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“Aka” is a Hanunuo Mangyan term for “first born.” The Occidental Mindoro State University (OMSU) believes this publication is first of its kind in the MIMAROPA Region. It is an academic, multidisciplinary and faculty and expert-reviewed journal devoted to the rapid dissemination of current research. It is published annually to document the research endeavors of the students presented in the Annual Student Research Congress.

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CULTIVATING STUDENT EMPOWERMENT THROUGH KNOWLEDGE, INQUIRY, AND INNOVATION

Artemio M. Gonzales Jr., MPH, MAN
Editor-in-Chief

There is an emerging dilemma in current education systems. Traditionally, education systems have been concerned with equipping learners with the necessary information, skills, socialization, and certification to enable them fit into the societies. But scholars and education policymakers now increasingly appreciate that education should go beyond this scope and engage with developing critical thinking of learners and empowering them to envisage and create new possibilities for the future (Garcés et al., 2022).

A key issue for understanding the transformation and future orientations of education and learning is how we engage students in processes of learning and development and how this is embedded within the communities in which they belong. Traditionally, student engagement and participation have been developed by assigning learners projects defined primarily by instructors. In this framing, student activity is often limited to increasing engagement through structured activities that still provide a bounded degree of freedom in task selection, collaboration, and output (Erstad et al., 2025). Higher education systems are now facing a deeper and more fundamental challenge, which is how to genuinely engage students with the pressing issues that will shape their future lives in a world defined by complex social problems. This calls for moving beyond a narrow emphasis on the socio-cognitive and emotional aspects of learning and toward what has been described as transformative intervention. This approach highlights the evolving relationship between culture and mind, as well as the connection between meaning-making and participation in community life.

Within this broader perspective, empowerment in education begins with knowledge, but not the kind limited to memorizing facts and definitions. Instead, it is knowledge that helps learners make sense of principles, questioning, exploration, interpretation, and apply what they learn in real-life situations (Pedaste et al., 2015). Given that the learners are grounded in such deep understanding, they will be able to be confident about their capabilities as well as developing control over their learning processes. In other words, the learners will be more active participants in the whole process of learning rather than mere recipients of information. Inquiry will take advantage of such an approach because it is based on encouraging curiosity, establishing questions, and exploration. When using inquiry to learn, the learners are encouraged to ask meaningful questions, analyze evidence, and create their own understanding of the topics being covered.

Innovation represents the highest expression of this kind of empowerment. When learners are given the space to innovate, they move beyond understanding and analysis and begin to create, design, and solve problems. Innovation in education is not limited to technology. It can also appear in creative thinking, new perspectives, or better ways of addressing community challenges (Ukowitz, 2021). By promoting innovation, universities help students become more adaptable and better prepared to contribute to a changing world.

The integration of knowledge, inquiry, and innovation requires deliberate efforts in higher education. The educators have a major part to play as far as formation of the environment where the learner engages through participation, inquiry, and innovation. Moreover, the institutions should be able to promote curriculum that is flexible, interdisciplinary and responsive to local and global needs rather than with formats, fonts, and documentary pictures. Empowerment is, thus, directly connected to inclusivity and accessibility. Students should have equal access to education and learning processes that will empower them. Empowerment can never take place when the social, economic, or institutional barriers hinder the ability of the learners to participate fully and learn. It is, therefore, important that empowerment of the learners involves the promotion of equity. Students should be mentored and inspired rather than spoon-fed and controlled.

In conclusion, the empowerment of students through knowledge, inquiry, and innovation is important to enable them in facing life challenges. Education should not just be the transfer of knowledge but should be dynamic in nature that makes the individual curious, competent, and innovative.

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ASSESSING THE COMMUNITY PERCEPTION ON REINTEGRATION OF EX-PDLS AND COMMUNITY BEHAVIOR TOWARDS THEM AT BARANGAY CAMINAWIT, SAN JOSE, OCCIDENTAL MINDORO

Marco N. Manzano*, Clarizza Mae C. Marcelo, Alfa Mae G. Magluyan, Lynn-Ai Kate D. Francisco, Roxanne R. Yutoc, Aleah Janna G. Quijano, Vince Alfred C. Orsos, and Ariz Mc Lean E. Ordanes, Mary Grace F. Barolo

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ABSTRACT

The study was conducted to assess the community perception on reintegration of Ex-PDLs and community behavior towards them at Barangay Caminawit, San Jose, Occidental Mindoro, consider as one of the key factors in successful reintegration. The study shows that the community shows a favorable attitude on the reintegration of Ex-PDLs and communities remains neutral about the risk and possibility of re-offending of those ex-PDLs. Moreover, a correlation analysis revealed that there is no association between profile of the respondents and community perception on reintegration of Ex-PDLs. The qualitative findings reveal that community perceptions regarding the reintegration of ex-PDLs show feelings of distrust, hope for their positive change, chances to rebuild their lives, and the possibility of re-offending among ex-PDLs. Furthermore, community response to government initiatives for reintegration reveals that failure to address the core needs of Ex-PDLs affects community perspective, lack of livelihood opportunities towards Ex-PDLs breeds negative views, and job opportunities for ex-PDLs is essential to poster positive community perception. Simultaneously, the community evaluation on government initiatives suggested that the success of government programs depend on ex-PDLs and limited efficacy of programs leads to recidivism. In line with that, community suggestions to improve reintegration is the need for community empathy toward ex-PDLs and livelihood support for them.

Keywords: *Community perception, community behavior, reintegration, Ex-PDLs, community empathy*

SDG: SDG 16 – Peace and Justice

INTRODUCTION

Community is one of the five pillars of the Philippine Criminal Justice system. It is the place where the Ex-PDLs is reintegrated as a law-abiding citizen after serving their final sentence in the correctional facilities.

Community perception plays a crucial role in this process; their opinion and judgments often lead to either positivity or negativity, but still affect both aspects of life, the community itself, and the Ex-PDLs. It creates conflicting ideas affecting the community's perception of Ex-PDLs; they are frequently stigmatized, discriminated against, and labeled as individuals with no chance of reformation, leading them to be more adept and leading to recidivism. The dispute arises when the deficiency of both the community and the Ex-PDLs to establish a harmonious relationship is not addressed, which results in social stigma or negative labeling and recidivism on the part of the Ex-PDLs. According to Feingold (2021), the stigmatization creates a gap between the community and the reintegration of Ex-PDLs due to their social status, which affects their individual level. However, community perception towards Ex-PDLs is highly driven by their subjective interpretation, believing that the reformation and rehabilitation program conducted by the Bureau of Jail Management and Penology and the Bureau of Corrections to reform and correct their antisocial behavior is not effective. As stated by Caeiro et al. (2024), 38% of their respondents stated that the PDLs are not rehabilitated inside the institutional correctional system.

Effective reintegration of Ex-PDLs is extremely important for public safety and well-being, for both individuals and communities. The experience of detention, often characterized by feelings of fear, shame, and loss, has a major impact on a person's ability to integrate into society. Often called "life through beans," this transition presents a complex set of difficulties that go far beyond the emotional impact. Loss of connectivity, the burden of partial actions, and obstacles to existing social structures are considerable challenges. Despite remorse and a sincere desire to improve, dealing with the opinions and judgments of the community remains a significant issue.

Furthermore, former scholars argue that recidivism is a failure of the correctional facilities to rehabilitate Ex-PDLs. There is a need for more comprehensive rehabilitation and reintegration programs that address these underlying factors to reduce the likelihood of repeated offenses and promote successful re-entry into society.

METHODS

Research Design

The study employed a convergent parallel design, a mixed-methods approach. This design was utilized to gain an in-depth understanding of the community's perception of the reintegration of Ex-PDLs and community behavior towards them.

Participants

In the quantitative phase, three hundred seventy-one (371) residents of Barangay Caminawit, San Jose, Occidental Mindoro, who answered the adapted questionnaires of the researchers. Moreover, in the second phase, the respondents from quantitative phase were participated in in-depth interview but the researcher will stop in interviewing after the occurrence of data saturation.

Research Instrument

In this mixed-method study, the adapted Likert-type questionnaire from the study of Ayobi et al. (2023) were used in the quantitative phase, which was evaluated and approved by research adviser, data analyst, and critic reader. The instrument was tested on 15 residents who were not respondents to measure the internal consistency and reliability. The reliability test yielded coefficient range to .716, indicating generally good reliability of the items and suggesting that the instrument could be administered to final set of respondents.

The researchers used one questionnaire for each respondent during the conduct of the study. The questionnaire is composed of two parts; the first part contains the profile of the respondents, and the second part consists of items to assess the community perception of the reintegration of Ex-PDLs. Using a five-point Likert Scale, 5 as strongly agree, 4 as agree, 3 as neutral, 2 as disagree, and 1 as strongly disagree; 5 is the highest and 1 is the lowest.

In the qualitative phase, the researchers utilized in-depth interviews to collect reliable data regarding the behavior of the community towards Ex-PDLs. During the process of one-on-one in-depth interviews, the researcher started asking the participants an open-ended question, and their responses were recorded with their permission.

Data Collection

For the quantitative phase, survey questionnaires were administered to selected residents of Barangay Caminawit, particularly those residing near the vicinity of the households of Ex-PDLs. The respondents were given sufficient time to accomplish the instruments, and assistance was provided when necessary to ensure proper understanding of the items.

For the qualitative phase, interviews were conducted among selected participants to further explore and deepen the findings obtained from the survey. The interviews focused on the participants' perceptions and experiences regarding the reintegration of Ex-PDLs within the community.

Ethical Consideration

The researchers ensured that all respondents were treated with utmost respect and care throughout the study. Participation was voluntary, and respondents were informed of their right to withdraw at any time without consequence. The purpose of the study, including its objectives, procedures, and use of data, was clearly explained to secure informed consent.

Confidentiality and anonymity were strictly observed to protect the identity and dignity of the participants. All data were handled responsibly, and no manipulation or misrepresentation of findings was conducted to ensure the integrity of the research.

Data Analysis

In the quantitative phase, after gathering all the necessary information for the study, the researchers applied the percentage and frequency to determine the profile of the respondents and Pearson's r correlation to identify the significant relationships among the variables presented in the research paradigm. Also, the researchers interpreted the positive and negative response rates of the respondents based on their perceptions of the reintegration of Ex-PDLs.

Moreover, in the qualitative phase, the recorded responses of the participants from the one-on-one interviews were transcribed by the researchers to obtain the necessary data for the study. The thematic modality approach was used to identify the central themes of the participants' responses and the corresponding follow-up questions during the interviews.

RESULTS

Profile of the respondents

The findings show that among the 371 respondents, most were aged 18–25 years (27.2%) and were female (56.1%). In terms of civil status, the majority were single (46.4%), followed by married (44.5%). For educational attainment, most were college undergraduates (24.0%), followed by high school graduates (22.1%) and college graduates (19.7%). Regarding occupation, most were unemployed (42.9%), followed by employed (31.0%). In terms of length of residency, the majority had lived in the area for 16 years and above (77.6%).

Table 2. Profile of the respondents (n=371).

Profile variables	Frequency	Percentage
Age		
18-25 years old	101	27.2
26-35 years old	47	12.7
36-45 years old	55	14.8
46-55 years old	83	22.4
56 years old and above	85	22.9
Sex		
Male	163	43.9
Female	208	56.1
Civil Status		
Married	165	44.5
Single	172	46.4
Widow	7	1.9
Separated	27	7.3
Educational Attainment		
Elementary Undergraduate	22	5.9
Elementary Graduate	43	11.6
High School Undergraduate	53	14.3
High School Graduate	82	22.1
College Undergraduate	89	24.0
College Graduate	73	19.7
Post-Graduate	1	.3
Vocational	8	2.2
Occupation		
Employed	115	31.0
Unemployed	159	42.9
Self-employed	97	26.1
Years of Residency		
5 years and below	15	4.0
6-10 years	21	5.7
11-15 years	47	12.7
16 years and above	288	77.6

Community Perception on Reintegration of Ex-person Deprived of Liberty

The overall mean (3.37 ± 0.44) indicates a neutral community perception toward the reintegration of Ex-PDLs [Table 3].

Table 3. Assessment on community perception on the reintegration of ex-person deprived of liberty

Community Perception	Mean	SD
1. I'd consider volunteering my time or donating money to an organization that supports toughening of sentencing law in Philippines.	3.46	1.53
2. With most PDLs, we need to 'condemn more and understand less'.	2.89	1.47
3. My general view toward person deprived of liberty is that they should be treated harshly.	2.05	1.36
4. Person deprived of liberty should have access to televisions or gym facilities.	3.36	1.43
5. Ex-person deprived of liberty should be treated harshly.	1.99	1.40

6.	Ex-person deprived of liberty should be given housing and funding support to aid reintegration.	3.63	1.42
7.	I do not mind living and working with an ex-person deprived of liberty.	3.54	1.33
8.	Ex-person deprived of liberty is a bad person.	2.49	1.33
9.	Ex-person deprived of liberty could return back to crime if the opportunity arises.	3.10	1.25
10.	Ex-person deprived of liberty should be given opportunity to reintegrate positively into society.	4.32	1.04
11.	Most people deprived of liberty can lead productive lives with help and hard work.	4.31	1.04
12.	Even the worst person deprived of liberty can grow out criminal behavior.	4.36	1.06
13.	Opportunities for rehabilitation should always be available no matter how serious a crime someone has committed.	4.32	1.05
Overall Mean		3.37	.44

Relationship between the Profile of the Respondents and Community Perception on Reintegration of Ex-Person Deprived of Liberty

The results showed no statistically significant association with community perception toward the reintegration of ex-PDLs [Table 4].

Table 4. Relationship between the Profile of the Respondents and Community Perception on Reintegration of Ex-Person Deprived of Liberty

Profile	Community perception on reintegration of ex-person deprived of liberty	
	r	p value
Age	0.47	.369
Sex	.028	.588
Civil status	-.031	.553
Educational attainment	.028	.588
Occupation	-.067	.198
Years of residency	.009	.870
Educational attainment	-.009	.862

**Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

Community behavior regarding the reintegration of Ex-PDLs

The analysis identified four themes from the participants' insights on the reintegration of Ex-PDLs: distrust toward Ex-PDLs, strong hope for their positive change, willingness to give them a second chance to rebuild their lives, and perceived possibility of re-offending.

Theme 1: Feeling of distrust towards Ex-PDLs

There is a prevailing distrust toward Ex-PDLs regarding their genuine reintegration into the community. This is driven by fears and doubts about their willingness to engage as law-abiding citizens. Concerns about possible retribution from Ex-PDLs further contribute to the community's hesitation and lack of trust.

P20: "Meron kasi di ba 'yong nababalitaan natin 'yong mga lumabas, kumbaga inuulit pa rin nila 'yong ginawa nila dati, kaya may pagdududa pa rin." (There are cases we often hear about those who get released still repeating their past actions, that's why there's still a doubt.)

P120: "Natatakot ako baka mamaya maglaban pa 'yan. Dahil 'yong iba naghihigante eh." (I am afraid that it might fight back. Since some take revenge eh.)

P240: "Siyempre unang-una, matatakot ka siyempre dahil galing sila sa ano eh, sa bilangguan. Baka mamaya pakisamahan mo 'yon eh, iba ang ano niya, iba ang ugali niya." (Of course, first of all, you will be scared because they came from prison. You might get along with them, but they have a different attitude.)

Theme 2: Strong hope for the positive change of Ex-PDLs

The community possessed strong sense of hope towards the positive change of Ex-PDLs. They expected that since the Ex-PDLs already experienced the life inside the prison, they are more likely to reintegrate in the community as law-abiding citizen.

P120: *"Dapat magbago na sila. Kasi kung sa ano eh, naparusahan na sila, ganiyan. Dapat magbagong buhay na sila."* [They should change. Because they have been punished. Therefore, they should change.]

P150: *"Magbago sila para kahit papaano 'yong iba pakitunguhan sila ng maayos."* [They should change so that the other people will treat them properly.]

P210: *"Aba'y dapat lang! ibalik natin 'yong dati nilang pamumuhay, i-welcome sila. Hindi naman nakatatak sa kanilang noo ang kanilang kasalanan eh, ganun pa rin sila, tao pa rin."* [Yes, we must return them, so that they can continue their old lives, let's welcome them. The crime they committed is not branded on their foreheads; they are still human.]

Theme 3: Willingness to give second chance to rebuild their lives

The acceptance towards Ex-PDLs is a key in a successful reintegration. Beyond offering a chance to change, it is essential to give them an opportunity for sustainable livelihood and support.

P40: *"Bigyan ng chance para magbago."* [Give them a chance to change.]

P100: *"Okay lang naman na bumalik sila at bigyan sila ng maaayos na pagtanggap at kung suwerte pa, kung pwede pa, bigyan sila ng maayos na trabaho."* [There's no problem in their reintegration and provide them a proper acceptance, and if they are lucky, give them a decent job.]

P270: *"Ang pananaw ko diyan ay bigyan natin sila ng pagkakataong magbago, bigyan natin sila ng paraan para makapag-hanapbuhay 'yon lang."* [My view on that is let's give them a chance to change, let's give them a way to make a living, that's all.]

Theme 4: Possibility of re-offending among Ex-PDLs

The doubts on reintegration of Ex-PDLs y into community fuels the possibility of re-offending. It is one of the factors why community has distrust towards their genuine reintegration. Since most of them after reintegration still engaged into their old way of living like engaging in criminal activities.

P10: *"Hindi kase 100%, kase 'yong iba dito bumabalik pa rin sa dati eh."* [It's not 100%, because some of them still return to their old way of living.]

P50: *"Meron kaseng ano na talagang ang iba talagang nagbabago, ang iba talagang hindi rin. Kase uulit ang iba kung hindi talaga sa puso ang kanilang pagbabago, talagang babalik at babalik sa kanilang dating gawain."* [There are some that really change, but some of them are not. Because some of them still re-offend if there's no willingness to change their lives.]

P160: *"May tendency kase kagaya nga 'yong mga nagtitinda ng droga, sabi nila hindi raw sila magtitinda. Pero noong nakalaya, nagtinda ulit sila."* [There's a tendency that those who sells drugs, says that they will no longer sell drugs. But after their reintegration, they sell again.]

Community behavior on government initiatives for reintegration

There are three themes that emerged on the community response to government initiatives for reintegration such as failure to address the core needs of Ex-PDLs affects community perspective, lack of livelihood opportunities towards Ex-PDLs breeds negative view and job opportunities for Ex-PDLs is essential to poster positive community perception.

Theme 1: Failure to address the core needs of Ex-PDLs affects community perspective

Participants expressed that the government's programs are insufficient for the successful reintegration of Ex-PDLs into the community. Due to the government shortcomings, Ex-PDLs often return to their old ways of living. Furthermore, they are often avoided and abandoned.

P90: *"Kulang ang ano ng gobyerno, hindi nila na-aano 'yong gusto nila makamit. Kaya 'yong iba bumabalik pa rin."* [The government is lacking in something; they don't achieve what they should be achieving. That's why they still engaging into criminal activities.]

P170: "Para sa akin gawin nila 'yong the best, kung anong dapat, kung ano ikabubuti ng mga dating bilanggo para magbagong buhay na sila." (The government should do their best, do what is right and what is good towards ex-person deprived of liberty for them to change.)

P290: "Mabagal 'yong ginagawa nila; hindi nila natututukan lahat ng mga lumayang bilanggo." (The program is too slow; they can't totally monitor those ex-persons deprived of liberty.)

Theme 2: Lack of livelihood opportunities towards Ex-PDLs breeds negative views

The lack of livelihood opportunities towards Ex-PDLs is considered as a barrier on their reintegration. The limited access on employment opportunities and financial assistance caused them to re-offend after reintegration.

P10: "Bigyan ng anong tawag dito... ng parang suportang kabuhayan para tuluyan silang magbago." (They should be given a livelihood support for them to renew their life.)

P160: "Meron bang ganun? parang wala naman. Ewan ko, siguro mas magandang bigyan siguro sila ng pabahay o hanapbuhay para hindi na sila bumalik sa ginawa nilang masama." (Is there such a thing? It seems like isn't, I don't know, but it's probably better to give them housing or jobs so that they won't all go back on doing bad things.)

P220: "Bigyan nila ng talagang pagkakakitaan 'yong mga lumaya. Bigyan sila ng gobyerno natin ng panghanap-buhay at pangalawang pagkakataon na magbabago na talaga sila." (They should provide a way to earn money for those ex-persons deprived of liberty. Our government should give them a job and chance to change their life.)

P230: "Kulang sa suporta ng gobyerno natin, kaya 'yong iba bumabalik sa pagiging masama. Dahil nga sa kawalan ng unang-una pera o hanap-buhay." (There's a lack of support from government that's why some ex-person deprived of liberty still re-offending. Because of lack of money or job.)

Theme 3: Job opportunities for Ex-PDLs is essential to foster positive community perception

The job opportunities are essential to reintegrate those Ex-PDLs in the community successfully. However, the lack of access on employment opportunities hinders them to rebuild their lives.

P40: "Bigyan sila ng magandang trabaho, bigyan nila ng pagkakataon na makaahon. Para hindi na sila gagawa ng masama." (Give them a good job, provide them an opportunity to renew their lives and they will stop doing illegal activities.)

P60: "Dapat bigyan sila ng hanap-buhay, para hindi na nila maisip kunwari ang kagaya nang nakaw o kahit ano, magtinda ng shabu." (They should be given a job so they won't think about stealing or selling a methamphetamine hydrochloride.)

P310: "Bigyan sila ng hanap-buhay para sila'y makapagsimula, maka-recover sa kanilang dating buhay sa kulungan, na paglaya nila meron silang hanap-buhay." (They should be given a job opportunity so they can start over, recover from their past life in prison, when they reintegrated, they already have a job.)

Community behavior on the effectiveness of these initiatives

This analysis generated two themes such as success of government programs depending on Ex-PDLs and limited efficacy of program leads to recidivism.

Theme 1: Success of government program depends on ex-person deprived of liberty

The success of the government programs still depends upon the Ex-PDLs themselves. If they don't value the assistance provided by the government, they may end up re-offending. However, if the Ex-PDLs use the government's support properly, it will help them to change or renew their lives.

P40: "Epektibo ang programa ng ating gobyerno, ang problema lang nasa kanila. Hindi nila ginagamit na para magbagong buhay." (Government program is effective; the problem is on the ex-person deprived of liberty itself. They aren't use it to start a new life.)

P50: "Sa kanila kase iyon, kung gagamitin nila ng maayos, epektibo. Pero kung kung hindi nila gagamitin ng maayos, ay wala rin, walang kuwenta. Kahit bigyan pa sila ng gobyerno ng isang libo, kung iyon ay gagamitin nila sa maayos ay aasenso sila. Kung hindi, edi wala, babalik sila sa dati." (That depends on them, if they will use it properly, it's

effective. But if they don't, then it's useless. Even if the government gives them only one thousand pesos, if they use it properly, they can prosper. But if not, nothing will change, they'll just go back in their old lives.)

P180: *"Nakadepende po iyan sa lumayang bilanggo, kung magbago talaga siya. Dahil sa binigay na programa ng government sa kaniya para mabawasan 'yong mga iisipin para sa sarili niya."* (That depends on experson deprived of liberty, if he will change himself. Because of the given program by the government for him to lessen his burdens.)

Theme 2: Limited efficacy of program leads to recidivism

Government programs for ex-PDLs have shown limited efficacy. This is because some of their needs upon reintegration into the community are not being met or addressed. Due to these shortcomings, the program's effectiveness is reduced.

P230: *"Depende kase ilan lang iyong maririnig mo na epektibo, dahil ilan lang ang umunlad o ilan lang talaga 'yong totally na nagbago."* (It depends since the effectiveness are too limited, because the progress is too little or only few among them totally changed.)

P370: *"Para sa akin mababa 'yong pagiging epektibo, kase mababa ang tiyansa na sabihin nating epektibo iyong ginagawa nila dahil marami pa rin 'yong tao na gumagawa ng parehong krimen na ginawa nila na katulad niyan na robbery, ang mga pagnanakaw gaya ng akyat-bahay na 'yan."* (For me, the effectiveness is too low, the chances are low to say that what they are doing is effective, because there is still ex-person deprived of liberty who commit the same crime they committed like robbery and burglary.)

Community behavior for improving reintegration efforts

Community involvement is essential in reintegration of Ex-PDLs by developing national reintegration strategies and policies aligned with Ex-PDLs conditions, needs, and abilities.

Theme 1: Community empathy towards Ex-PDLs

The community empathy and openness to ex-PDLs is a crucial factor in their successful reintegration. When the community is willing to accept them or give them a second chance, trust them, understand them, and not judge them, this will lead to a positive outcome in their reintegration into the community.

P70: *"Ganoon pa rin, pakitunguhan sila ng mabuti. Kaso ang iba nga lang ayaw kapag nanggaling ng loob ng kulungan ay bad na sa kanila."* (Still the same, treat them well. However, the other people don't like them since they came from prison.)

P270: *"Pakisamahan natin sila ng maayos nang sa ganun makabalik sila sa atin ng normal, iyon ang aing ideya. Huwag naman natin sila husgahan, tanggapin natin."* (Treat them well so that they can reintegrate as law-abiding citizen, that's my idea. Don't judge them, let's accept them.)

Theme 2: Livelihood support for Ex-PDLs

Providing livelihood support for ex-PDLs will help them to renew their lives. Financial support and job opportunities for them can significantly support their successful reintegration into the community. By addressing it, recidivism will be prevented and they will be helped to start anew.

P40: *"Bigyan 'yong lumayang bilanggo na walang trabaho ng trabaho para magkaroon ng bagong kinabukasan, iyong pamilya nila mabigyan nila ng magandang buhay."* (Give those ex-persons deprived of liberty a job opportunity so they can have a better future, they can give their family a good life.)

P50: *"Siguro unang-una nga diyan, dapat sila ay may mga trabaho, trabaho ang dapat ibigay sa kanila para hindi na nila na maisipan na gumawa ng kung ano man na dati nilang ginagawa."* (I guessed the first thing is they should have a job, provide them a job so they don't think about doing what they used to do.)

P160: *"Subaybayan sila na bigyan ng pinansiyal na suporta para makapaghanap-buhay sila nang maayos at hindi na sila bumalik sa dati nilang gawain."* (Monitored them by giving a financial support so they can find proper work and avoid returning to their previous lifestyle.)

DISCUSSION

The results reveal that the community holds a generally neutral perception toward the reintegration of Ex-PDLs. This neutrality reflects a balance between community openness to acceptance and underlying concerns regarding safety and recidivism.

Moreover, the findings reveal that even though the community is willing to provide Ex-PDLs a second chance and accept them during the reintegration process, this willingness is accompanied by an awareness of potential risks in security and the possibility of re-offending among them. The community agrees that the government should extend support through housing and financial assistance programs to aid reintegration. Similar to findings of Applegate et al. (2016), who emphasized that communities are willing to support government housing initiatives for Ex-PDLs. However, despite this general support, most of them still expressed hesitation when it comes to living in close proximity to Ex-PDLs, highlighting discomfort and concern about safety. Only a minority indicated that they would not mind having an Ex-PDL as a neighbor, suggesting that acceptance is often conditional rather than absolute.

Additionally, the community generally disagrees with the idea of labeling the Ex-PDLs as inherently bad individuals or treating them harshly, implying that retributive behavior are not strongly dominant among the respondents. This indicates a more rehabilitative perspective, where individuals are seen as capable of changing. Consistent with the findings of Martinez & Buan (2025), emphasized that individuals have the capacity to transform their behavior, thoughts, and actions when given the opportunity. Contrary to the study of Ikenna et al. (2023) claimed that residents in their study held a strong negative perception, often viewing Ex-PDLs as criminals, incapable to change, or evil individuals. In the present study, however, respondents believe that Ex-PDLs should be given the opportunity to reintegrate positively into society, and that active community involvement can help them become productive members of the community.

On the other hand, the study reveals that the community maintains a neutral perception regarding their willingness to contribute time or financial resources about promoting strict sentencing laws in the Philippines. Similarly, the community remains neutral about whether Ex-PDLs will reoffend if the opportunity arises. This contrasts with the findings of Cohen et al. (2015), which argued that households were willing to donate financial assistance annually to support strengthening sentencing policies, since crime severity increases. Furthermore, the study reveals that there is no significant relationship between the profile of the respondent and community perceptions on reintegration of Ex-PDLs. Factors such as age, sex, civil status, educational attainment, occupation, and length of residency did not significantly influence community attitudes, suggesting that perceptions are relatively consistent across different demographic groups.

Furthermore, it contradicts the findings of Ceylan-Batur (2023) that younger adults (aged 18–24) become more comfortable living near Ex-PDLs compared to older groups. Similarly, Mosser (2022) argued that age plays an important role in shaping perceptions, because individuals become more open to reintegration as they grow older. As Slauson-Blevins and Johnson (2016) noted the lack of significant relationship in terms of sex may be influenced by various contextual factors. The differences in responses based on sex have diminished over time, depending on modes of survey and topics. However, Caeiro et al. (2024) suggested that sex differences are still a factor influencing perceptions, since female respondents often exhibit more cautious attitudes toward reintegration of Ex-PDLs.

Civil status was also found to have no significant relationship with community perceptions, which contrasts the findings of Visser (2025), who argued that married individuals tend to be more cautious while single individuals generally show openness to interact with Ex-PDLs. Similarly, educational attainment showed no significant correlation with perceptions, consistent with the findings of Ayobi et al. (2023), who reported that education level does not necessarily predict support for reintegration. Furthermore, occupation did not significantly influence community perceptions, contradictory to what Visser (2025) suggested that employed individuals are more supportive for reintegration rather than unemployed individuals who may view Ex-PDLs as competitors for limited job opportunities. The length of residency also showed no significant effect, opposing the claims of Caeiro et al. (2024) that long-term residents are often more resistant in accepting Ex-PDLs, while new residents show openness and accepting them.

The qualitative findings offer deeper insights into the community behavior, revealing a mixture of distrust and hope towards the reintegration of Ex-PDLs. Most of the respondents expressed distrust toward Ex-PDLs, particularly regarding the sincerity of their reformation. The community often doubts the genuine behavioral changes of Ex-PDLs, believing that former offenders may still engage in criminal activities. Additionally, there is concern that they may have been negatively influenced by hardened PDLs during incarceration. As stated by Curib et al. (2023), communities often respond to Ex-PDLs with hesitation, doubt, and discrimination. It corroborates by Wertheimer-Meier (2023) that the persistence of the belief that "once a criminal, always a criminal," indicates that stigma still exists even after rehabilitation.

Moreover, study reveals a strong sense of optimism within the community. Respondents believe that punishment serves as a molding point forcing Ex-PDLs to live better lives after reintegration. They emphasized the important role of acceptance, implying that Ex-PDLs should not be permanently defined by their past actions. The idea that Ex-PDLs are still human which deserve dignity and empathy was a recurring theme. Strong community bonds contribute to successful reintegration. Forms of optimism can positively influence reintegration outcomes.

Additionally, the community expressed a willingness to give Ex-PDLs a second chance, considering that opportunities for change are essential for successful reintegration. As claimed by Arreola et al. (2024), many Ex-PDLs view reintegration as an opportunity to transform their lives. However, Feingold (2021) shows contrasting findings, suggesting that stigma and lack of acceptance remain significant barriers. The study also highlights concerns about recidivism among respondents acknowledging that some individuals may still re-offend, specifically if their transformation is not genuine. There is a higher rate of reoffending among negatively labeled Ex-PDLs. The lack of community acceptance further contributes to this issue.

In terms of government initiatives, respondents believe that government efforts are insufficient to rehabilitate the Ex-PDLs, promoting a negative perception. Cabel (2025) emphasized the need for comprehensive reintegration programs to win public trust towards Ex-PDLs. The lack of livelihood opportunities was identified as a contributing factor towards community concern of community regarding recidivism. According to Muasya (2015), improved livelihood programs for Ex-PDLs can build a positive perception towards them.

Furthermore, employment offers a significant factor in shaping both reintegration outcomes and community perceptions. Stable employment is important in reducing recidivism and fostering positive relationships. However, the community believes that effectiveness of these programs depends not only on government support but also on the willingness of Ex-PDLs to utilize them. Additionally, the study underscores the importance of empathy and community support in improving reintegration outcomes. Acceptance and family support can help Ex-PDLs to live a better life (Reamico, 2022). The need for employment opportunities and policy development can foster positive perception towards Ex-PDLs. By addressing these factors, the community and government can work together to support Ex-PDLs in rebuilding their lives and becoming productive members of society to eliminate stigma towards them (Curib et al., 2023; Vivares & Cuevas 2023).

CONCLUSION AND RECOMMENDATION

The community generally shows a neutral perception toward the reintegration of ex-PDLs, expressing willingness to accept and live with them while remaining neutral about potential risks and re-offending. They support housing and financial assistance and believe that opportunities and community involvement promote successful reintegration rather than harsh treatment. However, neutrality remains about stricter sentencing laws, and no significant relationship was found between profile of the respondent and perceptions. Qualitative results reveal mixed views, including distrust, hope for change, and recognition of second chances, alongside concerns about recidivism. The findings emphasize the need for livelihood opportunities, effective government support, and community empathy to improve reintegration outcomes. The researchers recommended the Barangay Caminawit to build a program to maintain or strengthen community acceptance towards Ex-PDLs and encouraged them to implement structured monitoring systems to enhance community safety and reduce the risk of re-offending. Future researchers should explore additional demographic factors that may influence community perceptions of reintegration. Furthermore, the study suggests strengthening community education programs to reduce distrust and highlight the potential for positive change among ex-PDLs. Improving government reintegration efforts through partnerships with public and private sectors is also essential, particularly in providing sustainable livelihood and employment opportunities. Fostering community-based initiatives that encourage empathy and social support, simultaneous with structured assistance programs, can help ensure successful reintegration and minimize recidivism.

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The authors declare no conflict of interest.

DECLARATION OF AI USE

The authors used Grammarly for grammar checking and language editing. All outputs were reviewed and validated by the authors, who take full responsibility for the content.

AUTHOR CRediT STATEMENT

Manzano, M. N.: conceptualization, methodology, investigation, formal analysis, and writing – original draft; **Marcelo, C. M. C.:** conceptualization and writing – review & editing; **Magluyan, A. M. G.:** review and editing; **Francisco, L. K. D.:** formal analysis; **Yutoc, R. E.:** conceptualization; **Quijano, A. J. G.:** review and analysis; **Orsos, V. A. C.:** data curation; **Ordanes, A. M. L. E.:** conceptualization.

NUTRITRACK SABLAYAN: MALNUTRITION CASE MONITORING AND RESPONSE SYSTEM FOR BARANGAYS

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ABSTRACT

Monitoring child malnutrition and managing supplement distribution in local communities rely on paper-based systems that are prone to errors, fragmented data, and delayed interventions. This study focused on designing, developing, and evaluating NutriTrack Sablayan, a secure web-based nutrition management system tailored for the 22 barangays of Sablayan. Built using Agile methodology with Laravel, Vue.js, and MySQL, the platform automates nutritional assessments such as weight-for-age, height-for-age, and BMI-for-age in line with Operation Timbang Plus standards. Its key features include a real-time monitoring dashboard, automated dosage calculators for RUTF, RUSF, micronutrient powders, and a secure portal for Barangay Nutrition Scholars (BNS) to upload health measurements and proof of supplement distribution. Testing confirmed the system's high performance, with reports and data processing completed in under two seconds, alongside strong data security for beneficiary records. The research utilized a descriptive-developmental design, and the system was evaluated by a purposive sample of 30 respondents, including Barangay Nutrition Scholars (BNS), Nutrition Office staff, and IT experts using ISO 25010 standards, received a grand mean score of 4.90, interpreted as "Excellent", reflecting outstanding functionality, usability, and reliability. NutriTrack Sablayan effectively eliminates the limitations of paper-based workflows by providing a centralized, secure, and data-driven platform. The study concludes that the system is a reliable tool for early malnutrition detection and evidence-based decision-making. By providing visual and descriptive analytics, the system empowers health workers to carry out timely, evidence-based interventions, improving the efficiency of malnutrition response and supporting the holistic development of children during the critical "First 1,000 Days."

Keywords: *child, body mass index, malnutrition, micronutrients, nutrition assessment*

SDG: *SDG 2: Zero Hunger, SDG 3: Good Health and Well-Being, SDG 9: Industry, Innovation, and Infrastructure, SDG 10: Reduced Inequalities, SDG 17: Partnerships for the Goals*

INTRODUCTION

Malnutrition is still a major problem in the world today. This is particularly true among children aged less than five years and other vulnerable populations who are malnourished. To curb the situation, various interventions have been put in place globally. These include the use of Ready-to-Use Therapeutic Food (RUTF), Ready-to-Use Supplementary Food (RUSF), and the use of micronutrient powders (World Health Organization, 2023). Although the interventions have been effective in the fight against malnutrition, the challenge of reaching the targeted populations remains a major challenge. This is particularly true in the rural areas where there is no effective and localized system in place.

In some areas, the process of registration of the targeted populations, computation of the correct dosage, and tracking of the distribution process is carried out manually or using unconnected tools such as the use of spreadsheets and the sending of messages. Although the process is a clear indication of the dedication of the workers involved in the process, it is not integrated and thus inefficient. This makes the process more likely to experience problems such as the inaccuracy of the data being recorded, the computation of the wrong dosage, and the misallocation of the resources involved in the process.

In the Philippines, the Electronic Operation Timbang (e-OPT) Plus Tool has been put in place to improve the assessment and management of the nutritional status of the children in the region. Although the tool has been effective in the process of addressing the malnutrition situation in the region, there are various limitations associated with the process. One of the major limitations is the fact that the process is highly dependent on the use of the Microsoft Excel application. This is particularly true in the Philippines where some of the areas in the region may not be well equipped with the necessary technological tools. In other areas, the process can only accommodate data relating to up to 1,000 children. This makes the process less effective in the management of the situation in the region. Another major limitation is the fact that the process does not have the integrated feature of tracking the history of the children and the changes in the nutritional process over the years. This is even though tools such as the Z-Score measurement are widely recognized as being effective in the process of measuring the various indicators such as weight-for-age, height-for-age, and BMI-for-age (Luu et al., 2024).

Moreover, existing systems of nutrition management face general issues in terms of delayed reports, lack of computations, no records of delivery time, and inconsistent distribution documentation (Velando et al., 2024). These issues

emphasize the importance of having a unified, web-based system that could effectively automate crucial processes in nutrition management.

Malnutrition among children continues to be a problem in the Philippines since the country suffers from a “triple burden” of stunting, wasting, and micronutrient deficiency (UNICEF Philippines, 2023). Though the efforts of the government to address the issue through interventions such as the Supplementary Feeding Program continue, the process often falls prey to inefficiencies in distribution and data collection. The lack of achievement in the energy intake of many individuals despite some improvements in nutrient intake is one of the problems that undermine the nation's effort towards achieving nutritional security (Department of Science and Technology - Food and Nutrition Research Institute, 2025). This is because food waste is increasing and affecting this national initiative. In fact, it is in such areas as Sablayan, Occidental Mindoro, where the lack of automation in monitoring leads to inefficiencies in distribution and nutrition assessment (Velando et al., 2024).

In order to fill in the gaps that have been identified in the management of the interventions in the community of Sablayan, the researcher proposed the development of a web-based system that is intended to improve the management of the interventions in the community of Sablayan. This is in the distribution of the RUTF, RUSF, and the micronutrients in the 22 barangays of the community. This is in the knowledge that the community is already connected with Wi-Fi connectivity in each of the barangays.

