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EMOTIVE LANGUAGE IN VIRTUAL INTERACTION ON LEARNING FROM HOME

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ABSTRACT

This study analyzed the Hiligaynon speakers' emotive language and communication devices in online conversation. Issues that went viral on the opening of online classes served as the interaction objects. The researcher used the qualitative research method, specifically, linguistic discourse analysis, to describe the online texts in various contexts. Result analysis revealed positive and negative emotive language to the viral posts on learning from home: sarcasm, disgust, optimism, and empathy. Sarcasm and disgust are common in attacks and humor, while optimism and empathy in hypocoristics/ endearment and appeals as language devices. The study promotes optimism and empathy for it broadens the students' attention and thinking towards new learning. These positive feelings give a favorable interest in response to online interaction or other communication situations. With the absence of negativity, positive emotions actively produce health and wellbeing as well. Sarcasm challenges creativity and motivation towards action.

Keywords: emotive language, learning, interaction, virtual

INTRODUCTION

Background of the Study

People express ideas in either a positive or negative way. To influence others and elicit a value judgment on a situation, people use appealing words or expressions. These words or utterances refer to the emotive language.

Emotive language is a word choice that can evoke emotion or cause an emotional response in the audience. This emotive power of words can direct or manipulate the person's attitudes, feelings, and decisions (Macagno & Walton, 2014, in Tsitsanoudis-Mallidis & Derveni, 2018). