptive analytics, while sales, peak demand periods, and operational scaling are predicted using sales forecasting methods, such as exponential smoothing. Based on these insights, decision-making concerning pricing, production volume, stock quantities, and overall strategy becomes more dynamic and responsive (Tirupati et al., (2024).

As a result, this approach transforms data from the community and businesses into actionable growth strategies. For example, local producers in Basista can now synergize small-scale production with tourist demand, increasing

revenue while improving marketing and reproduction in ecologically sound markets. Furthermore, the approach contributes to the United Nations SDG 12 on Responsible Consumption and Production and SDG 13 on Climate Action, focusing on efficient resource use, circular economy models, and low-carbon technologies (United Nations Environment Programme, 2023).

Figure 2
Conceptual Framework
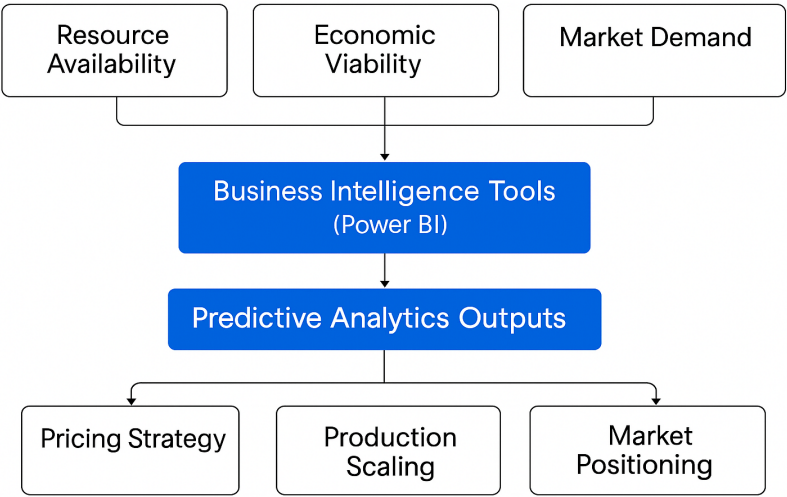
This research combines the most critical factors resource availability, economic feasibility, and market opportunity that influence the decision-making process of the coconut coir bag industry in the Philippines. All these factors are processed through Business Intelligence Tools, especially Power BI, which transform data into visualized information, yielding Predictive Analytics Outputs. These outputs help to inform pricing strategy, revision of the production volume cap, and even delineation of market focus vertically or horizontally.

Resources Availability

For coconuts specifically, Philippines' yield stands at about metric 14.6 million tons with byproduct generation of roughly 6.7 million tons in husks. The availability of coir resources, however, differs significantly by location. Davao Oriental, for example, has the highest concentration of husk production (0.70–

1.43 t/ha/yr), and Northern Samar has the highest husk weight (463 g). Thus, these regions are optimal for establishing coir extraction centers (Pogosa et al., 2018).

Economic Viability

The rising demand for coir products like activated charcoal has ensured that coir remains economically important, even if not fully utilized. The Philippine Coconut Authority (PCA) looks for potential areas of development for coir businesses under the governmental programs like the Coconut Farmers and Industry Development Plan (CFIDP), which focuses on boosting local value adding through PPPs (PCA, 2022).

Market Demand

In 2022, the Philippines exported 79,726.59 metric tons of activated carbon, valued at USD 154.88 million. This indicates an expansion of the domestic and international markets for coir-based products. However, coconut husks are not utilized, indicating a market gap and growth opportunities (PCA, 2022).

Coir Bags Pricing Strategy

Artisan data shows coir bags are sold at ₱200–₱350 per unit. The estimated production cost ranges from ₱110 to ₱130, with profit margins of ₱90 to ₱220. To enjoy a profit, it is suggested that basic products be priced at around ₱250-₱280, while premium bags should be priced at ₱300-₱350 (Philippine Coconut Authority, 2020; Rural Development Administration & DA-PRDP, 2021).

Production Expansion

The market scope of coco fiber is only 42% because only a fraction of coconut shells and husks are commercially processed. Most of the Processing Centers' underutilization stems from a lack of basic funding and outdated equipment. Currently, scaling efforts are being facilitated through new technologies, facility enhancements, and improved logistics, with the assistance of PCA and the Department of Trade and Industry (PCA, 2021; Rural Development Administration & DA-PRDP, 2021).

Marketing Strategy

Coconut coir bags have become a more sustainable substitute for plastic and other synthetic materials. They are gaining traction as they are marketed to environmentally responsible consumers. Other local initiatives, such as student coir fashion projects, demonstrate that innovation can start from the bottom up.

Coir bags are included in the Department of Trade and Industry's (DTI, n.d.; Philstar, 2019) downstream product promotion strategy.

OBJECTIVES OF THE STUDY

This study aims to ascertain the market viability of coconut coir bags by employing a mix of descriptive and predictive data analytics to foster sustainable entrepreneurship in rural areas. It specifically seeks to: (1) evaluate the availability and economic feasibility of coconut coir as a raw material for production of native bags by using mock financial calculations coupled with visual structural analysis, (2) assess the profitability for cottage industry level production of coir bags from analyzing cost, sales, revenue cadence cycles and monthly profit margins using Power BI dashboards, as well as (3) analyze consumer demand for coir and scalability of production through predictive models in order to facilitate planning aligned with international sustainability benchmarks.

METHODOLOGY

Research Design

The objective of this study was to evaluate the economic value of coconut coir bags in relation to income generation opportunities within specific areas of the Philippines. It pursued a quantitative framework focusing on analytics based on data for projecting sales value, profitability and market interest. For analytics and visualization, Power BI was used along with other tools where dashboards capturing relevant metrics like revenue streams, production volumes, profit margins among others were created. Important components of demand for some products during certain periods were forecasted using seasonal algorithms embedded in Power BI alongside snapshots from historical data. This facilitates evidence-based rural entrepreneurship decisions developed within environmental-economic development partnership frameworks.