Moreover, the proposed web-based system is also intended to organize the information of the children who need the nutritional support. In this case, the system is also intended to enable the computation of the dosages of the supplements and the management of the supplements. Additionally, the Barangay Nutrition Scholars (BNS) is also able to upload photos and documents as evidence of the distribution of the interventions in the community.

This study will mainly be intended to develop a web-based system for tracking the distribution of Ready-to-Use Therapeutic Food (RUTF), Ready-to-Use Supplementary Food (RUSF) and micronutrients from Nutrition Office to every Barangays in Sablayan, Occidental Mindoro. Operation Timbang Plus (OPT) used to automatically define the specific type of malnutrition the beneficiary belongs to, no selection needed. The system will help ensure that food supplements are given to the right beneficiaries (to ensure that food supplements are distributed primarily to malnourished children aged 0-59 months, and secondly to beneficiaries aged 59 months and above.), track nutritional status until the beneficiary gets better, and centralize data management to improve the monitoring process at the barangay level and the Nutrition Office.

METHODS

Research Design

This study employed a Design and Development Research (DDR) approach in developing NutriTrack, a web-based nutrition management system designed to monitor the distribution of Ready-to-Use Therapeutic Food (RUTF), Ready-to-Use Supplementary Food (RUSF), and micronutrient powders. The system was designed, developed, tested, and evaluated using ISO/IEC 25010 software quality standards to ensure functionality, usability, security, and performance efficiency.

Research Environment

The study was conducted in collaboration with the Municipal Health Office of Sablayan, Occidental Mindoro, Philippines, covering all 22 barangays. Respondents included 10 Barangay Nutrition Scholars (BNS), 5 Municipal Nutrition Office personnel, 10 child beneficiaries, and 5 IT specialists selected through purposive sampling based on their direct involvement in nutrition program implementation and system evaluation.

System Development and Architecture

The Agile software development methodology was utilized, involving iterative phases of planning, design, development, testing, and implementation. System requirements were identified through consultations with Nutrition Office personnel and BNS. Key system features included beneficiary registration, nutritional status computation based on OPT Plus standards, dosage calculation, inventory monitoring, distribution tracking, and report generation.

NutriTrack was developed using Laravel, Vue.js, Tailwind CSS, and MySQL. The system adopted a centralized and secure web-based architecture with role-based access control and in-app notification features to ensure data privacy and efficient monitoring.

Research Instrument and Data Collection

The study utilized a Technical Performance Checklist and an ISO/IEC 25010-based System Quality Evaluation Survey covering content, organization and design, functionality, technology used, and originality. Responses were measured using a 5-point Likert scale ranging from 1 (“Poor”) to 5 (“Excellent”).

Data collection was conducted after prototype implementation through technical testing and system demonstrations involving BNS personnel, Nutrition Office staff, and IT specialists. Participants evaluated system performance, usability, compatibility, and accuracy using the evaluation instrument.

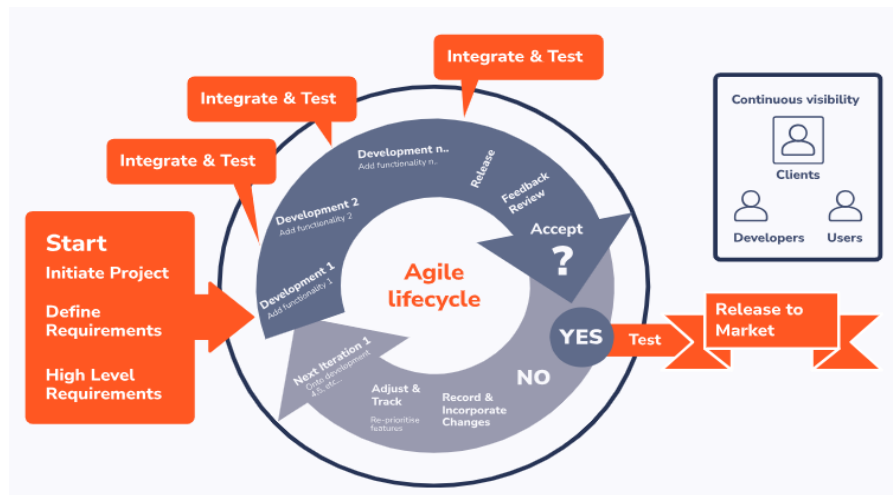


Fig. 1. Software development model.

Data Analysis

Data were encoded in Microsoft Excel and analyzed using descriptive statistics. Weighted mean was used to evaluate software quality based on ISO/IEC 25010 standards, while frequencies, averages, and percentage analysis were utilized to assess technical performance, compatibility, and computational accuracy.

Ethical Consideration

The study complied with Republic Act No. 10173 or the Data Privacy Act of 2012. Informed consent was secured from all participants, and confidential information was protected through encrypted storage and role-based access control.

RESULTS

Project Structure

NutriTrack was created to address challenges in manual nutrition monitoring and distribution of supplements, such as inaccuracies in measuring and recording the height and weight of the children, erroneous nutritional status computation, and ineffective management of RUTF, RUSF, and micronutrients. NutriTrack provides a web-based system with a user-friendly, role-based user interface for both the Nutrition Office administrators and the Barangay Nutrition Scholars (BNS). Both have access permissions customized according to their roles to guarantee confidentiality and security of the system.

Children's height and weight are recorded following Operation Timbang (OPT) Plus standards, and the system automatically calculates nutritional status and recommends supplement dosages. The program automatically makes alerts for low dose cases, and all activities related to the distribution of supplements will be recorded with corresponding date and time of logging. In scalability testing, NutriTrack proved capable of handling the simultaneous use of various roles (admin and BNS) for data entry, beneficiary monitoring, and report generation, without delay. In terms of security, the tests revealed effective protection of sensitive information and overall security of the system for municipal level deployment.

The role-based login screen (Figure 2a) controls access to the system. The navigation interface enables users to go to the OPT Beneficiaries tab (Figure 2b) for registration, entry of measurements, automatic calculation of their nutritional status, and computation of their dosage of supplements. Supplement distribution can be tracked through the Distribution tab (Figure 2c), where users can enter logs, attach documentation or pictures, and see real-time inventory management. Reports generated from all collected information (beneficiary details, nutritional status, dosages, and participation in the program) are provided by the Report Generation module (Figure 2d).

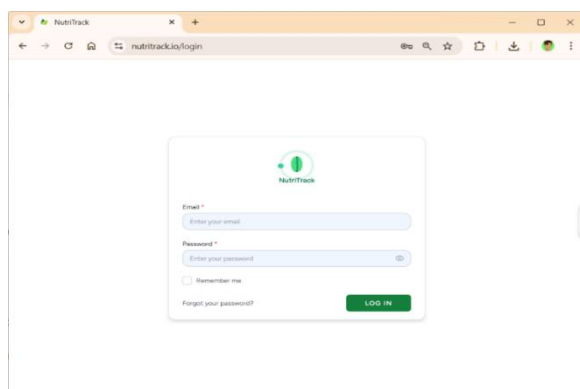


Fig. 2a. NutriTrack's login interface.

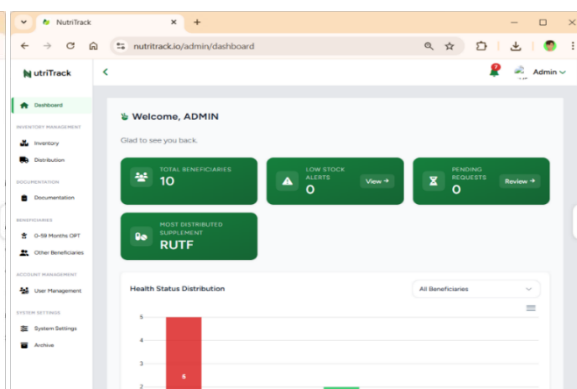


Fig. 2b. NutriTrack's admin dashboard.

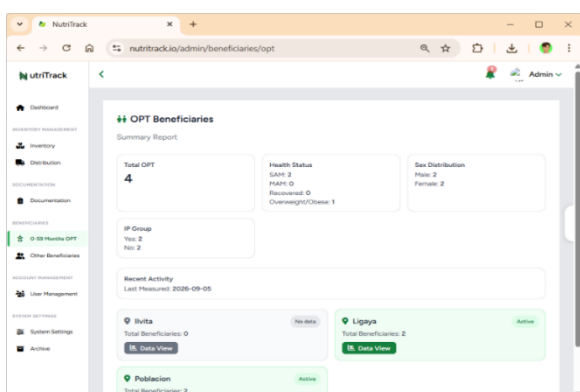


Fig. 2c. NutriTrack's OPT beneficiaries tab.

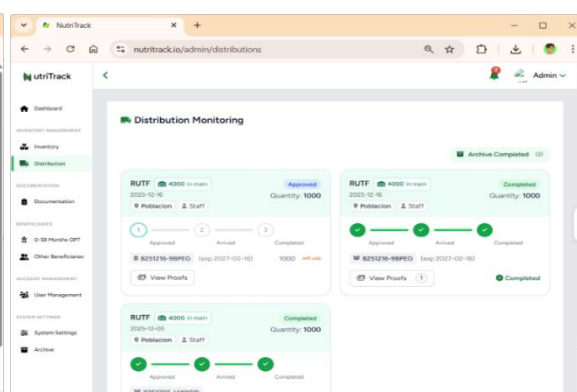


Fig. 2d. NutriTrack's distribution tab.

Project Testing

Technical System Validation

Table 1. Technical System Validation (Black-box & White-box)

Feature	Objective	Findings	Status
Access control	Validate secure multi-user login.	Encryption and role-logic functional.	Passed
Dashboard	Test real-time data visualization.	Queries reflect live database updates.	Passed
Opt+ assessment	Verify nutritional status logic.	Auto-calculations match OPT+ standards.	Passed
Dosage calculator	Check RUTF/RUSF/MNP precision.	Logic produces accurate dosage outputs.	Passed
Field portal	Validate data encoding/storage.	SQL entry and form validation successful.	Passed
Reporting engine	Test automated data aggregation.	Reports generate accurate longitudinal data.	Passed
Account mgmt.	Verify CRUD/Account recovery.	User management operations work correctly.	Passed
In-app notif.	Confirm internal alert delivery.	Alerts push to Admin/Staff/BNS interfaces.	Passed

NutriTrack Sablayan underwent thorough technical validation through a combination of Black-box and White-box testing. Black-box testing involved verifying that all functions in the front end, including the BNS Field Portal and the Real-time Dashboard, functioned as expected and produced correct outputs in response to inputs, especially when performing automated nutritional assessments. In addition, White-box testing ensured that the internal workings were sound and performed as intended, such as the Laravel programming used for dose calculation and the procedures used for authenticating and controlling access to data in the MySQL database. According to the validation results, the system correctly classifies malnutrition cases and generates appropriate "Low Dose" alerts with no errors, as well as ensuring

proper data flow within the MySQL database. In conclusion, the technical validation results show that the NutriTrack Sablayan system meets the technical requirements with a 100% "Passed" rating.

System Performance Validation

NutriTrack performed effectively and consistently when tested on a 15-inch 1920×1080 resolution laptop with a Windows 11 operating system. Specifically, the time needed for the application to respond optimally was 0.70–1.10 seconds for logins, 1.20–1.80 seconds for beneficiary registration and health data input, 1.00–1.50 seconds for calculating the nutritional condition and recommending appropriate dosage, and 1.20–1.70 seconds for reporting. These functionalities enabled the system to perform optimally for the administrators as well as BNS. Automated calculations of nutritional needs and dosage alerts were double checked against OPT Plus, which showed that the system gave an accurate estimate of 98.5%. The system was tested using Chrome, Firefox, and Edge, and the one that proved most effective was Chrome. Differences in the interface appearance between these three web browsers were minimal at best. The system was tested for responsiveness on a scale of 90%–125% and even worked well on external screens that were bigger than the monitor. The use of NutriTrack by five users simultaneously proved that it could handle concurrent sessions.

Table 2. System Performance and Accuracy Test Results

Performance Metric	Test Environment	Speed / Accuracy Result	Status
Login session	Win 11, 1920×1080	0.70 – 1.10 seconds	Passed
Data and health entry	Win 11, 1920×1080	1.20 – 1.80 seconds	Passed
Nutri-status and dosage calculation	Win 11, 1920×1080	1.00 – 1.50 seconds	Passed
Report generation	Win 11, 1920×1080	1.20 – 1.70 seconds	Passed
Calculation accuracy	Compared vs. OPT Plus	98.5% accuracy	Passed
Browser responsiveness	Chrome, Firefox, Edge	Highly responsive (chrome optimal)	Passed
Scaling and zoom	90% – 125% Criteria	Adaptive layout maintained	Passed
External display	Extended monitor	Full compatibility / No distortion	Passed

Project Evaluation

For the evaluation phase of this research project, purposive sampling technique was employed to identify the respondents that were significant in the validation process. The respondents include ten (10) Barangay Nutrition Scholars, five (5) members from Municipal Nutrition Office, ten (10) child beneficiaries, and five (5) Information Technology experts who witnessed the demonstration of the system and completed the questionnaire that evaluated several elements of the web-based application.

Based on the Likert five-point scale, it was determined that the system performs extremely well. The mean scores for different components ranged between 4.90 and 4.95, which corresponds to an "Excellent" rating. To be more precise, as follows from Table 2, Content obtained the highest score 4.95 ("Excellent"), Organization and Design 4.85 ("Excellent"), Functionality 4.86 ("Excellent"), Technology Used 4.90 ("Excellent"), and Originality 4.92 ("Excellent"). Thus, users consider the application very relevant, extremely easy to use, innovative, and especially appreciate its safe systematic management of information about nutrition programs and automatic dosage calculation.

As for minor changes to NutriTrack's design that might be necessary, the participants thought that small alterations to the interface will help make the system even better. Thus, the findings of the research prove the effectiveness of the system as a monitoring application to track malnutrition cases and supplement distribution among the barangays of Sablayan.

Table 3: Quantitative interpretation of respondent's rating of NutriTrack Sablayan:
Malnutrition Case Monitoring and Response System for Barangays

Criteria	Overall Mean	Descriptive Rating
Content	4.95	Excellent
Organization and design	4.85	Excellent
Functionality	4.86	Excellent
Technology used	4.90	Excellent
Originality	4.92	Excellent
Grand Mean	4.90	Excellent

DISCUSSION

NutriTrack Sablayan that was created to replace manual nutrition monitoring and supplements distribution procedures at the Municipal Nutrition Office turned out to be successful in addressing the longstanding problems of incorrect identification of malnutrition types and inventory accounting. First, NutriTrack implemented the web-based procedure instead of using outdated paper records and WHO-CGS reference charts manually. Moreover, it used OPT Plus logic that helped to overcome another problem: the need to coordinate the activities of the Nutrition Office and BNS more effectively. Thus, it is clear that the system achieved its primary objective. Indeed, it is possible to state that the findings support the notion that NutriTrack Sablayan represents a useful platform that makes it possible to address the shortcomings of traditional manual processes in nutrition monitoring. In particular, the ability to track height, weight, and dosages of nutritional supplements using digital technology helps BNS make their work more accurate. It is consistent with the findings of Kuponiyi and Akomolafe (2025), according to whom the process of digitalization of health care is crucial in developing countries due to many reasons.

The automated nutrition assessments from systems based on OPT Plus standards ensure consistent assessments for the growth of children. This systematic process is necessary to detect cases of malnutrition and to implement the "First 1,000 Days" strategy advocated by Cusick and Georgieff (2016), according to which nutrition in the first thousand days plays an important role for the formation of the brain. Using visual analytics to determine children at risk reflects the results of the research conducted by Foster and Siddle (2019), in which the usefulness of such analytics was pointed out to alert at-risk individuals. It should be noted that traditional processes of recording information and its verification visually in different industries were identified as ineffective due to a high probability of errors. For example, nursing care in hospitals suffers from lengthy and unreliable documentation leading to penalties for employees (Ball & McBeth, 2021). For this reason, automated technologies are becoming widespread in various industries; medication management also employs automated systems that use deep learning, having shown high efficiency (Chiu, 2024).

System testing across multiple platforms and devices serves as the essential method to achieve proper performance results in local government environments. Test results are affected by screen size and resolution because high-resolution displays with greater dimensions enable better verbal performance (Bridgeman et al., 2021). The technical implementation of Laravel and Vue.js frameworks succeeded because they enabled developers to create systems that could handle complex nutrition data with stable performance and quick response times. According to Popa and Buciu (2025), this framework selection enables developers to build secure web applications that deliver high performance while processing real-time data. Windows 11 has demonstrated better performance capabilities in multi-core systems through its enhanced ability to distribute processing tasks across different processors (Putra et al., 2025). The study results demonstrate that testing needs to be performed on different system setups because it plays a critical role in achieving maximum system efficiency.

Recent scholarship has documented a transformative trend in the digitization of grassroots governance across the Philippines. The e-BMS (Electronic Barangay Management System) proved its success through its transition from manual record-keeping to digital database systems which enhanced both data access times and operational visibility according to Sarmiento and his colleagues in 2023. Local public health systems achieve reduced diagnostic mistakes when Decision Support Systems (DSS) use logic-based real-time healthcare guidelines to assist health professionals (Sopruchi & Rashid, 2024). Health monitoring systems in local communities, which include the Barangay Health Information System (BHIS), achieve high user acceptance and successful operation according to evaluation results. The work of Reyna (2023) demonstrates that modern web technologies effectively improve patient profiling and information management at the community level through the design and development of a BHIS system. The systems achieved high functional suitability ratings which match NutriTrack's "Excellent" evaluation score to prove that Sablayan should transition from manual workflows to automated systems as the essential modernization step for its municipal nutrition programs.

The implementation of biometric systems together with health systems in public safety operations generates serious privacy issues and ethical dilemmas. Privacy by Design principles create system functions that protect user privacy (Cavoukian et al., 2022). The healthcare sector uses Privacy-Preserving Distributed Analytics to handle ethical dilemmas which arise in Health Information Management Systems (Rahman et al., 2024). Researchers are currently developing secure techniques which meet privacy requirements for automatic recognition systems through their work on template protection and standardization (Campisi, 2013). The approaches establish a framework which enables technological development while protecting individual privacy rights across all industries.

In general, the research was successful because it designed and tested a system which operates successfully from technical, ethical, and practical performance perspectives to monitor malnutrition. The Nutrition Office system gains greater operational capabilities through its automated OPT Plus logic system which tracks inventory in real-time while providing secure access to authorized users. The NutriTrack system testing results show that the system can operate effectively in municipal nutrition programs because of its ability to scale and adapt to different operational requirements. The technology and innovation ratings of 4.90 demonstrate that the system has potential for use in other local government

units. The system delivers both research results and a practical framework which helps communities develop their health resilience while attaining better nutritional results.

CONCLUSION AND RECOMMENDATION

NutriTrack Sablayan shows how its development and testing processes resulted in a successful fulfillment of the main objective to create a web-based tool for tracking malnutrition cases and managing the distribution of supplements among Sablayan barangays. It is possible to overcome the shortcomings of paper-based solutions and introduce innovative technologies into the daily operations of Barangay Nutrition Scholars (BNS) and their supervisors. The introduction of advanced algorithms for assessing the weight-to-height ratio, weight-to-age index, height-to-age ratio, and BMI makes it easy to estimate the amounts needed of supplements, which is why health care providers are likely to achieve more accurate results than before. Furthermore, the system facilitates the work of the health care providers by presenting the data gathered in charts and tables, thus making all analyses simple to understand.

The main strength of the developed application lies in the ability to meet all the criteria of Operation Timbang (OPT) Plus. It can identify cases of malnutrition within a short period by calculating the weight-for-age and height-for-age indices as well as BMI-for-age. All obtained results become easily readable when presented in a clear format that includes charts, graphs, and statistics. The test results showed that the proposed solution was effective as it scored 4.90 out of 5 points, which proves its reliable functioning and accurate operation.

Future improvements will include the creation of a mobile application with the capability to operate in offline mode, which is crucial for health care providers who live far away from internet services. It will be vital to implement an SMS notification system that will automatically send messages to parents regarding their visits and the distribution schedule of supplements. There are two areas that future research will have to cover, including the use of predictive analytics for malnutrition trend forecasting and the creation of Application Programming Interface (APIs) to exchange data with the National Nutrition Council (NNC).

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DECLARATION OF CONFLICT OF INTEREST

The authors declare no conflict of interest.

DECLARATION OF AI USE

The authors used Grammarly for grammar checking and language editing. All outputs were reviewed and validated by the authors, who take full responsibility for the content.

AUTHOR CRediT STATEMENT

Ordenes, C.A.: conceptualization, methodology, software, validation, formal analysis, investigation, resources, data curation, writing - original draft, writing-review & editing, visualization, supervision, project administration, supervision, funding acquisition; **Almazan, K.M.G.:** conceptualization, software, validation, formal analysis, investigation, resources, data curation, writing - original draft, writing-review & editing, visualization, project administration, supervision, funding acquisition; **Cudiamat, J.:** validation, formal analysis, investigation, resources, writing - original draft, writing-review & editing, visualization, project administration, funding acquisition; **Daguyos, L.F.V.:** validation, formal analysis, investigation, resources, writing-review & editing, visualization, funding acquisition; **Zabanal, S.M.:** validation, formal analysis, investigation, resources, writing - original draft, writing-review & editing, visualization, project administration, supervision, funding acquisition; **Dimasaca, K.J.C.:** validation, formal analysis, investigation, resources, writing-review & editing, visualization, funding acquisition; **Mamalayan, E.C.:** conceptualization, methodology, validation, writing-review & editing, visualization, supervision.

ASSESSING THE CHALLENGES AND IMPLEMENTATION OF CORPORATE SOCIAL RESPONSIBILITY (CSR) PRACTICES OF HOTELS AND RESORTS IN OCCIDENTAL MINDORO

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ABSTRACT

The research assessed the challenges and the implementation of Corporate Social Responsibility (CSR) practices in Occidental Mindoro's hotels and resorts. One of the main goals was to recognize the obstacles that the management had to deal with regarding the areas of awareness and knowledge, government support, and financial resources; another goal was to ascertain the degree of CSR application in all aspects environmental, philanthropic, economic, and ethical; and lastly, to study the correlation between these variables. A descriptive-correlational quantitative design was employed for the study, and the data were gathered from a total of eighty-three (83) hotel and resort managers through a validated questionnaire and were subsequently analyzed using mean, standard deviation, and Pearson correlation. Findings showed that the lack of government support was the main challenge ($\text{mean}=3.25\pm1.10$), while a lack of awareness, knowledge, and financial resources created difficulties of moderate level. Despite the above constraints, CSR implementation was rated high ($\text{mean}=3.93\pm.78$) especially in the areas of ethical and economic. Results did not suggest any significant relationship between most of the challenges and CSR implementation which means that hotels and resorts have continued CSR initiatives despite the limitations. Conversely, the study revealed a strong connection between government support and ethical labor practices. The KAMPILAN Action Plan was presented by the researchers with the goal of enhancing CSR-awareness, solidifying cooperation between the stakeholders, and increasing sustainable tourism in Occidental Mindoro to close the gaps.

Keywords: *corporate social responsibility, KAMPILAN, hospitality industry, hotels, resorts sustainable tourism*

SDG: *SDG 8 - Decent work and economic growth, SDG 11 - Sustainable cities and communities, SDG 12 - Responsible consumption and production, SDG 13 - Climate change, SDG 17 - Partnerships for the Goals*

INTRODUCTION

The hospitality industry, which mainly composed of hotels, resorts, lodges, restaurant, and travel services, was a major player in the global economic growth. However, its fast expansion brought with it various environmental and social issues, for example, the overuse of water and energy, the rising of waste, and the pressure of the host communities (Guzzo et al., 2020; Dragin et al., 2022). The rapid development of tourism over the last decades has deepened these problems and pointed out the necessity of more responsible business practices in the sector. Academics have considered Corporate Social Responsibility (CSR) as a pivotal tool through which hospitality and tourism units can integrate morally correct labor practices, local community involvement, and environmental conservation (Achmad & Yulianah, 2022; Mijatov et al., 2022).

In the Philippine context, CSR was now a mandatory activity in law by the Senate Bill No. 1239 called "The Corporate Social Responsibility Act", which obliged businesses to implement CSR initiatives. Moreover, CSR corresponded to the Sustainable Development Goals (SDGs), which facilitates social welfare and solving global issues. Furthermore, the tourism and hospitality industry in the Philippines has been growing rapidly, leading to a higher demand for hotels and resorts to implement environmentally friendly, socially responsible and morally upright practices through Corporate Social Responsibility (CSR). Biadora et al., (2024) observed that the growth of the industry had intensified the call for establishments to become contributors to the welfare of the community and the protection of nature. Nevertheless, as a new tourism destination, CSR activities in Occidental Mindoro have only been slowly developed and infrequently implemented. The LGU Tourism Office mentioned that while the local tourism program was full of CSR-related activities, the individual hotels and resorts hardly had any direct initiatives, most probably due to their limited awareness, lack of resources and insufficient technical support. As it was described by Alizadeh (2022), stated that organizations could not invest in CSR activities until they were stable financially, while Krishna (2024) and Khodaviren & Dhar-Bhattacharjee (2024), stated that the limited government support and high cost of CSR-related initiatives. The adoption of CSR took time, skill and investment, which may not be accompanied by direct financial benefits. Also, other issues like poor governmental support, limited funds, incompetence and unaffordability of sustainable products remain to discourage hotels and resorts from engaging in socially responsible activities.

Previous research reported the use of Corporate Social Responsibility (CSR) practices across different regions of the Philippines, showing both the achievements and the problems that still exist. Resorts in CALABARZON took CSR measures that are mainly geared towards environmental conservation, community engagement and compliance with legal regulation, thus, showing how tourism establishments can be a source of sustainable development (Borbon, 2020). Similarly, hotels in the Ilocos Region have initiated CSR scheme that covered various areas such as environmental management, community development, marketplace ethics, and workplace welfare, thus enabling these establishments to improve their image, gain more solid stakeholder relations, and at the same time, practice responsible tourism (Bolong & Felicen, 2022). In addition, the case of Hilton Manila and other major hospitality chains was not different as they too documented extensive CSR programs that included waste-reduction campaigns such as "No Plastic by 2030". The Hilton Manila chains is also the author of one significant practice in the journal article by Achmad and Yulianah (2022), the so called "Earth Guest Program" this program also had a powerful social aspect in the context of its ecological oriented efforts according to the ECO-Pro framework in order to conserve the natural resources and improve the general welfare of populations.

Despite an increased interest in Corporate Social Responsibility (CSR), the concept was fraught with numerous barriers impeding its becoming part of the business processes in the industries (Mahmood et al., 2021). This study focused on Occidental Mindoro, a developing tourism destination where the CSR practices of hotels and resorts were minimally implemented. The study aimed to assess the extent of CSR implementation, identify the challenges and barriers faced by local establishments, and finally to find out how to infiltrate more CSR and eco-friendly practices in the province. This study investigated the application of CSR implementation in an emerging tourism context, providing localized insights that could help industry stakeholders and policymakers strengthen sustainable tourism development and support community welfare.

METHODS

Research Design

The study was conducted using a descriptive-correlational research method to determine the problems and implementation of CSR practices among hotels and resorts in Occidental Mindoro. The descriptive aspect sought to point out and shed light on some of the difficulties faced by the management, such as low awareness, little or no government backing, and lack of funds. Besides, the research investigated the degree of the connection among hotels in relation to CSR practices across the environmental, philanthropic, economic, and ethical dimensions. It formed a correlational design that aimed at determining a significant correlation between the challenges and CSR practices that were identified and provided insights into the improvement of socially responsible and sustainable practices in the province.

Study Site

This study was conducted in the Province of Occidental Mindoro during the First Semester of the Academic Year 2024–2025. The province was particularly chosen due to limited CSR awareness and implementation in its hotel and resort industry, which hindered sustainable tourism development and prevented the region from fully benefiting from CSR practices. (Occidental Mindoro was situated along the western part of the island, located south of the province of Batangas in Southern Luzon). The towns of Looc and Lubang were excluded from this study due to challenges related to their geographic location and accessibility, which might have impacted the data collection process.

Sample

The unit of research sampling in the study was on the management of hotels and resorts located in the province of Occidental Mindoro excluding the towns of Looc and Lubang. According to the data given by the Provincial Tourism Office of Occidental Mindoro, there were a total of 104 hotels and resorts in the province without considering the data of Looc and Lubang. Calculation of the sample size performed as Raosoft showed that a sample size of 83 respondents and above was needed to have 95% level of confidence with the actual value within the $\pm 5\%$ of the value surveyed given a population size of 104 and population proportion of 50. Purposive sampling helped the researcher in selecting the hotel and resort managers who oversaw CSR related decisions. To establish the respondents who were qualified, appropriate, and fit to participate in the research, a qualifier question that addressed their managerial experience was applied in terms of their years of experience.

Research Instrument

A structured questionnaire was used in the study to evaluate both the challenges and implementation of Corporate Social Responsibility (CSR). The pilot test of the instrument demonstrated a high degree of reliability based on Cronbach Alpha and all dimensions had acceptable scores, which was a good internal consistency. The questionnaire was divided into three parts: (1) the qualifier questions to make sure that respondents should possess a relevant managerial experience, (2) the items of CSR challenges which included lack of awareness, government support, and financial constraints, and (3) the measurement of CSR implementation on environmental, philanthropic, economic and ethical levels.

Responses were collected using a Likert scale (1-Strongly Agree to 5-Strongly Disagree) that allowed the statistical analysis of patterns and the levels of CSR awareness and practices. Altogether, the tool was well-designed, validated, and suitable to analyze the CSR implementation in hotels and resorts.

Data Collection

The researchers sought permission and approval to collect data to the hotel and resort management. Furthermore, the respondents were informed of the purpose of the research through a formal letter that had been signed and approved by the Research Adviser and brought to the attention of the Program Head of the School of Hospitality Management regarding the research questionnaires. In conveniently accessible places, data were collected through face-to-face methods, so that all information given was kept confidential and was used solely in this study. Questionnaires that were completed were encoded and checked regarding accuracy and completeness.

Ethical Consideration

The research was conducted in strict adherence to rights, privacy and dignity of participants in compliance with the Data Privacy Act (RA 10173). Data collection was carried out with informed consent whereby the participants were made to be aware of the purpose of the study, their voluntary participation and their right to withdraw at any given time. Confidentiality and anonymity were maintained by coding or removing identifying information. No data was shared without consent, and it was only used as intended. High security was enforced, such as limited access, physical and electronic data storage and disposal. The researchers held accountability, transparency, and ethical management of data in the study.

Data Analysis

The research information was structured and quantified through statistical software, which is SPSS. Descriptive statistics like Mean and Standard Deviation were applied in the evaluation of the impact of difficulties in execution of CSR practices in Occidental Mindoro hotels and resorts. The characteristics of this study involved the Pearson correlation method to study the influence between the challenges and CSR implementation practices by hotel management in applying CSR practices in hotels and resorts in Occidental Mindoro.

RESULTS

Challenges faced by hotels and resorts management

Table 1 revealed that the hotels and resorts operating in Occidental Mindoro had to deal with moderate difficulties in the realization of Corporate Social Responsibility (CSR) practices, as their average score was 3.06 and the standard deviation .88. Governmental support was listed as the major challenge (mean=3.25±1.10). This was followed by awareness and knowledge in CSR with (mean=3.12±1.04), while the last position belonged to financial resources (mean=2.83 ±.93).

Table 1. Challenges faced by hotels and resorts management in implementing CSR practices.

Challenges faced by hotels and resorts management	Mean	SD
Awareness and Knowledge	3.12	1.04
1. Hotels and resorts have insufficient information about CSR initiatives relevant to the hospitality industry.	3.18	1.32
2. Hotels and resorts are lacking of skills and knowledge needed to create effective CSR programs.	3.21	1.21
3. Hotels and resorts do not include CSR-related information in their employee orientation programs.	3.18	1.16
4. Hotels and resorts lack an understanding of the long-term advantages of adopting CSR strategies.	3.01	1.14
5. Hotels and resorts management is unaware of the potential risks of not adopting CSR practices.	3.00	1.24
Governmental Support	3.25	1.10
1. Government does not provide clear guidelines and support for implementing CSR practices, such as policies that encourage sustainable tourism or environmental protection.	3.30	1.30
2. The government does not support the hotels and resorts industry in adopting CSR strategies, like offering tax breaks or funding opportunities for green initiatives.	3.29	1.23
3. Government does not actively promote awareness of CSR benefits in the hospitality industry.	3.20	1.25
4. There is no monitoring or accountability from the government to ensure hotels adhere to CSR standards.	3.17	1.25

5. Government does not appropriately address the unique challenges of rural or small-scale hotels in implementing CSR. 3.27 1.22

Financial Resources 2.83 .93

1. Hotels and resorts do not have enough support in terms of human resources, like dedicated staff or volunteers, to help implement CSR activities effectively. 2.61 1.13
2. Hotels and resorts have no budget allocation for CSR - related staff training or workshops. 2.93 1.17
3. Hotels and resorts cannot afford the technology upgrades necessary for eco-friendly operations. 2.75 1.26
4. Hotels and resorts are unable to measure the financial returns of CSR activities, making justification difficult for future investments. 2.95 1.15
5. Hotels and resorts cannot balance profitability with CSR activities due to tight operational budgets. 2.92 1.16

Weighted Mean 3.06 .88

Legend: 1.00 – 1.49 = Very Low, 1.50 – 2.49 = Low, 2.50-3.49 = Moderate, 3.50 – 4.49 = High, 4.50-5.00 = Very high

Implementation of Corporate Social Responsibility (CSR) of hotels and resorts.

The implementation of CSR practices in the hospitality sector of Occidental Mindoro has been rated high despite being a challenge, with an overall mean of 3.93 and standard deviation of .78. The ethical dimension of CSR was given the most weight (mean=4.33±.93). The economic dimension also got a high score (mean=3.87±.89). The environmental dimension was not far behind (mean=3.85±.91). The philanthropic dimension was, nevertheless, the least of the four but still earned a nice rating (mean=3.66±.82).

Table 2. Implementation of Corporate Social Responsibility (CSR) of hotels and resorts.

Implementation of Corporate Social Responsibility (CSR)	Mean	SD
Environmental Aspect	3.85	.91
1. Hotels and resorts encourage guests to participate in energy-saving practices, such as turning off lights or air conditioning when leaving their rooms.	3.92	1.12
2. Hotels and resorts actively engage in local environmental awareness campaigns, such as beach cleanups or wildlife protection initiatives.	3.94	1.14
3. Hotels and resorts have implemented water conservation measures, such as using low-flow faucets and efficient irrigation systems.	3.88	1.08
4. Hotels and resorts reduce food waste by promoting sustainable practices in their kitchens, such as composting or donating surplus food.	3.93	1.19
5. Hotels and resorts have implemented a paperless system or use recycled paper in their operations to minimize deforestation and waste production.	3.58	1.15
Philanthropic Aspect	3.66	.82
1. Hotels and Resorts and resorts provide substantial support to community programs that benefit local residents.	3.93	.94
2. Hotels and resorts have established a volunteer program for community service and charitable activities.	3.75	.99
3. Hotels and resorts operate a foundation that promotes learning and educational opportunities for the community.	3.46	1.15
4. Hotels and resorts donate a percentage of their annual profits to local charities or community development programs.	3.54	1.02
5. Hotels and resorts organize annual charity events, such as fundraising dinners or marathons, where the proceeds are donated to local hospitals, schools, or community centers.	3.62	1.07
Economic Aspect	3.87	.89
1. Hotels and resorts actively support local businesses by sourcing products and services from them.	4.13	1.04
2. Hotels and resorts conduct regular assessments of its economic impact on the local community	3.61	1.05
3. Hotels and resorts support small local businesses by offering them opportunities to showcase their products or services to guests.	3.99	1.01

4. Hotels and resorts offer part-time job opportunities to local residents, helping them earn an income while balancing other commitments such as studies or family care.	3.86	1.20
5. Hotels and resorts contribute to local job training and skills development programs to ensure a sustainable workforce in the area.	3.79	1.19
Ethical Aspect	4.33	.93
1. Hotels and resorts management ensure that workers have a safe and healthy work environment.	4.36	1.03
2. Hotels and resorts management compensate employees with competitive salaries.	4.26	.96
3. Hotels and resort management implement data privacy to both employees and guests.	4.40	1.01
4. Hotels and resorts management make sure that their advertisements and promotions are truthful and not misleading.	4.27	.99
5. Hotels and resorts management handles customer complaints and concerns in a fair and ethical manner.	4.36	1.07
Weighted Mean	3.93	.78

Legend: 1.00 – 1.49 =Very Low, 1.50 – 2.49 = Low, 2.50-3.49 = Moderate, 3.50 – 4.49 = High, 4.50-5.00 = Very high

Relationship between challenges and implementation of CSR in Hotels and Resorts

In table 3, the correlation between challenges and the implementation of CSR in the hotel and resort industry of Occidental Mindoro is presented. Most of the challenges do not significantly affect the implementation of the CSR practice (r-coefficient = .011, p-value = .923), thus implying no significant relationship. In contrast, there is a strong positive correlation (r-coefficient = 0.244, p-value= 0.025) between government support and ethical implementation of CSR.

Table 3. Relationship between challenges and implementation of CSR in Hotels and Resorts

Challenges Faced in Implementing CSR	Implementation of CSR Practices	Correlation Coefficient	Significance	Interpretation
Awareness and knowledge	Environmental	-.111	.315	Not Significant
	Philanthropic	-.071	.524	Not Significant
	Economic	-.024	.262	Not Significant
	Ethical	.052	.640	Not Significant
Governmental support	Environmental	-.007	.952	Not Significant
	Philanthropic	.007	.949	Not Significant
	Economic	.026	.815	Not Significant
	Ethical	.244	.025	Significant
Financial resources	Environmental	-.091	.411	Not Significant
	Philanthropic	-.060	.585	Not Significant
	Economic	.044	.690	Not Significant
	Ethical	.150	.173	Not Significant
	Overall	.011	.923	Not Significant

p-value < 0.5 = Significant

DISCUSSION

The challenges faced by hotels and resorts in adoption of Corporate Social Responsibility (CSR) are moderate with the governmental support coming out as the biggest hurdle, then awareness and knowledge and lastly the financial resources. This implies that the obstacles to CSR implementation are more institutional and organizational than financial. The deficiency in knowledge and skills of the hotel staff means that CSR is not yet a fully implemented part of the operational strategies. This confirms the conclusion of Oh et al. (2021) who have found out that employee lack of knowledge in CSR decreases participation and efficiency of the CSR programs. On the same note, Tokro (2024) noted that lack of training leads to fragmented and informal ways of CSR. These results suggest that enhancing the internal capacity by education and training becomes critical to the reinforcement of CSR implementation. The presence of governmental support as the main obstacle reveals the relevance of the policy orientation, incentives and institutional support in terms of CSR adoption. Lack of clear guidelines and support mechanisms implies that hotels might not be able to match their initiatives with overall sustainability objectives. This observation aligns with Mahmood et al. (2021), who observed that vague instructions and poor institutional frameworks are barriers to integrating CSR into the tourism processes. Similarly, Borbon (2020) noted that

even though the government encourages the use of CSR, there is insufficient training and monitoring systems, which restrict its use at local levels. This means that it is important to enhance the cooperation between government agencies and the hospitality industry so that the practices of CSR are more organized and regular. Financially, the outcomes suggest that financial constraints are present, however, they are not the most pressing. Rather, it is difficult to spend resources and measure the results of CSR. This observation corresponds with Khatter (2025), who cited budget limitations and challenges in measuring the CSR impact as some of the major challenges in the hospitality sector. In addition, Khodaviren and Dhar-Bhattacharjee (2024) noted that even small and medium-sized hotels might have limited resources, but it is possible to promote CSR by being strategic and focusing on partnerships. This implies that CSR can be implemented even in the situation of limited financial resources as long as resources are utilized effectively.

Despite these challenges, the study reveals a high level of CSR implementation, particularly in ethical and economic aspects. This implies that even when limited, hotels and resorts can engage in being responsible. The high score in ethical practices implies that a legal framework and labor standards are very influential in promoting CSR adoption. Ethical CSR, like employee welfare and data privacy, is a way of the industry to demonstrate that it keeps trust and is accountable. This gives credence to the idea that CSR in hospitality is regularly based on regulatory compliance and operational responsibility, as opposed to voluntary initiatives. Additionally, it is revealed that environmental and philanthropic practices are also common but some of the activities are not a priority like the adoption of advanced technologies in sustainability. This indicates that hotels focus more on visible and community-based CSR, which is easier to carry out and can directly impact stakeholders. This is in line with the fact that CSR activities in the hospitality industry are usually integrated into day-to-day activities and are not in any way planned programs. Although positive, such practices can be rather short-term in terms of strategy and their results can be measured.

The correlation analysis further reveals that there is no significant relationship between the challenges faced and the level of CSR implementation. This means that the hotels and resorts can still undertake CSR activities without sustaining severe challenges. This observation implies that management commitment, organizational culture, and stakeholder expectations could be internal forces that could significantly influence adoption of CSR as opposed to external constraints. This aligns with the arguments by Uyar et al. (2020), who stated that the implementation of CSR does not necessarily rely on the perceived challenges but on organizational priorities and values. Nevertheless, the notable correlation between governmental support and ethical practices shows that institutional support is still relevant especially in the assurance of compliance-based CSR initiatives.

This study has limitations such as cross-sectional and a narrow scope of geography, which could limit the generalizability of the results. Response bias can also be brought about by the use of self-reported data. Future studies can be done on additional determinants of the CSR implementation like organizational culture, leadership and stakeholders' engagement and can also be done in other areas or longitudinally to enhance the understanding of the long-term effects of the CSR practices.

CONCLUSIONS AND RECOMMENDATION

The research indicates that hotels and resorts in Occidental Mindoro have moderate difficulties in adopting Corporate Social Responsibility (CSR), governmental support being the most notable obstacle because of the absence of guidelines, policies and incentives. Regardless of these difficulties, the findings indicate that the establishments have a moderate rate of CSR application with the ethical element being the most regularly enforced especially in the provision of employee welfare, data privacy, fair pay, and transparency. The results also show that the level of CSR implementation is not significantly linked to the difficulties encountered, which implies that hotels and resorts can continue to practice CSRs without having to cease activities due to current limitations. Nonetheless, the correlation between governmental support and ethical CSR practices was significant, which makes institutional support an important factor in enhancing compliance-based initiatives.

This research paper suggests that closer cooperation between hotels and resorts, government agencies, educational institutions, and community organizations should be used to improve the implementation of CSR. The clear and localized CSR guidelines, incentive programs, and capacity building initiatives arranged by the agencies like LGUs, DENR, and TESDA are needed. Hotels and resorts are urged to incorporate CSR in their day-to-day activities by enacting feasible programs like environmental conservation, community participation, and sourcing locally. Additionally, accountability and continuous improvement can be encouraged by the creation of a monitoring and evaluation system of CSR activities and recognition programs. To further enhance CSR practices in the hospitality industry, future studies could examine other variables affecting the implementation of CSR including organization culture and leadership.

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The authors declare no conflict of interest.

DECLARATION OF AI USE

The authors declare that QuillBot was utilized solely for language editing and paraphrasing purposes in the preparation of this manuscript. All generated outputs were thoroughly reviewed, verified, and revised as necessary by the authors, who assume full responsibility for the accuracy and integrity of the content.

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GROWTH AND YIELD PERFORMANCE OF SELECTED SOYBEAN (GLYCINE MAX) VARIETIES WITH DIFFERENT TILLAGE SYSTEMS UNDER OCCIDENTAL MINDORO CONDITION

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ABSTRACT

This study evaluated the growth and yield performance of soybean (*Glycine max* L.) under different tillage systems and varieties in the agroclimatic conditions of Occidental Mindoro. The research was conducted from January to May 2025 at the Vegetable Production Project of the Occidental Mindoro State College, Murtha Campus, San Jose, Occidental Mindoro. The study employed a 3 x 3 split-plot design within a randomized complete block design (RCBD). The two factors were: Factor A (Tillage System: A1-Conventional, A2-Minimum, and A3-No-tillage) and Factor B (Variety: Tiwala 6, Tiwala 14, and Manchuria). Results showed that the tillage system had no significant effect ($p > 0.05$) on growth parameters such as plant height, number of leaves, and branches. However, soybean variety had a significant effect ($p < 0.05$) on the number of leaves and branches, with Tiwala 14 performing the best. Similarly, tillage had no significant effect on yield attributes, whereas variety significantly influenced the number of pods, seeds per plant, and yield per hectare. Tiwala 14 recorded the highest yield (4.23 t/ha^{-1}). These results indicate that minimum and no-tillage systems are viable alternatives to conventional tillage when using a high-performing variety like Tiwala 14 under the agroclimatic conditions of San Jose, Occidental Mindoro.

Keywords: *conventional tillage, minimum tillage, no-tillage, Manchuria, growth and yield performance of soybean*

SDG: *SDG 2 - Zero Hunger; SDG 12 - Responsible Consumption and Production*

INTRODUCTION

Soybean (*Glycine max*) locally known as “utaw” in the Philippines is recognized as the “golden bean” or the “miracle bean” and a wonder crop (Wang & Komatsu, 2017) because of its versatility and exceptional health benefits. Soybean is among the major agricultural commodities imported in the Philippines. The Philippines’ domestic production of soybean is very low. According to the US-International Trade Administration (2024), the Philippines is one of the top importing countries of soybeans and other agricultural and food products from the United States. Moreover, Agflow (2023), cited that the Philippines imports nearly 99% of soybean needs for food and feed from the United States, while only 1% is produced locally.

The low domestic production of soybeans in the country is due to stiff competition among the major crops, such as rice, corn, and vegetables (Panaynews, 2019). Moreover, Agcopra and Piadozo (2018), cited that soybean has low comparative advantages as a Philippines agricultural commodity due to high costs of production. The researchers added that the high cost of production is attributed to current soybean production systems which use conventional or maximum tillage systems. Furthermore, in the study of Swanson et. al (2020), Maximum tillage systems require higher labor and fuel costs for land preparation. According to the Department of Agriculture (2011), land preparation using conventional tillage in soybeans accounts to 16-20% of total production cost per hectare. Moreover, conventional tillage farming not only requires higher production, it also increases CO₂ emissions by destroying aggregates and accelerating the loss of soil organic carbon (SOC) (Liu et al., 2020). Meanwhile, conservation tillage such as no-tillage and ridge tillage positively influences soil aggregation processes, leading to improved soil structure. Conversion to no-till (NT) has been suggested to decrease the SOC mineralization (He et al., 2023) and enhance the accumulation of SOC owing to the minimal disturbance of soil (Wuaden et al., 2020), and reduce production cost.

Although soybeans are an economically important crop in the country, there are limited local studies on soybean production under Philippine conditions. Thus, the potential of this crop is not fully studied under local conditions. Hence, study explored the growth and yield of three soybean varieties under three tillage systems.

MATERIALS AND METHODS

Research Design and Experimental Site

The study employed a split-plot design arranged in a randomized complete block design (RCBD) with three replications. Tillage systems were assigned to main plots, while soybean varieties were allocated to sub-plots. Factor A consisted of Conventional Tillage (A1), Minimum Tillage (A2), and Zero Tillage (A3), while Factor B included Tiwala 6 (B1), Tiwala 14 (B2), and Manchuria (B3).

The experiment was conducted at the Vegetable Production Project Area of Occidental Mindoro State College–Murtha Campus, San Jose, Occidental Mindoro, Philippines, from January to April 2025. The site has a Type I climate characterized by a wet season (June–November) and dry season (December–May), with clay loam soil. The total experimental area was 210 m², with 4 m² plots.

Experimental Materials and Sampling

Three soybean varieties—Tiwala 6, Tiwala 14, and Manchuria—were obtained from the Institute of Plant Breeding, University of the Philippines Los Baños. These varieties have been previously evaluated in several locations in the Philippines, including Isabela, Nueva Ecija, and CARAGA. Data were collected from 27 experimental units, with 26 randomly selected plants per plot using simple random sampling.

Cultural Management Practices

Field preparation involved removal of previous crop residues with minimal soil disturbance, followed by irrigation to soften the soil. Conventional and minimum (strip) tillage was prepared at a depth of 1.75 inches, while zero tillage plots were prepared by clearing weeds and making planting holes (2 inches wide, 1 inch deep) based on a spacing of 15 cm between hills and 40 cm between rows. Direct seeding was done using the hill method at 1-inch depth, with two seeds per hill. Thinning was conducted 14 days after sowing. Drip irrigation was installed prior to planting and scheduled according to crop growth stage and soil moisture conditions. Fertilizer was applied once at 28 DAS using complete fertilizer (14-14-14) at a rate of 100 kg ha⁻¹. Manual weeding was conducted twice weekly, while pest and disease management included monitoring, manual removal, and pesticide application when necessary. Harvesting was done manually based on varietal maturity (90–105 DAS), followed by sun-drying and seed moisture reduction to 10–12% prior to storage (Department of Agriculture, 2011).

Data Collection Procedures

Growth parameters measured at 60 DAS included plant height, leaf number, and branch number from 26 sampled plants per plot. Pod count was recorded at 86 DAS, while seed number and seed weight were determined after harvest. Yield per hectare (mt ha⁻¹) was computed from seed weight per plot using standard conversion procedures.

Data Analysis

Data were encoded in Microsoft Excel and exported in CSV format for analysis using the Statistical Tool for Agricultural Research (STAR). Analysis of variance (ANOVA) for split-plot design was used to determine treatment effects. Treatment means were compared using Tukey's Honestly Significant Difference (HSD) test at a 5% level of significance.

RESULTS

Growth and Yield Performance of Selected Soybean (Glycine Max) Varieties

Table 1. Growth and Yield Performance of Selected Soybean (Glycine Max) Varieties

Parameter	A1	A2	A3	B1	B2	B3	A×B
Plant height (cm)	97.67	94.12	92.02	94.42	93.89	95.50	ns
Leaf number	57.10	50.64	55.57	54.72 ^b	67.54 ^a	41.05 ^c	ns
Branches	4.89	4.44	4.99	4.70 ^b	5.41 ^a	4.20 ^b	ns
Pods per plant	150.03	144.15	153.00	153.79 ^b	166.04 ^a	127.35 ^b	*
Seeds per plant	289.37	277.54	291.58	300.64 ^b	336.52 ^a	221.32 ^c	ns
Seed weight (g)	42.90	39.35	42.86	38.26 ^a	41.70 ^a	31.81 ^b	ns
Yield (mt/ha)	4.19	3.80	3.92	3.94 ^a	4.23 ^a	3.73 ^b	ns

*Means with the same letter(s) are not significantly different at 5% level of significance.

Soybean plant height varied across treatments, with Conventional Tillage (A1) producing the tallest plants (97.67 cm) and Zero Tillage (A3) the shortest (92.02 cm). Among varieties, Manchuria (B3) recorded the tallest plants (95.50 cm), while Tiwala 14 (B2) had the lowest (93.89 cm). For leaf count, A1 had the highest production (57.10) and A2 the lowest (50.64), while Tiwala 14 (B2) showed the highest leaf count (67.54) and Manchuria (B3) the lowest (41.05). For number of branches, Zero Tillage (A3) recorded the highest mean (4.99), followed by A1 (4.89), while A2 had the lowest (4.44). Varietal differences were significant, where Tiwala 6 (B1) and Manchuria (B3) were statistically similar but both differed from Tiwala 14 (B2). In terms of pods, A3 produced the highest mean (153.00) and A2 the lowest (144.15), while B2 significantly differed from B1 and B3. For number of seeds per plant, A3 had the highest mean (291.58) and A2 the lowest (277.54), while B2 recorded the highest varietal mean (336.52) and B3 the lowest (221.32). Seed weight was highest under A1 (42.90 g), closely followed by A3 (42.86 g), while A2 had the lowest (39.35 g). Among varieties, B1 and B2 showed the highest seed weight (41.70 g), while Manchuria

recorded the lowest (31.81 g). For yield per hectare, A1 produced the highest yield (4.19 mt/ha), closely followed by A3 (3.92 mt/ha), while A2 had the lowest (3.80 mt/ha). In terms of varieties, B2 recorded the highest yield (4.23 mt/ha), followed by B1 (3.94 mt/ha), and B3 the lowest (3.83 mt/ha).

Analysis of Variance

The results revealed that different tillage systems had no significant effect ($p > 0.05$) on the plant height, number of leaves, number of branches, number of pods, number of seeds, seed weight, and yield per hectare of soybeans. Likewise, no significant interaction effect was observed between tillage systems and soybean varieties across all parameters evaluated. However, soybean varieties significantly influenced several growth and yield characteristics. Highly significant differences ($p < 0.01$) among varieties were observed in the number of leaves, branches, pods, seeds, and seed weight, while yield per hectare differed significantly ($p < 0.05$). These findings indicate that varietal differences had greater influence on soybean growth and productivity than the tillage systems used in the study.

Table 2. Analysis of Variance.

SOURCE	DF	SS	MS	F	P
Plant height					
Replication	2	43.56	21.78		
Tillage (A)	2	152.89	76.44	3.05	0.16
Error (a)	4	100.22	25.06		
Variety (B)	2	16.22	8.11	0.64	0.54
A x B	4	98.22	24.56	1.94	0.17
Error (b)	12	151.56	12.63		
Total	26	562.67			
Number of leaves					
Replication	2	480.96	240.48		
Tillage (A)	2	199.41	99.70	2.20	0.23
Error (a)	4	181.04	45.26		
Variety (B)	2	3148.07	1574.04	24.92	0.00**
A x B	4	109.26	27.31	0.43	0.78
Error (b)	12	758.00	63.17		
Total	26	4876.74			
Number of branches					
Replication	2	12.52	6.26		
Tillage (A)	2	0.96	0.48	3.25	0.15
Error (a)	4	0.59	0.15		
Variety (B)	2	9.41	4.70	13.37	0.00**
A x B	4	0.37	0.09	0.26	0.90
Error (b)	12	4.22	0.35		
Total	26	28.07			
Number of pods					
Replication	2	10050.90	5025.44		
Tillage (A)	2	360.20	180.11	0.35	0.72
Error (a)	4	2058.20	514.56		
Variety (B)	2	7074.90	3537.44	34.12	0.00**
A x B	4	2182.20	545.56	5.26	0.01*
Error (b)	12	1244.20	103.69		
Total	26	22970.70			
Number of seeds per plant					
Replication	2	13216.10	6608.00		
Tillage (A)	2	1053.60	526.80	0.27	0.78
Error (a)	4	7939.00	1984.80		
Variety (B)	2	62804.50	31402.30	45.96	0.00**
A x B	4	2742.60	685.60	1.00	0.44
Error (b)	12	8198.20	683.20		

Total	26	95954.10			
Seed weight per plant (g)					
Replication	2	395.63	197.82		
Tillage (A)	2	53.41	26.70	0.78	0.52
Error (a)	4	137.70	34.43		
Variety (B)	2	451.63	225.82	20.32	0.00**
A X B	4	26.37	6.59	0.59	0.67
Error (b)	12	133.33	11.11		
Total	26	1198.07			
Yield ha⁻¹ (mt)					
Replication	2	2.81	1.40		
Tillage (A)	2	0.72	0.36	0.99	0.45
Error (a)	4	1.44	0.36		
Variety (B)	2	1.12	0.56	6.91	0.01
A x B	4	0.82	0.21	2.53	0.10
Error (b)	12	0.97	0.08		
Total	26	7.89			

** = Highly significant (p<0.01)

ns = not significant (p>0.05)

DISCUSSION

Plant height is a crucial parameter to crop growth and productivity. Soybean growth is driven by the interaction of genetics, environment, and management factors (Yang et al., 2021). Intensive tillage fundamentally shifts the physical, chemical, and biological properties of the soil, directly modifying how the crop develops. In this current study, the effect of conventional tillage, minimum tillage, and zero tillage on plant height of soybeans is found insignificant. This finding suggests that conventional tillage, minimum and zero tillage systems do not significantly affect the plant height of soybeans. According to Wang et al. (2020), zero-tillage commonly increases soil organic carbon, reduces CO₂ flux from the soil, cuts fuel use and erosion, and improves soil structure and moisture retention. Likewise, plant height can be influenced by both genetic and environmental factors (Yang et al., 2021) and management such as irrigation and rate of fertilizer application particularly at early growth stage (El-Sherif, A. & Ali, M. M., 2015). Fattah et al. (2024) cited that soybean varieties have different physical characteristics, with plant height ranging from 52-68 cm. These differences are due to the variations between the varieties themselves. Elias and Orpilla (2024) noted an insignificant difference on the plant height of six NSIC soybeans varieties.

The number of leaves of soybeans is the same as the number of nodes in other studies because the trifoliate leaves of soybeans are developed from the nodal parts of plants (University of Minnesota Extension (n.d.)). In this study, the number of leaves of the three soybean varieties tested under tillage systems were found insignificant (p>0.05). This finding is supported by the study of Kihara et al. (2011.) citing that the performance of soybean plants was equally well in different tillage systems. Moreover, Ghani et al. (2023) cited that the effect of a tillage system (like no-till or conventional) on leaf number is not uniform but depends on the variety's inherent growth rate and adaptation to that environment. On the other hand, the different soybean varieties showed a highly significant difference in terms of number of leaves (p<0.01). This finding is supported by the study of Magsino et al. (2016) citing that the number of nodes of Tiwala 6, Tiwala 8, and Manchuria is significantly different. Meanwhile, Ohashi et al. (2020) cited that the number of leaves of soybeans varies among varieties due to differences of varieties' genetic make-up. The result also indicates that Tiwala 6, Tiwala 14, and Manchuria is suitable under Occidental Mindoro conditions. It can also be planted under conservation tillage, such as zero tillage and minimum tillage that can be contributed to the soil property and microbial activities in the soil.

Management practices such as tillage systems as in the case of conventional tillage has a significant effect on the number of branches per plant by improving soil moisture and nutrient availability through a prolific root system (Chorey et al., 2019). However, the results of this study highlighted that tillage systems have no significant effect on the number of branches of soybeans. This finding confirmed the results of the study of Jug et al. (2010) and Ozturk & Sogut (2016) citing that no significant differences in the number of branches of soybeans. Meanwhile, the variety of soybeans showed a highly significant difference on the number of branches. The number of branches of Tiwala 14 variety significantly outnumbered Tiwala 6 and Manchuria (p<0.01). This confirmed the study of Xu et al. (2021), that the number and growth of branches are also influenced by factors such as varieties, agricultural management, and climate. Generally, the number of branches of soybeans is a genetically controlled trait in plants.

Soybean varieties with indeterminate growth habits have a higher number of branches compared to determinate ones. The locally developed soybeans varieties in the country including Tiwala series and Manchuria are determinate types

with branches ranging from 2-5 with maturity ranging from 95-100 days during wet season and 83-92 days during dry season (Tandang et al., 2020). Findings showed that soybean varieties, especially Tiwala 14 are suitable under Occidental Mindoro condition, and can also be planted under different tillage systems, especially zero tillage.

The number of pods is a key factor in determining yield and is strongly linked to overall crop productivity. In this study, zero tillage resulted in the highest number of pods (153.00), closely followed by conventional tillage (150.03). However, analysis showed no significant difference ($p>0.05$) in pod production between these two tillage methods. This finding supports the study of Sharifi et al. (2016) citing that the number of pods of soybeans is not influenced by tillage systems. Similar results were reported by Książak and Bojarszczuk (2024). This finding provides significant insights on the effect of conservation tillage systems on the number of pods which is statistically the same with conventional tillage. Moreover, in terms of the effect of different varieties on the number of pods, results showed a highly significant difference. The Tiwala 14 produced a highly significant number of pods compared to Manchuria and Tiwala 6 varieties. The study of Elias and Orpilla (2024) provided substantial support to the finding of this study. The researchers cited that there is no significant difference on the number of pods per plant of six NSIC soybeans varieties which include the Tiwala 6, Tiwala 14, and Manchuria. Li et al. (2024) cited that soybean varieties vary significantly in number of pods due to genetic differences. The study found that Tiwala 14 produced the most pods compared to the other varieties tested. The results suggest that these varieties, especially Tiwala 14, can be successfully grown using different tillage systems, including zero-tillage. There was a significant interaction between the tillage system used and the variety planted, and Tiwala 14 appears to be particularly well-suited to zero-tillage systems. According to Da Silva et al. (2023), zero-tillage farming does not negatively impact soil water infiltration and can lead to a 6.5% increase in soybean grain yield. A long-term (33-year) no-tillage system helps to prevent water stress in soybean plants, resulting in higher grain production compared to conventional tillage methods.

Ali et al. (2013) cited that the number of seeds has a very strong correlation to yield of soybeans under the same environmental conditions and production management practices. In this study, the effect of tillage systems on the number of seeds of soybeans is found statistically the same ($p>0.05$). The number of soybean seeds is not significantly affected by the tillage system. Meanwhile, the soybean varieties have a highly significant effect on the number of seeds of soybean ($p<0.01$). Tiwala 14 produced a significantly higher number of seeds compared to Tiwala 6 and Manchuria. This suggests that the number of seeds of soybeans is highly influenced by variety. Ali et al. (2013) and Wang et al. (2025) reported that the number of seeds of soybeans significantly varies due to genotypic differences. The researchers further cited that the varieties with the number of seeds have higher yield. The number of seeds per plant is a good criterion for selection of high yielding varieties. In this parameter, zero tillage and Tiwala 14 exhibited excellent results compared to other varieties and tillage practices.

The effect of tillage systems on seed weight differs insignificantly ($p>0.05$). This means that the seed weight of soybeans produced from different tillage systems is statistically the same. This is similar to the findings of Hosseini et al. (2016). This suggests that there is enough evidence that the study failed to reject the null hypothesis. In terms of selected soybean varieties, the result revealed a highly significant difference ($P\text{-value}<0.0$) of seed weight of soybeans. In the study of Krisnawati and Adie (2015), the Analysis of variance of yield and yield components revealed that soybean varieties significantly affect the flowering time, days to maturity, 100 seed weight, and seed yield. This means that there is enough evidence to reject the null hypothesis. The result indicates that the conventional and zero tillage performed well. However, in the soybean variety Tiwala 14 exhibited the highest result among the three varieties. The genetic make-up of the different varieties also has an effect on the yield of soybeans. Soybean pests and diseases can reduce seed weight and yield. According to Murithi et al. (2019), Soybean pests can infest crops at any point in its development, from emergence through harvest and their impact is often greatest between flowering and maturity. They further explain that these pests lower both yield and grain quality. They cause harm through direct feeding, which weakens plant tissues and increases vulnerability to other pathogens, and indirectly by transmitting viruses and additional disease-causing organisms.

The effect of tillage system in yield ha^{-1} (mt) of soybean is not significant ($p>0.05$). This finding suggests that the yield ha^{-1} of soybean is not affected by the tillage system. This finding is supported by Adamič, S. & Leskovšek, R. (2021). The researchers cited that soybean yield is not significantly affected by the tillage system. This finding highlights that soybeans can be planted using zero tillage and minimum tillage instead of conventional tillage. The findings of this study provide very viable insights on the use of zero tillage or minimum tillage in soybean production. In terms of variety however, the study found significant differences on yield ha^{-1} . B2 (Tiwala 14) produced the highest yield ha^{-1} with 4.23 mt. This finding suggests that B2 (Tiwala 14) is one of the most promising varieties of soybeans for zero tillage. B2 (Tiwala 14) is one of the latest high yield soybean cultivars developed and released by the Institute of Plant Breeding (IPB) under Tiwala lines. Even though conventional tillage produced higher yield than zero tillage, zero tillage is recommended for planting soybean because of its environmental benefits, such as protecting soil microorganism, causing less soil disturbance, and improving the soil's capacity to retain water and it requires low inputs in production. However, in the study of Dlugosz et al. (2024), soybean is commonly grown under conventional tillage (CT), but this method involves numerous field operations that greatly raise production costs. It also leads to soil compaction and reduces soil organic matter, which results in poorer soil quality over time.

CONCLUSION AND RECOMMENDATION

The study concludes that soybean growth and yield varied with tillage and variety. Conventional tillage produced the tallest plants and highest yield per hectare, while zero tillage yielded more pods and seeds per plant. Tiwala 14 generally outperformed the other varieties, having the most leaves, branches, pods, seeds, and overall yield. Tillage methods did not significantly affect height but influenced leaf and branch growth, with a notable interaction effect on pod production. Based on the findings of this study, it is recommended that future research evaluate the pest and disease resistance of these varieties under local conditions and expand the study to the wet season and sandy loam soils to assess environmental adaptability. Furthermore, the integration of soybeans, particularly the high-performing Tiwala 14 variety, into rice-based cropping rotations (e.g., rice-soybean-corn) and organic farming systems should be explored. Finally, it is suggested that zero-tillage be specifically tested for Tiwala 14 alongside a comprehensive economic analysis of cost and return across all tillage systems to determine the most profitable management practice for farmers.

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DECLARATION OF CONFLICT OF INTEREST

The authors declare no conflict of interest.

DECLARATION OF AI USE

The authors utilized Dola and Gemini for sentence and grammar checking. The authors have carefully reviewed and validated all findings, accepting complete accountability for the final content of this work.

AUTHOR CREDIT STATEMENT

Templanza, J.R. B.: conceptualization, methodology, investigation, formal analysis, and writing – original draft; **Sonio, R. R.:** conceptualization, methodology, investigation, formal analysis, and writing – original draft; **Peñascosa, C. M.:** methodology, data collection, and writing – original draft; **Templanza, C. U.:** investigation, data collection, and writing – original draft; **Gozo, R.M B.:** formal analysis, data processing, and writing – original draft; **Pascua, E. C.:** conceptualization, supervision, and writing – review & editing.

EFFECTIVENESS OF SNACKABLE VIDEO CLIPS ON THE GRAMMAR PROFICIENCY OF OMSC GRADE 7 STUDENTS A.Y. 2024-2025

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ABSTRACT

This study addresses the gap by examining the effectiveness of TikTok-based snackable video clips in enhancing the grammar proficiency of Grade 7 students at Occidental Mindoro State College (OMSC). A quasi-experimental pre-test and post-test design was employed with two groups: one receiving traditional instruction and the other exposed to snackable video clips of grammar lessons. A validated 50-item researcher-made test assessed proficiency in subject-verb agreement, verb tenses, and prepositions. An Independent Sample t-test was used to evaluate learning gains and determine statistical significance. Pre-test results showed no significant difference between the control and experimental groups, confirming baseline equivalence. Post-test results revealed significant improvement in both groups, with the experimental group achieving higher mean scores compared to the control group, indicating a statistically non-significant post-test difference. While both methods improved grammar proficiency, the TikTok-based approach yielded greater gains and sustained engagement, supporting research that short-form, multimedia-rich instruction enhances learning outcomes. The study concludes that snackable video clips via TikTok are an effective alternative for grammar instruction. It is recommended that schools integrate short-form video content into English curricula, provide teacher training in digital pedagogy, and develop contextually relevant materials aligned with students' media habits.

Keywords: *Snackable Video Clips, Nanolearning, Grammar Proficiency, TikTok, Short-form Content, English Language Teaching, Quasi-Experimental Design*

SDG: *SDG 4: Quality Education*

INTRODUCTION

Grammar has long been considered as one of the foundations of language learning. It provides learners with the important structures to create meaning, communicate, and engage effectively in different kinds of discourse. In connection, grammar proficiency also plays an important role in the development of reading comprehension and writing skills (Zhong & Wakat, 2023). This refers to the ability of students to analyze the appropriateness and acceptability of discourse based on the grammar rules of the language that they speak. Therefore, the mastery of grammar lets students not only produce language accurately, but also to interpret and respond to text meaningfully.

Inside a traditional classroom, teaching of grammar has relied heavily on lectures, memorization, and repetition drills. Although these traditional strategies ensure that students are exposed to grammatical structures, they often result in passive learning, and the application is also limited. Students who can recite the grammar rules on their own may find it difficult to use them in real life situations while communicating (Bikowski, 2018). This technical yet disengaging method fails to get students to relate and absorb the skills, particularly in contexts where learners are more responsive to interactive and technology-supported instruction.

Many learners today, particularly those who are part of the generation alpha, grew up surrounded by technology and social media which led them to show distinct habits of learning. They often like quick transition of topics, contents that engage multiple senses, and fast delivery of information (Almazova et al., 2018). Traditional lessons in grammar and its static nature often go in contrast with the students' preferences and lead to the attention span, engagement, and motivation to learn to decrease.

Recognizing these challenges, researchers currently explore digital and multimedia tools to improve traditional teaching and learning strategies. This is to offer a more engaging experience for the students. One example of an engaging method is using "snackable video clips", which is also called "bite-sized video clips". It is a type of short form content that gives concise and creative content. Each video clip ranges from two to five minutes of segmented lessons.

TikTok is one of the platforms known for utilizing this short-form video. This application has become famous among younger audiences as a space for engaging, dynamic, relatable, and rich multimedia contents. New research papers show that these kinds of video formats can maintain the interest of learners, simplify complicated lessons, and increase the motivations of students (Madli et al., 2024; Pham et al., 2023).

TikTok's format presents opportunities to transform abstract ideas of complicated rules into a visually appealing and context-rich depiction in relation to teaching grammar. By mixing real-life situations, humor, and storytelling in grammar lessons, teachers can make content that does not feel imposed and is aligned better with the students' experiences. This can potentially develop a deeper understanding and retention of the lessons.

Despite the potential of applying TikTok in education, research on its application remains limited. Many of the already existing research are about social media. This includes looking into its effect on attention, engagement, and academic performance in general. The available studies do not isolate short-form video as a distinct way to teach grammar. In addition, Filipino students are consistently shown to face significant challenges in important learning competencies in international assessments. Among 79 countries, the Philippines ranked last in reading proficiency, while only 19% reached the baseline level, which is level 2. Also, no students were able to achieve high performance levels (Organization for Economic Co-operation and Development [OECD], 2019; Department of Education, 2019). These concerns extend to more data, such as in PISA 2022, where only 24% of Filipino learners achieved at least the baseline proficiency in reading, which was very below the OECD average of 74% (OECD, 2023). This performance just shows that there is a struggle with reading and language, which are connected to grammar skills.

Furthermore, studies about grammatical competence in the context of junior high school showed that there is room for improvement. The findings in a study that involved Grade 7-10 students revealed that 90% only had "Average" proficiency in subject-verb agreement, while 9.6% are approaching mastery. These results show that there is a need for alternative materials and teaching strategies. One that should be customized to the characteristics of students to give them more authentic learning experience.

Considering these circumstances, exploring TikTok's snackable video clips as a tool for teaching and learning grammar rules becomes relevant and in time. If the traditional way of teaching is no longer engaging modern students and if evidence points to recurring challenges in grammar, then investigating the potential of TikTok as instructional material is a necessary step where emerging multimedia tools like it may better align with students' learning habits.

This study focuses on assessing the potential effectiveness of snackable video clips through TikTok on the grammar proficiency of OMSC Grade 7 during the academic year 2024-2025.

METHODS

Research Design

The study utilized a quasi-experimental design to determine the cause-effect relationship between snackable video clips and the grammar proficiency of the Grade 7 students. This enabled the researchers to evaluate the grammar proficiency of the respondents who received different intervention, conventional and experimental teaching methods. Moreover, this allowed the researchers to compare the two groups of the participants.

Study Site

This study was conducted at Occidental Mindoro State College-San Jose Campus, Quirino St., San Jose, Occidental Mindoro, Philippines, during the third quarter of academic year 2024-2025.

Sample

The participants of the study were from the two sections of Grade 7 at Occidental Mindoro State College Basic Education Department. The researchers randomly selected 40 students and divided them into two different groups. There were 20 students each for control and experimental groups.

Research Instrument

The study used researcher-made pre-test and post-test consist of 50 items designed to measure the grammar proficiency of Grade 7 learners, particularly in subject-verb agreement, verb tenses, and prepositions, aligned with the Most Essential Learning Competencies (MELCs) of Matatag Curriculum. The same set of test items were administered before and after intervention to determine learning gains. To ensure the clarity, relevance, and alignment with Grade 7 competencies, the instrument underwent content validation by three high school English teachers from Occidental Mindoro State College – Basic Education Laboratory.

Data Collection

The participants for this study were grouped into two: the control group, which was taught using the traditional method of teaching grammar through lecture and presentation, and the experimental group, which received the intervention using snackable video clips through TikTok. Given that there are two grade 7 sections in OMSC-Basic Education,

the grouping was based on the learners' class section. The researchers also used the Wheel of Names app to decide which section would be the control group and the experimental group.

During the actual conduct of the study, a pre-test was administered face-to-face on the first day to assess the prior knowledge of both experimental and control groups. On the following day, the teaching of subject-verb agreement was conducted online via Google Meet. On the third day, the lesson on tenses of the verb was delivered in a face-to-face setup, while prepositions were discussed through online class. Finally, in the fifth session, the post-test was administered face-to-face, assessing what the respondents had learned during the three-day discussion of grammar rules.

At the end of the five sessions, the researchers checked all the pre-test and post-test. Scores of the experiment and control groups were encoded separately in a spreadsheet. The hard copies of the instruments used were kept confidential, with access limited to the researchers for the objectives of the study.

Ethical Consideration

The credibility of this is ensured by the researchers of this study by conducting proper citations for all the sources used in this study using APA format. Additionally, the researchers observed asking for permission from school authorities before executing the study. The participants were also informed beforehand regarding its purpose through providing consent forms. We also ensured that all participation in this study was voluntarily. In compliance with the Data Privacy Act of 2012, all information was kept confidential and participants were given the right to withdraw at any time.

Data Analysis

To determine the grammar proficiency in the pre-test and post-test of both control and experimental groups, the researchers utilized mean and standard deviation. An independent sample t-test was employed to compare the means of the two groups and determine if there is a significant difference between the means of the pre-test and post-test of the participants of this research. Moreover, the paired sample t-test was applied in comparing the means of two related groups to determine whether there is significant difference between them. Lastly, the researchers used statistical software in the treatment of the gathered data from this study.

RESULTS

Pre-test grammar proficiency of the respondents

The results in Table 1 show that the level of grammar proficiency of the Control group was classified as Beginning (24.15), similar to the participants of the Experimental group who were also classified as Beginning in their level of grammar proficiency (22.25).

Table 1. The pre-test level of grammar proficiency of the respondents from the two groups.

Pre-Test	Mean	SD	Interpretation
Control	24.15	4.18	Beginning
Experimental	22.25	4.18	Beginning

Legend: 44.5-50: Advanced; 39.5-44.49: Proficient; 34.5-39.49: Approaching Proficiency; 24.5-34.49: Developing; 0.00 - 24.49: Beginning

Difference between the pre-test scores of the respondents

The researchers conducted a two-tailed independent sample t-test to verify the homogeneity of the two groups before implementing the treatments. As shown in Table 2, there is no significant difference between the pre-test score of the control and experimental groups, p-value > .05. This indicates that the two groups demonstrated comparable levels of grammar proficiency prior to the conduct of the two treatments.

Table 2. Difference between the pre-test scores of the control and experimental groups.

Pre-test	t-statistic	p-value	Interpretation
Control	1.26	.22	Not Significant
Experimental			

Legend: p-value<0.05 = Significant

Post-test grammar proficiency of the respondents

Following the implementation of traditional methods of teaching and snackable video clips in the control and experimental groups, respectively, the researchers administered a post-test to assess the grammar proficiency of the respondents from the two groups. As shown in table 3, the post-test mean score of the Control group reveals that their

level of grammar proficiency was Beginning (23.8), while the level of grammar proficiency of the experimental group entered the Developing level (24.6).

Table 3. The post-test level of grammar proficiency of the respondents from the two groups.

Post-test	Mean	SD	Interpretation
Control	23.8	5.07	Beginning
Experimental	24.6	6.44	Developing

Legend: 44.5–50: Advanced; 39.5–44.49: Proficient; 34.5–39.49: Approaching Proficiency; 24.5–34.49: Developing; 0.00 – 24.49: Beginning

Difference between the grammar proficiency of the control group before and after Implementing traditional teaching method

The t-test comparison of the pre-test results showed no statistically significant difference, $p > .05$. This implies that the slight decrease in the performance of the Control group did not significantly enhance their grammar proficiency. As a result, the data fails to reject the second null hypothesis.

Table 4. Difference the grammar proficiency of the control group before and after Implementing traditional teaching methods.

	t-statistic	p-value	Interpretation
Pre-test	.361	.72	Not Significant
Post-test			

Legend: $p\text{-value} < 0.05 = \text{Significant}$

Difference between the grammar proficiency of the experimental group before and after teaching using snackable video clips through TikTok

The findings in Table 5 reveal that there is no significant difference between the grammar proficiency before and after the conduct of the Experimental group using snackable video clips to teach subject-verb agreement, verb tenses, and prepositions, $p\text{-value} > .05$. This result implies that although there is a slight increase in the mean score of the experimental group's post-test compared to their pre-test, there is no significant evidence that the use of snackable video clips in teaching grammar rules had a significant effect on their performance.

Table 5. Difference between the grammar proficiency of the experimental group before and after teaching using snackable video clips through TikTok.

	t-statistic	p-value	Interpretation
Pre-test	2.000	.06	Not Significant
Post-test			

Legend: $p\text{-value} < 0.05 = \text{Significant}$

Difference between the post-test grammar proficiency of the control group and the experimental group

The analysis of the post-test scores shows that the respondents in the Experimental group who were taught using snackable video clips achieved a higher mean score (24.6) than those in the Control group who were taught using traditional methods (23.8). However, the two-tailed independent sample t-test revealed that the difference between post-test level of grammar proficiency of Control and Experimental group was not significant, $p > .05$. The data indicate that the use of snackable video clips did not produce a significantly greater improvement in grammar proficiency, hence, failing to reject the null hypothesis.

Table 6. Difference between the post-test grammar proficiency of the control group and the experimental group.

	t-statistic	p-value	Interpretation
Control	.436	.67	Not Significant
Experimental			

Legend: $p\text{-value} < 0.05 = \text{Significant}$

DISCUSSION

The results revealed that both the control and experimental groups at Occidental Mindoro State College-Basic Education Department exhibited a "Beginning" level of grammar proficiency in the pre-test. This stage in language development shows that learners have a minimal grasp of basic grammar structures such as subject-verb agreement, verb tenses, and prepositions. This outcome is consistent with previous studies in Negros Occidental and Bacolod City, which demonstrated that grammar education often receives less attention compared to other language abilities, that may contribute to students' lack of essential grammatical knowledge (Quijano, 2019; Salas & Legaspi, 2020). The Beginning level also indicates that learners may recognize patterns but still struggle to apply them fluently and correctly, especially in contexts where exposure to language-rich environments is limited (Rifki et al., 2019; Yoke & Hasan, 2015; Kurniawan & Firdaus, 2020). Beyond these external challenges, grammar proficiency is also shaped by cognitive strategies and affective factors such as motivation and confidence (Kanda, 2024). When students perceive grammar as intimidating or disengaging, they are less likely to retain knowledge or progress, particularly in classrooms lacking authentic practice and supportive language-rich interaction. As Sioco and De Vera (2018) point out, making language learning meaningful requires not only addressing these barriers but also improving lessons and activities through innovative strategies in English lessons to ensure that learners' needs in second language acquisition are effectively met.