Research Site

Pangasinan played a crucial role in boosting its coconut business. In September 2024, Pangasinan's Guv. Guico III had already backed a national government proposal to plant coconut tree seedlings nationwide, suggesting that Pangasinan would benefit from the program (Provincial Government of Pangasinan, 2024). An increase in coconut production will also lead to a rise in by-products, such as coconut husks, which will create other business opportunities, including coir fiber, Eco-friendly crafters, and value-added products. This growth enables certain

municipalities like Basista to protect the environment while sustaining profit.

Northern Samar is a significant coconut-producing province, with an annual output exceeding 300,000 metric tons, spanning approximately 84,000 hectares of coconut farms. Research indicates that coconuts in the area possess some of the heaviest husks, enabling them to produce coir fiber. The planned Coconut Industrial Park in Bobon highlights the effort that the province is making regarding husk-based processing and featuring value-added job creation (Provincial Government of Northern Samar, 2024).

Davao Oriental has been capitalizing on its title as the "Coconut Capital of the Philippines." To enhance the productivity of its farmlands, the provincial government signed an agreement with the Philippine Coconut Authority (PCA) in September 2023 to establish a shared nursery and a coconut seed farm. This undertaking aims to supply farmers with hybrid coconut seedlings while achieving the Coconut Farmers and Industry Development Plan (CFIDP) objectives to reactivate the province's coconut industry (Provincial Government of Davao Oriental, 2023).

Adjusting their focus towards the coir industry, the coconut husks in Javier, Leyte continue to be processed into valuable coconut fiber mats, ropes, and carpets. The community-based fiber processing plant employs women and local farmers, thus creating a greener way of life through sustainable agriculture. The PCA gave its support to the facility, which is already marked for expansion and intended to be managed by local cooperatives. These initiatives foster rural activism while fully incorporating waste and fiber processing as systematic assets of holistic regional development (Philippine Coconut Authority, 2022).

Participants

The study included two key groups of participants, both identified via purposive sampling because their experiences and perspectives were relevant to the study goals, specifically the market viability and sustainability of coconut coir bags.

Tourists

Domestic tourists from different ecotourism locations and souvenir shops within Basista were interviewed. These respondents were determined based on their participation in souvenir shopping and ecotourism activities. The respondents were asked a questionnaire with different domains, which were:

- Consumers' Participation over Time (frequency, preferred product types, and spending range),
- Consumers' Self-Categorization Participation Over Time: Aesthetic

preferences (style, color, size, texture of the material),
- Consumers' Sensitivity Range (acceptable price range and perceived value),
- Cognitive and behavioral aspects of sustainability and handmade crafts citizens' consciousness.

This information added to the evaluative framework as an identified potential target market for coconut coir bags.

Coir Artisans and Producers

The second group comprised all local artisans who work in coir product manufacturing in Basista. Participants were selected based on their active involvement in the sourcing, designing, and manufacturing of coir-based bags and home fittings. A guide concentrating on the following was used for the semi-structured interviews conducted:

- Practices concerning the availability and cost of materials, yards, and supplies on a local market,
- Production tools, techniques, and technology for the product's making,
- Labor computations and time estimates for the creation of the products,
- Supply constraints, consistency of the product, access to the market, and other encountered challenges,
- Forecasted market sales and the sales of the business in question.

Sampling Procedure and Representation

Participants were chosen purposefully focusing on tourists who, at a minimum, bought eco-friendly mementos from ecotourism centers located in Basista, Pangasinan. To improve representativeness, the sample was also stratified by age and income level alongside travel frequency which resulted in a more balanced demographic profile of domestic ecotourists. While this approach might seem purposive based, it is still grounded under the rationale that active shoppers within rural markets serve as a mosaic representation of the typical consumers targeted for coir bags. This broadens external validity and strengthens case similarities for the broader research conclusions in rural ecological tourism regions.

A total of 30 domestic tourists (60% female, 40% male; aged 20–55) and 10 local coir artisans (70% female) participated in the study. This sample size was determined based on participant availability and relevance to the study's objectives.

Instrument Reliability and Validity

The tourist questionnaire included items on price sensitivity, eco-product preference, bag features, and perceived value. The scale's internal consistency assessment showed the use of Cronbach's Alpha, which measured a reliable 0.81. Confirming expert validation in this case also ensured proper content coverage aligned with the goals of the study. All item-total correlations were examined along with contribution for each item towards overall construct reliability and those with low correlation ($r < 0.30$) were removed to enhance relevance among the constructs within the scale closed. Of the original 20 survey items, 16 were retained after applying item-total correlation analysis ($r > 0.30$), ensuring internal consistency and construct validity.

Research Ethics Protocol

This study was conducted in compliance with ethical standards. Each participant gave their informed consent before data collection began. Interviewees received a complete overview of the study's purpose, their right to withdraw at any time, the procedures for anonymizing responses, and the management protocols for the data collected. There are no personal identifiers included in the published results. For future research stages if they are conducted later an institutional review board grants ethics clearance.

In addition, the institution's protocols were followed with regard to the ethics clearance procedures. With regards to the matter of ethics, relevant faculty ensured that there would be no harm associated with the data collection methods after reviewing the final version of the questionnaire and an interview guide. All personally identifiable information was anonymized prior to analysis and locked away during processing.

Data Collection

The participating coir artisans provided additional monthly records regarding production, costs, and sales. Based on these inputs, revenue, cost per unit, net profit and profit margin were calculated. Structured questionnaires were administered to tourists through purposive sampling at souvenir stalls, ecotourism hubs as well as craft markets. Some interviews were conducted online while others were face-to-face depending on convenience for coir artisan respondents.