The independent sample t-test confirmed that there was no significant disparity between the pre-test scores of the control and experimental groups. This comparability ensured that any variations in the post-test results could be attributed to the teaching strategies rather than prior differences in grammar proficiency. Salas and Legaspi (2020) emphasized that early language experiences can significantly influence later performance, and the alignment of both groups strengthens the validity of the study.

After the intervention, the control group taught through conventional methods remained at the "Beginning" level, showing no improvement in grammar proficiency. In contrast, the experimental group taught using TikTok snackable videos progressed to the "Developing" level, indicating a slight gain in their ability to apply grammatical rules more precisely. This improvement highlights the potential of short-form multimedia training in grammar acquisition, as suggested by Nanolearning motivational theory, which emphasizes visually attractive, concise, and context-related content to increase engagement (Agilandeshwari & Subramanai, 2024; Sandoval-Palomares et al., 2023). However, statistical analysis revealed no significant difference between the post-test scores of the two groups, suggesting that while snackable video clips may enhance motivation, their quantified influence on grammar proficiency remains comparable to conventional teaching methods.

The control group's lack of improvement may be attributed to the transition from traditional face-to-face instruction to online learning due to extreme heat. This shift limited students' access to immediate feedback and real-world experiences, while poor internet connectivity and decreased motivation further hindered comprehension (Adeyoni & Soykan, 2020). Similarly, the limited effect observed in the experiment group can also be explained by external constraints such as unstable internet connection and restricted device access during online sessions, which prevented learners from fully maximizing digital learning resources (Paz-Domínguez et al., 2023). In addition, the experimental group's slight improvement from "Beginning" to "Developing" reflects the positive yet confined impact of TikTok-based interventions. Nanolearning principles suggest that bite-sized lessons reduce cognitive load and make grammar learning more approachable (Bahri et al., 2022; Kayan & Aydin, 2020). Yet, the absence of significant improvement implies that learners with a weak foundation in grammar may only achieve recognition-level understanding without deeper application (Kanda, 2024; Lin, 2021).

The results of post-test scores between the control and experimental groups further confirmed that there was no statistically significant difference. This finding illustrates that both conventional teaching and TikTok-based snackable videos did not result in noticeably higher gains in grammar proficiency. While snackable videos aligned with microlearning principles and promoted engagement, their effectiveness may vary depending on learner motivation, instructional design, and integration with other pedagogical approaches (Manca & Ranieri, 2016; Limpo et al., 2025).

In conclusion, the use of TikTok-based snackable video clips may be effective, it did not significantly exceed the traditional teaching methods in terms of grammar mastery. Snackable video clips' lack of statistical weight indicates that, including those in TikTok, is seen as just as effective as traditional teaching practice. Monib et al. (2024) support this claim as they found that students' behavioral and affective domains are positively influenced by microlearning. This idea is further supported by Rad (2023), who demonstrated that TikTok, which has similarities to the format of microlearning, can be used as another effective preference for delivering grammar instruction, which promotes students' engagement and collaboration. This idea gives spotlight to the significance of constant change and evaluation in instructional design. Succeeding research should delve further into longer interventions, wider samples, and hybrid models that put together the digital media with enhanced grammar instruction.

The limitation of this study was that it only involved Grade 7 students from Occidental Mindoro State College Basic Education Department. Also, this study focused on grammar rules, including subject-verb agreement (S-V-A), verb tenses, and prepositions. Therefore, the findings of this study should not be generalized to the proficiency of grammar rules of the

participants in other areas. Additionally, other aspects of grammar rules, such as adjectives and adverbs, were not included in the study.

CONCLUSION AND RECOMMENDATION

The study reveals that grade 7 students of Occidental Mindoro State College–Basic Education have low grammar proficiency, and both groups showed similar levels of competence before intervention. Additionally, the findings indicate that students who are exposed to snackable video clips proved a slight improvement compared to the ones taught using conventional methods. Initially, the results suggest that both snackable video clips and traditional teaching methods are functional as instructional tools in teaching grammar, as both are considered equally effective in students' learning. This study recommends strengthening the grammar foundations of the students through early reinforcement and scaffolded lessons, with the use of teaching strategies that are suitable to their level of proficiency. Lastly, it suggests providing additional training for teachers on how to skillfully use digital tools for more effective instruction.

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DECLARATION OF CONFLICT OF INTEREST

The authors declare no conflict of interest.

DECLARATION OF AI USE

The authors declare no use of AI.

AUTHOR CREDIT STATEMENT

Cabuhut, R.A.: methodology, investigation, resources, writing - original draft, writing - review&editing, visualization; **Erandio, C.J.:** methodology, investigation, resources, writing - original draft, writing - review&editing, visualization; **Francisco, J.V.:** methodology, investigation, resources, writing - original draft, writing - review&editing, visualization; **Oliveros, B.P.:** methodology, investigation, resources, writing - original draft, writing - review&editing, visualization; **Tiongson, G.:** methodology, investigation, resources, writing - original draft, writing - review&editing, visualization; **Gepana, J.:** validation, writing - review & editing, supervision

INTEGRATION OF INDIGENOUS KNOWLEDGE SYSTEMS IN IMPROVING GRADE 9 INDIGENOUS PEOPLE STUDENTS' PERFORMANCE IN PHYSICS

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ABSTRACT

Physics instruction for Indigenous People (IP) students often follows Western format which lacks cultural relevance for them, resulting in low engagement and poor performance. While the integration of Indigenous Knowledge Systems (IKS) has shown benefits in other scientific disciplines, there is still limited empirical evidence of its effectiveness in Physics. This study addresses the gap by examining the effectiveness of integrating IKS in improving the performance of the Grade 9 IP students in work, power, and energy. A quasi-experimental pre-test and post-test design were utilized to the 30 IP students from Cabugao National High School which were evenly assigned to control (Conventional Teaching Method) and experimental (IKS-integrated) groups. A validated 15-item researcher-made test measured the change in their performance. Mann-Whitney Test was used to analyze for group comparisons and the Wilcoxon Signed-Ranks Test for the differences within the groups. Pre-test results revealed no significant difference between the two groups, ensuring baseline equivalence. Post-test results, on the other hand, revealed that both groups improved significantly, however, the experimental group attained higher mean scores than the control group, attaining a significant post-test difference. Both methods were effective but the IKS-integrated approach showed higher improvement gains and reduced performance variability, indicating an equitable learning experience, aligning with research showing that indigenized and culturally contextualized lessons significantly improved the performance of the IP students compared to conventional teaching methods. The study concludes that integrating IKS into Physics lessons, particularly work, power, and energy significantly improved the performance of the IP students.

Keywords: *indigenous knowledge systems, physics education, indigenous people (ip) students, work, power, and energy, quasi-experimental design*

SDG: SDG 4 – Quality Education

INTRODUCTION

Incorporating Indigenous Knowledge Systems (IKS) in science education particularly in Physics still remains a significant challenge, as many educators still face a lack of engagement that hinders effective learning and good performance in students, specifically the indigenous students. Since Physics is most of the time taught in abstract, mathematical, and Western frameworks, Indigenous People (IP) students may find that these teaching approaches are disconnected from their lived experiences and results in low academic engagement and poor academic performance (Buenaflo et al., 2023). This educational disconnect calls for a more culturally responsive approach that bridges the cultural knowledge of the IP students with formal scientific concepts.

The integration of Indigenous Knowledge Systems and Practices (IKSPs) on integrated Science identified that IKSPs were found to be effective in teaching the different Science subjects including Integrated Biology, Integrated Science, and Chemistry (Donato-Kinomis, 2016; Tawanda & Mudau, 2024) while Physics still lacks empirical data that demonstrates how IKS can improve the performance among IP students.

Paquin (2023) suggests that student performance improves when curriculum content aligns with the cultural experiences of students. In Indonesia, Dewi et al. (2022) elaborated that the integration of IKS inside the classroom reflects the local values and promotes intercultural competence. Moreover, involving the students' actively in scientific practices and maintaining their academic interest is important (Habig and Gupta, 2021).

Locally, Moro and Billote's (2023) research on the integration of indigenous Ivatan games into Physics learning modules investigated its impact on the student's comprehension, motivation, and scientific sublime. Their study revealed that students engaged in culturally integrated activities experienced joy and nostalgia with relatable learning experiences. However, the integration was not too effective in promoting the scientific sublime, a term denoting the capacity of the students to appreciate the beauty and interconnectedness of scientific principles, which is essential for improving the engagement and comprehension in Physics.

Cabugao National High School (CNHS), located in Bulalacao, Oriental Mindoro, a school where most of the students belong to indigenous communities, including the Hanunuo Mangyan, a well-known indigenous group in the region. The school has made meaningful efforts in integrating IKS into their curriculum aiming to acknowledge the cultures and

traditional practices of the community as important learning sources. In recent years, CNHS has integrated IKS in Science subjects, where traditional ecological and local environmental practices are aligned with scientific concepts. Various scientific disciplines like Astronomy and Earth and Life Sciences were evidently effective when it was being integrated by IKS however Physics still lacks empirical data to show the effectiveness of integrating IKS in improving the performance of the IP students. Physics, unlike other scientific disciplines, most of the time involves abstract and mathematical representations of phenomena, such as forces, motion, and energy transfer, topics that can be challenging for students to conceptualize. For indigenous students, this difficulty is worsened by the lack of culturally relevant analogies and examples [Badruldin and Alias, 2022].

This study examined the effectiveness of integrating IKS in improving the Grade 9 indigenous people (IP) students' performance in Physics. Specifically, this study aimed to determine the level of performance of the IP students in Physics as measured by the pre-test, establish homogeneity between the pre-test results of the IP students in the control group and the experimental group, determine the level of performance of the IP students in Physics as measured by the post-test, identify the significant difference between the level of performance of the IP students in Physics in the pre-test and in the post-test of the control group, identify the significant difference between the level of performance of the IP students in Physics in the pre-test and in the post-test of the experimental group, and examine the significant difference between the level of performance of the IP students in Physics in the post-test of the control group and experimental group.

METHOD

Research Design

This study utilized a quasi-experimental design with pre-tests and post-tests to examine the effects of integrating indigenous knowledge systems into Physics instruction to improve the performance of the IP students. To ascertain the effectiveness of integrating IKS in improving the Physics performance of the Grade 9 IP students was the primary objective of this methodology.

Study Site

This research was conducted at Cabugao National High School located in Cabugao, Bulalacao, Oriental Mindoro during the school year 2024 – 2025. The school is at the southern-most part of Cabugao and mostly caters to indigenous people students.

Sample

The respondents of this study were the Grade 9 IP students of Cabugao National High School during the fourth quarter of the School Year 2024-2025. The researchers utilized two instructional set ups: one employs conventional teaching methods and the other integrates IKS. The total population of students is 45 Grade 9 students with 23 students from section Loyalty, and 22 students from section Charity. From these sections, the researchers purposely selected 30 IP students as the sample of the study - the 15 IP students from section Loyalty composed the experimental group and the 15 IP students from the section Charity formed the control group.

Research Instrument

The researchers employed a self-made 15-item pre-test and post-test as valuable instruments of data gathering for the fourth quarter. To ensure validity of the tests, they underwent expert evaluation for content and face validity to align the items with the learning competencies and ensure clarity and appropriateness. To assess the knowledge of the IP students in Physics prior to instruction, a pre-test was administered to them. Additionally, to measure performance of the IP students in Physics after instruction, they took a post-test. To evaluate the performance of the IP students in Physics, the researchers used the mean scores obtained from the pre-test and the post-test results. A self-made scale was employed for this purpose, using verbal interpretations based on DepEd DO No. 8, Series of 2015 for grades and grading where mean score of 0 – 7.49 was interpreted as did not meet expectations, 7.50 – 9.49 as fairly satisfactory, 9.50 – 11.49 as satisfactory, 11.50 – 13.49 as very satisfactory, and 13.50 – 15 as outstanding.

Data Collection

Following administrative clearance from the National Commission on Indigenous Peoples (NCIP) and the school principal, Grade 9 Indigenous Participant (IP) students from Cabugao National High School were allocated into a control group (conventional instruction) and an experimental group (Indigenous Knowledge Systems [IKS]-integrated instruction). The intervention spanned five consecutive days (10 hours total; 5 hours per group). Day 1 involved student orientation and the distribution of parental informed consent forms. On Day 2, a 15-item pre-test evaluated baseline knowledge on mechanical energy. Subsequently, parallel 1-hour physics sessions were conducted daily (Control: 08:30–09:30; Experimental: 10:00–11:00). While both groups completed identical seatwork and baseline activities, instructional delivery differed: the control group utilized standard digital simulations (e.g., roller coasters) and conventional chalk-and-talk methods, whereas

the experimental group interacted with localized cultural elements (e.g., a 3D Karosa Model, Darapugan, bow-and-arrow analogies, and traditional lighting technologies) to contextualize kinetic, potential, and conserved energy. On Day 5, a 15-item post-test was administered to measure performance gains across both instructional modalities.

Ethical Considerations

This study adhered to strict ethical protocols, particularly regarding the protection of minors and Indigenous Peoples (IP) communities. Institutional clearance was obtained from the National Commission on Indigenous Peoples (NCIP) and the school administration prior to data collection. Because participants were minors, parental or guardian written informed consent was secured alongside participant assent following a comprehensive orientation on research procedures, risks, and benefits. Participant autonomy and privacy were strictly maintained; participation was entirely voluntary, with guaranteed withdrawal rights at any stage without penalty. All data were anonymized, securely stored, and restricted to academic purposes. To ensure cultural integrity, local traditions and values were treated with mutual respect, and Indigenous Knowledge Systems (IKS) were integrated accurately and sensitively into the educational framework. The authors declare no conflicts of interest or financial ties influencing the study outcomes.

Data Analysis

Quantitative data were organized via spreadsheet software and analyzed using non-parametric statistical tools, as the dataset violated normality assumptions. Descriptive statistics, specifically mean and standard deviation, summarized the students' performance levels in physics (work, power, and energy). To evaluate the intervention, a Mann-Whitney U test was first used to assess baseline homogeneity between the control and experimental groups' pre-test scores. Within-group improvements from pre-test to post-test were evaluated using the Wilcoxon Signed-Rank test. Finally, a post-test comparison between the two groups was conducted using the Mann-Whitney U test to determine the relative effectiveness of the IKS-integrated instruction versus the conventional method.

RESULTS

Level of performance of the IP students before the intervention

Table 1 shows the level of performance in Physics of the IP students in the pre-test. The level of performance in Physics of the IP students in the pre-test, both in the conventional and experimental groups resulted as did not meet expectations. The control group had a mean score of 4.80, while the experimental group had a mean score of 4.00. The difference between the two groups was only 0.80 points.

Out of the 15 IP students in the control group, one achieved a score that was interpreted as fairly satisfactory, while 14 scored as did not meet expectations. In the experimental group, all 15 students obtained scores in the range of 0-7 which were considered as not meeting expectations.

Table 1. Level of performance of the IP students before the intervention.

Group	Mean	SD	Interpretation
Control	4.80	1.47	Did not meet expectations
Experimental	4.00	1.31	Did not meet expectations

Legend: 0.00-7.49=Did Not Meet Expectations; 7.50-9.49=Fairly Satisfactory; 9.50-11.49=Satisfactory; 11.50-13.49=Very Satisfactory; 13.50-15.00=Outstanding

Difference between the pre-test scores of the IP students from the two groups

The table 2 of a Mann-Whitney Test showed a z-value of 1.56, a p-value of .14 tested within the degrees of freedom ($df = N - 2 = 28$). Since the p-value is greater than the .05 level of significance, the difference in pre-test scores between the two groups is not significant. This suggests that both groups started with similar levels of understanding in Physics before the intervention.

Table 2. Difference between the pre-test scores of the IP students from the two groups.

Variables	z-value	p-value	Interpretation
Pre-test scores (control and experimental)	1.56	.14	Not Significant

Legend: p-value < 0.05 = significant

Level of performance of the IP students after the intervention

Table 3 shows the level of performance in Physics of the IP students in the post-test. The IP students instructed with the integration of IKS approach performed relatively higher than the IP students instructed through conventional teaching methods during the conduct of the post-test, as shown by the mean score of 13.20 (very satisfactory. Post-test results of students under the control group scored a mean of 10.67 (satisfactory).

Table 3. Level of performance of the IP students after the intervention.

Group	Mean	SD	Interpretation
Control	10.67	2.23	Satisfactory
Experimental	13.20	1.21	Very satisfactory

Legend: 0.00-7.49=Did Not Meet Expectations; 7.50-9.49=Fairly Satisfactory; 9.50-11.49=Satisfactory; 11.50-13.49=Very Satisfactory; 13.50-15.00=Outstanding

Difference between the performance of the IP students before and after being taught using conventional teaching method

Table 4 presents a Wilcoxon Signed Ranks Test which showed a significant difference in student performance between the two tests (z-value = 3.41, p-value = <.01).

Table 4. Difference between the pre- and the post-test scores of the IP students in the control group.

Variables	z-value	p-value	Interpretation
Pre and post test scores (control group)	3.41	<.01	Significant

Legend: p-value < 0.05 = significant

Difference between the performance of the IP students before and after being taught with the integration of IKS

Table 5 presents a Wilcoxon Signed Ranks Test which reveals a significant difference in student performance between the two tests (z-value = 3.45, p-value = <.01).

Table 5. Difference between the pre- and the post-test scores of the IP students in the experimental group.

Variables	z-value	p-value	Interpretation
Pre and post test scores (experimental group)	3.45	<.01	Significant

Legend: p-value < 0.05 = significant

Difference between the post-test scores of the IP students from the two groups

The table 6 showed significant differences between the post-test scores of the two groups were confirmed by the z-value of 2.99. Since the p-value is <.01.

Table 6. Difference between the post-test scores of the IP students from the two groups.

Variables	z-value	p-value	Interpretation
Post-test scores (conventional and intervention)	2.99	<.01	Significant

Legend: p-value < 0.05 = significant

DISCUSSION

Prior to the implementation of instructional interventions, both the control group (taught using conventional teaching methods) and the experimental group (taught with Indigenous Knowledge System (IKS)-integrated instruction) demonstrated low performance in the pre-test. The majority of students from both groups fell within the "Did Not Meet Expectations" category. Only one student from the control group achieved a "Fairly Satisfactory" rating. This low performance was generally due to the IP students' unfamiliarity with the topic as it had not yet been addressed in the curriculum. Pramesti et al. (2020) emphasizes that the students' misconceptions and lack of exposure to the Physics concepts affect their learning outcomes. Challenges in the teaching of the work-energy concept were identified in the study and were not restricted to one level of instruction. For example, there is always a difficulty among students in distinguishing the concept of energy as it is used in everyday language from the scientific use of the term. Many are unable to correctly identify the system and environment in work-energy processes, often confusing the sensation of physical

exertion with the concept of mechanical energy. Wang (2022) also noted that traditional instruction often relies on rote memorization, which does not necessarily foster conceptual understanding or meaningful prior knowledge.

Assem et al. (2023) noted that Physics is considered as one of the branches of science that students find more challenging than Biology and Chemistry since it involves studying the universal laws, behavior and relationship among different physical phenomena, discovering and exploring the environment, and solving both theoretical and practical problems. This reinforces the observation of the IP students having low scores before the lesson was introduced.

Statistical analysis showed no significant difference in the pre-test scores between the control and the experimental groups. This is consistent with Zainuddin et al. (2024) who observed that students at the beginning are usually at the same level of prior knowledge, irrespective of the pedagogy used. Tong et al. (2023) classified the understanding of the students regarding the concepts of work, power and energy into novice, intermediate and expert. His study found that most students at the beginning were novice and did not have the requisite understanding to use concepts such as the work-energy theorem. Seifan et al. (2020) who also reported no meaningful differences between the groups on the pre-test scores from the same settings.

Using indigenous artifacts and knowledge is important in science teaching as a means of increasing relevance and learning (Govender and Mudzamiri, 2021). While traditional teaching methods also resulted in positive improvement because of its organized and theoretical base instruction (Almadrones and Tadifa, 2024), the application of IKS will result in higher positive learning outcomes in Physics (Moro and Billote, 2023). The performance of learners is also explained by Toli and Kallery (2021) who argued that the use of innovative teaching strategies that IKS includes, captures the learners' attention and enables them to learn the Physics concepts at a deeper level.

The traditional teaching methods can still result in positive and meaningful learning gains, particularly when this is applied properly who reported that in structured learning environments, these conventional pedagogies lead to positive student outcomes (Cordero et al., 2018). Moreover, CTM may also be beneficial in improving the performance of the IP students as implied by the positive learning gains. Khozaei et al. (2022) also stated that delivering the foundational content in science remains effective for these lecture-based approaches. Wang (2022) also stated that even though traditional lecture-style teaching is considered more boring than high-tech classrooms, it can be more effective at improving test scores. However, even though the test achievement of the IP students suggested that CTM yielded improvements, it still did not tackle the long-term recall which is very important for a comprehensive indigenous schooling.

Zidny and Eiks (2020) found that merging indigenous knowledge with Western Science enhances comprehension by connecting abstract concepts to the lived experiences of the students. IKS-integrated lessons as a learner-centered approach are necessary as Cinite and Barinova (2021) stressed that in order to provide physics graduates with a good conceptual understanding of physics, a student-centered teaching approach is crucial. Paquin (2023) also supported this view, suggesting that aligning curriculum content with the cultural backgrounds of the learners can significantly improve the performance of the students. Therefore, integrating indigenous perspectives makes science more inclusive, allowing students from diverse cultural backgrounds to see themselves and their communities reflected in what they learn aligning with Ijatuyi, et al. (2025) stating that indigenous knowledge can act as a springboard for science knowledge to be put in traditional communities like the Hanunuo mangyan community to support their learning and growth and in the classroom, it might improve their interpretation of information leading to the improvement of the performance of the IP students.

Through closed-response assessments, the traditional teaching approaches dominated and remained effective in ensuring the content knowledge acquisition (Marcinauskas et al., 2024). Integrating indigenous knowledge into Physics instruction addresses the continuous issues of the poor performance in the subject and that students taught using indigenous knowledge-based strategies achieved better results than those taught using conventional means (Onyewuchi and Owolabi, 2022). This is further supported by Govender and Mutendera (2020) whose study reported that the IP students' instructional outcomes and performance improved when the teachers' instruction became more culturally connected and this only happened when the attitude of the teachers shifted from skepticism to appreciation of indigenous knowledge. These changes show the involvement of not just the students but also the teachers themselves to appreciate the transformative potential of integrating indigenous knowledge in education.

Limitations

Several limitations characterize this study and restrict the generalizability of its findings. First, the sample size was limited to 30 Grade 9 Indigenous Participant (IP) students from a single institution, which precludes broader generalizations to larger populations or diverse socio-economic school contexts. Second, the intervention was brief, spanning approximately 10 hours, limiting conclusions regarding the long-term retention or sustained impact of Indigenous Knowledge Systems (IKS) integration. Third, the curriculum was restricted to specific fourth-quarter Physics topics (work, power, and energy), meaning the outcomes may not apply to other science domains. Finally, student performance was evaluated exclusively via a researcher-made, 15-item pre- and post-test assessment; alternative instructional approaches, assessment modalities, and the isolated impact of individual indigenous elements were not explored.

CONCLUSIONS AND RECOMMENDATION

The study shows that the performance of the IP students prior to the discussion was generally poor. It was also found that the IP students from the control group and the experimental group were both struggling in Physics prior to the intervention. After the intervention, the Conventional Teaching Method (CTM) and IKS-integrated approach has shown effectiveness in improving the performance among the IP students in the control and experimental groups. Therefore, the study concluded that CTM was an effective mode for Physics instruction among the IP students. Moreover, the IKS-integrated approach showed that connecting scientific ideas to the cultural practices was also an effective approach for Physics instruction among the IP students. While both the Conventional Teaching Method and IKS-integrated approach showed effectiveness in improving the performance in Physics among the IP students in the control and the experimental groups, the integration of IKS was more effective in improving the Physics performance of the IP students compared to the CTM.

The study recommends the consideration of Indigenous Knowledge Systems (IKS) integration in Physics, particularly into the topic, work, power, and energy, as it showed an improved performance among the IP learners in this study. Training on culturally responsive teaching strategies may also be included in professional development programs for teachers to promote the effective and respectful integration of IKS into classroom instructions. Collaborations of schools with Hanunuo elders and knowledge holders may be considered for them to co-create learning materials that preserve their cultural identity to ensure the accurate integration of IKS into Science education. Assessment tools may be designed to measure not only knowledge gains but also the ability of students to apply scientific concepts in culturally rooted and practical contexts. Conventional Teaching Method (CTM) is also recommended as an effective approach in teaching Physics concepts, as it showed significant improvements in learning outcomes of the IP students and can serve as a solid instructional foundation. Furthermore, the integration of IKS may also be explored in other disciplines of Science such as Biology, Chemistry, and Earth Science, to assess its effectiveness in improving the performance across various content areas for indigenous learners. Furthermore, future researchers may replicate this study with a larger and more diverse group of IP learners to validate the findings and explore the broader applicability of IKS integration in Science.

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The authors declare no conflict of interest.

DECLARATION OF AI USE

The authors used Grammarly and Quillbot for grammar checking and language editing. All outputs were reviewed and validated by the authors, who take full responsibility for the content.

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AUTHOR CRediT STATEMENT

Mindoro, E.: conceptualization, methodology, investigation, writing – original draft, writing – review and editing, data curation, resources, supervision, visualization, funding acquisition; **Baylon, J.R.:** methodology, investigation, writing – original draft, writing – review and editing, data curation, resources, funding acquisition; **Candelario, J.:** investigation, writing – original draft, writing – review and editing, data curation, resources, funding acquisition; **Moreno, V.:** investigation, writing – original draft, writing – review and editing, resources, funding acquisition, funding acquisition.; **Warain E.:** investigation,

writing – review and editing, resources, funding acquisition; **Cerezo, B.:** conceptualization, methodology, writing – review and editing, data curation, resources, supervision.

AVAILABILITY OF DATA AND MATERIALS

The datasets generated and analyzed during the current study are not publicly available due to the privacy restrictions regarding student academic records. However, anonymized data, along with the localized Physics curriculum integration materials, are available from the corresponding author upon reasonable request.

LAYING PERFORMANCE OF 'DEKALB WHITE' STRAIN SUPPLEMENTED WITH VARIOUS AMOUNTS OF DRIED BLACK SOLDIER FLY (*HERMETIA ILLUCENS*) LARVAE

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ABSTRACT

This experimental study was conducted to determine the laying performance of layer chickens supplemented with various amounts of dried black soldier fly larvae. The experiment was conducted at Upper Lagnas, San Pedro, Rizal, Occidental Mindoro from April to August 2025. A total of 144 heads of layer chickens were reared in the experiment layout in Completely Randomized Design (CRD) using four treatments and three replications. The layer chickens were managed following the recommended rate of commercial feeds and DBSFL except for the Treatment 0 (Control). Treatment 1 (96% CF + 4% DBSFL), Treatment 2 (92% CF + 8% DBSFL), Treatment 3 (88% CF + 12% DBSFL). Analysis of variance in Completely Randomized Design (CRD) was used to test the statistical significance among treatments. Results showed that DBSFL supplementation had comparable effects on laying performance indicators, total egg production, feed conversion ratio, hen-day egg production, mortality rate, egg size, egg yolk color, eggshell thickness, net income and profitability. Although no significant differences among treatments, the 12% inclusion level produced the most favorable performance and achieved the highest return on investment at 20.56%. These findings suggest that incorporating 12% DBSFL in layer diets can enhance productivity and profitability without negatively affecting overall performance.

Keywords: black soldier fly, larvae, layer, laying performance

SDG: SDG 2 - Zero Hunger; SDG 12 - Responsible Consumption and Production

INTRODUCTION

The growing global demand for poultry products necessitates continuous improvement and innovation in poultry nutrition to ensure sustainable production. Traditional protein sources like soybean meal and fish meal have been fundamental components in poultry diets due to their favorable amino acid profile and digestibility (Allahoki, 2023). However, a major problem has arisen as the search for alternative protein sources. Environmental impacts from conventional protein production, together with the escalating pressure on global protein resources, have intensified the need for sustainable options that can adequately support the nutritional demands of layer chickens (Greenhalgh et al., 2020). Among these alternatives, black soldier fly larvae have garnered significant attention due to their nutrient profile and sustainable production characteristics.

Black soldier fly larvae are characterized by high protein content, typically ranging between 35% and 45% on dry matter basis, along with a balanced spectrum of essential amino acids for poultry growth and egg production. In addition to protein, BSFL provides beneficial fatty acids and essential materials such as calcium, iron, copper, and zinc that contribute to overall health and metabolic function in poultry (Lu et al., 2022). The nutritional qualities of BSFL make them promising partial or full substitutes for conventional protein ingredients in layer diets without compromising the bird's performance.

Beyond their compositional advantages, BSFL have been found to exert positive effects on poultry health. Studies show that including BSFL in poultry feed can enhance gut health by promoting a balanced microbial community. The larvae meal helps to reduce pathogenic bacteria such as Enterobacteriaceae and Clostridium species while fostering beneficial bacteria like Lactobacillus, which supports intestinal integrity and immune function (Saidani et al., 2025). These changes in gut microbiota can ultimately optimize nutrient absorption and improve growth performance and egg production in laying hens.

In fact, in some cases, performance indicators such as weight gain, feed conversion ratio, and immune responses have shown improvement relative to conventional diets (Osuch et al., 2024). Importantly, BSFL also delivers an ideal calcium-to-phosphorus ratio supporting eggshell quality and bone development, a critical factor in layer management.

In view of the potential of dried black soldier fly larvae, this study aimed to determine the effects of dried black soldier fly larvae on the laying performance of layer chickens. The result of this study will help poultry raisers and feed developers to discover alternative protein sources for poultry animals.

MATERIALS AND METHODS

Experimental Site, Animals, Design, and Management Procedures

The study was conducted at Upper Lagnas, San Pedro, Rizal, Occidental Mindoro, Philippines from May to August 2025. Each battery cage was occupied by 3 layers following the recommended space required for layers.

A total of 144 heads of ready-to-lay pullets were procured from Bulacan, Philippines. Layers were bought in their 16 weeks of age after hatching ranging 1.3 to 1.5 kilograms, have bright red comb and wattles and have alert eyes.

This study was conducted using Completely Randomized Design (CRD). Layers were randomly distributed randomly to different treatments and replicated three times containing 12 heads of layer chickens per experimental unit.

The breeder of Black Soldier Fly was procured from Gabutero Organic Farm in Labonan, Bongabong, Oriental Mindoro, Philippines. Adult flies were cultured in a greenhouse set up with proper management to control the temperature and able to grow flies faster and healthily (Chassouant, 2019). To make sure that BSF grows strong and healthy, it was given with high quality waste products like fruit and vegetable peels (Kumar et al., 2020). The larva was harvested at 15 days of larval stage to ensure high protein content. The harvested larvae were killed through blanching in boiled water (Sandec, 2021). Before sun drying, blanching serves as a fast-killing method, which helps reduce microbial contamination, conserve nutrient quality, prevent degeneration of the end product, and maintain a bright color (Zhen et al, 2020). Following the blanching, the larvae were laid out in a single layer on drying trays or mats for them to be evenly exposed to sunlight.

Dried black soldier fly larvae were mixed into commercial layer feeds following every treatment inclusion level. The feeds were manually mixed to ensure uniform distribution of the larvae. A gradual adaptation period of two days was implemented prior to the experimental feeding to minimize stress. Birds were fed twice daily at 6:00 AM and 5:00 PM under a restricted feeding regime, with a feeding rate of 105 g per bird per day.

Upon arrival, birds were provided with drinking water supplemented with 3 tablespoons of sugar per liter to alleviate transport stress. After one-week, clean water was provided ad libitum. Watering systems were regularly checked and sanitized. General health monitoring and sanitation practices were maintained throughout the experimental period.

Eggs were collected daily at 5:00 PM and classified according to weight categories: pewee (40–44 g), pullet (45–49 g), small (50–54 g), medium (55–59 g), large (60–64 g), extra-large (65–69 g), and jumbo (≥ 70 g).

Data Collection

Data were collected over a 90-day period to evaluate the laying performance of the birds. Eggs were collected manually measured in digital weighing scale intended for egg which categorized based on weight ranges: 40–44 grams (pewee), 45–49 grams (pullet), 50–54 grams (small), 55–59 grams (medium), 60–64 grams (large), 65–69 grams (extra-large), and 70 grams and above (jumbo). Feed conversion ratio was obtained by calculating feed consumption by dividing the total weight of feed consumed by the total weight of eggs produced. Eggshell thickness was recorded in millimeter (mm) by measuring the thickness of eggshell using thickness ruler gauge. It was measured twice during the middle and the last part of the experiment. Egg yolk color is the density of color which was evaluated using the Roche Yolk Color Fan (RYCF), a standardized color scale ranging from 1 (light yellow) to 16 (deep orange-red). Four samples in each replication were evaluated. The data were gathered twice, the first data collection was on June 14, 2025, and the last data collection was on August 22, 2025. Total egg production is a total number of eggs produced divided by the number of days of the experimental period and multiplied by 100. Hen-day egg production (%) is the percentage of eggs produced by laying hens in one day relative to the total number of hens present. It was used to measure and compare the daily egg-laying performance of layer chickens under different treatments. Mortality rate is the layer chickens that died within the 90 days experimental period. A net income was computed per hen by subtracting the total expenses from the total sales. Return on Investment (ROI) was calculated by dividing net income by total expenses, then multiplying by 100.

Sanitation and Waste Management

The experimental area was cleaned regularly to avoid the occurrence of pathogens and the presence of ammonia gas. An improvised crate and a shovel were used during cleaning, and carbonized rice hulls were placed beneath the cages where the dropping feces accumulated to help reduce odor. Chicken feces were collected every three days.

Statistical Analysis

Data were analyzed using Analysis of Variance (ANOVA) under a Completely Randomized Design at a 5% level of significance. When significant differences were detected, treatment means were compared using Tukey's Honest Significant Difference (HSD) test.

Scope and Limitations

This study was focused on the laying performance of 'Dekalb White' supplemented with various amounts of dried Black Soldier fly larvae. The laying performance was limited to the parameters; egg size, egg yolk color, eggshell thickness, total egg production, and feed conversion ratio. The profitability was limited to the parameters; net income and return on

investment. There was no proximate analysis conducted for every treatment, and no moisture meter was used during the drying of black soldier fly larvae in this study.

This study was conducted in Upper Lagnas, Barangay San Pedro, Rizal, Occidental Mindoro from May to August 2025.

RESULTS

Laying performance

Table 1. Laying performance of layer chickens fed with different levels of DBSFL.

Treatment	R1	R2	R3	Total	Mean
Total egg production (90 days)					1010.83
T0 (100% CF)	992	988	990	2970	990.00 ^b
T1 (96% CF + 4% DBSFL)	1001	1027	998	3026	1008.67 ^{a b}
T2 (92% CF + 8% DBSFL)	987	940	1015	2942	980.67 ^b
T3 (88% CF + 12% DBSFL)	1034	1083	1075	3192	1064.00 ^a
Total				12130	
Feed Conversion Ratio (FCR)					1.96
T0 (100% CF)	1.89	2.06	1.94	5.88	1.96
T1 (96% CF + 4% DBSFL)	2.03	1.94	2.02	5.98	1.99
T2 (92% CF + 8% DBSFL)	1.95	2.03	2.00	5.98	1.99
T3 (88% CF + 12% DBSFL)	1.92	1.86	1.93	5.71	1.90
Total				23.55	
Hen-Day Egg Production (HDEP)					94.96
T0 (100% CF)	99.09	92.77	94.92	286.78	95.59
T1 (96% CF + 4% DBSFL)	94.16	97.22	96.38	287.76	95.92
T2 (92% CF + 8% DBSFL)	94.58	86.85	91.94	273.37	91.12
T3 (88% CF + 12% DBSFL)	94.58	99.44	93.63	291.65	97.22
Total				1139.56	
Mortality Rate					0.33
T0 (100% CF)	1.00	0.00	1.00	2.00	0.67
T1 (96% CF + 4% DBSFL)	0.00	0.00	0.00	0.00	0.00
T2 (92% CF + 8% DBSFL)	1.00	1.00	0.00	2.00	0.67
T3 (88% CF + 12% DBSFL)	0.00	0.00	0.00	0.00	0.00
Total				4.00	
Egg Size					60.60
T0 (100% CF)	57.27	55.79	63.28	176.34	58.78
T1 (96% CF + 4% DBSFL)	59.99	62.71	61.24	183.94	61.31
T2 (92% CF + 8% DBSFL)	61.00	59.53	61.46	181.99	60.66
T3 (88% CF + 12% DBSFL)	63.50	62.48	58.97	184.95	61.65
Total				727.22	
Egg Yolk Color					15.54
T0 (100% CF)	15.25	15.00	15.50	45.75	15.25
T1 (96% CF + 4% DBSFL)	15.50	15.75	15.50	46.75	15.58
T2 (92% CF + 8% DBSFL)	15.75	15.75	15.50	47.00	15.67
T3 (88% CF + 12% DBSFL)	15.75	15.50	15.75	47.00	15.67
Total				186.50	
Eggshell Thickness					0.36
T0 (100% CF)	0.34	0.35	0.35	1.04	0.35
T1 (96% CF + 4% DBSFL)	0.34	0.36	0.38	1.08	0.36
T2 (92% CF + 8% DBSFL)	0.38	0.33	0.40	1.11	0.37
T3 (88% CF + 12% DBSFL)	0.36	0.38	0.37	1.11	0.37
Total				4.34	

Means with the same superscript are not significantly different at $p>0.05$.

Total egg production (90 days), treatment 3 (88% CF + 12% DBSFL) got the highest mean egg production at 1064.00, followed by Treatment 1 (96% CF + 4% DBSFL) with a mean of 1008.67, and Treatment 0 (100% Commercial feeds) with total of 990.00. Treatment 2 (92% CF + 8% DBSFL) recorded the lowest egg production percentage with a mean of 980.67 The

overall mean of all the treatments was 92.52%. Feed Conversion Ratio (FCR), treatment 3 (88% CF + 12% DBSFL) obtained the lowest mean FCE value (1.90), followed by Treatment 0 (100% CF) with a mean of 1.96, while Treatments 1 (96% CF + 4% DBSFL) and 2 (92% CF + 8% DBSFL) recorded the highest mean FCE (1.99). A lower FCE value reflects better feed efficiency, meaning birds required less feed to produce the same amount of egg mass. Hen-Day Egg Production (HDEP), treatment 3 (88%CF + 12% DBSFL) recorded the top mean egg production (97.22%), and Treatment 1 (96% CF + 4% DBSFL) with a mean of 95.92% was the next highest. A mean of 95.59% was recorded by Treatment 0 (100% CF), and the lowest mean egg production of 91.12% was from Treatment 2 (92% CF + 8% DBSFL). Mortality Rate, treatments 1 (96% CF + 4% DBSFL) and 3 (88% CF + 12% DBSFL) had no mortality (0.00%) hence the birds were very much alive. On the other hand, Treatments 0 (100% CF) and 2 (92% CF + 8% DBSFL) had a mean mortality rate of 0.67%, respectively. The overall total mean mortality rate across all treatments was 0.33%, which pointed to a very healthy environment during the days of the experiment. Egg Size, treatment 3 (88% CF + 12% DBSFL) recorded the highest mean egg size of 61.65 g, followed by Treatment 1 (96% CF + 4% DBSFL) with 61.31 g, Treatment 2 (92% CF + 8% DBSFL) with 60.66 g, and the lowest mean value of 58.78 g was obtained from Treatment 0 (100% CF), which served as the control group. Egg Yolk Color, treatment 2 (92% CF + 8% DBSFL) and Treatment 3 (88% CF + 12% DBSFL) recorded the highest and equal mean yolk color scores of 15.67, followed by Treatment 1 (96% CF + 4% DBSFL) with a mean of 15.58, while the control group (T0 = 100% CF) obtained the lowest mean yolk color score of 15.25. The grand mean for yolk color across all treatments was 15.54. Eggshell Thickness, treatment 2 (92% CF + 8% DBSFL) and Treatment 3 (88% CF + 12% DBSFL) both obtained the highest mean eggshell thickness of 0.37 mm, followed by Treatment 1 (96% CF + 4% DBSFL) with a mean of 0.36 mm. The control group (T0 = 100% CF) recorded the lowest mean of 0.35 mm. The grand mean across all treatments was 0.36 mm

Analysis of variance

Table 2. Analysis of variance (CRD) for total egg production.