Statistical Techniques

- Descriptive Analysis was used to determine average production volumes, profit margins, and sales trends. To create visual summaries, Power BI dashboards, including bar graphs and time-series charts, were developed.
- Based on historical data, Predictive Analytics using linear regression was

applied to estimate coir bag sales in the following three months.
- Financial computations included:
    - o   Revenue = Sold Bags × Unit Selling Price
    - o   Production Cost = Produced Bags × Unit Cost
    - o   Net Profit = Revenue - Production Cost
    - o   Profit Margin (%) = (Net Profit / Revenue) × 100

RESULTS AND DISCUSSION

Objective 1: Assessing the Availability and Economic Potential of Coconut Coir for Bag Production

Interviews with coir-makers in Basista, Pangasinan, show that coconut coir-the fiber striped from local husks-is easy to find all year round. The artisans said people usually treat the fiber as farm waste, so they pay very little to get it. They either pick it up themselves or take delivery from nearby sellers, which saves them the bother of buying in bulk through middlemen. Because of this steady, cheap supply, the craftspeople keep unit costs near ₱120, a figure that covers basic materials and their own labor.

Similar observations appeared in Pogosa et al. (2018), who pointed out that huge amounts of husks go to waste across the country, with Davao Oriental and Northern Samar leading in volume and weight. The Philippine Coconut Authority (2022) noted that millions of these husks sit unprocessed every year, leaving a big resource still waiting for rural villages to turn it into livelihood.

Lamug and Naval (2022) notes that women-led groups in Camarines Norte are already proving this point, turning coconut leftovers into mats and ropes that earn real money, so coir clearly holds promise. Coir is easy to find, and studies show it beats most other fibers in strength, salt-water resistance, and long-term wear, so designers now specify it for structural parts and items that get wet often; its adaptability even supports premium lines (Gopalan et al., 2022). Add those traits together, and coir moves up the value ladder, dropping its old image as waste and proving it can be a reliable, green ingredient in environmentally minded workshops.

In Basud, Camarines Norte, Naval and Lamug (2018) performed a mixed method study on the production of coco coir revealing its benefits on women's socio-economic well-being. The study showed that women who participated in coir fiber weaving were working almost daily (seven times a week) which enabled them to provide regular household meals and even pay for their children's schooling. Moreover, engagement in coir production improved their social status and self-reliance (Naval & Lamug, 2018). These outcomes capture the greater

human and social capital improvement as defined by the Sustainable Livelihood Framework (SLF). For instance, in addition to income reliability and operational efficiency achievements of rural women entrepreneurs, income stability alongside increased operational efficacy could be achieved by employing predictive analytics such as forecasting consumer demand, smoothing raw material supply, and optimizing production schedule through implementing the coir bag enterprise model.

Reddy (2019) adds that coir is now on the world stage as a green, biodegradable stand-in for plastic fibers, turning up in eco-bags, packing materials, and even furniture. From an economic angle, the Rural Development Administration and DA-PRDP already noted in 2021 that coir-focused microbusinesses lift rural incomes, especially when linked to plans like the Coconut Farmers and Industry Development Plan (CFIDP). Support like these fuels value-added work on coconut leftovers, coir included, and fits the small-scale methods seen in Basista.

People everywhere are slowly waking up to the quiet usefulness of coir. In many Sri Lankan and Indian villages, small husk workshops now hold daily life together; neighbors pool money to buy coconuts, twist the tough strands into mats or rope, and keep most earnings close to home (Food and Agriculture Organization, 2021). Stelte et al. (2022) go further, ranking coir as a top pick for tomorrow's green factories because the fibre is cheap, plentiful, and flexible enough to fuel low-impact production.

Production notes from the artisans involved show that each workshop turns out about 30 to 40 bags a month, with output swinging up or down according to available hands and incoming orders. That pace hints that small setups can work, especially since raw materials cost very little and outside supplies are rarely called in.

Since the raw materials stay cheap and each coir bag moves for roughly ₱300, the venture clears around ₱120 on every piece-a clear hint that it can feed a steady wallet. Rosli et al. (2022) say that leaning on local supplies and holding costs tight gives rural areas the breathing room they need, a point that lines up perfectly with the Sustainable Livelihood Framework. FAO (2021) backs circular-waste schemes too, and that's exactly the spirit this project wants to put into action.

Overall, the study shows that small coir-bag shops can stay afloat if coconut husks are handy, people get good training, and local cooperatives lend a hand. The approach not only pads farmers pockets but also cuts down on trash and spurs green product ideas, matching UN goals on responsible consumption and climate action (UNEP, 2023).

Stelte et al. (2022) pointed out that coconut coir, which was once regarded

as a low-value byproduct, is now gaining popularity for its use in composite construction materials and for biodegradable products. Their research further supports the notion that coir can be utilized not only in traditional crafts but also in modern eco-industrial applications, advocating for its involvement in circular economic approaches for rural production ecosystems.

Objective 2: Evaluating Profitability through Predictive Analytics

Data gathered from artisan records were analyzed using Power BI, allowing a month of financial performance visualization. The analysis confirmed a consistent profit margin of 60%, calculated using the formula:

Profit Margin Formula:
Profit Margin (%) = ((Selling Price – Cost Price) / Selling Price) × 100
Given:
Selling Price = ₱300
Cost = ₱120
Solution:
Profit Margin (%) = ((300 – 120) / 300) × 100 = (180/300) x 100 = 0.4 x 100 = 60%

Research now shows that turning out coir bags in small batches can actually make good money. The Philippine Coconut Authority (2020, 2022) says coconut products are getting more popular at home and overseas but the countrys coir industry remains mostly dormant and still has room to fill rural wallets. As the Rural Development Administration and DA-PRDP (2021) explain, cheap village workshops become worthwhile once weavers add a few quick upgrades that boost speed, polish, and style.

In terms of the Sustainable Livelihood Framework, those modest gains show that thin inputs can still grow into dependable cash. That makes coir production a sturdy safety net for farming families wherever land, fibre, and basic skill already exist (Natarajan et al., 2022; Rosli et al., 2022).