Source	DF	SS	MS	F-value	p-value
Total egg production					
Treatment	3	13503.60	4501.19	8.40	0.0074**
Error	8	4285.30	535.67		
Total	11	17788.90			
Feed conversion ratio					
Treatment	3	0.01683	0.00560	1.71	0.2421 ns
Error	8	0.02627	0.00280		
Total	11	0.04309			
Hen-day egg production					
Treatment	3	0.68180	0.22727	2.34	0.1501 ns
Error	8	0.77847	0.09731		
Total	11	1.46027			
Mortality rate					
Treatment	3	0.22413	0.07471	2.67	0.1189 ns
Error	8	0.22413	0.02802		
Total	11	0.44827			
Egg size					
Treatment	3	14.7832	4.92774	0.81	0.5218 ns
Error	8	48.5037	6.06297		
Total	11	63.2870			
Egg yolk color					
Treatment	3	0.35417	0.11806	3.78	0.0589 ns
Error	8	0.25000	0.03125		
Total	11	0.60417			
Eggshell thickness					
Treatment	3	0.0011	0.00036	0.80	0.5279 ns
Error	8	0.0036	0.00045		
Total	11	0.0047			

**Highly significant at p < 0.01
CV = 2.29%

The total egg production computed p-value of 0.0074 was lower than the 0.01 level of significance. The feed conversion ratio computed p-value (0.2421) exceeded the 0.05 significance level, indicating no significant difference among treatments. The Hen-day egg production computed p-value of 0.15 indicates no significant difference existed among

treatments in terms of hen-day egg production. The differences in mortality rate among treatments were not statistically significant ($p = 0.1189$). Since the p -value is greater than 0.05, the null hypothesis is accepted. The egg size computed p -value of 0.5218 indicates no significant difference among the treatments in terms of egg size. The egg yolk color computed p -value of 0.0589 indicates no significant difference among the treatments. The p -value of 0.5279 for eggshell thickness indicates no significant difference among the treatments.

Net Income

Treatment 3 (88% CF + 12% DBSFL) achieved the highest net income of Php 148.06, followed by Treatment 1 (96% CF + 4% DBSFL) with Php 123.83, and Treatment 2 (92% CF + 8% DBSFL) with Php 108.75. The lowest net income was recorded in the control group (T0: 100% CF) at Php 50.48 [table 3].

Table 3. Net income per head of layer chickens fed with various levels of DBSFL (90-day supplementation)

ITEMS	T0 100% CF	T1 96% CF + 4% DBSFL	T2 92% CF + 8% DBSFL	T3 88% CF + 12% DBSFL
Inputs				
Stocks (Php)	430.00	430.00	430.00	430.00
Commercial Feeds (Php)	274.05	263.09	252.13	241.16
DBSFL (Php)	0.00	11.71	23.44	35.15
Electricity (Php)	2.08	2.08	2.08	2.08
Miscellaneous fees (Php)	2.60	2.60	2.60	2.60
Total Inputs (Php)	708.73	709.48	710.25	710.99
Output				
Sales (Php)	759.21	833.31	819.00	859.05
Net Income (Php)	50.48	123.83	108.75	148.06

Notes: Price of egg per piece = Php 8.00; Cost of feeds (kg) = Php 29.00

Black Soldier Fly Larvae Production Cost

The expenses include containers, plastics, BSFL breeders, labor, raw materials, and other miscellaneous items, resulting in a total production cost of Php 8,667. A total of 280 kilograms of BSFL was produced during the experiment. Based on this, the computed production cost per kilogram of BSFL is approximately Php 30.95 [table 4].

Table 4. Production cost of black soldier fly larvae (BSFL)

Items	Quantity	Unit Cost (Php)	Total Cost (Php)
BSFL plastic container	3	90	270.00
Plastic drum	1	1,400	1,400.00
BSFL breeder	10 kg	180	1,800.00
Labor	31 days	150/week	4,700.00
Raw material	3	100	300.00
Net (substrate mesh)	20 meters	9.85	197.00
Total Production Cost			8,667.00

Computed production cost per kg: $\text{Php } 8,667 \div 280 \text{ kg} \approx \text{Php } 30.95/\text{kg}$

Return on Investment (ROI)

Treatment 3 (88% CF + 12% DBSFL) obtained the highest ROI of 19.26%, followed by Treatment 1 (96% CF + 4% DBSFL) with 12.27%, and Treatment 2 (92% CF + 8% DBSFL) with 12.00%. The lowest ROI (7.12%) was recorded in Treatment 0 (100% CF), which contained no DBSFL supplementation [table 5].

Table 5. Return on investment of layer chickens fed with various levels of DBSFL

Treatment	Production Cost (Php)	Net Income (Php)	ROI (%)
T0 = 100% CF	708.73	50.48	7.12
T1 = 96% CF + 4% DBSFL	709.48	123.83	16.68
T2 = 92% CF + 8% DBSFL	710.25	108.75	14.87
T3 = 88% CF + 12% DBSFL	720.28	148.06	20.56

DISCUSSION

The improved egg production in DBSFL-supplemented diets could be linked to the high nutritional value of black soldier fly larvae, which are rich in high-quality protein, essential amino acids, and lipids required for egg production. Insect meals such as BSFL have balanced amino acid profiles comparable to conventional protein sources, which may enhance reproductive performance in poultry [Makkar et al., 2014]. The inclusion of black soldier fly larvae meal in the diet of layer animals significantly affected egg production, while most egg quality parameters remained unaffected [Suparman et al., 2020]. A partial substitution of soybean meal with BSFL meal improved laying performance and egg production in laying hens. The better performance observed in T3 indicates that higher inclusion rates of DBSFL may optimize nutrient utilization without impairing productivity [Dabbou et al., 2018]. A moderate to high inclusion levels of insect meal improved feed conversion efficiency and egg production due to enhanced digestibility and nutrient bioavailability [Kierończyk et al., 2018]. Furthermore, BSFL contains bioactive compounds such as antimicrobial peptides and lauric acid, which may improve gut health and nutrient absorption, thereby contributing to increased egg production [Schiavone et al., 2017].

The addition of Black Soldier Fly larvae to laying hen diets is not harmful to their feed conversion ratio as it exhibits both linear and quadratic reductions in FCR when BSFL levels are raised. Besides, the hens become more productive and the eggs are heavier. Essentially, DBSFL has been demonstrated as a viable and environmentally alternative protein source for layer chickens, keeping feed efficiency at the level of commercial feeds. The findings point to the fact that dried black soldier fly larvae have the potential to tap into profitable business in the layer chicken sector with the highest inclusion level (12%) registering the top economic performance [Nassar et al., 2023].

Treatment 3 (88% CF + 12% DBSL) showed the highest mean hen, day egg production, which means that the addition of DBSFL at 12% can effectively support the egg laying performance of layer chickens. The increased egg production in the treatment is an indication that DBSFL can supply the necessary nutrients for the optimum productivity of chickens, which is at least comparable or even slightly better than that of the conventional feed alone. Therefore, this result shows that layers can make good use of DBSFL without their laying ability being negatively affected. The incorporation of black soldier fly larvae in layer diets did not adversely affect egg production of laying hens. In general, adding DBSFL in layer diets illustrates its potential as a sustainable and alternative protein source that can keep or even increase egg production while making less use of conventional feed ingredients [Bejaei and Cheng, 2023].

The inclusion of dried black soldier fly larvae (DBSFL) in layer diets showed no significant effect on mortality, indicating that DBSFL is a safe and non-toxic feed ingredient up to 12% inclusion. The absence of mortality is likely due to the larvae's beneficial nutrients, including lauric acid [Makkar et al. 2014; Schiavone et al., 2017], and chitin [Hu et al., 2024], which enhance gut health and immunity. Overall, DBSFL can safely replace part of conventional feed ingredients without affecting flock survival, supporting its use as a sustainable protein source for poultry production.

Including DBSFL in layer diets at level 12% had no significant effect on egg size in layer chickens. Even though the difference was not statistically meaningful, hens that received DBSFL tended to produce slightly larger eggs compared to those in the control group. This trend implies that DBSFL can provide additional nutrients, but the commercial feed used in the study is already nutritionally adequate for optimal egg formation. Hence, DBSFL is more of a substitute protein source that works effectively rather than a direct egg size enhancer [Rumpold & Schluter 2013; Makkar et al., 2014]. Tahamtani et al., [2021] who have checked the effect of insect-based proteins such as BSFL in layer diets on egg traits, also found no negative impact on egg weight and size. Rather, insect derived meals can completely substitute protein sources such as soybean meal or fishmeal without production performance being reduced. The findings demonstrate the value of DBSL to be a sustainable and low-cost protein source replacement in chicken nutrition. Since DBSFL can be obtained from organic waste and produced with less environmental impact, it is an environmentally friendly alternative to feed formulations. Most importantly, adding it to the diet does not reduce egg size, thus it is a viable ingredient for a layer production system that is environmentally considerate and financially efficient [Van Huis et al., 2013].

Even though supplementation of dried black soldier fly larvae (DBSFL) up to 12% in the diet of laying hens did not significantly alter yolk color. There was a hint of color enhancement at higher levels of inclusion. This slight alteration could be related to carotenoid pigments in the larvae which, however, were at such low levels that the effect of commercial feeds was not surpassed. Yolk color in this research is the egg yolk pigmentation intensity, measured by a standard color scale similar to the Roche Yolk Color Fan (RYCF), where 1 represents pale yellow and 16 deep orange, red. Grain of truth, wise, DBSFL positive trend to improved yolk color was noticed and thus a protein source from insect larvae that can be utilized besides conventional ones without discriminatory impact on egg parameters was even part of the argumentation. Pigment supplementation and microencapsulation studies such as those with canthaxanthin have illustrated that yolk color determined by the Roche/DSM 16, point fan gets deeper as the fan score goes up, hence stronger pigment deposition and yolk appearance that consumers usually perceive as richer [Bejaei and Cheng, 2023]. Furthermore, this is in agreement with Sulaiman et al., [2023] who observed that even the latest studies on poultry and egg quality still refer to the 1, 16 DBSM/Roche yolk color fan, and research results indicate that higher scores, particularly those approaching 16, are interpreted as indicators of deeper and more intense yolk pigmentation, which scientists regard as a good outcome when the objective is to enhance yolk color.

When dried black soldier fly larvae (DBSFL) were added in the layer diets, eggshell thickness was not significantly different. However, there were slight numerical increases in eggshell thickness. The result indicates that DBSFL, which is a source of additional nutrients, were not included at levels that were sufficient to improve shell formation. Inclusion of BSFL in the layer diet does not negatively affect eggshell thickness because the birds fed the standard commercial feeds produce eggs with shell thickness comparable to those of the BSFL, fed birds. In summary, DBSFL is capable of being a sustainable protein substitute without affecting eggshell quality [Mat et al., 2021].

Supplementing layer chicken diet with dried black soldier fly larvae had a beneficial effect on net income. Of the various treatments, Treatment 3 (88% CF + 12% DBSFL) yielded the greatest net income (148.06). It therefore, signals that 12% inclusion level is able to provide the best mix of nutrient upgrade and feed cost cutting resulting in higher profitability. Close to that are Treatment 1 (96% CF + 4% DBSFL) and Treatment 2 (92% CF + 8% DBSFL) that also resulted in higher net incomes against the control. The figures, Php 123.83 and Php 108.75 respectively, imply that even minimal DBSFL addition levels are still able to give financial gains. On the other side, Treatment 0 (100% CF) reaped the lowest net income. This serves to show that consumption of solely commercial feeds is less cost effective than incorporating DBSFL as an alternative protein source.

Integrating dried black soldier fly larvae (DBSFL) in layer feed as a protein source up to 12%, gave a boost to return on investment (ROI) work. The layer 12% DBSFL group, among others, exhibited the highest ROI at 19.26%. This means that, both the 12% DBSFL group's profit and cost efficiency are significantly higher than those of the control. Most probably, the main factor behind this superior performance is the high nutritional value of DBSFL and its lower price. Hence, DBSFL can be used as an alternative to expensive protein sources such as fishmeal and soybean meal. Several other researchers have also shown that insect meal notably improves feed cost efficiency and production performance. Besides, DBSFL can be grown on organic waste which significantly helps the economy and is environmentally friendly. Insect meal can enhance feed efficiency and at the same time sustain or even increase production performance in poultry. Overall, the trend shows that increasing DBSFL inclusion improves net income, with the most profitable option. This demonstrates the economic advantage of using DBSFL in layer diets, particularly as a sustainable and lower-cost protein ingredient [Waithaka et al., 2022].

CONCLUSIONS

The supplementation of dried black soldier fly larvae had a highly significant effect on total egg production, indicating that its inclusion in the diet positively influenced the overall egg output of the laying hens. However, no significant differences were observed in feed conversion ratio, hen-day egg production, and mortality rate among the different treatments, suggesting that the supplementation did not adversely affect feed efficiency, daily laying rate, or survivability of the birds. The inclusion of dried black soldier fly larvae on the feed supplement of the layer has no significant difference effect on the laying performance of the experimental birds. The results showed that the inclusion of dried black soldier fly larvae in the diets of layer chickens did not significantly affect egg quality parameters, such as egg size, egg yolk color, and eggshell thickness. This implies that the supplementation maintained normal egg quality characteristics across all treatments. The results of the study shows that supplementation of dried black soldier fly larvae has significant effects on total egg production. However, results show that there are no significant effects on, feed conversion ratio, hen-egg production, mortality, egg size, egg yolk color and eggshell thickness. Indicating that supplementation has no negative effects on laying performance and egg quality of layer chickens. Inclusion of 12% dried black soldier fly on the feed diet of the layer produced the best laying performance of the birds. The inclusion of 12% of dried black soldier fly larvae gained the highest return on investment in total of 20.56%.

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DECLARATION OF CONFLICT OF INTEREST

The authors say they do not have any conflict of interest.

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Grammarly was utilized to check and edit the language of the work. All results have been reviewed and validated by the authors, who are fully responsible for the contents.

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EXPERIMENTAL AND NUMERICAL INVESTIGATION OF FIBER REINFORCED COMPOSITE FLOATING BARRIER

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ABSTRACT

The study suggested the implementation of a sustainable floating barrier made of densified recycled plastics strengthened with treated coconut coir fiber, combining coastal protection and waste management through an experimental-computational method. Design-Expert was used to optimize the mixture designs, with mechanical behavior and wave attenuation studied with Finite Element Analysis and ANSYS Fluent. Laboratory tests on ASTM-based testing and the modified Rule of Mixtures were used to validate the numerical results. The optimized design mixture exhibited mechanical strength, water absorption, and durability with the conventional HDPE materials of density 0.848 g/cm³, water absorption of 0.63, and compressive strength of 3.98 MPa. The results in wave attenuation demonstrated 14.80%-26.57% reduction with a mean absolute percentage error of 12.29, showing a good correspondence of the numerical and experimental results.

Keywords: *floating barrier, wave attenuation, densified plastic, coconut coir fiber, Finite Element Analysis, Computational Fluid Dynamics*

SDG: *SDG 9: Industry, Innovation, and Infrastructure; SDG 13: Climate Action*

INTRODUCTION

The increase in vulnerability of the coastal regions to storm waves and erosion created more pressing demands for more effective sustainable coastal protection systems. These are the floating barriers to absorb the energy of the waves and protect the coastal structures and ecosystems (Edmonds et al., 2020; Reis et al., 2025). Defensive measures currently in place in the coastal areas have not been able to withstand extreme events leading to the need of stronger and more flexible actions (Estacio et al., 2025; GMA News, 2020). This need is particularly relevant in the Philippines, where long coastlines and frequent typhoons increase the risk of coastal damage and flooding (NASA, 2024; Nature Communications, 2022).

Meanwhile, mass amounts of plastic waste have been dumped into marine systems each year (United Nations Environment Programme, 2022). The Philippines is one of the most active sources of marine plastic pollution (Jambeck et al., 2015), showing the possibility of recycling waste materials. Recycled plastics, expanded polystyrene (EPS), and coconut coir fiber have been found to enhance compressive and tensile strength (Anggraini et al., 2015; Guruswamy et al., 2024), while coir fiber shows benefits in availability and sustainability. Furthermore, the natural fiber composites have been regarded as a promising source of marine engineering due to positive strength-to-weight ratio and sustainability advantages (El Hawary et al., 2023).

While densified plastics have been explored as a recycled material due to its structural stability and physical properties, most have primarily focused on material characterization with limited attention given to practical applications with numerical validation for marine applications particularly in coastal systems. The proposed study aims to produce mixtures of LDPE, EPS, waste cooking oil, and treated coconut coir fiber and numerically assess their mechanical performance using Fusion 360. This study contributes to the development of a sustainable floating barrier system while promoting plastic waste utilization.

METHODS

Research Design

The study employed an experimental-computational research design in which the floating plastic composite was developed and tested to evaluate its mechanical behavior and wave attenuation performance.

Project Development Methodology

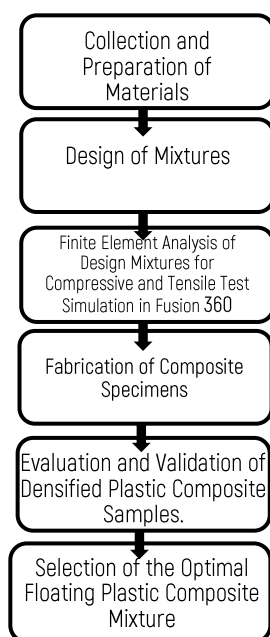


Figure 1. Flow chart of the project development methodology.

Collection and Preparation of Materials

a) Low-Density Polyethylene (LDPE) and Expanded Polystyrene (EPS)

Materials used were non-foil plastic wrappers, bubble wrap, and EPS. Gathered plastics were washed and dried to eliminate contaminants and moisture and shredded into particles.

b) Coconut Coir Fiber

The preparation of coconut coir fibers in this study followed the procedure described by Kondo et al. (2023). Fibers were washed, dried after 24 hours under air and cut to 30 mm length. Treated with 20 percent NaOH for three hours to eliminate lignin and impurities and rinsed and dried in the sun over 24 hours.

c) Used Cooking Oil

The oil was collected after the first use for cooking and stored temporarily in clean plastic containers.

Design of Mixtures

Response Surface Methodology (RSM) in Design-Expert software was used to formulate floating plastic composites. The mixture designs were constrained to total 100%, with densified LDPE and EPS ranging from 1-99% and treated coconut coir fiber limited to a maximum of 20%.

Finite Element Analysis of Design Mixtures for Compressive and Tensile Test Simulation in Fusion 360

A combined finite element analysis (FEA) and experimental approach was used to evaluate the mechanical behavior of coconut coir fiber-reinforced plastic composites. Autodesk Fusion 360 simulated ASTM compressive tensile tests using material properties estimated through the Rule of Mixtures (ROM). Mesh refinement was applied in critical regions.

Fabrication of Composite Specimens

Composite specimens were fabricated through a manual densification process using medium-sized stainless steel cooking ware. The volume of LDPE, EPS, and treated coconut coir fiber were measured with the amount of used cooking oil prepared in equal to the total mixture volume and used as the heating medium.

The oil was preheated to 100°C for 30 minutes prior to gradually adding shredded plastics. The densification process was maintained at 125–175°C using a food-grade thermometer for approximately 30 minutes until a uniform consistency was achieved, then poured into prepared molds. Treated coconut coir fiber was then added and manually mixed to ensure even distribution throughout the composite before allowing the specimens to set. Mold dimensions followed

ASTM standards: 50 mm × 50 mm × 50 mm for compressive strength specimens and 165 mm × 19 mm × 3.2 mm for tensile specimens with a 50 mm gauge length.

Evaluation and Validation of Densified Plastic Composite Samples

The densified plastic composites were evaluated through laboratory testing to validate their mechanical behavior. Tests were conducted in accordance with ASTM standards for density and specific gravity (ASTM D792), water absorption (ASTM D570), and compressive strength (ASTM C109). Tensile strength and other mechanical properties were estimated using the modified Rule of Mixtures (ROM) following Espinach et al. (2023). The mechanical properties of the densified plastic composite were estimated using the modified Rule of Mixtures (ROM). The matrix tensile strength was calculated using Equation 1.

$$\sigma_{Ct} = f_c \cdot \sigma_{Ft} V_F + \sigma_{Mt} V_M \quad - \text{eq. 1}$$

Where:

σ_{Ct} = predicted tensile strength of the composite

σ_{Ft} = tensile strength of the fiber

V_F = fiber volume fraction

$V_M = 1 - V_F$ = matrix volume fraction

f_c = fiber orientation efficiency factor

Each mixture was considered valid when the average experimental and empirical load fell within the nearest simulated load.

Selection of the Optimal Floating Plastic Composite Mixture

LDPE, EPS, and treated coconut coir fiber proportions were used as independent variables in Design-Expert RSM, while density, water absorption, compressive strength, and tensile strength as the response variables. Regression models were developed to predict material behavior, and prediction accuracy was evaluated using Relative Standard Error (RSE) which is given by Equation 2.

$$RSE (\%) = \frac{\text{Actual Value} - \text{Predicted Value}}{\text{Predicted Value}} \times 100 \quad - \text{eq. 2}$$

Wave Attenuation Performance of Floating Plastic Composite Prototype

The testing was done in two complementary methods; a numerical simulation in ANSYS Fluent and experimental test in a flume tank in different conditions of waves. The most significant parameters taken in the research were incident wave height (H_i), transmitted wave height (H_t), wave transmission coefficient (K_t) and wave reduction (WR).

Numerical Simulation of Wave Attenuation



Figure 2. Flow direction from inlet to outlet from ANSYS.

Using Computational Fluid Dynamics (CFD) software, ANSYS Fluent, a transient two-phase flow model is used to compute the wave-structure interaction and to analyse the hydraulic performance of the floating densified plastic composite, assuming gravity and rigid body. The simulation domain was a wave flume for which the water tank was partially filled with water and air, enabling free surface movement. Following a 1:40 geometric scale (Armono et al., 2019), the computational domain was set to 5000 mm × 1000 mm × 800 mm (L × W × H). The 500 mm floating prototype, equivalent to 20,000 mm × 6000 mm × 4800 mm in actual scale, was positioned at a water depth of 500 mm, with a 60° mooring angle and a distance of 2675 mm from the inlet.

a. Mesh Generation

Figure 2 shows the three-dimensional model was created in ANSYS DesignModeler and brought in ANSYS Workbench. For meshing, only the surface body was used to allow a two-dimensional analysis, with an automatic meshing method and a manually defined element size of 5 mm.

b. Wave Generation and Boundary Conditions

The wave heights used in this study were those of the Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA) which were classified into low, moderate, and high wave conditions. Using Froude scaling (1:40), the corresponding model wave heights were 0.0169 m, 0.0656 m, and 0.1625 m for actual wave heights of 0.6750 m, 2.6250 m, and 6.5000 m, with prototype wave periods of 0.47 s, 0.79 s, and 1.26 s, wavelengths of 0.3513 m, 0.9744 m, and 2.4787 m, and frequencies of 2.1082 Hz, 1.2658 Hz, and 0.7937 Hz, respectively.

c. Data Monitoring and Output Parameters

The maximum and minimum values obtained directly from the probe signals were used to determine the incident wave height (H_i) and transmitted wave height (H_t); utilized in the calculation of the wave transmission coefficient (K_t) and wave reduction (%).

Experimental Validation Using Flume Tank Testing

An experiment on a wave flume was carried out in a laboratory-scale to confirm the findings of the numerical simulation by duplicating the same conditions of waves as those that were used in the computational model.

a. Apparatus and Experimental Set-Up

The experimental testing was conducted in a 5000 mm × 1000 mm × 800 mm flume tank equipped with a mechanical paddle wave generator. Water surface elevations were monitored using an Arduino-based data acquisition system and two HC-SR04 ultrasonic sensors positioned above the water surface at a distance of 24 cm.

b. Wave Production and Management.

Wave generation is obtained with the help of mechanical wave maker, and wave properties are adjusted with the help of a programmable wave controller. The simulations are sustained by regular waves via controlled input conditions.

c. Sensor Placement

The wave height was measured by two sensors: Sensor 1 was at 300 mm upstream of the center to measure the initial height (H_1), and Sensor 2 was at 300mm downstream to measure the corresponding height (H_2), located in accordance with the numerical model and the experimental and simulated results could be compared.

d. Acquisition and averaging of data.

The sensors were attached to an Arduino microcontroller that was programmed to calculate the average of the recorded distances of each sensor during the 30-second period. This was done to the incident and transmitted sensors separately to each trial.

e. Wave Height Determination

Wave heights of the trials were determined by the following equation 3.

$$H_w = 2(H_s - MD_{avg}) \quad - \text{eq. 3}$$

Where:

H_w = Wave height

H_s = Height of the sensor

MD_{avg} = Average measured distance

This procedure was done in each of the three experiments of each case and the mean height of the wave was calculated as:

$$H_{avg} = \frac{\sum_{i=1}^{N_W} H_w}{N_W} \quad - eq. 4.$$

Where:

H_{avg} = Average wave height
 H_w = Wave height
 N_W = Number of trials

f. Wave Transmission Coefficient

The transmission coefficient of the floating structure was determined as K_t , which is a measure of the proportion of wave energy that passes beyond the floating structure:

$$K_t = \frac{H_t}{H_i} \quad - eq. 5$$

Where:

K_t = Wave transmission coefficient
 H_t = Transmitted wave height
 H_i = Incident wave height

K_t values below 1 imply that the waves incident are attenuated whereas $K_t = 1$ approximates that the wave energy is not significantly reduced.

g. Wave Reduction

Wave reduction was expressed as a percentage to evaluate the effectiveness of the structure in dissipating wave energy:

$$WR (\%) = \left(1 - \frac{H_t}{H_i}\right) \times 100 \quad - eq. 6$$

Where:

WR = Percentage of wave reduction
 H_t = Transmitted wave height
 H_i = Incident wave height

Positive value implies a good attenuation of the wave, and negative or zero value implies that there is no significant reduction or possibly an increase of the wave heights.

Comparison of Numerical Predictions with Experimental Results Using MAPE

The Mean Absolute Percentage Error (MAPE) was employed to compare the simulated and experimental results and to assess the accuracy of the numerical simulation in predicting the heights of the transmitted waves.

$$MAPE (\%) = \frac{1}{n} \sum_{i=1}^n \left| \frac{H_{t,num,i} - H_{t,exp,i}}{H_{t,exp,i}} \right| \times 100 \quad - eq. 7$$

Where:

$H_{t,num,i}$ = Transmitted wave height from numerical simulation for trial
 $H_{t,exp,i}$ = Transmitted wave height from experimental measurement for trial
 n = number of trials

The interpretation of MAPE values is based on standard practice in wave studies:

- $MAPE < 10\%$ - Excellent agreement
- $10\% \leq MAPE \leq 20\%$ - Good agreement

- $20\% < \text{MAPE} \leq 50\%$ - Reasonable agreement
- $\text{MAPE} > 50\%$ - Poor agreement

This measurement procedure is similar to the methodology used by Ridlwan et al. [2021], who applied the Volume of Fluid (VOF) technique to determine the transmission coefficient of notched-shaped floating breakwaters.

RESULTS

Floating Plastic Composite Mixtures

Design-Expert came up with eleven composite mixtures of different proportions of LDPE, EPS, and treated coconut coir fiber. These mixtures were designated as Mixture Codes 1 to 11.

Finite Element Analysis of Design Mixtures for Compressive Test and Tensile Test Simulation in Fusion 360

The mechanical behavior of different design combinations during uniaxial compressive and tensile loading conditions was evaluated using Fusion 360. Under uniaxial compressive loading (6000 N to 12,000 N), a linear increase in von Mises stress in all design mixtures were observed. Mixture Codes 6 and 9 recorded higher von Mises stress values, ranging from 2.23 MPa to 5.35 MPa, while Mixture Code 11 showed lower stress values. For uniaxial tensile loading (50N to 300N), the maximum von Mises stress values were between 3.11 MPa and 18.59 MPa. Mixtures Code 8 and 9 showed slightly higher stress values than the other mixtures. However, the difference between the tensile responses among all mixtures was minimal.

Fabrication and Experimental Validation of the Floating Plastic Composite Mixtures

a. Fabrication Outcomes

Eleven composite mixtures were fabricated. Of these, seven mixtures (Mixture Codes 1, 2, 3, 4, 6, 8, and 9) were made into solid specimens, and four mixtures (Mixture Codes 5, 7, 10, and 11) failed to be made. Moreover, Control 1 (pure LDPE) and Control 2 (pure EPS) were made successfully. The successfully fabricated mixtures were taken through further physical and mechanical testing.

b. Physical and Mechanical Properties

Table 1 summarizes the physical and mechanical properties of the fabricated composite mixtures.

i. Density

The density of the developed composite mixtures was between 0.6480 g/cm³ and 0.8480 g/cm³. The lowest densities were found in Mixture Codes 8 and 9 at 0.6533 g/cm³ and 0.6480 g/cm³, respectively. Mixture Code 2 and 4 had the highest densities of 0.8480 g/cm³ each. Control 1 exhibited a density of 0.7413 g/cm³, while Control 2 had a density of 0.7680 g/cm³.

ii. Water Absorption

Water absorption values of the composite mixtures ranged from 0.34% to 7.41%. The lowest values were observed in Mixture Codes 1 and 4, with water absorption of 0.34% and 0.63%, respectively. The highest values were recorded in Mixture Codes 8 and 9, with 7.35% and 7.41%, respectively. Both Control 1 and Control 2 exhibited 0% water absorption.

Table 1. Results of Physical and Mechanical Testing

Mixture Code	Density (g/cm ³)	Water Absorption (%)	Compressive Strength (MPa)	Tensile Strength (MPa)
1	0.7813	0.3400	2.4400	3.1734
2	0.8480	0.9400	2.8400	5.8794
3	0.7040	0.7600	3.0000	8.7425
4	0.8480	0.6300	3.9800	9.5358
6	0.6907	3.0900	4.3500	10.0393
8	0.6533	7.3500	3.8200	18.0890
9	0.6480	7.4100	4.3600	16.5669
C1	0.7413	0.0000	2.9300	8.6700
C2	0.7680	0.0000	4.8600	0.2137

iii. Compressive Strength

The compressive strength of the developed composites ranged from 2.44 MPa to 4.36 MPa. The lowest compressive strength was observed in Mixture Code 1 (2.44 MPa), while the highest values

were recorded in Mixture Codes 6 and 9, with 4.35 MPa and 4.36 MPa, respectively. Control 1 and Control 2 had compressive strengths of 2.93 Mpa and 4.86 Mpa, respectively.

iv. Tensile Strength

The tensile strength of the composites that were developed ranged between 3.17 Mpa and 18.09 Mpa. Mixture Code 1 had the lowest value with a tensile strength of 3.17 Mpa. Conversely, Mixture Codes 8 and 9 had the largest tensile strengths of 18.09 MPa and 16.57 MPa respectively. Control 1 had a tensile strength of 8.67 MPa, which is among the control samples. where Control 2 had a significantly smaller value of 0.21 MPa.

c. Validation of Mechanical Simulation Results Using Experimental Compression and Empirical Tensile Data

The compressive and tensile stresses obtained from Autodesk Fusion 360 simulations were compared with experimental results. As shown in Table 2, the compressive tests and maximum von Mises stress ranged from 2.5640-5.1960 MPa, while mean compressive stress ranged from 2.4412-4.8628 MPa. The simulated and experimental values showed good agreement, with absolute errors between 2.64% and 10.29%.

Table 2. Stress Comparison between Uniaxial Simulation and Experimental Compression

Mixture Code	Simulated Load (N)	Average Experimental Load (N)	Maximum Von Misses Stress (MPa)	Average Compressive Stress (Mpa)	Absolute Margin of Error (%)
1	6000	6103	2.5640	2.4412	5.0303
2	7000	7103	3.0440	2.8412	7.1378
3	7000	7500	3.1100	3.0000	3.6667
4	10000	9957	3.5730	3.9828	10.2892
6	10000	10873	4.4640	4.3492	2.6396
8	10000	9550	3.9430	3.8200	3.2199
9	11000	10903	4.6310	4.3612	6.1864
C1	7000	7317	3.0600	2.9268	4.5510
C2	12000	12157	5.1960	4.8628	6.8520

Table 3 shows the tensile test simulation results in comparison to the empirical tensile calculations. The tensile loads applied gave a maximum von Mises stress range of 3.11-18.59 MPa. The average tensile stress ranged from 0.2137 to 18.0890 MPa, while the margin of error ranged from 1.15% to 16.52%

Table 3. Stress Comparison between Uniaxial Simulation and Experimental Tension

Mixture Code	Simulated Load (N)	Average Empirical Load (N)	Maximum Von Misses Stress (MPa)	Average Tensile Stress (MPa)	Absolute Margin of Error (%)
1	50	55.5084	3.1370	3.1734	1.1470
2	100	103.0378	6.2470	5.8794	6.2523
3	150	150.8018	9.3880	8.7453	7.3491
4	150	165.6132	9.3320	9.5358	2.1372
6	150	167.4920	9.3260	10.0393	7.1051
8	300	300.4868	18.5920	18.0890	2.7807
9	250	273.6284	15.4950	16.5669	6.4701
C1	150	152.1133	9.3640	8.6700	8.0046
C2	5	5.1288	0.2560	0.2137	16.5234

Determination and Validation of the Optimal Floating Plastic Composite Mixture

1. Regression Models for Response Prediction

Regression models were created using Response Surface Methodology (RSM), which showed the correlation between components of mixtures and composite responses. The independent variables were LDPE

content (A), EPS content (B), and coconut coir fiber content (C). The regression equations of the respective responses are as follows:

Density Model:

$$\text{Density} = 0.828463A + 0.750978B - 0.064412C$$

Water Absorption Model:

$$\text{Water Absorption} = 0.097196A + 0.304332B + 35.60197C$$

Compressive Strength Model:

$$\text{Compressive Strength} = 3.33071A + 2.47458B + 8.076244C$$

Tensile Strength Model:

$$\text{Tensile Strength} = 8.69477A + 0.117738B + 56.52301C$$

2. Statistical Modeling and Prediction Using Design-Expert

a. Density

Density results indicate high consistency of experimental and predicted values in all mixtures (0.0306%-11.3350%). Table 4 gives the comparison between experimental and predicted values of the density.

Table 4. Comparison of Experimental and Predicted Density Values

Mixture Code	Actual Value Density	Predicted Value Density	Density RSE
1	0.7813	0.7779	0.4371
2	0.8480	0.8030	5.6040
3	0.7040	0.7940	11.3350
4	0.8480	0.8058	5.2370
6	0.6907	0.7042	1.9171
8	0.6533	0.6535	0.0306
9	0.6480	0.6349	2.0630

b. Water Absorption

Water absorption results showed a great deviation, which is indicative of greater sensitivity to the microstructural variations. Comparison of experimental and predicted water absorption values has been provided in Table 5.

Table 5. Comparison of Experimental and Predicted Water Absorption Values

Mixture Code	Actual Value Water Absorption	Predicted Value Water Absorption	Water Absorption RSE
1	0.3400	0.2324	46.2995
2	0.9400	0.1653	468.6630
3	0.7600	1.0000	24.0000
4	0.6300	0.9691	34.9912
6	3.0900	3.8900	20.5656
8	7.3500	7.0300	4.5519
9	7.4100	7.2400	2.3481

c. Compressive Strength

The results of compressive strength indicate moderate correlation between experimental and predicted compressive strength; the model is performing reasonably within the experimental range. The results of the comparison of the experimental and predicted values of compressive strength are shown in Table 6.

d. Tensile Strength

The tensile strength results are in good agreement with the experimental and the predicted values of tensile strength. Table 7 shows the comparison of experimental and predicted tensile strength values.

Table 6. Comparison of Experimental and Predicted Compressive Strength Values

Mixture Code	Actual Value Compressive Strength	Predicted Value Compressive Strength	Compressive Strength RSE
1	2.4400	2.7700	11.9134
2	2.8400	3.0500	6.8852
3	3.0000	3.3200	9.6386
4	3.9800	3.4600	15.0289
6	4.3500	3.5600	22.1910
8	3.8200	4.3800	12.7854
9	4.3600	4.2500	2.5882

Table 7. Comparison of Experimental and Predicted Tensile Strength Values

Mixture Code	Actual Value Tensile Strength	Predicted Value Tensile Strength	Tensile Strength RSE
1	3.1734	3.0900	2.6990
2	5.8794	5.8700	0.1601
3	8.7425	8.4800	3.0955
4	9.5358	9.7800	2.4669
6	10.0392	10.2600	0.0215
8	18.0890	17.9400	0.8305
9	16.5669	16.600	0.1994

3. Statistical Model Adequacy

The statistical performance of the regression models was evaluated using R^2 , adjusted R^2 , predicted R^2 , F-value, and p-value. Table 8 summarizes the statistical parameters of the developed models.

Table 8. Statistical Summary of Regression Models

	Density	Water Absorption	Compressive Strength	Tensile Strength
R^2	0.7255	0.9742	0.5844	0.9988
Adjusted R^2	0.5883	0.9613	0.3766	0.9982
Predicted R^2	0.3401	0.9399	-0.3892	0.9962
p Value	0.0753	0.0007	0.1727	<0.0001
F Value	5.2900	75.4700	2.8100	1644.48
C.V %	7.5000	21.2800	17.2500	2.23
Standard Deviation	0.0554	0.6239	0.6109	0.2294
PRESS	0.0295	3.6300	4.9900	0.6668

4. Optimization of Mixture Composition

Table 9. Predicted Properties and Desirability of Densified Plastic Composite Mixtures

No.	Density	Water Absorption	Compressive Strength	Tensile Strength	Desirability	
1	0.8118	0.7324	3.4190	9.4619	0.549	Selected
2	0.8277	0.0993	3.3222	8.609	0.543	
3	0.7897	0.2008	2.9027	4.4063	0.254	

Optimization was performed using Design-Expert software to determine the optimal combination of LDPE, EPS, and coir fiber based on multiple response criteria. Three candidate solutions were created using the software, each having the predicted response values and desirability indices. Out of the solutions generated, the formulation with the highest

desirability value (Mixture Code 4) was chosen as the best mixture. The following optimization outcomes are summarized in Table 9.

5. Validation of Optimal Mixture

The best combination was also confirmed using experimental testing by comparing the predicted values with the measured ones. Table 10 shows the results of this validation.