With the addition of Power BI, coir artisans can closely monitor their expenses, identify revenue trends, and even estimate future profits. Mohammed et al., 2024 demonstrate that integrating natural-fiber style with timely digital notifications enables companies to make faster and more cost-effective decisions. This cooperation is crucial for small shops as rapid revamps and straightforward visuals safeguard profits. Tirupati et al. (2024) note that real-time charts and easy-to-read reports from such tools sharpen day-to-day choices and boost earnings in small firms. Orji et al. (2023) echo this, saying Power BIs clear visuals help rural

managers move beyond gut feelings and plan with hard numbers.

Craft workers' eagerness in relation to Power BI corresponds with Rosli et al. (2022) approach to the Technology Acceptance Model; it is perceived as beneficial and, most importantly, straightforward to learn. Their regular pauses at the dashboards to scan costs, sales, and profits show that good intentions have turned into a habit they lean on every day. Research backs this up: a friendly, straightforward interface plus just a pinch of light training can send acceptance of forecasting tools soaring-a conclusion supported by both Rosli et al. (2022) and Tirupati et al. (2024).

Power BI, used here to track profits, shows how even simple digital tools can give small makers real strength. Joined with SLF and TAM, the approach proves that rural craft workers with easy tech and local materials can keep costs in check, guard margins, and still run green, community-led businesses.

With regard to Vieira et al. (2024), after analyzing more than 4000 studies, they concluded that coconut waste and coir offer significant prospects for sustainable utilization, especially within circular economy frameworks centered on balance. This clearly indicates that local coconut coir industries have an opportunity for enhancing sustainability in ecosystem management and rural development if incorporated appropriately into circular production system.

In relation to the behavioral intention construct of TAM, the use of Power BI by coir artisans for cost, revenue, and profit margin tracking illustrates the gap between intention and actual behavior. The adoption of Power BI dashboards was driven by use and engagement at deeper levels, reflecting impact, signifying success toward the predictive capability of the model.

Objective 3: Forecasting Market Demand using Productive Modeling

Analytics predict the future, and it is one of the most effective measures regarding productivity within the production processes and supply chain systems. As noted by Gunasekaran et al. (2017), small-scale producers are better enabled to improve their demand planning, inventory control, and production schedule when decisions driven by analytics are made in resource-limited regions. These benefits address many functional challenges for rural businesses. Enabling rural peoples' access to predictive analytics in sustainable coconut coir bag industries helps sustain income diversification while improving resource utilization, market alignment, and stabilizing income volatility. This approach contributes to other models like TAM (Technology Acceptance Model) with SLF (Sustainable Livelihood Framework), thus performing a greater role toward providing evidence on the application of data-centric technologies fostering innovation and economic resilience into rural revitalization.

Power BIs in-house forecasting tools were put to work on past monthly sales figures from artisan coir-bag makers so we could see what demand might look like down the road. The resulting line chart shows months along the bottom and actual bags sold up the side, making seasonal trends easy to spot immediately. After that, we leaned on the model's analytics engine to project future sales from those already-cleared patterns. Thanks to the forecast, artisans and their partners can now gear up, schedule labor smartly, and reduce the surprise costs that come when orders suddenly jump or drop.

Supporting this hands-on approach, Tirupati et al. (2024) note that tools found in Power BI-exponential smoothing, trend lines, and the rest-give small firms the agile planning backbone they need. For coir bag makers operating on slim margins, such features turn raw numbers into easy-to-read forecasts, letting them scale up or down without losing control. Liu et al., 2024 reports that coir producers who log their environmental numbers with clear future targets draw in green-minded buyers and overseas partners. When credible forecasts support a visible sustainability story, trust deepens, and shoppers are more likely to stick around.

At the workshop level, Power BIs built-in forecast tool let artisans see upcoming sales, so they could raise or cut output before raw materials piled up. Because these predictions draw on real sales records, planning becomes quicker, cheaper, and far less guesswork. Orji et al. (2023) reach a similar conclusion, showing that even small, low-tech firms in rural areas turn raw numbers into useful moves when predictive analytics sit on their desktop.

Such adoption also echoes the Technology Acceptance Model (TAM), as Rosli et al. (2022) point out. When artisans call up the forecast feature, they prove-and reinforce-that they find the tool handy and easy, two cornerstones of intention and uptake in TAM. Tourist surveys highlight how vital accurate demand forecasts can be. Figures 3 to 6 reveal that more than 81 percent of visitors usually buy souvenirs, 76.67 percent are ready to spend at least ₱301, and 78.33 percent lean toward medium or large bags. Even more telling, 83.34 percent rate eco-friendly items as either good or top value. Together, these numbers prove the tourist's appetite for coir goods and strengthen the argument for using data analysis to match stock with real shopping habits.

These observations echo 2022 findings from the Philippine Coconut Authority, which noted a growing local and export market for coir products along with an urgent call for tighter supply-chain links. Parallel recommendations by the Rural Development Administration and DA-PRDP in 2021 urge community businesses to embed forecasting systems so they can fine-tune orders and cut

waste-tipping points that matter most in seasonal, tourism-driven markets.

The forecast signals an 8% yearly output lift, climbing from 402 pieces in 2026 to 589 by 2030 if growth stays green. That trend shows coconut-coir firms can grow with sustained demand, good access roads, proper training, technology, and systems in place.

Use of Power BIs to combine business and local data as well as market trends allows the company to reduce overreliance on guesswork. That data-informed decision boosts SLF by leveraging financial, physical, as well as human resources. It also supports SDG 12 on responsible production and SDG 13 on climate action which, as noted by the UN Environment Programme (2023), connects village enterprises to sustainable planning.

Methodological Reflections and Limitations

While Power BI served its purpose in managing and analyzing artisanal sales data alongside predicting future marketing trends, there are issues which must be dealt with. The use of purposive sampling is optimal for tracking active souvenir buyers; however, it overlooks the broader tourism purchasing population, thus limiting generalizability. Future studies could employ randomized sampling to improve external validity. Verification of internal consistency with Cronbach's Alpha was done, but due to time limitations test-retest reliability could not be assessed. It is recommended that replication studies incorporate longitudinal data for assessing temporal consistency. Also, because the forecasting model used default exponential smoothing in Power BI, custom parameter tuning was restricted. Though functional for practical requirements, advanced time-series models would better serve long-term strategic planning due to increased predictive accuracy.