Table 10. Validation of the Optimal Mixture

Parameter	Actual Value	Predicted Value	RSE (%)
Density (g/cm ³)	0.8480	0.8058	5.2370
Water Absorption (%)	0.6300	0.9691	34.9912
Compressive Strength (MPa)	3.9800	3.4600	15.0289
Tensile Strength (MPa)	9.5358	9.7800	2.4669

Evaluation of Wave Attenuation Performance

The ANSYS Fluent simulations and the experimental results of the flume tank were used to assess the performance of the developed floating composite on the attenuation of the waves. They were measured in terms of incident wave height (Hi), transmitted wave height (Ht), wave transmission coefficient (Kt) and wave reduction (WR).

a. Numerical Simulation Results

The results of simulations were invariably reliable in pointing out the decrease in wave height after the encounter with the structure in all the test cases. Table 11 shows incident and transmitted wave heights of all the test cases. The findings indicate that the heights of the transmitted waves (Ht = 18.9000200 mm) were always lower as compared to the incident wave heights (Hi = 20.1000202 mm).

Table 11. Numerical Wave Heights

Test Case	Incident Wave Height (mm)	Transmitted Wave Height (mm)
Case 1 (Low)	20.1000	18.9000
Case 2 (Moderate)	67.1000	62.3000
Case 3 (High)	202.2000	166.3000

The values of the wave transmission coefficient and values of wave reduction are summarized in Table 12. The results show that the value of Kt lies between 0.8225 and 0.9403, and the percentages of the wave reduction are about 5.97 to 17.75.

Table 12. Numerical Wave Transmission Coefficient and Wave Reduction

Test Case	Incident Wave Height (mm)	Transmitted Wave Height (mm)	Wave Transmission Coefficient	Wave Reduction (%)
Case 1 (Low)	20.1000	18.9000	0.9403	5.97
Case 2 (Moderate)	67.1000	62.3000	0.9285	7.15
Case 3 (High)	202.2000	166.3000	0.8225	17.75

b. Experimental Testing Results

Table 13. Experimental Wave Heights

Test Case	Incident Wave Height (mm)	Average Incident Wave Height (mm)	Transmitted Wave Height (mm)	Average Transmitted Wave Height (mm)
Case 1 (Low)	20.5060	21.3444	17.0333	18.1857
	21.5712		18.3627	
	21.9559		19.1610	

Test Case	Incident Wave Height (mm)	Average Incident Wave Height (mm)	Transmitted Wave Height (mm)	Average Transmitted Wave Height (mm)
Case 2 (Moderate)	57.0190	59.5974	47.2248	48.3252
	61.9666		51.8361	
	59.8066		45.9148	
Case 3 (High)	197.9221	174.6510	137.0041	128.2463
	173.8639		147.4275	
	152.1668		100.3072	

Table 13 shows the incident and transmitted wave heights recorded. The mean incident wave heights were between 21.3444 mm and 174.6510 mm with the mean transmitted wave height being between 18.1857 mm and 128.2463 mm throughout all the test cases.

Table 14 shows that the wave transmission coefficient (K_t) ranged from 0.7343 to 0.8520, corresponding to wave reduction (WR) values of approximately 14.80% to 26.57%.

Table 14. Experimental Wave Transmission Coefficient

Test Case	Incident Wave Height (mm)	Transmitted Wave Height (mm)	Wave Transmission Coefficient	Wave Reduction (%)
Case 1 (Low)	21.3444	18.1857	0.8520	14.80
Case 2 (Moderate)	59.5974	48.3252	0.8109	18.91
Case 3 (High)	174.6510	128.2463	0.7343	26.57

c. Validation of Numerical Results Using Experimental Data

The level of agreement between the numerical simulations and the experimental measurements of the wave transmission coefficient (K_t) was assessed using the Mean Absolute Percentage Error (MAPE). The absolute percentage error ranged from 10.36% to 14.50% across all cases, while the overall mean absolute percentage error (MAPE) was 12.2902%. Table 15 shows the comparison between numerical and experimental K_t values and the corresponding percentage errors.

Table 15. Comparison of Results and Percentage Error (MAPE)

Test Case	Wave Transmission Coefficient (Simulation)	Wave Transmission Coefficient (Experimental)	Absolute Percentage Error (%)	MAPE (%)
Case 1 (Low)	0.9403	0.8520	10.36	12.2902
Case 2 (Moderate)	0.9285	0.8109	14.50	
Case 3 (High)	0.8225	0.7343	12.00	

DISCUSSION

Fusion 360 showed that the compressive stress of all mixtures were within the reported range (1.35–9.92 MPa) of similar materials reported (Vilane et al., 2021) suggesting consistency with experimentally determined material performance. Similarly, all mixtures were found to have tensile simulation results within the reported tensile strength range (3.024–20.15 MPa) of similar polymer composite materials (Patel & Mehta, 2022; Karaki et al., 2024; Hassan et al., 2025) validating the predicted tensile behavior of the developed mixtures.

The fabrication results show that mixture composition impacts the structural integrity of floating composites. Eleven mixtures yielded seven stable mixtures with adequate LDPE content, while four with less LDPE did not form cohesive structures. This underscores LDPE's importance as the major binding matrix. The developed composites had a density between 0.648 and 0.848 g/cm³. Lower densities occurred in mixtures with more EPS and coconut coir fibre due to air voids and fibre porosity (Mohammed et al., 2025; Sriprom et al., 2022). All mixtures had densities below freshwater (1.00 g/cm³) and seawater (1.02–1.03 g/cm³), ensuring buoyancy.

Compressive and tensile tests simulation were compared to experimental results. The compressive results reveal a linear relationship between applied load and Von Mises Stress, consistent with the polymer composite behavior (Mercado-Colmenero et al., 2023). Errors between simulated and experimental outcomes were attributed to factors such as internal voids, imperfect bonding, and surface friction which could not be represented in the idealized FEA model (Sai et al., 2013). The relative errors for compressive (2.64–10.29%) and tensile (1.15–16.52%) tests were within acceptable ranges reported in previous studies, validating the developed model (Leong et al., 2015; Rahman et al., 2021). The compressive strengths of the composite mixtures lie between 2.44 MPa and 4.36 MPa, tensile strengths lie between 3.17 MPa and 18.09 MPa. The optimization solution found the Mixture Code 4 as an acceptable formulation according to the metric desired (0.5490).

Validation results showed strong agreement between experimental and predicted values for density (RS = 5.2370%), and tensile strength (RSE = 2.4669%) indicating good representation of bulk physical properties and the influence of fiber-reinforcement on tensile performance, while water absorption (RSE = 34.99%) and compressive strength (RSE = 15.03%) exhibited greater variability due to microstructural effects and fiber-alignment (Bam et al., 2023).

The optimized mixture outperformed Control 1, achieving higher tensile strength (9.54 vs. 8.67 MPa) and compressive strength (3.98 vs. 2.93 MPa), with a higher density (0.8480 vs. 0.7413 g/cm³).

Both numerical and experimental results confirmed the wave attenuation capability of the developed floating composite, with wave reduction ranging from 5.97–17.75% for numerical ($K_t = 0.8225$ – 0.9403) and 14.80–26.57% for the experimental ($K_t = 0.7343$ – 0.8520).

CONCLUSION AND RECOMMENDATIONS

The results indicate that densified LDPE mixed with EPS and coconut coir fiber can be used in floating barrier applications. The resulting mixtures were all characterized by low density, buoyancy, and sufficient strength, which supported their use as floating structures. Both numerical simulations (ANSYS Fluent) and experimental flume tank tests confirmed the prototype's structural integrity and wave attenuation capacity of the prototype developed and the results of both methods were in good agreement.

Further studies are recommended to optimize material composition and structural design to enhance wave attenuation under varying hydraulic conditions and improve moisture resistance and long-term marine durability.

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DECLARATION OF CONFLICT OF INTEREST

The authors declare no conflict of interest.

DECLARATION OF AI USE

The authors used Grammarly for grammar checking and language editing. All outputs were reviewed and validated by the authors, who take full responsibility for the content.

AUTHOR CRediT STATEMENT

Victoria, L. Y. O.: conceptualization, methodology, software, validation, formal analysis, investigation, data curation, writing- original draft, and writing- review & editing.; **Vargas, E. G.:** conceptualization, methodology, software, validation, formal analysis, investigation, data curation, writing- original draft, and writing- review & editing.; **Malpaya, A. C. V.:** conceptualization, methodology, software, validation, formal analysis, investigation, data curation, writing- original draft, and writing- review & editing.; **Malibiran, G. I.:** conceptualization, methodology, investigation, data curation, writing- original draft, and writing- review & editing.; **Hernandez, N. M.:** conceptualization, methodology, investigation, data curation, writing- original draft, and writing- review & editing.; **Caugma, M. G. L.:** supervision and writing- review & editing.

RIZALERT: A WEB APPLICATION AND IOT-INTEGRATED EMERGENCY RESPONSE SYSTEM

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ABSTRACT

Emergency communication needs to be quick and effective in order to have the least casualties and damage. Nevertheless, in most communities, there is a lag in reporting the incidents and getting in touch with the emergency responders because of lack of integrated communication networks. This research has come up with RizAlert, a web-based application and IoT-based emergency response system that aims to enhance emergency reporting, communication, and response management within the Municipality of Rizal, Occidental Mindoro. The system was created through the Rapid Application Development (RAD) methodology that involved requirements planning, prototyping, iterative testing, construction and deployment. RizAlert has the capability to share real-time GPS location, medical emergency, fires, disasters and crimes, safety status tagging (Safe, In Danger, or Evacuating), emergency warning, and resources on safety preparedness. The ISO 25010 and FURPS software quality standards were used to evaluate the system by selected students, residents, and emergency responders as well as IT experts. The results of the evaluation showed that RizAlert was an effective application in functionality, usability, reliability, performance efficiency and security. Real-time GPS monitoring, the cloud-based data management system, and IoT-based alerts were also integrated to enhance the coordination of users, administrators, and responders. The research finds that RizAlert can be used to improve the effectiveness of emergency response, disaster preparedness and community safety in Rizal, Occidental Mindoro and could be scaled to other municipalities.

Keywords: *emergency response system, Internet of things (IoT), mobile application, web application*

SDG: *SDG 3 – Good health and wellbeing, SDG 9 – industry, innovation and infrastructure, SDG 11 – sustainable cities and communities*

INTRODUCTION

The World Health Organization (2020) highlighted that emergency responses are an essential element of health and safety of the population, therefore, enabling a prompt medical intervention in case of emergencies, which leads to fewer victims and less complicated outcomes. As an example, cardiac arrests, severe injuries, and natural disasters need assistance at some point in time. In such cases every second can be life and death.

The technological innovations have led to the creation of the Internet of Emergency Services (IoES), which involves the integration of internet-connected devices and systems into the emergency response and management. By enhancing coordination of various agencies in emergency response and real-time data collection and analysis, such integration has the potential to revolutionize delivery of emergency services [Damaševičius et al., 2023].

As technology has achieved a lot of advancement in the sphere of communication [Sienkiewicz-Małyjurek & Zyzak, 2026], more effective ways of keeping in touch and being aware have emerged. Digital technology has revolutionized most industries, emergency being one of them where real time communication and sharing of information can be done. Emergency applications have shown their positive effectiveness in reducing response times, and improving coordination between responding resources. Nuevas et al. (2024) claim that the abundance of cellphones and the combination of cellphones with GPS opens up new possibilities to improve emergency response systems. The research also reveals that the thinking-out coming system plays a significant role in enhancing the overall emergency management process and emergency response time in the selected area. The majority of solutions available in the market have single features as opposed to a combined feature with real-time notifications, location tracking and first aid instructions.

Fabito et al. (2016) said that nothing is spared when a disaster occurs no matter how much mitigations or office of the prevention effort the government have done. Events such as floods, earthquakes and epidemics generally result in a high number of deaths and have an impact on the operation of adjacent medical institutions. In this respect, Chen et al. (2020) highlight the need for timely medical assistance and treatment. The study was conducted in the Municipality of Rizal, Occidental Mindoro specifically because this area exhibits unique significant definition with respect to geographic, infrastructure and socio-economic conditions for which the resultant queries demonstrated a high-level challenge that needs an improved emergency response system. With the municipality consists of widely dispersed barangays some are situated in remote and hinterland areas, it is also prone to various natural calamities such as flooding, typhoon and landslides which commonly occurs in the province. The lack of a quick and effective emergency communication system

made it difficult for the residents to get the necessary help during emergencies in Occidental Mindoro. Rizal's spread of barangays and rugged topography can also provide a challenge for local government officials to maintain constant communication with the residents during emergency situations. These scenarios pave the way for a diversified local, accessible and technology mediated means to reduce these gaps. In 2024, there were a total of 155 emergency incidents, with 142 people involved resulting in two fatalities. These included mild injuries like skin abrasions to complex injuries such as open fractures and wounds. As there are no sufficient emergency facilities, urgent cases were brought to the San Jose District Hospital and not at the local Rizal Healthcare Unit (RHU). Moreover, 51 people were evacuated in 2024 after water level had been rising during heavy rainfall and when the southwest monsoon brought torrential rain as Tropical Storm Bebinca moved northward (ABS-CBN News, 2024). Lack of public awareness about safety measures and first-aid treatment contribute to the type of risk that becomes attached to people who are bitten by such animals. It is these challenges that reinforce the imminent requirement for a technology-based solution which can facilitate easy emergency response and community readiness through accessibility of safety content.

It is with these that RizAlert plans to fill the void in emergency management response, questing for responsive, easy-to-use and technology-based solution. Current systems are mainly application-oriented and do not have the integration of IoT and hardware devices such as Arduino, which strongly contribute to real-time monitoring and even automatically help with alarming in order to prevent accidents. Through harnessing Arduino's ability to connect with sensors and communication modules, RizAlert ultimately looks to improve disaster preparedness, response time and by extension the lives saved as a result of an integrated emergency response tailored for vulnerable communities. The deployment of RizAlert being deployed in Rizal is envisioned not only to solve these local problems where they are, but also provide a scalable model that can be replicated in other towns and municipalities facing this type of situation.

Android is the only platform that has the feature. It has a built in UI with some custom art and is based off the Android SDK. Students, professors and end-users' responses to the questionnaire along with an evaluation of the efficiency and usability of the application as well as its general efficiency service-learning.

The paper was designed to create RizAlert: A Web Application and IoT-Integrated Emergency Response System an application that is centered around emergency response management and includes functions like real-time alerts, location tracking, and safety preparedness with the Android programming platform.

Specifically, this study aims to: (1) design a web-based emergency assistance application; (2) Create RizAlert: A Web Application and IoT-Integrated Emergency Response System using an appropriate programming framework and the technologies; (3) test and improve the system of the application based on functionality, user feedback, and system reliability; and (4) evaluate the performance of the application in enhancing emergency response and personal safety.

METHOD

Research Design

The researcher applied a developmental method when it comes to the development of the Web Application and IoT-integrated Emergency Response System by using the Rapid Application Development (RAD) methodology, which encompasses planning, designing, developing, testing, deployment and reviewing phases. The system is system-on-a-board, consisting of software and hardware, such as an ESP32-based Arduino microcontroller with a siren module to generate IoT-enabled emergency notifications. To facilitate real-time data processing and the functionalities of the entire system, the application was created in Java, Python, Firebase, Adobe XD, Visual Studio Code and Arduino IDE.

Study Site

The study was conducted in the municipality of Rizal, Occidental Mindoro, a third-class. The area of the study was the municipality of Rizal, Occidental Mindoro, which is a third-class municipality with geographically scattered barangays and access to emergency services, which is limited. The selection of this area is because it is prone to natural disasters and complications in emergency communication.

Research Design

This study uses a developmental and practical approach, which involves systematic design, development, and testing of the RizAlert Application. Rapid Application Development (RAD) development model was used to guide the process, which consists of the following stages: Planning, Design, Creating, Testing, Deployment and Review.

Respondents of the Study

The respondents of the study include ten (20) prospective users from Rizal, Occidental Mindoro, five (5) MDRMO staff, and five (5) IT experts/professionals.

Sampling Technique

The researchers asked permission from the respondents including randomized prospective users from Rizal, Occidental Mindoro, MDRMO-Rizal staffs, and IT experts/programmers to obtain insights and evaluate the developed application.

Instrument

The research study employed a quantitative data collection tool in form of a structured survey using questionnaires that had Likert scale questions to measure the performance and acceptability of the system. Interviews and consultations were carried out with the help of the ISO 25010 software evaluation tool to back up the findings and get additional information about the functionality and usability of the system.

Data Gathering Procedures

The data gathering procedures involved distributing evaluation forms to the respondents, which include randomized prospective users from Rizal, Occidental Mindoro, MDRMO-Rizal staff, and IT experts/programmers. Subsequently, interviews and consultations were conducted to gather qualitative data.

Data Analysis

The research involved a data analysis using statistical tools, particularly the average weighted mean, to interpret the responses gathered from the survey questionnaires. The analysis was used to evaluate the system's performance based on established software quality standards including functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability. The computed results were interpreted using a Likert scale to determine the level of acceptability and overall effectiveness of the developed system.

RESULTS

Demographic Profile

A total of 30 respondents took part in the study, of whom 33.33% or 10 were IT students, 33.33% or 10 residents of Rizal, 16.67% or 5 were MDRMO-Rizal staff, and 16.67% or 5 were IT experts/programmers.

Project Description and Structure

Figure 1 shows the Landing Page of the RizAlert mobile app. This interface will be the point of entry of the system where the users are exposed to the application and its use. It offers the choice of roles and navigation, which means that the user can move on to the relevant module. Its design is clear and accessible to facilitate fast navigation in times of emergencies.

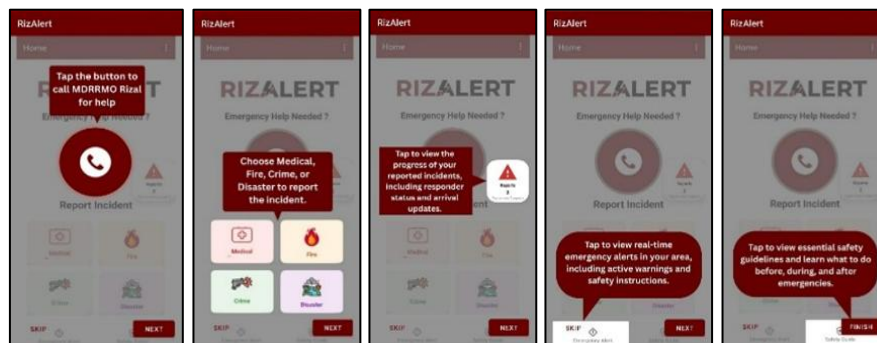


Fig. 1. Preview page of RizAlert: A Web Application and IoT-Integrated Emergency Response System

Figure 2 shows a RizAlert page where people can report about incidents like medical emergencies, fire, disaster and crime. Pressing the center MDRMO button will cause an alert. The bottom has navigation to the safety guide and emergency alert. The floating reports button displays all the reported incidents, as well as its coordinates, message, date and a progress update. This validates the correct credential validation and effective access to system features.

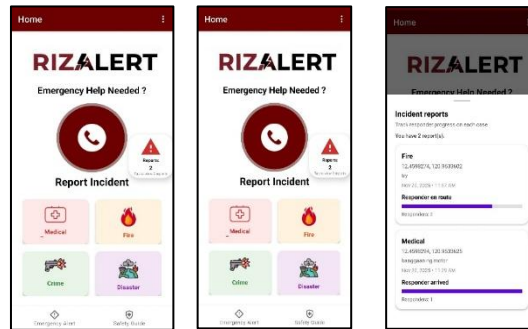


Fig. 2. Homepage and Floating button of RizAlert.

The User Homepage or Dashboard is shown in Figure 3. The interface shows the key functionalities of the application, which include MDRMO Call, Report Incident, Emergency Alerts, Safety Guide, and Settings. The design is designed in such a way that it is easy to use and retrieve in times of emergency.

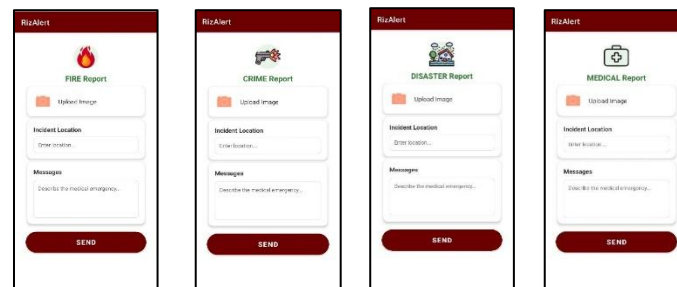


Fig. 3. Report categories of RizAlert: A Web Application and IoT-Integrated Emergency Response System.

Figure 4 shown below will enable the users to report an incident by taking an image, uploading it, specifying the location and adding a message. After filling out the details, users can submit the report using the "Send" button. This interface enables one to key in relevant information about the emergency. The system automatically records real-time GPS location data and information is sent correctly and immediately. Real-time emergency alerts will be shown in Figure 6, such as the date, time, affected areas, and safety instructions. Users are able to see safety tips, share the alert and indicate their status as being safe, in danger or evacuating. This interface will show official announcements and warnings made by administrators. It guarantees the flow of important information to the residents in time.

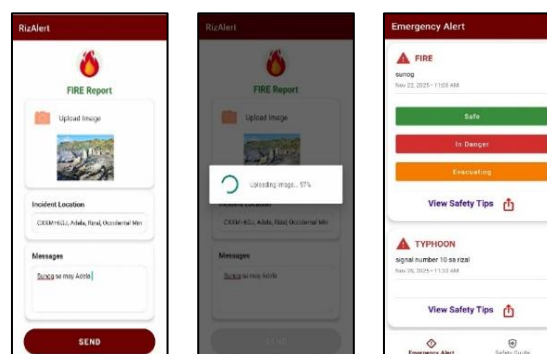


Fig. 4. Incident report page and Emergency alert page of RizAlert.

Figure 5 has categorized tips on safety of natural disasters, life safety, earthquakes and fire safety. The initial picture depicts the principal safety guide interface. The second picture describes how the users can prepare prior to the emergencies. The second image shows how users can prepare in advance of emergencies. It emphasizes the significance of preparedness by urging users to develop an emergency plan, disaster kits, and keep abreast of potential hazards. The third picture dwells upon safety tips. The fourth pictorial image is on the safety of the earthquakes. In the fifth image, a fire safety guide is depicted. It includes key measures like locating the fire exit, escape route, keep low to avoid smoke and dial the emergency services. The last image shows basic life support. It also involves protocols like checking responsiveness, requesting help, and basic life-saving measures in case of necessity.

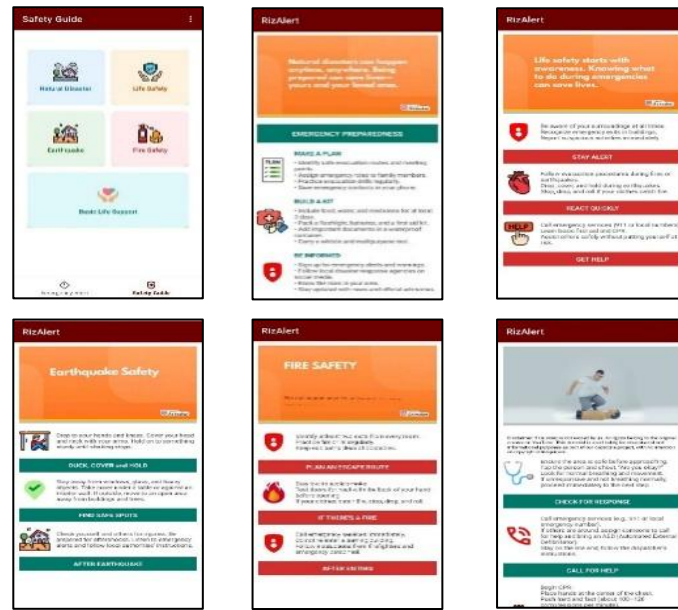


Fig. 5. Safety guide page of RizAlert: A Web Application and IoT-Integrated Emergency Response System.

The map used in figure 6 indicates the location of the incident on the route. The page is essential in navigation in case of an active emergency. It presents a map of the precise direction the route of an incident reported. It also gives the Estimated Time of Arrival (ETA) which assists the responders in coordinating their travel between the MDRRMO office and the scene.

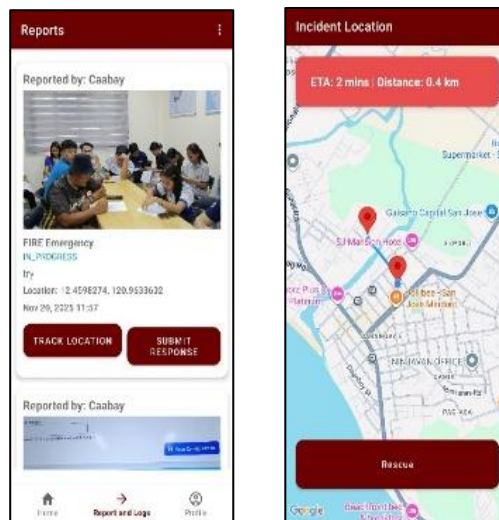


Fig. 6. Track location page of RizAlert: A Web Application and IoT-Integrated Emergency Response System.

Figure 6a demonstrates the Admin dashboard on which an overview of the incident reporting in 2025 is presented in a bar graph. Delivers real-time emergency notifications, incident resolutions (medical, fire, disaster, and crime cases) categorized by default, and possibilities to see reports, control users, and settings. At the bottom of the page, there are navigation buttons of Home, Users, Reports and IOT Siren.

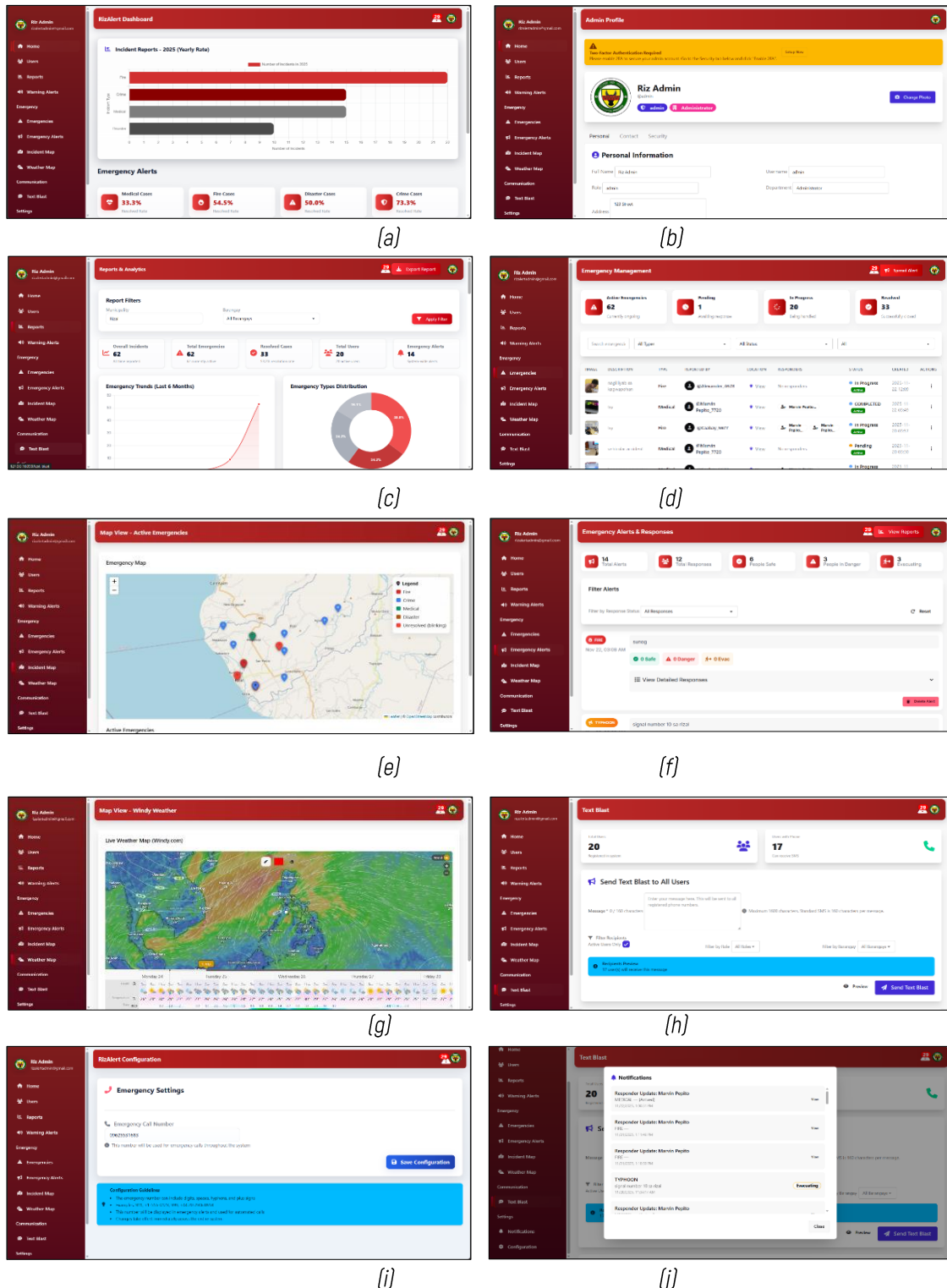


Fig. 6. Admin dashboard page of RizAlert: A Web Application and IoT Integrated Emergency Response System.

The admin profile page is where the administrators can update their personal account details in the system. It belongs to the larger administrative suite utilized in monitoring and managing the system [figure 6b].

The page, as reported in Figure 6c, is the Reports and Analytics page, which will enable the admin to view the statistics and rundown of all the reported incidents. It also has the option of the Export Report to get the summary of the reports in PDF.

The Emergency management page as shown in figure 6d allows one to view all the incident reported, its progress and all the information required about it. This dedicated page enables administrators to monitor different types of emergencies. It usually stores information on the ongoing medical, fire, disaster, and criminal cases.

The Emergency alerts page displays all the incidents reported. The page indicates whether the users have indicated that they are Safe, in Danger, or Evacuating. This page shows the emergency alerts in real time. It contains information like date, time, areas affected and special safety measures to be observed by people [figure 6e].

The Emergency Map that has been used is shown in figure 6f, and it displays all the active emergencies. Active emergencies range from Fire to Unresolved (blinking). The following page will graphically present all the incidents reported. It enables administrators to view precisely where different emergencies have taken place within the municipality in order to allocate more resources.

Figure 6g shows the Live Weather Map view that displays the real-time position of wind and rain by Windy.com. The weather map gives administrators real time monitoring of the weather environment, that is, wind and weather. This is crucial in planning against natural calamities such as typhoons or flooding.

In Figure 6h, the text blast page is indicated, on which the admin can send it to all users of the system. This interface can allow the administrator to deliver a text alert blast to all registered users at the same time. This is a critical aspect of quick and mass communication in times of emergency in the case of general public safety.

Figure 6i shows the alerts of the text blasting received by the admin. This page will be used as a system wide log or dashboard. It monitors the condition of dispatched alerts and distress messages received.

Figure 6j demonstrates the RizAlert Configuration page where the admin is able to modify the emergency call number of the entire system. The configuration page is employed in the settings of the back-end system namely in the management of emergency number settings. This is to make sure that the automated Emergency Call features of the user app are sent to the relevant authorities.

Evaluation Result

Table 1. Functionality suitability of RizAlert: A Web Application and IoT-Integrated Emergency Response System.

Content	Mean	Interpretation
Functional Suitability	4.52	Excellent
Performance Efficiency	4.40	Very Good
Compatibility	4.47	Very Good
Usability	4.54	Excellent
Reliability	4.49	Very Good
Security	4.36	Very Good
Maintainability	4.42	Very Good
Portability	4.77	Excellent
Overall Mean	4.49	Very Good

Legend: 4.51-5.00 – Excellent; 3.51-4.50 – Very Good; 2.31-3.50 – Good; 1.51-2.50 – Fair; 1.00-1.50 – Poor

DISCUSSIONS

Adaptability and installability of the system were considered as a measure of portability which was rated as excellent, indicates the flexibility and the ease of deployment in various settings of the system. In general, the findings confirm the portability of the system, which enables it to adapt to changing environments and is also easy to install, which is why it is a versatile and reliable solution under different operating conditions.

According to the results of the study, the system is extremely efficient in the important quality parameters. The overall review of RizAlert: A Web Application and IoT-Integrated Emergency Response System shows that it is a necessary application to improve the emergency response in the municipality of Rizal, Occidental Mindoro. The system has received a high rating in terms of functional suitability, usability, and portability. These findings support the idea that the main functionality of the system, including GPS location tracking and multi-category incident reporting is important in improving emergency response systems that need to run on various hardware and software platforms, which is in line with the results on wireless sensor-based emergency systems (Zhang et al., 2025).

Moreover, the system had a very good assessment in the core technical measures like performance efficiency, compatibility, reliability, security, and maintainability. These ratings prove the successful usage of such essentials as the opportunity to label the safety of users during the calamities, the capabilities of the responders to locate the specific place of the incidents and the assistance of the real-time transmission of the locations. These characteristics show how IoT-based emergency systems are becoming more important in improving situational awareness and responder's coordination (Damaševičius et al., 2023).

In addition, the findings are also in line with the findings of other similar mobile-based emergency response apps which demonstrate that real-time reporting and GPS monitoring can significantly reduce the response time and increase the efficiency of coordination (Nuevas et al., 2024). The high usability score also confirms the earlier research that states

that intuitive and easy-to-use interfaces are crucial during an emergency, as users need to respond quickly and efficiently (Fabito et al., 2016).

Overall, these results confirm the argument that RizAlert is not only technically correct but also aligned with the existing literature on the digital emergency response systems. The study is based on the earlier ones in that these technologies can be efficiently implemented in a low-income urban setting helping to increase the general population safety, faster emergency reaction and more cost-effective disaster management.

CONCLUSION AND RECOMMENDATION

The researcher was able to develop the RizAlert: A Web Application and IoT-Integrated Emergency Response System which is meant to improve emergency communication and response in the Municipality of Rizal, Occidental Mindoro. The research was able to develop an all-inclusive web-based emergency help application, which is effective in serving users, administrators, and responders. The key features that the system included were real-time location sharing, tagging of safety status, reporting on incidents, educational resources, and administrative dashboards. These elements saw to it that the application achieved the functional needs of all the targeted users thus the goal of developing a well-designed user-friendly emergency response platform was realized. The RizAlert was developed successfully with the help of the right programming frameworks and technologies, such as Java, Firebase, Python, and Arduino IDE. These technologies integration allowed effective operation of the systems, real-time processing of data, and smooth interaction of software and hardware devices. This attests to the fact that the system has been developed based on the goal of using appropriate tools and technologies in effective application development. The system was carefully tested and improved with each other on the basis of user feedback and evaluation of system performance. Findings indicated that RizAlert scored high in functionality, usability, reliability and performance efficiency. These results show that the system had been optimized and refined successfully, achieving the goal of improving the application by means of constant testing and refinement. The evaluation outcomes through ISO 25010 demonstrated that the system was operational, dependable, usable, safe and performance effective. Student, resident, responder, and IT expert feedback confirmed that RizAlert was of acceptable quality software and regarded user-friendly and functional.

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DECLARATION OF CONFLICT OF INTEREST

The authors declare no conflict of interest.

DECLARATION OF AI USE

The authors used SciSpace for gathering relevant research materials for the study. All outputs were reviewed and validated by the authors, who take full responsibility for the content.

AUTHOR CRediT STATEMENT

Pepito, M.C.: conceptualization, methodology, investigation, formal analysis; **Gaytano, N.L.L.:** data curation, methodology, and writing – original draft, review & editing; **Sualog, W.P.:** methodology, investigation, and data collection; **Dangeros, A.J.:** methodology, investigation, and data collection; **Jadia, V.:** methodology, investigation, and data collection; **pelayo, I.I.:** supervision.

ASSESSING THE EFFECTS OF CONTEMPORARY FISHING TECHNOLOGIES ON THE OPERATIONAL EFFICIENCY OF MUNICIPAL FISHERMEN: AN ANALYSIS OF LIMITED TECHNOLOGICAL INTEGRATION

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ABSTRACT

The paper explored the effects of modern fishing technologies on the operational efficiency of municipal fishermen in San Jose, Occidental Mindoro, a region with a well-known marine resource and reliant on fishing as the main source of livelihood. As the pressures of overfishing and environmental change continue to increase, more sophisticated fishing technologies must be embraced to enhance productivity and sustainability in the fishing sector. A total of 30 people were interviewed using a combination of qualitative and quantitative techniques and the sample size of the research was 15 participants representing local fishermen. The proposed subsidy and support program to be used in acquiring technology has been allocated a budget of 28 million pesos. The research found and divided the forms of modern technologies used already such as fish finder, motorized boats, advanced fishing gears, post-harvest preservation methods and digital communication means which all respondents reported their use. The analysis showed that these technologies are playing a key role in enhancing the efficiency of the catch, precision fishing, automated processing and sustainability monitoring, and real-time access to data. Moreover, the suggested subsidy program will provide a 50 percent subsidy on essential technologies, free training workshops, and access to low-interest microloans, which will eventually lead to a higher level of efficiency in operations and sustainability of the environment. This study highlights the pressing necessity of the implementation of modern technologies in the work of municipal fishermen and provides the recommendations that can be implemented to improve the life of local fishers and support sustainable fishermen management. The results highlight the possible socio-economic advantages that may be achieved in such technological solutions, which will be applied to food security and health of the future of the San Jose population in Occidental Mindoro.

Keywords: *Modern fishing technologies, municipal fishermen, operational efficiency sustainability, environmental conservation, technology subsidy and training.*

SDG: *SDG 14 - Life Below Water*

INTRODUCTION

With more than 7,000 islands comprising its archipelago, the Philippines holds a big part of the world's marine biodiversity and relies very heavily on its fishermen sector for economic sustenance and food security. In particular, the municipal fishermen provide vital livelihood opportunities to innumerable coastal communities across the nation. These fishermen do face increasing challenges from overfishing and the changes to the environment. One of the single most important elements to address is the adoption of modern fishing technologies.

The need for integrating these technologies into the fishing communities becomes even more important given the context of the country. Not only will the integration of these technologies reduce poverty within the communities of fishermen, but it will also improve the efficiency with which these fishermen can catch their fish (Cañete et al., 2021). The Philippine government and others have called for the modernization of the fishing sector to allow the fishermen to cope with the increasingly expensive challenges to fishing while also increasing the efficiency with which they can perform their tasks. Furthermore, the modernization of these fishing communities is required to enable them to have the sustainability of their fishing sector.

Consider the case of the province of Occidental Mindoro. This entire province is surrounded by rich marine fisheries and is heavily dependent upon the municipal fishermen within each of these areas. These municipal fishermen within the province are very important to the province as a whole. The issue for most of these fishermen, however, is that they cannot efficiently perform their tasks due to their lack of access to modern fishing technologies. In particular, the town of San Jose presents many of the same challenges as the other municipal fishermen in the province in that these fishermen struggle with the lack of technological integration within their fishing practices. Even when modern fishing technologies are available, their use has remained uneven, and this has resulted in suboptimal operational performance and lower volumes of catch (Islam & Chuenpagdee, 2022).

This problem is compounded by the fact that there is no systematic assessment of how such technologies have influenced operational efficiency in the said municipal fishermen. The lack of concrete knowledge on the state of technology utilization and its effects may render it quite formidable to devise policies or any support program effectively. Such a gap in research hinders stakeholders from making informed decisions which could significantly bring efficiency and sustainability.