Linkages to Prior Literature

The positive consumer response toward coconut coir bags echoes findings by Reddy (2019), who noted global shifts in favor of biodegradable alternatives to plastic. Moreover, the mentioned region's profitability and reliance on local resources further corroborate Rosli et al. (2022) who emphasized the significance of community resources in planning sustainability. Equally important is the 60% profit margin in conjunction with tourist expenditure which is parallel to microenterprises centered around coconuts in India and Sri Lanka (FAO, 2021). In another case, Liu et al. (2024) stated that green entrepreneurs who analyze environmental data market better and replicate here with Power BI driven forecasts as well as tourist spending patterns. Regardless of these similarities, sparse regional studies have aimed to bolster rural entrepreneurial frameworks

through predictive analytics; visual, data-driven models of coir bag feasibility are meant to fill this void.

Power BI Dashboard Summary of Coir Bag Enterprise Performance.
The dashboard displays financial trends, a production versus sales comparison, and demand forecasting based on enterprise data, providing clear decision support.
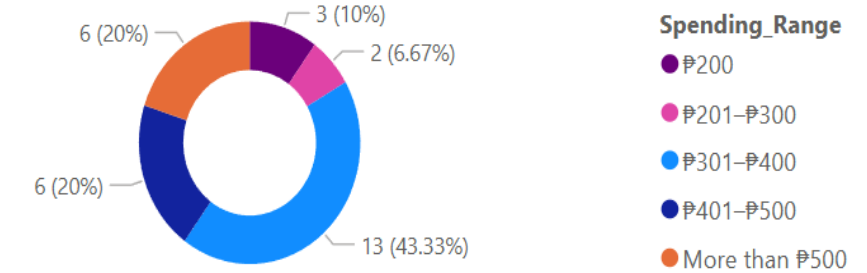
Tourist Insights on Eco-Friendly Preferences

Figure 3
Frequency of Purchasing
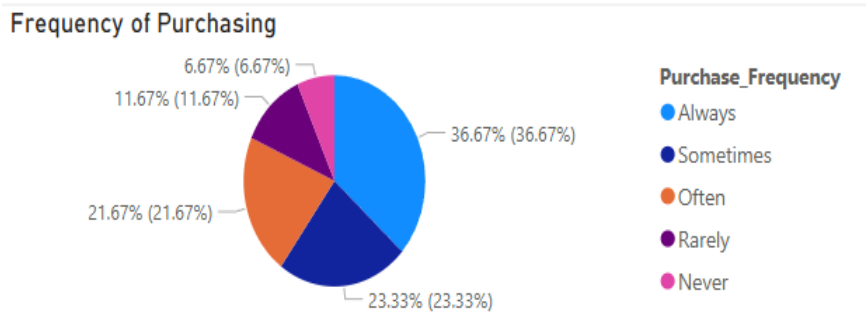
Most tourists frequently purchase, with over 81.67% indicating that they "Always," "Sometimes," or "Often" do so. This suggests a strong potential demand for eco-friendly products like coconut coir bags.

Figure 4
Spending Range

Tourists generally prefer to spend between ₱301 and ₱500 on eco-friendly

products and coconut coir bags, with a significant number willing to pay more than ₱500. This spending behavior supports the marketing of eco-friendly bags in the mid-to-premium price range, striking a balance between quality and affordability.

Figure 5
Bag Size Preferences
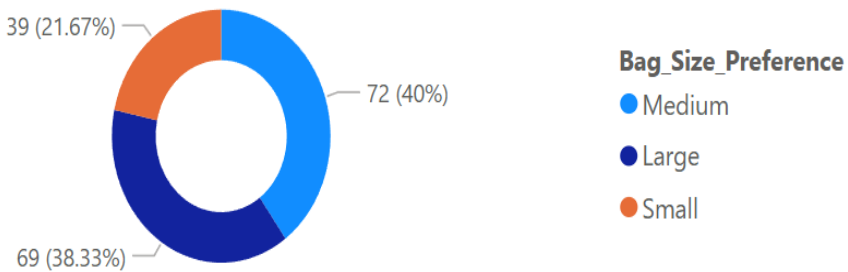
Medium and large bags are the preferred sizes, accounting for 78.33% combined. This suggests that tourists prioritize function and capacity, essential for product design and inventory decisions.
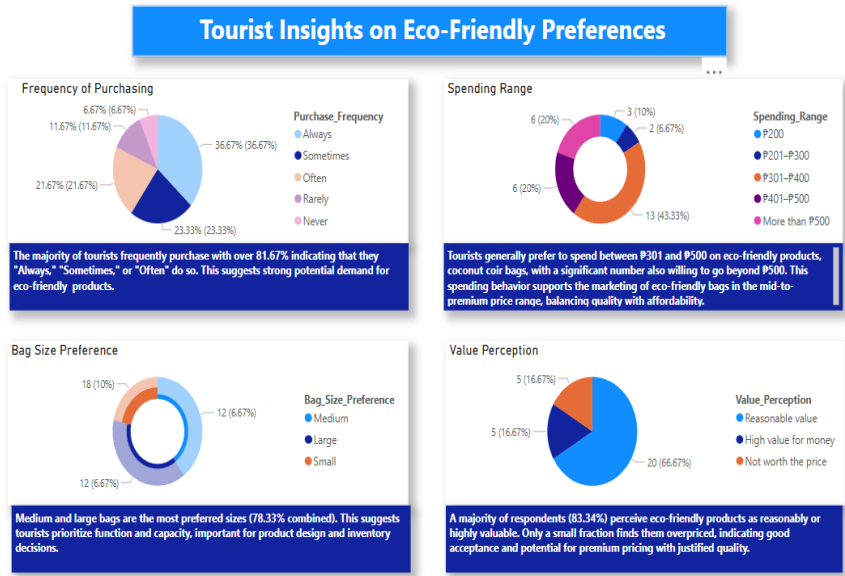
Figure 6
Value Perception
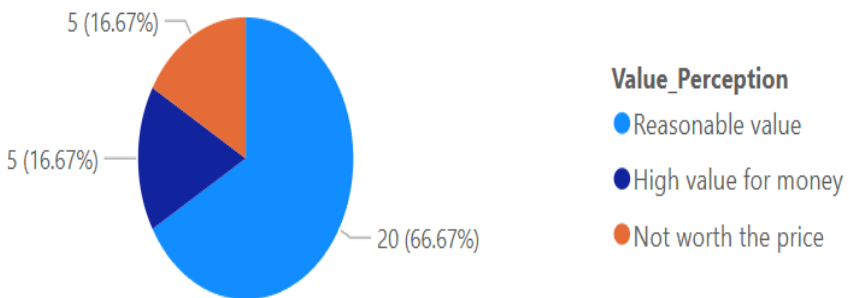
Most respondents (83.34%) perceive eco-friendly products as reasonably or

highly valuable. Only a small fraction finds them overpriced, indicating good acceptance and potential for premium pricing with justified quality.

Figure 7

Overall Summary of Tourist Insights on Eco-Friendly Preference

The survey data presented using Power BI best showcase key observations about consumer behavior, like how they spend, what they prefer, and their perception of value in eco-friendly souvenir products, especially coir bags.

A good majority (81.67%) of tourists reported that they "Always," "Sometimes," or "Often" purchase souvenirs, indicating a consistent and strong interest or demand for these products. From a spending perspective, most participants (43.33%) were willing to spend around ₱301-₱400 on souvenir items, while 33.34% were also willing to spend more than ₱400. This shows that participants are willing to pay within a reasonable range.

Most users prefer medium (40%) and large (38.33%) bag sizes, which cumulatively account for 78.33% %. This means tourists care about a product's functionality and put value in storage, which is critical in helping guide product design and inventory planning.

Eco-friendly products are appreciated and valued at a premium, but compared to other products, they hold a much higher value. According to the value perception data, 83.34% of respondents viewed eco-friendly products as

providing "reasonable value" or "high value for money." A small share of 16.67% found the price unjustifiable, indicating a baseline good acceptance towards premium eco-friendly goods.

The findings summarize the potential opportunities for endorsed coir-based bags to complement eco-friendly consumers while indicating that the market is readily available. Moreover, they help position the aids in pricing, size, and quality to attract optimum eco-friendly consumers.

Figure 8
Monthly Sales Per Artisan

Artisans Sales and Profitability Overview
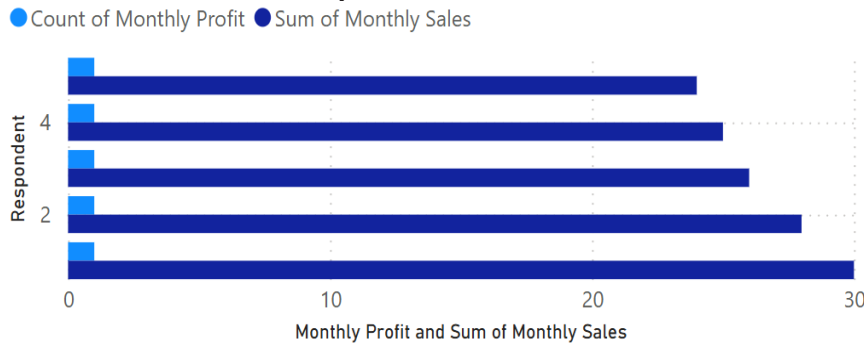
Artisan respondents have identical monthly sales, with Respondent 1 recording the highest. However, given the low number of recorded monthly profit entries across all respondents, it can be inferred that while sales are available, tracking profit likely is not. This indicates a need to enhance financial information capture, enabling documentation supporting improved business strategies.

Figure 9

Monthly Profit

The bar chart shows the respondents' monthly revenue from coir bag production. Profits varied for each respondent, ranging from 2,520 to 5,400 monthly pesos. Such differences suggest that some artisans had lower outputs than others or achieved cost efficiencies, but all profits were positive, indicating that producing coir bags is profitable.

Figure 10

Cost and Selling Price
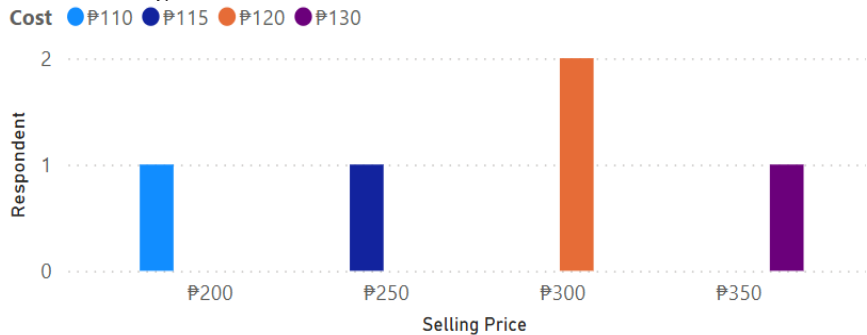
The chart illustrates the relationship between production costs and selling prices for coir bags. The selling price of ₱300, alongside a production cost of ₱120, demonstrates a significant profit margin; this means that ₱ 120 is the model's production cost. Other price points range from 200 to ₱350, and production costs also change between ₱110 and ₱130. This range suggests that the pricing model depends on the economy, product quality, or market positioning.