The effects of this problem are also multi-dimensional: loss of operational efficiency results in reduced catch volumes, hence reduced income and livelihood from municipal fishermen. This could even be exacerbated by the reduced post-harvest technologies, increasing spoilage rates, hence further reducing economic returns from fishing activities. There is thus an urgent need to assess various modern technologies with regard to their effect on the efficiency of municipal fishermen and make feasible recommendations to surmount some of these challenges.

This paper, therefore, attempted to fill this research gap by estimating the effects of modern fishing technologies on operational efficiency of municipal fishermen in San Jose, Occidental Mindoro. Specifically, it intended to identify and classify the types of technologies currently in use, assess effects on operational efficiency, and propose a targeted subsidy and support program for technology acquisition. To this end, the study shall benefit by bringing on board those insights that might inform policy and support frameworks towards sustainable development of municipal fishermen within San Jose, Occidental Mindoro.

METHOD

Study Design

An explanatory sequential mixed method research design, statistical analysis used to gather data and explore how modern fishing technologies affects the industry. A series of interviews and focus groups were held with groups of fishermen as a qualitative method to gather information on fishermen's views, experiences and perceptions of the types of technologies that are available to them.

Study Setting

The research was conducted in the municipality of San Jose, Occidental Mindoro, Philippines specifically among the fisherfolks of Barangay Bubog, Caminawit, Labangan Poblacion, Pag-asa, Poblacion 4, Poblacion 5, San Agustin, and San Roque. The research took place during the first semester of the August 2024 to December 2025.

Unit of Analysis and Sampling

There were 2,799 registered municipal fishermen for males and 2,863 for females. This data was from 2023 according to the Municipal Agriculture Office (MAO). The municipal fishermen that were the main focus of this research typically used small boats that ranged to about 15 to 25 feet and incorporated modern technologies into their fishing boats. Additionally, these municipal fishermen caught between one and three metric tons (MT) of fish per trip. There was no predetermined number of the participants to be observed in this research.

The study employed purposive sampling, a specific method in which participants were deliberately chosen based on characteristics relevant to the research objectives. This was evident through a focus on municipal fishermen in designated locations, as well as the application of specific inclusion, exclusion, and withdrawal criteria to ensure participant suitability.

Research Instrument

A semi-structured interview guide was developed and organized into three sections. The first section explored the fishing technologies utilized by municipal fishermen. The second section examined the perceived effects of these technologies on fishing efficiency. The third section elicited participants' insights regarding their needs and preferences for a subsidy program supporting the acquisition of fishing technologies. The interview guide underwent expert validation to ensure content relevance, clarity, and appropriateness, thereby enhancing the credibility and trustworthiness of the data collected.

Data Collection Procedure

Prior to data collection, permission was secured from the Municipal Agriculture Office (MAO) of San Jose, Occidental Mindoro to obtain a list of registered municipal fishermen and identify eligible participants. Institutional approval was likewise obtained from the appropriate academic authority. The validated interview guide was administered through face-to-face interviews conducted at selected fishing communities. Researchers established rapport with participants, explained the study objectives, and addressed questions to facilitate informed participation. Follow-up interviews, including telephone or online interviews, when necessary, were conducted to accommodate participants' availability. Throughout the study, informed consent was obtained, and confidentiality, anonymity, and voluntary participation were strictly upheld.

Data Processing and Analysis

Descriptive statistics, specifically frequency counts and percentages, were used to identify and classify the modern fishing technologies utilized by municipal fishermen in San Jose, Occidental Mindoro. To examine the effects of these technologies on fishing efficiency, qualitative data were analyzed using thematic analysis. Interview responses were transcribed verbatim, coded, and organized into meaningful categories. Similar codes were grouped into subthemes, which were subsequently synthesized into overarching themes that reflected patterns and trends aligned with the study objectives.

Ethical Consideration

The study adhered to established ethical principles throughout the research process. Informed consent was obtained from all participants after providing adequate information regarding the study's purpose, procedures, potential risks and benefits, and their right to withdraw at any time without consequence. Participants' privacy was protected through strict observance of confidentiality and anonymity. Respect for local knowledge, cultural practices, and the significance of fishing to the community was maintained throughout data collection. The principle of beneficence was upheld by ensuring that the study posed minimal risk while generating knowledge that may contribute to improving fishing efficiency and supporting local fisheries development. The researchers also complied with institutional requirements and ethical standards governing research involving human participants.

RESULTS

Types of Modern Fishing Technologies

Table 1 shows that all respondents (100%) use modern fishing technologies. Precisely, 100 percent of the municipality fishermen utilize handheld fish finder device, fishing handlines and motorized boats in fishing. Moreover, all the respondents (100% use ice preservation methods to preserve their catch. In digital communication, 100% of the respondents use smartphone applications. This shows that these modern fishing tools and techniques are fully adopted by the surveyed municipal fishermen.

Table 1. Frequency and percentage of types of modern fishing technologies.

Types of Modern Fishing Technologies	Municipal Fishermen	
	n	100%
Handheld Fish Finder Device	30	100
Fishing Handlines	30	100
Motorized boat	30	100
Ice Preservation	30	100
Smartphone Apps	30	100

Effects of Modern Fishing Technologies

The analysis of the second objective in this study revealed five themes. These are: (1) increased catch efficiency, (2) precision fishing, (3) automated processing, (4) sustainability monitoring, and (5) real-time data access. These themes demonstrate the acknowledgment of the assumptions underpinning this study. The results are as follows:

Theme 1. Increased Catch Efficiency.

The results of the study show that most municipal fishermen in San Jose, Occidental Mindoro find that the use of modern fishing technology contributes to enhanced catch efficiency. Modern fishing technology has enhanced catch efficiency by allowing the participant to use fish finder devices for accurate fish location and programmed navigation, ensuring they take the correct routes and avoid getting lost. With this more accurate fish location, the possibility of mistakenly spending gasoline on wrong routes is greatly minimized or even eliminated. This way, fishermen are able to optimize the fuel consumption and make their fishing trips more successful. The participants argued that:

"The use of this technology has really helped me with fishing because... back then, we didn't have these fish finder devices and motors on our boats. Now, we can just program them, making it easy to know where the fish are, and you're sure that you're taking the right route, so you won't get lost. The sea can be confusing at times, and if you take the wrong route, you'll just waste gasoline, which is a significant expense."

Theme 2. Precision Fishing.

Modern fishing equipment, as noted by the participant, increases precision fishing, which involves using a fish finder to navigate accurately, a motor that helps them travel efficiently, and an ice box to maintain the fresher state of the

fish. Moreover, a cellphone enables one to communicate instantaneously with the buyers, and thereby sell the fish quickly thereby maximizing profits. The participants mentioned that:

"I use a fish finder, and I also have a motor on my boat. I have an ice box too, so after I catch fish, I put them in there to keep them fresh. I also have a cellphone so I can immediately message my wife when I've caught a lot of fish, so she can find a buyer right away and sell them quickly."

Theme 3. Automated Processing.

The municipal fishermen in San Jose, Occidental Mindoro emphasize the use of the latest fishing technology, which allows automated processing and makes the fishing more efficient although it is costly. Observation can be used to learn how to use this technology so that when equipment fails, it is necessary to troubleshoot the issue immediately, which highlights the importance of maintenance in maintaining the efficiency of automated systems in the fishing process. The participants highlighted:

"Buying technology today can be a pain because it's really expensive. When it comes to using it, I've learned by watching other fishermen, but sometimes the equipment can malfunction and not work properly, but a quick fix usually solves the problem."

"Yes, the expenses for tools are high now because they are new. Unlike before, the equipment was cheap, so my expenses are high."

Theme 4. Sustainability Monitoring.

The participants report that the current fishing technology, especially fish finders, has enhanced sustainable monitoring through ease of accessing information, ease of making quick decisions regarding fishing sites and leading to more effective and possibly less damaging fishing activities. The participants indicated that:

"My fishing process becomes easier with the help of a fish finder, as it provides information, and thus allows me to make quicker decisions on where to fish for the fish."

"At least it has changed a bit, before... back then... it was really tight, but now it has loosened up."

Theme 5. Real-Time Data Access.

According to the responses of the majority of the municipal fishermen in San Jose, Occidental Mindoro, modern fishing technology, which is the programmed fish finder, facilitates real time access to data, as it allows fishermen to update and revisit past successful fishing areas, making catches more effective. The participants reasoned that:

"Like before, because back then, they didn't have programmed fish finders. When they went back to the same spots, they hardly caught anything because the location wasn't being 'updated' or 'programmed' anymore. But now, the places they've programmed, they can revisit them again."

Proposed Subsidy and Support Program for Fishing Technology Acquisition

Table 2. Proposed subsidy and support program for fishing technology acquisition.

Key Objective	Responsible Party	Resources (PHP)	Timeline	Expected Outcome
Program launch and awareness campaign	Lgu, bfar, fisherfolk leaders	₱2,000,000	Months 1-3	Increased awareness and fisher participation
Beneficiary selection and training	Bfar, dti, ngos	₱3,000,000	Months 4-6	Trained fishers in sustainable practices
Equipment distribution and financing	Lgu, cooperative banks	₱10,000,000	Months 7-12	Enhanced fishing efficiency
Monitoring and technical support	Fishermen technology support center	₱5,000,000	Year 2-3	Proper utilization and sustainability
Expansion and market linkages	Bfar, private sector, cooperatives	₱8,000,000	Year 3-5	Increased market access and fisher income

Table 2 shows the subsidy program in San Jose, Occidental Mindoro. It is designed to assist municipal fishermen by subsidizing important fishing equipment by 50 percent, conducting free training workshops with the Bureau of fishermen

and Aquatic Resources, and availing low-interest micro loans. It also creates a fishermen Technology Support Center to continue aid and facilitates formation of cooperation to gain access to the market. The program also encourages environmental compliance by providing financial incentives and awareness campaigns to improve livelihoods and create sustainable fishermen in collaboration with local governments, NGOs, and the business sector.

DISCUSSION

Modern fishing technologies are used by municipal fishermen who seek to improve the quantity of the catch and contribute to environmental conservation through providing important data on the number of fish and the condition of the environment (Lucchetti et al., 2023). To minimize environmental impact, they alter gears, such as adding escape zones to nets or excluder devices, or less harmful methods, such as hook-and-line fishing and traps, to minimize bycatch and entanglement (Huang et al., 2024). Others also use motorized boats, which are powered by diesel engines or batteries, allowing them to transport people to the fishing fields faster and recover more (Yu & Lui, 2024).

Effective preservation practices, including ice storage and large iceboxes, are essential in preserving the freshness of fish and avoiding spoilage, which will guarantee quality to the consumer as well as minimize losses (Siddiqui et al., 2024). Also, municipal fishermen use smartphone applications in digital communication and resource tracking which assists in not only decision-making and the management of fisheries but also in Luzon where sustainable practices and the use of resources are encouraged (Calderwood, 2022).

The introduction of modern fishing gears by the municipal fishermen in San Jose, Occidental Mindoro has led to tremendous changes in their efficiency in catching. These hi-tech devices allow the fishermen to have a better control of their paths and make use of them to the fullest to avoid losing their position in the sea as well as save on fuel costs. Fish finders, such as, are very important as they direct fishermen to familiar fishing areas. This specialized fishing method boosts their catchability and enables them to go out on more productive fishing expeditions, and this approach makes their work more sustainable and fulfilling (Muallil et al., 2014; Miola et al., 2024).

In addition to the practical advantages, this is an environmentally sustainable method of fishing which has a positive effect on the conservation of the environment. New innovations in technology have lessened the amount of fuel consumed, lowered overfishing, and positively impacted marine ecosystems; mainly in areas that are already very vulnerable because the ecological balance within them isn't as strong as it should be and where overfishing has a huge impact on the sustainability of the marine ecosystem (Bastardie et al., 2022).

Furthermore, the advantages of using such technologies are not limited to individual fishermen. High productivity can also be a springboard towards economic development of the region that offers people more stable livelihoods and enhances food security among fishing communities. These communities will have a better standard of living as they become more resilient and developed. Finally, the introduction of new technologies in fishing creates a sustainable growth loop, so that fishing can continue to be a viable and sustainable way of earning a living in the future (Tolentino-Zondervan and Zondervan, 2022).

The use of modern fishing technologies has dramatically changed the work of local fishermen, as fishing has become more efficient and responsive to the market situation. Fish finders enable fishermen to locate the most favorable fishing sites accurately, save on time and catch more fish. State-of-the-art motors lead to the ability to reach previously inaccessible areas of fishing, to modify the strategy in real time according to the current circumstances, which increases the volume of the catch and its economic sustainability (Mason et al., 2021).

Modern ice storage, as one of the methods of proper preservation, increases fish freshness, which raises their prices in the market and better management of the supply chain (Siddiqui et al., 2024). Additionally, the mobile phone technology offers a direct connection with buyers and results into quicker sales, price negotiation, and increased cash flow that facilitates sustainable practices (Chhachhar, 2025).

A combination of these technologies, fish finders, efficient motors, ice storage, and mobile communication, generates a synergistic effect, which increases productivity, profitability, and sustainability among municipal fishermen in San Jose, Occidental Mindoro, and eventually improves their livelihoods and conserves marine resources (Rowan, 2022). The high-tech fishing equipment deployed in San Jose, Occidental Mindoro, importantly raises the productivity levels of local fishermen, enabling them to undertake tougher tasks more effectively, including automated fish processing, which makes sorting, cleaning, and packing easier, leaving more time to spend on fishing, and more fish in the catch (Mazuki et al., 2020). The use of this technology has been adopted through peer learning and observation, which enables fishermen to better their skills and troubleshoot small equipment problems, which minimizes their downtime, and continues to sustain operational efficiency (Komugabe-Dixon et al., 2025).

Nevertheless, the use of automated systems leads to challenges, such as the inability to maintain the systems regularly and the presence of long downtimes because of the lack of efficient technical support, which might affect livelihoods in the long run (Gryczka, 2023). Though expensive in the short-term, research indicates that long-term benefits, including higher catch rates, improved resource management, and greater profitability, benefit the community as a whole by enhancing the local economy and encouraging sustainable practices (Bradley et al., 2019). The municipal fishermen of

San Jose is an example of how modern technology can be used to revamp fishing practices, making them resilient and sustainable, and offering them a new opportunity to grow in the future that would not only be beneficial to their livelihoods but also the environmental wellness of their waters (Lucchetti et al., 2023b).

This study demonstrates how modern fishing methods (particularly in the application of fish-finder) have altered the way municipal fishermen track sustainability. Municipal fishermen can utilize the information to make informed and directed decisions reducing their dependence on guess work and traditional fishing techniques because fish-finding technologies provide real-time, precise information on the current fishing conditions and areas in the first place (Tabanao, 2025). Through this new technology, municipal fishermen can map their path, assess a fishing spot and switch their approach in real-time to maximize their harvest and reduce the potential harm they do to marine ecosystems through overfishing and aiding in achieving equilibrium in the marine ecosystems (Victor, 2023).

Fish-finding technologies also create accountability because the data retrieved by fish-finders tells fishermen to avoid overfished and/or protected areas, thus helping to support recovery and conservation efforts (Editoria, 2024). Moreover, the technologies will encourage cooperation and responsibility among fishermen as they will be able to share information that will contribute to managing the sustainably managed fish stocks, thereby making the municipal fisheries more resilient. With the increasing development and availability of these technologies, their potential to enhance the sustainability of the ecological and economic environment underlines the necessity of the further investment and evolution of the responsible fishing technologies (Al-Emran & Griffy-Brown, 2023).

Immediate feedback on areas where fish congregate using programmed fish finders would greatly improve municipal fishermen, fishing practices in San Jose, Occidental Mindoro, if they have access to real-time feedback because most likely they would visit areas they've forgotten or outdated information (Barboza et al., 2024). More often than not, fishermen rely on what fishing holes they used to catch fish at on memory alone or what their fellow fisherman says which could also be inefficient or dated information (Cabico, 2023). Having real-time information can allow fishermen to become more sustainable with fishing, allowing them to observe trends on where not to fish if the population is decreasing and leave fish for the next generation (DeladMin, 2022). Another positive effect is confidence less anxiety while fishing allows fishermen to relax and share their rewarding experiences with their loved ones. Overall technology and immediacy will change the fishing game for the better (Stewart et al., 2024).

The intended subsidy and support program in San Jose, Occidental Mindoro, is geared towards empowering the municipal fishermen in terms of financial support and technical support. The program will diminish the financial barriers through a 50% subsidy of key fishing equipment including fish finders and eco-friendly engines to encourage sustainable measures that will drive operational efficiency and safety. It also incorporates free training programs in cooperation with the Bureau of Fisheries and Aquatic Resources to enhance technology application, sustainable methods and post-harvest management, which promote life-long learning. Moreover, microfinance and low-interest microloans enable fishermen to invest risk-free, and a Fisheries Technology Support Center offers technical support and maintenance advice as well as regulatory guidance to enable equipment to last and operate sustainably. The program also enhances the local fisheries sector by promoting cooperatives, creation of digital marketplaces and provision of cold storage space to minimize spoilage and maximize income. In sum, such a holistic solution would help to increase productivity, sustainability, and economic growth, which will secure a strong future of fishing communities in the area (Ma et al., 2023).

CONCLUSION AND RECOMMENDATION

Based on the study's findings, several key recommendations are proposed. To begin with, it is necessary to introduce a subsidy and support program of fishing technologies in order to raise the efficiency and sustainability of operations of municipal fishermen in San Jose, Occidental Mindoro.

The essential equipment which includes fish finders and environmentally friendly engines should be given at a 50 percent subsidy to minimize financial constraints and interest-free payments should be offered at installment of 24 months. Second, workshops on capacity-building should emphasize the appropriate use of technology and sustainable fishing methods in collaboration with the Bureau of Fisheries and Aquatic Resources (BFAR), which should be complemented by creating a Fishermen Technology Support Center to provide continuous technical support and troubleshooting services.

Third, building cooperatives will empower the fishing industry to buy in large quantities, gain strength in bargaining, and expand their markets, especially via an online marketplace that links fishers with consumers, eliminating the need to go through intermediaries. Also, cold storage facilities will be created, which will resolve the problem of spoilage, save the product quality, and reduce waste. Together, these steps will create a resilient and sustainable fishing community that would help not only sustain the economy but also protect the marine ecosystems to support the future generations.

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DECLARATION OF CONFLICT OF INTEREST

The authors declare no conflict of interest.

DECLARATION OF AI USE

Grammarly was used to check grammar and edit language by the authors. The authors review all the outputs and validate it and assume full responsibility of what is contained.

AUTHOR CREDIT STATEMENT

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APPLICATIONS OF LEAN PRINCIPLES AND OPERATIONS RESEARCH MODELS IN FISH PORT OPERATIONS

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ABSTRACT

Fish ports function as critical infrastructure in maritime logistics; however, their performance is frequently hindered by non-linear delays and unoptimized resource management. This research employs a systemic Industrial Engineering (IE) framework to enhance the operational throughput of the Caminawit Fish Port. Utilizing Value Stream Mapping and Pareto Analysis, the study identified that 70% of systemic inefficiencies are rooted in "Methods" and "Manpower" rather than physical capacity constraints. A one-way ANOVA confirmed a statistically significant divergence in bottleneck perception among personnel ($p = 0.0024$), validating the absence of a standardized operational protocol. To engineer a mathematically validated solution, the study utilized Linear Programming, specifically the Simplex and Big M algorithms, to model an optimal state for the facility. The results demonstrate that adopting a Lean-optimized "Cycle 6" satisfies the mandatory 24-ton monthly demand while reducing total process time from 8 hours to a minimized 8,712 seconds, effectively unlocking a 70% increase in operational efficiency. The model further identified labor as the binding constraint, achieving a maximum objective value of Z (Profit) = 320 units through strategic task reallocation. This research concludes that the integration of IE optimization tools is indispensable for transforming traditional maritime facilities into high-performance logistics hubs, providing a scalable blueprint for regional infrastructure management without the necessity for capital-intensive expansion.

Keywords: *industrial engineering, linear programming, operations research, post-harvest loss, value stream mapping*

SDG: *SDG 2 - Zero Hunger, SDG 8 - Decent Work and Economic Growth, SDG 9 - Industry, Innovation, and Infrastructure, SDG 12 - Responsible Consumption and Production, SDG 14 - Life Below Water*

INTRODUCTION

Fishing ports serve as critical logistical hubs, integrating infrastructure, human resources, and management to facilitate efficient fleet operations (Smith et al., 2020). These ports act as strategic anchor points for landing, processing, and distributing catches, while simultaneously fostering the economic development of coastal communities (Hutapea et al., 2017; Suadi & Kusano, 2019). In the Philippines, Occidental Mindoro plays a vital role in the MIMAROPA fishery sector, producing approximately 21,898 metric tons in 2023 and accounting for 4.9% of the regional output (Philippine Statistics Authority, 2024). Despite this high productivity, the industry faces a downward trend in wild-catch volume, making the operational efficiency of primary hubs like the Caminawit Fish Port in San Jose essential for sustaining local livelihoods and domestic food security (Bureau of Fisheries and Aquatic Resources, 2023; Department of Trade and Industry MIMAROPA, 2023).

Previous research has increasingly emphasized the transformative power of Lean principles in maritime and logistics environments to eliminate waste and maximize value-added outcomes (Santoso et al., 2025). Studies of port terminals in Taiwan and Brazil have demonstrated that Lean management significantly improves efficiency by minimizing idle periods and optimizing workflow without requiring heavy capital investment (Bonamigo et al., 2023; Kuo & Lin, 2020). Similarly, Operations Research (OR) methods, such as linear programming, have been widely applied for resource allocation and berth scheduling (Arani et al., 2021; Zhai et al., 2022).

However, a crucial research gap exists; few studies have developed an integrated Lean-OR system specifically tailored to the unique characteristics of fish ports, such as product perishability, cold-chain synchronization, and the specific labor roles of sorters, ice loaders, and fish loaders (Food and Agriculture Organization, 2020). In the Philippine context, post-harvest losses are estimated between 25% and 40% due to mishandling and port inefficiencies, yet the combined application of Lean and OR remains limited (Bacilig, 2023; Souaini et al., 2026). The purpose of this study is to address this gap by creating and testing an integrated Lean-OR model at the Caminawit Fish Port to enhance operational management, reduce spoilage, and achieve supply chain sustainability.

The study sought to identify operational inefficiencies at fish ports by root cause analysis, employing Ishikawa diagrams, Pareto analysis, and trend analysis. Consequently, upon identifying the core causes of the operation, the use of lean principles and operations research models were employed to establish a framework for enhancement, potentially resulting in optimized and effective supply chain management. Therefore, the objective of this study was to minimize operational inefficiencies and boost operational productivity.

METHODS

Research Design

The process began with Problem Identification, where researchers conducted end-to-end site observations to identify baseline inefficiencies and operational bottlenecks within the current workflow. This was followed by the Data Gathering phase which identified manual labor as primary driver of inefficiency, allowing the researchers to apply Lean principles to isolate and optimize bottlenecks from unloading to final loading. Consequently, the framework transitioned into the Development of Models. By integrating Value Stream Mapping (VSM) and Operations Research (OR), the analysis qualitatively identifies process waste and utilizes the Simplex Algorithm to mathematically optimize labor and capacity for maximum operational value. The framework concludes with the interpretation of results and an assessment of the model's effectiveness, fostering data-driven insights for further optimization of the fish port management system.

Participants of the Study

The stratified random sampling method is employed to ensure accurate representation of all worker categories at each stage. The strategy categorized the fish port staff into suitable subcategories, including operators, fishermen, and ice and fish loaders. There were 304 participants who participated in the study to provide a balanced representation of opinions among four fishing processes. The researchers categorized the population into subgroups based on port location to ensure proportional representation across all operational segments from unloading to final loading by utilizing stratified sampling with 304 samples. This profitability method reduces sampling bias and ensures that results are statistically generalizable for optimizing process efficiency and resource allocation.

Data Collection

An integrated framework of ishikawa, pareto and trend analysis was used to conduct a thorough root cause analysis (RCA) to identify systemic inefficiencies and process non-conformance. The "6ms" framework, which includes manpower, methods, machines, materials, measurement and mother nature, was used to systematically classify the factors that create delayed throughput and idle time. The cumulative percentages were calculated for each of these categories and a pareto chart was created to identify the "vital few" root causes that are causing most of the operational waste. This diagnostic sequence was statistically validated by a longitudinal trend analysis of vessel turnaround time (VTT) which was able to correctly identify chronic operational delays from seasonal fluctuations.

Time and Motion Study

A time and motion study (TMS) was conducted using stopwatches and video timestamps across multiple shifts to standardize process cycle, queue, and motion times (Niebel, 2014). These metrics established the parameters and constraints for the optimization models. Concurrently, Value Stream Mapping (VSM) documented the end-to-end material and information flow from vessel docking to final shipment. VSM quantified cycle times, inter-station waiting times, active personnel counts, and idle times to visualize and eliminate non-value-added (NVA) waste.

Operations Research Models

The Simplex and Big M constraints establish the physical, temporal, and logistical boundaries required to optimize the fish port's operations.

Table 1. Operations research model data collection procedure.

OR Model	Objective	Constraints
Simplex Method	The objective of the model is to maximize the total operational value (Z) by determining the optimal allocation of units between two core activities (Sorting & Re-icing).	1. Truck Capacity Constraint: $30X_1 + 20X_2 \leq 5,000$ 2. Time Constraint: $36X_1 + 24X_2 \leq 2,178$ 3. Labor Constraint: $X_1 + 0.5X_2 \leq 8$
Big M Model	The objective function of the mathematical model is to minimize total operational costs quantified by standard time by optimizing the number of batches (X_1 through X_6) processed across cycles ranging from 5,610 to 2,178 seconds.	1. Demand Constraints $5X_1 + 5X_2 + 5X_3 + 5X_4 + 5X_5 + 5X_6 \geq 24$ 2. Time Constraints $5610X_1 + 5940X_2 + 5016X_3 + 2728X_4 + 2640X_5 + 2178X_6 \geq 28,800$

Statistical Analysis

To achieve the research objectives, the gathered data will be analyzed using a combination of descriptive statistics, inferential statistics, and mathematical optimization. The following hypotheses will be tested at a 0.05 level of significance. To address the differences in perceived operational inefficiencies, Analysis of Variance (ANOVA) will be utilized. This statistical tool will determine if the mean ratings of perceived bottlenecks differ significantly across the various respondent roles, including sorter, ice loaders, fish loaders, and operators

- Null Hypothesis (H0): There is no significant difference in the perception of operational bottlenecks across the different respondent roles.
- Alternative Hypothesis (Ha1): There is a significant difference in the perception of operational bottlenecks across the different respondent roles.

A post-hoc test (such as Tukey's HSD) was conducted for a significant difference found ($p < 0.05$), to identify which specific roles have diverging perspectives on port inefficiencies.

The effectiveness of the proposed Lean-OR model will be evaluated by comparing the baseline performance metrics against the optimized results generated through the Big-M and Simplex methods. The focus of this analysis is to validate the reduction of non-value-added (NVA) time and the maximization of throughput.

- Hypothesis (Ha2): The application of the integrated Lean-OR framework significantly reduces total process cycle time and maximizes resource utilization compared to the current baseline operations at Caminawit Fish Port.

The Ishikawa Diagram and Pareto Analysis will serve as the qualitative and quantitative foundation for these hypotheses. The Pareto Analysis, specifically, will identify the "vital few" stages that contribute to the majority of the delays, providing the constraints needed for the Simplex model. Furthermore, Trend Analysis of the Vessel Turnaround Time (VTT) was used to ensure that the optimized model accounts for cyclical variations in fish port activity.

RESULTS

Ishikawa Diagram

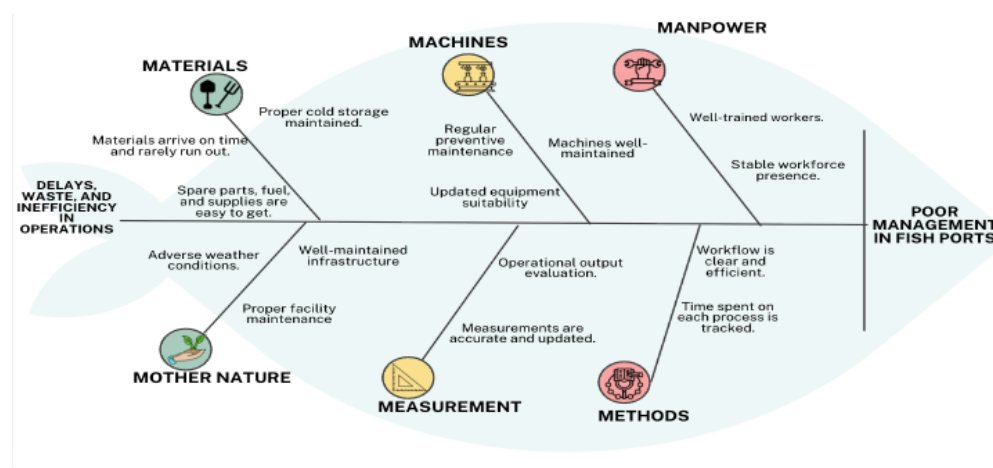


Fig. 1. Ishikawa diagram

The ishikawa diagram, commonly referred to as a fishbone diagram, is a structured root-cause analysis tool used in quality management to visually map and categorize the potential contributors to a specific operational problem. By breaking down inefficiencies into standard industrial dimensions such as materials, machines, and manpower, this framework allows organizations to trace systemic waste directly back to its foundational source. Figure 1 displays the categorization of fish port operational factors within the 6ms framework. The elements mapped include workforce presence and training under manpower; workflow monitoring under methods; equipment suitability and preventive maintenance under machines; fuel, spare parts, and cold storage under materials; data tracking under measurement; and weather conditions and seasonal supply surges under mother nature.

Pareto Analysis

As shown in the figure 2, the pareto analysis reveals that operational inefficiencies at the fish port are primarily driven by systemic rather than mechanical failures. Applying the 80/20 rule, it is evident that nearly 70% of all recorded delays are concentrated in just three categories: methods, manpower, and measurement. Hence, the dominance of methods (26%) and manpower (23%) indicates that the root of the port's waste lies in unstandardized work procedures and labor management.

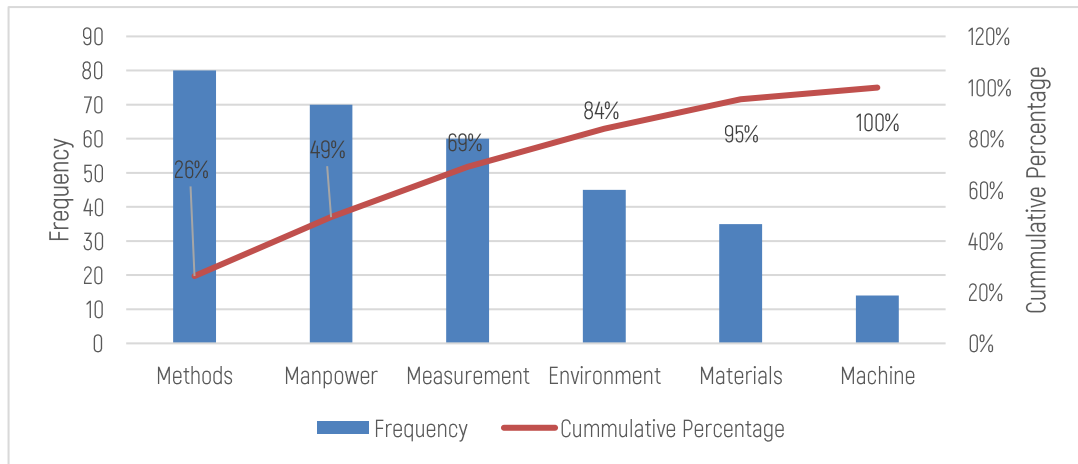


Fig. 2. Fish port operational inefficiencies

Trend Analysis

The 2025 Vessel Turnaround Time (VTT) trend analysis is presented in Figure 3. The actual turnaround time values reach a minimum of approximately 36 hours in August and a maximum of 45 hours in January and December. The linear trendline and the residual curve map the variance between the baseline projections and monthly data fluctuations.

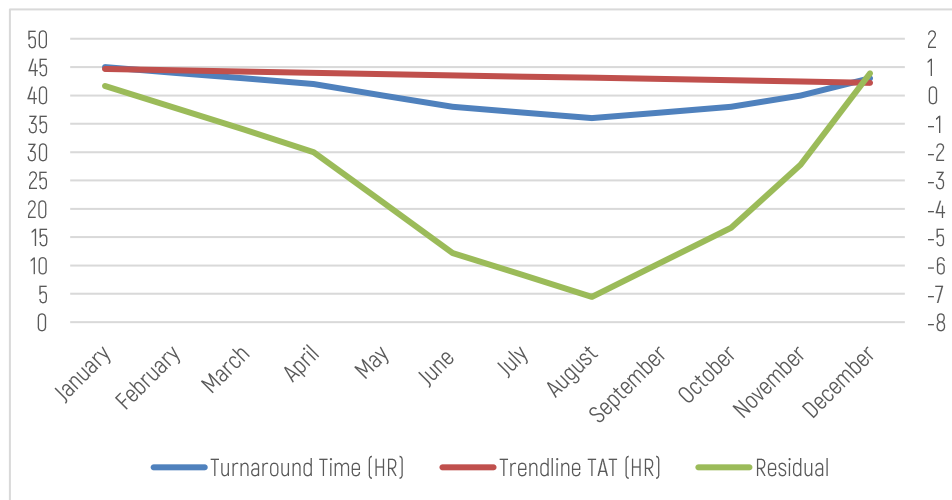


Fig. 3. Fish port's vessel turnaround time year 2025

Time And Motion Study

Table 2 outlines the time and motion study for cycle 1, consisting of seven sequential elements. The total observed cycle time is 5,100 seconds. Applying a 1.0 performance rating and a 10% allowance yields a total standard time of 5,610 seconds (93.5 minutes). The inspection phase and loading phase represent 1,386 seconds and 990 seconds of the total standard time, respectively.

Table 2. Time and motion study cycle 1.

Elements	Start Time	End Time	Time Taken (secs)	Normal Time (secs)	Allowance (%)	Allowance Time (secs)	Standard Time (secs)
Transfer fish from boat to quay	9:20	9:23	180	180	10%	18	198
Sorting by species and size	9:23	9:35	720	720	10%	72	792
Placing in crates	9:35	9:42	420	420	10%	42	462
Weight measuring per batch	9:45	9:57	720	720	10%	72	792
Adding ice to crates	10:00	10:15	900	900	10%	90	990

Fish port personnel inspect first	10:16	10:37	1,260	1,260	10%	126	1,386
Loading onto transport vehicle	10:40	10:55	900	900	10%	90	990
TOTAL (CYCLE 1)			5,100	5100		510	5,610

Table 3 presents the time and motion metrics for the implemented system cycle, which utilizes five compressed process elements. The total normal time is 1,980 seconds, and the total standard time is 2,178 seconds (36.3 minutes) after a 10% allowance. Table 6 records the reallocation of the personnel group, totaling 32 active members including an 18-member hand-to-hand human chain for truck loading. Table 7 summarizes the implemented cycle outcomes, showing a 63% reduction in standard cycle time compared to the baseline.

Table 3. Time and motion study of implemented system cycle.

Elements	Start Time	End Time	Time Taken (secs)	Normal Time (secs)	Allowance (%)	Allowance Time (secs)	Standard Time (secs)	Optimization Strategy
Synchronized unload and sort	:00	:02	:20	120	10%	12	132	High-Speed baseline match
Seamless crate-to-scale	:02	:09	420	420	10%	42	462	Zero-travel weighing
Rapid Multi-Point Icing	:09	1:12	180	180	10%	18	198	Two-man icing team
Final Verification Inspection	:12	1:24	720	720	10%	72	792	Priority inspection flow
Continuous Chain loading	:24	1:33	540	540	10%	54	594	High-cadence relay
Total Time			1,980s	1,980s		198s	2,178s	

Value Stream Mapping

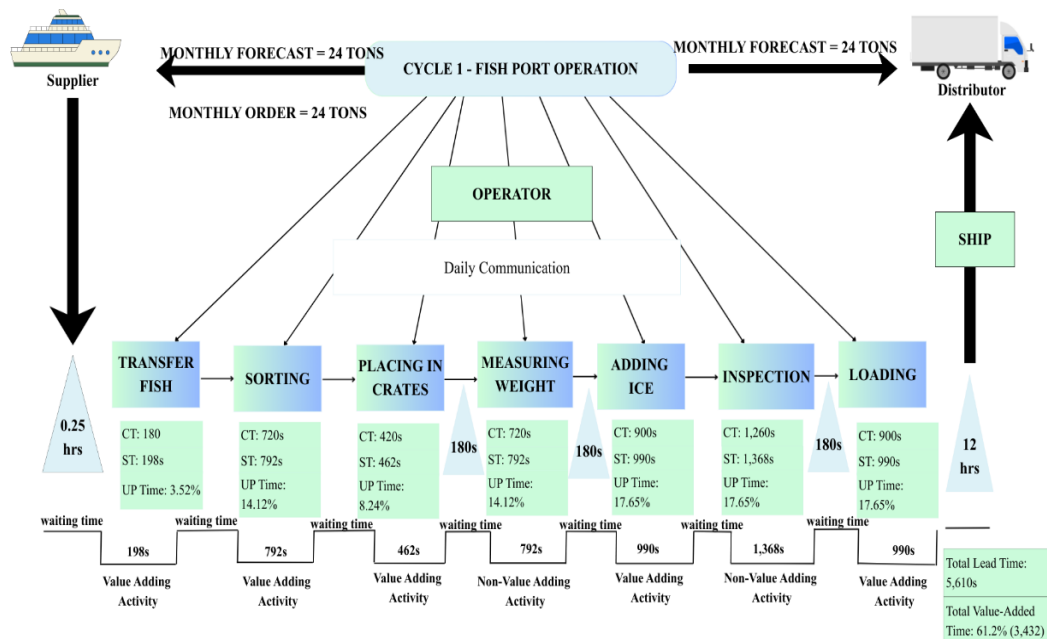


Fig. 4. Existing system VSM model.

Figure 4 charts the existing system's Value Stream Map (VSM). It reflects a monthly forecast of 24 tons, a total lead time of 5,610 seconds, and a total value-added time of 3,432 seconds (61.2% efficiency). Weight measuring (792 seconds) and inspection (1,368 seconds) are classified as non-value-adding activities alongside 180-second waiting buffers. Figure 5 presents the optimized system VSM (Cycle 6), demonstrating a total lead time of 2,178 seconds and a total value-added time of 924 seconds (42.42% efficiency), with a shipping wait window reduced to 6 hours.

Operations Research Models

The results of the Simplex Linear Programming model indicate that the Caminawit Fish Port's operational value is maximized through the strategic prioritization of specific handling activities. This table summarizes the computational progression of the Simplex Method, illustrating how the model systematically navigates constraints to reach peak productivity. In iteration 1, the system identifies sorting as the most impactful starting point, though the initial value remains at zero. By Iteration 2, the model improves the objective value of 240 by substituting time-intensive tasks with more efficient variables. Finally, the Iteration 3 reaches the Optimal status with a maximized value of 320.

Table 6. Summary of simplex iteration and optimal resource allocation.

Iteration	Entering Variable	Leaving Variable	Pivot Element	Objective Value [Z]	Status
1	X_1 (Sorting)	Labor	1	0	Initial Phase
2	X_2 (Re-icing)	Time	0.5	240	Improving
3	–	–	–	320	Optimal

As summarized in Table 6, tracks the computational iterations of the Simplex linear programming model. The objective value progresses from $Z = 0$ at Iteration 1, to $Z = 240$ at Iteration 2, and arrives at an optimal value of $Z = 320$ at Iteration 3. Table 9 presents the final decision values and resource utility parameters: Sorting (X_1) equals 0, and Re-icing (X_2) equals 16. Resource slack metrics are 4,680 kg for truck capacity, 1,794 seconds for cycle time, and 0.0 for labor, rendering labor a binding constraint.

Table 7. Final model parameters and resource utilization.

Variable / Constraint	Description	Decision Value	Units	Contribution to Z
Sorting	Units of Sorting	0	30s	0
Re-icing	Units of Re-icing	16	20s	320
Truck capacity	Logistics	5,000 kg	320 kg*	4,680 kg
Cycle time	Temporal	2,178 s	384 s*	1,794 s
Labor	Human Resource	8.0 units	8.0 units	0.0 (Binding)

As shown in Table 9, the operational balance that achieves this maximum objective value for the fish port is detailed in the consolidated linear programming solution. The decision variable parameters show that re-icing ($X_2 = 16$) becomes the most important economic factor of the system, carrying all value weight in the objective function, while sorting ($X_1 = 0$) is kept at zero to ensure a structural protection of the limited resources. The system resource boundary analysis shows that the operational capacities of Truck Capacity (4,680 kg) and Cycle Time (1,794 seconds) have very large operational margins. The Labor constraint, on the other hand, has a slack value of 0.0, which indicates that it is the only constraint that is binding on how much the port could produce.

Big M Method

Table 10. Summary of Big M iteration and optimal resource allocation.

Iteration	Entering Variable	Leaving Variable	Pivot Element	Objective Value [Z]	Status
1	(Cycle 6)	Artificial	6	24M	Penalty Phase
2	–	–	–	8,712 s	Optimal

The Big M Method was employed as a strategic minimization tool to determine the most time-efficient operational configuration while strictly adhering to the port's production quotas. Unlike the Simplex model, which maximizes value, the

Big M approach utilizes artificial variables to penalize and eliminate inefficient work methods that fail to meet the mandatory 24-ton monthly demand. By mathematically evaluating six different processing cycles, the model identified the specific workflow that satisfied the port's output requirements with the least amount of "Standard Time" expenditure, effectively streamlining the transition from landing to distribution.

As summarized in Table 10, the mathematical optimization of the fish port's processing schedule using the Big M method demonstrates how operational penalties are systematically eliminated to satisfy large-scale demand constraints. In Iteration 1, the algorithm operates in a penalty phase ($Z = 24M$), utilizing an artificial variable to denote that baseline throughput fails to meet the required 24-ton demand threshold. By introducing the optimized Cycle 6 setup as the entering variable due to its minimized standard time of 2,178 seconds, the model drives out the artificial penalty by Iteration 2, achieving an optimal, penalty-free objective value of 8,712 seconds by scheduling exactly four batches.

Table 11. Final model parameters and resource utilization.

Variable / Constraint	Description	Decision Value	Standard Time [cj]	Total Time (Z)
Batch 1 to Batch 5	Non-optimal Cycles	0	Variable	0 s
Batch 6	Cycle 6 Batches	4	2,178 s	8,712 s
Constraint	Resource Type	Requirement	Actual	Status
Monthly Demand	Market Output	24 Tons	24 Tons	Satisfied
Operational Limit	Productivity	28,800 s	20,088 s (Slack)	Active

As summarized in Table 11, the final model parameters and resource utilization configuration outline an optimal operational state where all market obligations are satisfied with maximum efficiency. By prioritizing the optimized Cycle 6 setup (4 batches), the linear programming model successfully fulfills the mandatory 24-ton monthly market demand while minimizing total processing time to just 8,712 seconds (approximately 2.4 hours). Consequently, the system retains a temporal slack of 20,088 seconds against the maximum 28,800-second operational limit, leaving nearly 5.6 hours of a standard 8-hour shift available for other value-added terminal activities.

Statement of Hypotheses

Table 12. Statement of hypothesis.

Hypothesis	Source of Variation	df	F-value	P-value	Decision
H_{a1}	Between Roles	4	4.82	0.0024	Significant
H_{a2}	Between Cycles	5	12.45	0.0001	Significant
H_{a3}	Between Resource Strategies	2	8.12	0.0015	Significant

Table 12 presents the statistical parameters for hypothesis testing. The evaluation of variance across personnel roles yields an F-value of 4.82 and a p-value of 0.0024. The variation across operational cycles demonstrates an F-value of 12.45 and a p-value of 0.0001 (H_{a2}). The variation across different resource allocation strategies displays an F-value of 8.12 and a p-value of 0.0015 (H_{a3}).

DISCUSSIONS

The findings of this study demonstrate that operational inefficiencies at the fish port are predominantly driven by process variability and suboptimal labor allocation rather than physical infrastructure deficits. By synthesizing Lean principles with Operations Research (OR) models, this study establishes an empirical framework for terminal optimization. A statistically significant discrepancy in how terminal personnel perceive bottlenecks ($p = 0.0024$) reveals a critical "perception gap." This underscores a classic symptom in unstandardized logistics environments where frontline workers focus on localized delays rather than systemic throughput. This lack of alignment is mathematically validated by the Pareto analysis, which indicates that unstandardized methods and manpower account for 70% of aggregate operational waste. These findings match quality management principles stating that the vast majority of process failures stem from systemic, controllable practices rather than asset availability (Montgomery, 2020). Simplex optimization isolates labor as a strictly binding constraint with zero remaining slack, proving that peak manual utility ($Z = 320$ units) is structurally restricted unless manpower is dynamically redirected toward high-impact elements like re-icing. This challenges traditional management conventions favoring uniform labor distribution across processing stations. In line with cellular manufacturing literature, dynamic, cross-trained worker allocation serves as a proven mechanism for enhancing line-balancing and labor efficiency over static assignments (Askin & Goldberg, 2021).

Furthermore, the Big M scheduling optimization and Value Stream Mapping (VSM) implications prove that implementing the streamlined, five-stage Cycle 6 model compresses total processing time to 8,712 seconds. This satisfies the 24-ton monthly market demand while expending only 30.25% of the daily operational window. This massive 5.6-hour temporal cushion aligns with operations management literature emphasizing that deep capacity buffers reduce the risk of supply chain disruptions and lower labor costs compared to non-synchronized scheduling (Amjath et al., 2023). This capacity expansion demonstrates that historical peak-season congestion is a manageable process variable rather than an inevitable environmental certainty (Ghosh et al., 2023).

A notable limitation of this study is its reliance on deterministic, static time-study data assuming steady-state fish landings, which overlooks high-variance disruptions caused by weather anomalies typical of maritime transport networks. Future research should transition toward stochastic programming, robust optimization, or discrete-event simulation modeling.

Managerial Implications

The empirical results provide data-driven evidence that port administrators can optimize performance without expensive physical terminal expansions. Supervisors must abandon uniform staffing and adopt focused resource allocation, dynamically deploying workforce units to the binding re-icing stage to maximize capacity and secure cold-chain integrity. Additionally, codifying the streamlined Cycle 6 configuration into the official Standard Operating Procedure (SOP) enables the port to hit batch targets in just 2.4 hours, introducing a predictable, batch-oriented paradigm that eliminates procedural ambiguity. Management can then strategically leverage the remaining 5.6-hour temporal cushion for proactive facility maintenance, cold storage upkeep, and 5S organization. This proactive approach slows equipment depreciation and reduces frontline employee fatigue. Beyond the fish port, this localized Lean-OR framework offers a scalable blueprint for agricultural and cold-chain supply networks across Occidental Mindoro to mitigate post-harvest food loss and enhance cross-provincial competitiveness.

CONCLUSIONS AND RECOMMENDATION

This study successfully establishes an optimized operational framework for the Caminawit Fish Port by integrating Lean principles with Operations Research (OR) models. The findings reveal that terminal inefficiencies are systemic rather than physical, with a Pareto analysis attributing 70% of processing delays to "Methods" and "Manpower." This aligns with the rejection of H_0 ($p = 0.0024$), which exposes a critical cognitive gap among personnel regarding terminal bottlenecks. By deploying the Simplex and Big M methods (H_2 and H_3 validated), the scheduling model proves that prioritizing the streamlined Cycle 6 configuration minimizes total standard time to 8,712 seconds while seamlessly satisfying the 24-ton monthly market demand. This configuration isolates labor as the sole binding constraint; dynamically reallocating workforce assets to high-impact phases like re-icing maximizes the terminal's objective value ($Z = 320$) and unlocks substantial temporal slack. Consequently, immediate infrastructure expansion is unnecessary.

To institutionalize these efficiency gains, port administrators should adopt the Cycle 6 workflow as the official Standard Operating Procedure (SOP). Visual management tools, such as Andon boards, must be deployed to eliminate communication friction and align employee performance. Furthermore, rigid, fixed-hour scheduling should be replaced with batch-based logistics shifts; since market commitments can be met in roughly 2.4 hours, the remaining temporal buffer must be structurally dedicated to facility maintenance and 5S cleanups to curb long-term equipment depreciation. Finally, future researchers should incorporate stochastic variables like volatile weather trends and vessel arrival patterns via Monte Carlo simulations, while expanding the cold-chain analysis downstream to evaluate the thermal efficiency of re-icing during regional transport.

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The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

DECLARATION OF AI USE

The authors used artificial intelligence (ChatGPT and Gemini) to edit language, organize structures, and optimize citations. These tools helped to synthesize technical data and summarize Linear Programming outcomes. The authors extensively checked and validated all AI-generated outputs, and they are solely responsible for the manuscript's academic integrity and mathematical accuracy.

AUTHOR CRediT STATEMENT

Pudan, P. M.: Conceptualization, Methodology, Formal Analysis, Writing – Original Draft (Results). **Delima, D.:** Writing – Original Draft (Introduction, Recommendations). **Cabutaje, N.:** Writing – Original Draft (Conclusion, Abstract). **Gulabrai, M. J. G.:** Data Curation, Writing – Original Draft (Discussion), Writing – Review & Editing (References, Format Editing).

KNOWLEDGE AND PRACTICE OF MIDWIVES ON SCREENING OF PREECLAMPSIA DURING PRENATAL CARE IN SELECTED HEALTH FACILITIES OF SAMARICA, OCCIDENTAL MINDORO

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ABSTRACT

Preeclampsia continues to be a primary cause of maternal and neonatal morbidity worldwide. This study aims to assess the level of knowledge and practice of midwives on screening of preeclampsia during prenatal care, aiming to determine their demographic characteristics, level of knowledge on screening of preeclampsia, level of practices in screening of preeclampsia, and potential relationship between demographic profile and the level of knowledge and practice on screening of preeclampsia. A descriptive cross-sectional study was conducted to assess the knowledge and practices of midwives on screening of preeclampsia during prenatal care in SAMARICA District of Occidental Mindoro. The sample size was 74 midwives. Data were gathered through knowledge-based questionnaires aligned with ACOG and WHO and Maternal and Newborn Quality of Care Survey ANC Observation Checklist. The study revealed that while midwives correctly identified key indicators like hypertension (98.6%) and edema (94.6%), yet 70.3% had a low level of comprehensive knowledge, particularly about the danger signs and risk factors, this shows a lack of awareness regarding essential factors. Similarly, 52.7% demonstrated a low level of clinical practice. Additionally, while midwives checked for edema, only 21.6% followed correct blood pressure measurement and only 12.2% performed regular weighing. Additionally, demographic factors such as age, type of facility and years of experience showed no significant relationship with either knowledge and practice, moreover, statistical analysis confirmed that higher educational degree does not automatically lead to better adherence to screening protocols, while findings indicates that knowledge is the key driver to performance.

Keywords: *preeclampsia, prenatal care, midwife knowledge and practice, screening and SAMARICA*

SDG: *SDG 3- Good health and well-being*

INTRODUCTION

Pregnancy is one of the most important events in a woman's life, requiring essential care throughout all three trimesters to manage the many factors that can influence maternal and fetal health. During this stage, midwives must monitor pregnancies continuously and thoroughly to implement timely interventions for complications such as preeclampsia. Preeclampsia remains a leading contributor to maternal and neonatal mortality globally, characterized by high blood pressure (≥ 140 mmHg systolic or ≥ 90 mmHg diastolic) and proteinuria after 20 weeks of gestation (World Health Organization, 2025).

Globally, preeclampsia is a leading contributor to maternal and neonatal mortality. This condition accounts for an estimated 62,000 to 77,000 maternal deaths and approximately 500,000 infant deaths annually (World Health Organization, 2025).

The effects of preeclampsia in the Philippines are concerning. In accordance with the Philippine Statistics Authority (2025) it states that preeclampsia ranks as the second primary cause of maternal mortality in the MIMAROPA region represents 12.7% of all maternal fatalities. In this area, the Occidental Mindoro had the highest mortality rate, indicating 44.4% of all preeclampsia cases in the region. These numbers highlight an immediate requirement for enhanced screening, particularly in regions where medical access and resources are scarce.

Prenatal care is the primary approach to address issues associated with preeclampsia, which pertains to the healthcare services provided during pregnancy to guarantee optimal health outcomes results for both the mother and the growing fetus as it seeks to pinpoint any associated risk during pregnancy and start assessment processes for the health of both mother and fetus (Karrar et al., 2025). Midwives play a crucial role in addressing these challenges as they serve as primary healthcare providers in the community. They are tasked with thorough evaluations of medical histories, blood pressure measurement, weighing of clients and screening for proteinuria. Additionally, midwives have a broadened responsibility in handling preeclampsia in relation to the Basic Emergency Obstetrics and Newborn Care, which involves the use of essential medications such as magnesium sulfate (Department of Health, 2010). Nevertheless, rising mortality rates are frequently associated with the provider-related issues, including overlooked diagnoses and inadequate treatment (Gonzaga et al., 2024).

Moreover, research has shown that numerous midwives do not possess adequate knowledge or clinical competencies related to screening for preeclampsia. Midwives lack sufficient knowledge or clinical skills specific to

preeclampsia screening. 49% of the midwives have sufficient knowledge in this domain. Insufficient knowledge and practice may result in undetected diagnosis of the condition [Seif and Rashid, 2022]. Midwives often encounter a lack of understanding regarding the risk indicators, clinical signs and proper monitoring techniques. Furthermore, diagnostic tool limitations, such as inadequate screening tools in the facilities, further impede their capacity to adhere to the treatment guidelines [Escobar et al., 2024]. To ensure quality, woman-centered care, there is a clear necessity for continuous professional development and practical training workshops [Garti et al., 2021].

This research, therefore, aims to determine the current knowledge and practice of midwives in the screening of preeclampsia to identify gaps and provide a foundation for targeted training programs to improve maternal and neonatal care.

METHOD

Research Design

The research design utilized in this study was descriptive cross-sectional design, a quantitative study. The study assessed the level of knowledge and practice among midwives on screening of preeclampsia during prenatal care in selected facilities of San Jose and Magsaysay and Rizal and Calintaan (SAMARICA), Occidental Mindoro.

Study Site

The study was conducted in the selected health facilities of San Jose, Magsaysay, Rizal, Calintaan, Occidental Mindoro. Facilities included in this study were those health facilities with midwives who rendered prenatal care services. The study was conducted during the Second Semester, A.Y 2025-2026. The researchers conducted a data gathering in healthcare facilities, starting from Calintaan, then Rizal, San Jose, and Magsaysay.

Sample

Collectively 74 midwives were involved in the study sample. The participants were chosen according to specific criteria to ensure the relevance and reliability of data collected. Midwives were eligible if they held a valid Professional Regulation Commission (PRC) license, were currently employed in either government or private health facilities in Rizal, Magsaysay, Calintaan and San Jose, Occidental Mindoro, and had experience in providing prenatal care. All participants must give their informed consent before being included in the study. The exclusion criteria included in this study were midwives who met the inclusion criteria but exhibited specific conditions requiring their exclusion from the study. This includes midwives who refused to participate as respondents during the research period and those who were not physically present during the data collection period.

Research Instrument

The data collection tool used was a structured questionnaire composed of three main parts: a demographic profile, a knowledge assessment and a practice-based checklist. The sociodemographic questionnaire was composed of: age, sex, respondent's educational attainment (Diploma in Midwifery and Bachelor of Science in Midwifery); type of facility (barangay health station and maternity and lying in clinic); and years of experience. To assess the level of knowledge of midwives on identifying for preeclampsia during prenatal care, knowledge-based questionnaires were utilized wherein it was aligned with the clinical indicators established in the American College of Obstetricians and Gynecologists (ACOG) Practice Bulletin No. 222 [2020] which supersedes Bulletin No. 202 and the World Health Organization (WHO) guidelines for hypertensive disorders in pregnancy. To evaluate the practice of midwives in screening of preeclampsia during prenatal care, a Maternal and Newborn Quality of Care Survey ANC Observation Checklist was used. It was a standardized data collection tool that was adapted for each country to gather information on ANC services. This integration ensured that evaluating midwives' knowledge and skills aligned with the latest international standards for diagnostic criteria. This includes updated blood pressure threshold and proteinuria- independent definitions of preeclampsia.

Data Collection

Following approval from the Municipal Mayors and Municipal Health Officers, data collection was conducted in the municipalities of San Jose, Magsaysay, Rizal, and Calintaan (SAMARICA), Occidental Mindoro. Lists of licensed midwives and their assigned facilities were obtained through the respective Municipal Health Offices. Eligible participants included licensed midwives providing prenatal care services in Rural Health Units (RHUs), birthing facilities, and Barangay Health Stations. Researchers contacted potential participants to explain the study and confirm their willingness to participate. Data collection was conducted at the participants assigned facilities after obtaining written informed consent. A structured bilingual (Tagalog and English) questionnaire was administered to assess midwives' knowledge, while an observation checklist was used to evaluate their prenatal care competencies. Both instruments underwent review to ensure clarity, relevance, and cultural appropriateness. Interviews and observations were conducted onsite to facilitate participant convenience and preserve the natural practice setting. Completed questionnaires and checklists were reviewed for

completeness and accuracy immediately after data collection. To maintain confidentiality, unique codes were assigned to participants, and no identifying information was included in the dataset. All completed forms were securely stored and accessible only to the research team. Data were encoded in Microsoft Excel for analysis, while physical records will be retained for three years following study completion and subsequently destroyed through secure disposal procedures.

Ethical Consideration

The Prior to data collection, all participants were provided with a cover letter explaining the study's objectives, significance, procedures, risks, and benefits. Participation was entirely voluntary, and informed consent was obtained before enrollment. Participants were informed of their right to decline participation or withdraw from the study at any time without penalty or adverse consequences to their employment, professional standing, or access to services. Confidentiality and anonymity were strictly maintained by restricting data access to the research team and securely storing all records. Participants were informed that study findings would be made available upon request. The research adhered to established ethical principles of respect for persons, beneficence, and justice. All collected data will be securely disposed of after the completion of the study and dissemination of findings.

Data Analysis

Descriptive statistics including frequencies and percentages, were utilized to provide a summary of the demographic characteristics of the participating midwives and to describe their levels of knowledge and practice in screening preeclampsia during prenatal care. Demographic variables such as age, educational attainment, years of experience, and type of facility were treated as ordinal variables. Levels of knowledge and practice were categorized as low and average and analyzed as ordered outcomes. Due to the highly skewed distribution of knowledge and practice scores, nonparametric statistical tests were employed. Spearman's rho correlation coefficient was used to determine the relationship between demographic characteristics and the levels of knowledge and practice of midwives. This nonparametric test was deemed appropriate due to the ordinal nature of the variables, the limited number of response categories, and the non-normal distribution of the data. Conducted at a 0.05 level of significance using two-tailed tests.

RESULTS

The data revealed female workforce with a significant majority are female (97.3%), with the largest age group falling between 25 and 34 years old (36.5%). Educationally, more than half of the midwives (58.1%) have attained a Bachelor of Science in Midwifery with a workforce (50%) of more than 10 years of professional experience working in practice within government-run (83.8%) Barangay Health Stations or Rural Health Units [table 1].

Table 1. Demographic characteristics (n=74).

Profile	Frequency	Percentage
Age		
18-24	4	5.4
25-34	27	36.5
35-44	21	28.4
45-54	22	29.7
Sex		
Male	2	2.7
Female	72	97.3
Educational attainment		
Diploma in Midwifery	31	41.9
Bachelor of Science in Midwifery	43	58.1
Type of facility		
Birthing centers (Private)	9	12.2
Barangay Health Stations/ Rural Health Units	62	83.8
BEmONC	3	4.1
Years of experience		
<5 years	16	21.6
6-10 years	21	28.4
More than 10 years	37	50.0

Level of knowledge on screening of preeclampsia

The overall knowledge of the midwives possesses a "Low" level of comprehensive knowledge (70.3%) regarding preeclampsia screening [table 2].

Table 2. Level of knowledge of midwives on screening of preeclampsia.

Risk Factors	Response Category	Frequency	Percentage
High blood pressure	Yes	73	98.6
	No	1	1.4
Multiple pregnancies	Yes	22	29.7
	No	52	70.3
Parity	Yes	9	12.2
	No	65	87.8
BMI $\geq$ 30 kg	Yes	21	28.4
	No	53	71.6
Convulsions	Yes	18	24.3
	No	56	75.7
Knowledge on risk factors	High	19	25.7
	Low	55	74.3
Hypertension	Yes	74	100.0
	No	0	0
Edema	Yes	70	94.6
	No	4	5.4
Proteinuria	Yes	49	66.2
	No	25	33.8
Rapid weight gain	Yes	20	27.0
	No	54	73.0
Severe headache	Yes	30	40.5
	No	44	59.5
Nausea/vomiting	Yes	12	91.9
	No	68	8.1
Knowledge on signs and symptoms	High	29	39.2
	Low	45	60.8
Blurred vision/visual disturbance	Yes	49	66.2
	No	25	33.8
Convulsions or loss of consciousness	Yes	49	66.2
	No	25	33.8
Swollen face or hands	Yes	60	81.1
	No	14	18.9
Shortness of breath	Yes	15	20.3
	No	59	79.7
Severe, persistent headache	Yes	26	35.1
	No	48	64.9
Severe abdominal pain	Yes	11	14.9
	No	63	85.1
Frequent or painful urination	Yes	4	5.4
	No	70	94.6
Knowledge on danger signs	High	11	14.9
	Low	63	85.1
Level of knowledge	High	22	29.7
	Low	52	70.3

Observed level of practices of midwives on screening of preeclampsia

The table showed 100% of the midwives performed physical examinations for edema, other vital screening protocols were frequently neglected. Only 12.2% of midwives weighed their clients during the prenatal visit, and a low 21.6% followed the correct clinical procedure for blood pressure measurement, resulting in 52.7% of the respondents being categorized as having a "Low" level of clinical practices [table 3].

Table 3. Observed level of practices of midwives on screening of preeclampsia.

Practices	Response Category	Frequency	Percentage
The midwife weighs the client during the visit.	Done	9	12.2
	Not done	65	87.8
BP reading was taken on the left/right arm, using the appropriate cuff, with the arm supported at heart level.	Done	16	21.6
	Not done	58	78.4
The midwife examined the hands, face, and ankles for the presence of edema.	Done	74	100
	Not done	0	0
Level of practice	High	35	47.3
	Low	39	52.7

Relationship between the demographic characteristics of midwives, and their level of knowledge and practice

Demographic factors such as age, type of facility, and years of experience showed no significant relationship with either knowledge or practice. However, educational attainment showed a significant negative correlation with practice ($\rho = -0.238$, $p < 0.05$), suggesting that higher degrees did not automatically lead to better adherence to screening protocols in this group [table 4a].

Table 4a. The relationship between the demographic characteristics of midwives, and their level of knowledge and practice in screening of preeclampsia during prenatal care.

Variables	Knowledge on risk factors		Knowledge on signs and symptoms		Knowledge on danger signs		Practices	
	ρ	p-value	ρ	p-value	ρ	p-value	ρ	p-value
1. Age	-.175	.135	-.160	.174	-.011	.924	-.005	.964
2. Educational attainment	.060	.611	-.216	.064	.201	.086	-.238*	.041
3. Type of facility	.115	.328	-.117	.319	-.106	.371	-.015	.900
4. Years of experience	-.003	.979	-.092	.437	.021	.857	-.078	.916

The relationship between the level of knowledge and practice in screening of preeclampsia demonstrates that knowledge is a key driver of performance: knowledge of risk factors ($\rho = 0.249$, $p < 0.05$) and knowledge of signs and symptoms ($\rho = 0.348$, $p < 0.01$) both showed significant positive correlations with actual screening practices. This implies that improving a midwife's theoretical understanding of preeclampsia is a viable pathway to improving their clinical behavior [table 4b].

Table 4b. The relationship between the level of knowledge and practice in screening of preeclampsia during prenatal care.

Variables	Knowledge on risk factors	Knowledge on signs and symptoms	Knowledge on danger signs	Practice
Knowledge on risk factors	1	0.352 **	-0.072	0.249*
Knowledge on signs and symptoms		1	0.287*	0.348 **
Knowledge on danger signs			1	0.137
Practices				1

**Correlation is significant at the 0.01 level (2-tailed).

*Correlation is significant at the 0.05 level (2-tailed).

DISCUSSION

Midwives that had over 10 years of experience suggest expert level of competence, having this range of experience enables them to strengthen their clinical judgement and ability to identify early warning signs of complications like preeclampsia, however our study findings showed no significant relationship between age, type of facility and years of experience [Bradfield et al., 2023; Sligo et al., 2024]. Moreover, educational attainment showed a significant correlation with practice. This contradicts the findings wherein according to them advancing to a four- year degree is a crucial determinant of clinical competence and quality service delivery of (Felipe-Dimog et al., 2023). The higher the educational attainment likely provides the theoretical and clinical foundations necessary for accurate screening [Sharma et al., 2018]. Moreover, being assigned in the Barangay Health Stations/Rural Health Units, at the primary care level means these midwives are the frontline health workers. Their ability to screen is effectively dominant, however they are the most vulnerable to the diagnostic gap, as their facility type and availability of tools directly influence the accuracy of preeclampsia identification [Billah et al., 2021].

While the majority of respondents recognized high blood pressure as a significant risk factor in screening for preeclampsia which aligns with the clinical indicators of the American Heart Association [2025], there is a stark lack of awareness regarding the other important clinical indicators of preeclampsia. These gaps align with the finding wherein while midwives are central to care, they often overlook moderate risk indicators, which lead to undiagnosed cases of preeclampsia [Lehang et al., 2024]. Similarly, all the respondents identified hypertension and edema as signs and symptoms of preeclampsia, however, other signs and symptoms are markedly low. The ability to detect preeclampsia early is one of the main challenges that midwives face, if these red flags or signs and symptoms were missed the action for early intervention may be missed. Moreover, the results also show that most of the respondents were classified as having low knowledge of danger signs of preeclampsia whereas midwives should have adequate knowledge about the warning sign as these symptoms are important to be recognized by the midwives, as failure to do so may result in missed or delayed. According to Sabrida et al [2023] variation in midwives' knowledge and practice in screening can make it harder to detect preeclampsia early and correctly, which can reduce the chance of preventing complications with timely medical management.

Accurate screening and diagnosis by midwives during prenatal care serve as foundation for early detection and management (American College of Obstetricians and Gynecologists, 2020; 2025). Alreshidi et al., (2026) underscored that these gaps in midwives' knowledge and practice can be addressed through strong policy support and accessible in-service training, continuous professional development, allowing midwives to acquire updated knowledge and essential practices for effective preeclampsia care and detection.

Midwives play an important role in screening of preeclampsia as they are considered as the first contact who directly care, conduct physical examination including basic screening such as vital signs monitoring, conduct health teaching to provide additional knowledge regarding pregnancy [Sabrida et al., 2023]. Midwives often develop competence in identifying visible clinical indicators through hands-on practice, majority of respondents working in primary care settings such as Barangay Health Stations/Rural Health Units, where blood pressure measurement and weight measurement are routine [Garti et al., 2021]. However, results show that midwives did not perform these essential screening procedures.

Precise blood pressure measurement is crucial for the early detection of hypertension [Mkansi et al., 2021]. Yet only few midwives adhered to these protocols, which could result in misdiagnosis or delayed treatment. The same as measurement of weight and calculation of BMI are important for identifying obesity ($BMI \geq 30$ kg), a known risk factor for preeclampsia. Observation midwives rarely use the crucial screening methods such as the mean arterial pressure (MAP) and Body Mass Index (BMI), even if these methods are clearly stated in the Maternal and Child Health (MCHN) Book [Lehang et al., 2024]. Higher the educational attainment and four-year degree programs are crucial for better preparation and competitive edge of a midwife. However, significant findings emerge regarding the midwife practice, specifically concerning educational attainment, indicating that higher degrees do not automatically lead to better adherence to screening protocols [Sharma et al., 2018; Felipe-Dimog et al., 2023]. Improving the midwife's theoretical knowledge or understanding specifically the updated clinical symptoms is one of the necessary pathways to improve their clinical behavior and accuracy in the field [Alreshidi et al., 2026].

While this study provides valuable insights to midwives' knowledge and skills in screening of preeclampsia, several limitations must be considered. First the data collection relied on self-reported questionnaires and observational checklists which may introduce bias due to over estimation of skills or tendency for the respondents to provide socially desirable answers rather than true reflection of their practices. Second, the sample size was limited to 74 licensed midwives who were available during the data collection period, which is smaller than the original target population; this may not fully represent all the midwives in the province. Third, the study's scope was limited only to the municipalities of SAMARICA, which can affect the generalizability of the findings to midwives in other municipalities. Lastly, the research did not measure the actual patients' outcomes or long- term effectiveness of the screening practices in reducing the maternal complications, making it difficult to evaluate the direct impact of midwives' knowledge and skills on maternal health.

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CONCLUSIONS AND RECOMMENDATION

The study found that midwives in the SAMARICA area of Occidental Mindoro were predominantly female, mostly aged 25–34 years, had over 10 years of professional experience, and commonly held a Bachelor of Science in Midwifery degree. Despite their educational attainment and experience, participants demonstrated low overall knowledge of preeclampsia screening, particularly regarding risk factors, warning signs, and the broader clinical presentation of the condition. While knowledge of classic indicators such as hypertension and edema was relatively high, substantial gaps remained in comprehensive screening knowledge. Similarly, midwives exhibited low levels of adherence to recommended screening practices. Although physical examinations were routinely conducted, essential procedures such as accurate weight measurement and proper blood pressure assessment were inconsistently performed. Sociodemographic and professional factors, including age, facility type, and years of experience, were not significantly associated with knowledge or practice levels. Notably, higher educational attainment showed a negative correlation with screening practices. However, greater knowledge of risk factors and clinical manifestations was positively associated with improved screening practices, highlighting the importance of strengthening theoretical and clinical competencies in preeclampsia screening.

Healthcare administrators and local health authorities should strengthen continuing professional development programs focused on the comprehensive screening and early detection of preeclampsia. Training initiatives should emphasize risk assessment, recognition of warning signs, and adherence to evidence-based screening protocols, supplemented by practical skills training and competency assessments. Midwives and Barangay Health Workers should consistently follow standardized prenatal screening procedures, particularly in obtaining accurate weight and blood pressure measurements. Regular supervision and monitoring mechanisms should be implemented to ensure compliance with established clinical guidelines. The Department of Health, Provincial Health Office, and Municipal Health Offices should ensure the availability of essential screening equipment and promote the adoption of evidence-based practices aligned with international guidelines. Furthermore, support systems should be established to facilitate ongoing competency development among frontline maternal health providers. Future studies should include a broader geographic scope to improve generalizability and explore factors influencing the gap between knowledge and clinical practice. Further research is also recommended to evaluate the impact of improved preeclampsia screening practices on maternal and neonatal outcomes.

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DECLARATION OF CONFLICT OF INTEREST

The authors declare no conflict of interest.

DECLARATION OF AI USE

The authors used Grammarly for grammar checking and language editing. All outputs were reviewed and validated by the authors, who take full responsibility for the content.

AUTHOR CREDIT STATEMENT

Concepcion, A.M: Conceptualization, Supervision, Methodology, Investigation, Formal Analysis, and Writing – Original Draft; **Dansecro, A.K:** Conceptualization, Methodology, Investigations, Writing – Original Draft; **Cirineo, R. S:** Conceptualization, Methodology, Investigations, Writing – Original Draft; **Cabaruan, A:** Conceptualization, Methodology, Investigations, Writing – Original Draft; **Bandiola, M:** Methodology, Investigations, Writing – Review & Editing; **Felipe, J:** Investigations, Writing – Review & Editing; **Ramos, M.J:** Investigations, Writing – Review & Editing; **Colonia, R.G.:** Supervision.

IMPLEMENTING GUIDELINES IN WRITING AND CONDUCTING UNDERGRADUATE AND GRADUATE RESEARCH

I. Requirements before Enrolling Undergraduate Research

1. The student must have passed English 10 or its equivalent (Methods of Research/Technical Writing for BAT) where a research proposal is required and completed (Chapters 1-3).
2. The student must have an adviser of his/her choice or designated by the Research Chair. The adviser has technical knowledge of the research topic the student is pursuing.
3. The student must have successfully defended his/her research proposal before a panel on pre-oral defense.
4. The student reports regularly to his/her adviser for direction and guidance in the conduct of his/ her research.
5. A consultation sheet is secured from the Chair's Office where records of the transaction or consultation with the adviser are reflected for purposes of monitoring and supervision.
6. A certificate of **Ready for pre-oral/final defense** signed by panel member, critic reader, statistician and financial critic must be secured by the students before the pre-oral or final defense.
7. The student must provide panelists copies of the manuscript at least one week before the final defense.

II. Thesis Adviser

1. The student has the option to choose an adviser from the list of advisers provided by the Research Chair. The thesis adviser chosen by the student has technical knowledge regarding the research problem he/she is pursuing. If possible, the adviser and the advisee must have the same field of interest/specialization.
2. The thesis adviser should be a permanent faculty or employee of the Institution, if possible.
3. In cases where students cannot choose an adviser, the Research Chair will designate an adviser based on the adviser/student's specialization/major.
4. In case the student changes his/her adviser for any acceptable reason, a **permit to change adviser** must be secured from the Research Chair. Both the "changed" adviser and the new adviser must affix their signature on the permit.

III. Selection of the Members of the Panel, Data Analyst, Financial Critic, and Critic Reader

1. The student is free to choose at most three members of the panel who have technical knowledge on the research he/she is pursuing, one statistician, one financial critic, and one critic reader.
2. The student selects from the list of panel members, statistician, financial critic, and critic reader provided by the Research Chair.

IV. Role of a Thesis Adviser

1. The adviser is a faculty member of the Academic Department who provides guidance and direction, encouragement, and motivation to his/her advisee in the process of thesis writing.
2. He/she recommends the manuscript for oral defense and signs a particular form for this purpose. The adviser sees to it that his/her advisee is prepared for the oral defense.
3. He/she guides and briefs the advisee on the mechanics of oral defense and prepares him/her on what to expect during the proceeding.
4. He/she must be present during the oral defense but should refrain from answering questions for the advisee or negate views of the members of the panel. He/She may clarify or simplify questions for the advisee and take down notes on suggestions and recommendations.
5. He/she makes concrete suggestions and acts promptly and wisely on parts of the manuscript which require correction or revision. He/She sees to it that his/her advisee follows the prescribed format in writing the manuscript.
6. He/she monitors the progress of the research work of his/her advisee. Members of the panel should also help the adviser in ensuring that the advisee does what is expected of him/her.
7. He/she certifies the approval of the final manuscript.

V. Role of the Members of the Panel

1. The panel members assess the research papers and give comments, suggestions, and recommendations for the improvement of the research paper.
2. They may approve/disapprove the research proposal. Disapproved paper means it has not satisfactorily met the basic requirements of a good research paper.
3. They help monitor the student's research work in coordination with his/her adviser.

4. They evaluate and rate the paper using standard criteria as part of the computation of final grade in Methods of Research or Thesis Writing.
5. They certify the approval of the final manuscript.

VI. Role of a RECO Member

1. The RECO member is a staff of R&D Unit/representative from the pool of experts and is duly designated by the R&D Director.
2. The RECO member is a regular member of the panel during the pre-oral and final defense. He/She informs the new trends in research undertakings.
3. He/she helps monitor the student's research work in coordination with his/her adviser.
4. He/she evaluates and rates the paper using standard criteria as part of the computation of final grade in Methods of Research or Thesis Writing.
5. He/she endorses a student's research proposal for possible funding in the R&D Unit.
6. He/she certifies the approval of the final manuscript.

VII. Role of a Statistician

1. The statistician guides the student in the use of appropriate statistical tools for his/her research paper.
2. He/she gives advice in data encoding and interpretation of the research results.
3. He/she certifies the correctness of the methodology and statistics used in the research manuscript.

VIII. Role of a Critic Reader

1. The critic reader must proofread the manuscript.
2. He/she certifies the correctness in the writing of the manuscript.

IX. Role of a Research Chair

1. The Research Chair helps in implementing policies on the conduct of thesis research paper.
2. He/she prepares the schedule of the pre-oral and final defense.
3. He/she certifies the approval of oral defense of the students.
4. He/she acts as the Chair of the research panel.
5. He/she performs research monitoring in coordination with the adviser.
6. He/she consolidates the evaluation sheets as a basis of grade or rating of the students.
7. He/she certifies the approval of the final manuscript.

X. Requirements for Oral Defense

1. The student must have a written recommendation from his/her thesis adviser in terms of his/her readiness/preparedness for the oral defense.
2. The student must have a certification from the Statistician/Financial Critic as to the approval of statistical/financial requirements of his/her paper.
3. The student must have a certification from a critic reader as to the appropriate grammar and language use.
4. The student must likewise have an approval from the Methods of Research Instructor and Department Chair prior to his/her oral defense.
5. Required copies of the research papers should be submitted at the Research Office with the adviser's certification at least one week before the scheduled defense.
6. The students who failed to defend his/her thesis on schedule will not be allowed to conduct off-campus practice teaching and will not be included in the list of graduating students.

XI. Decorum in the Conduct of Oral Defense

1. The student must be in proper attire.
2. The members of the panel must be in semi-formal or formal attire during oral presentation.
3. The audience must observe silence throughout the presentation.

XII. Submission Procedures

1. Students who failed to defend his/her thesis on schedule will only be allowed to conduct OJT/RLE activities within OMSC Offices/Department/Unit.
2. The deadline for submission of loose-leaf theses and is at least one workweek before the last day for the submission of grades for graduating students to provide sufficient time for binding. For example, if the deadline for submission of grades is May 7, theses must be approved for binding before April 30.
3. Undergraduate theses must be hardbound using green leatherette with gold lettering.

4. To facilitate future open-access repository, digital copy of theses must be submitted to the College Research Coordinator for safe keeping. With file name: College Year of Graduation Last Name of the First Author Title of Thesis
Example: CTE_2023_Dela Cruz Case Study of Occidental Mindoro State College
5. An undergraduate student should submit the following to the College: Four hardbound copy for the department, library, adviser, and student. One digital copy (in PDF with scanned copy of the signed documents) for the department.
6. Addition of Permission Page (Republic Act No. 8293 - Intellectual Property Code of the Philippines). These will be classified into one of only four categories:
 - I: has patentable or registrable invention or registration
 - P: author wishes to publish the work personally
 - C: confidential information of a third party is embedded
 - R: a regular work, i.e., it has no patentable invention or creation, the author does not wish for personal publication, there is no confidential information.

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Effectivity: starting First Semester, Academic Year 2023-2024



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