Figure 11

Profit per Unit
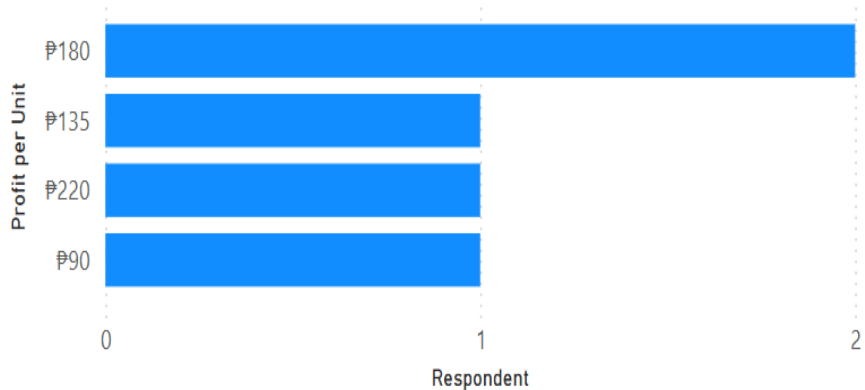
The diagram illustrates changes in profit associated with producing coir bags. Business profits fall within the range of ₱90 to ₱220, indicating a divergence in production costs and selling prices among different producers. The modal profit value per unit is ₱180, which suggests a considerable earning capability for coir-based products, considering the profit margin when successfully marketed and manufactured.

Figure 12

Monthly Production Capacity
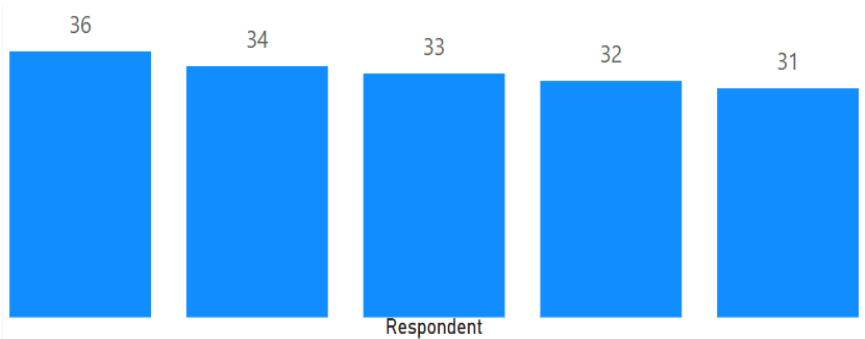
The coir bags produced by each respondent ranged from 31 to 36 units per month. This level of production indicates a reasonable and consistent manufacturing capacity. Fluctuations in the output are most likely because of labor, resources, or market demand. This suggests that the production of coir bags can be reliably undertaken, thus establishing a dependable revenue stream.

We, the researchers, offer a projection concerning the output of coir bag

enterprises for the next five years, which we benchmark under 'sustainable growth conditions' using previously detailed profitability and production data. Predictive analytics were utilized, and it is assumed, rather cautiously, that rural sustainable enterprises' annual productivity growth rate will be 8%.

The projection suggests that small-scale coir producers have the potential to consistently increase earnings if there is constant demand in the market and training and necessary infrastructure are made available. The productivity estimation suggests that if the production capacity is 402 units in 2026, the yearly output could grow by 2030 to around 589 units, reinforcing the possibilities of coir-based entrepreneurship as a sustainable livelihood option.

A detailed production projection and its schematic representation can be found in Figure 12.
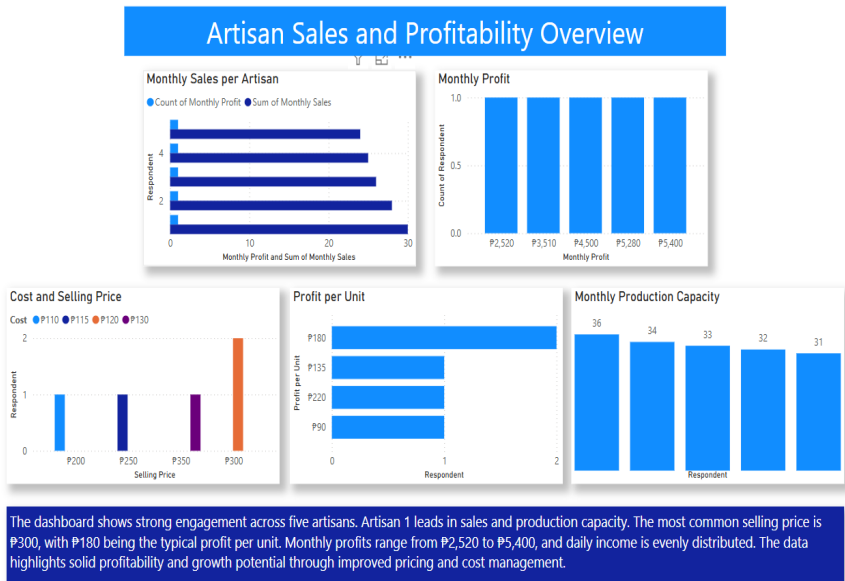
Figure 13

Five-Year Production Forecast for Coconut Coir Bags (2026-2030)
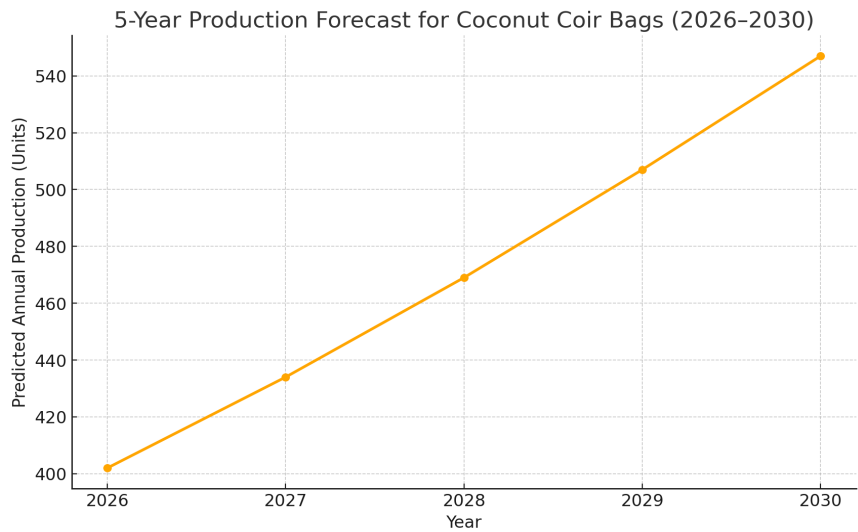
Figure 14

Overall Summary of Artisan Sales and Profitability Overview

The interpretation of the five visualizations illustrates the production of coir bags as a financially feasible coir-based entrepreneurship business. The estimated monthly production is between 31 and 36 bags per month. Their selling price ranges from ₱200 to ₱350 while the cost varies from ₱110 to ₱130. The average producer earns a profit of ₱180 per bag, which brings his monthly earnings to a level between ₱2,520 and ₱5,400. Revenue seems uniform among the producers, although tracking profits leaves something to be desired. Coir bag production appears to be an excellent opportunity to generate income but requires better financial management.

Interdisciplinary and International Relevance

The results strengthen the prospects for replication in other ASEAN coconut-producing countries and rural regions in the Global South. Ullah et al. (2025) add that coir-based biocomposites now used in cars, boxes, and export goods win broad appeal because they save money and shrink the planet's footprint. This shift shows room worldwide for local coir start-ups that pair up-to-date digital tools with solid, on-the-bench skills training. Drawing on primary constituents, including raw materials, fashion analytics (Power BI), and community-level consumer behavior data, an innovative, eco-friendly production model that aligns with SDGs 12 and 13 emerges.

Coconut coir, a plentiful and renewable resource in rural Philippine

communities, is a viable raw material for sustainable, locally produced bags. The combination of descriptive and predictive facilitated desktop assessments of the market feasibility, which was real data-driven. Basista coir-based enterprises were shown to have a sustained 60% profit margin and stable monthly sales, confirming the economic viability of these enterprises to small-scale producers. The modestly forecasted demand for coir-based products would strengthen the eco-venture, alongside declining ecotourism and an ever-increasing demand for ethical fashion. In addition, international tourist evaluations of local businesses confirmed several critical assumptions central to the business: culturally infused design, sustainability-centric, and value-centric branding worked effectively.

This research aligns with established sustainability frameworks, such as SDGs 12 and 13. It provides an evidence-based community model for product innovation that can be scaled in other regions where coconuts are produced. The study expands the understanding of data-informed entrepreneurial innovations in rural settings by combining capital accessible to people within the region and local knowledge, thus furthering the discourse on empowerment in peripheral economies and circularity.

CONCLUSION

This research illustrates the economic importance of coconut coir bags and their market as sustainable livelihood products for the regions that produce coconuts in the Philippines. Utilizing both The Sustainable Livelihood Framework (SLF) alongside Technology Acceptance Model (TAM), this research showed how business intelligence tools like Power BI Business Intelligence overcome barriers brought by nature, human, and financial resources, thus making possible sustainable ventures centered around agro-industrial waste.

Embedding the Technology Acceptance Model (TAM) helped in reinforcing the findings by demonstrating the ease of use and its usefulness towards the artisan's intention to use Power BI. The artisans' continued interaction with the financial and forecasting dashboards demonstrates the potential of technology in rural enterprises and how it drives informed decision making through data.

In Batangas, local government units (LGUs) have spearheaded various projects for climate change mitigation through community-based livelihood activities. Some of these are workshops, training on conservation farming, and support for secondary employment opportunities that help reduce residents' climate vulnerabilities. According to Manalo (2018), LGUs played a critical role in empowering farmers and fishers by providing them access to technical training, funding, and localized strategies that utilize community-based natural resources.

These initiatives exemplify the use of the Sustainable Livelihood Framework (SLF) focusing on enhancing human, social and natural capital in fragile rural regions. The same approach to rural businesses like the manufacturing of coconut coir bags illustrates the benefits that local government unit (LGU) supported programs can offer towards establishing sustainable resilient livelihood models. Furthermore, integrating predictive analysis tools into the SLF based frameworks would enhance resource allocation, demand forecasting, and production optimization for coir-based industries in the Philippines thus improving these industries' sustainability.

Coconut coir as a by-product of coconuts has great potential as an underexploited resource in the Philippines, offering many avenues for environmentally friendly product development. Based on the projection, a 60% profit margin is feasible. Furthermore, Power BI estimates confirmed the sustained interest of domestic tourists. Consumer research also indicated a strong preference for functional and environmentally friendly products, which supports using coir bags in tourism markets. The study employed predictive analytics and provided data-efficient evidence to demonstrate that producing coir bags can be profitable, aligning with SDGs 12 and 13. The implemented digital dashboards provide easier decision-making, real-time performance tracking, and a model for replication in other GDP-lower ASEAN countries. To conclude, the study claims that coir-based businesses can be optimized using local resources along with community skills and appropriate analytics to develop sustainable eco-friendly innovations integrating circular economy frameworks while minimizing climate harmful products.

TRANSLATIONAL RESEARCH

Several translational strategies are implemented to ensure that the study's outcomes align with those of the targeted community stakeholders. First, local cooperatives, artisan groups, and local government units (LGUs) can benefit from the real-time decision-making facilitated by the Pivot Power BI dashboards developed for this study, which may be translated into interactive training sessions. Additionally, in the visual aids used by entrepreneurial programs, financial and market insights can be translated into infographics and posters in local dialects, which would be utilized in livelihood workshops at the barangay level. Notably, the study has the potential for digital storytelling through short videos featuring successful coir artisans, highlighting the environmental benefits of using biodegradable materials instead of plastic-based ones. Additionally, the research can inform policy at the government level or be recommended to government

agencies, such as DTI and DOT, to promote sustainable products and to cap support for these products. Lastly, the insights collected can be used to teach senior high school and university students majoring in business entrepreneurship or sustainability to use analytics and local materials for business model design. These strategies ensure that the research does not remain siloed within academic circles but enhances community capacity building and promotes sustainable economic development.

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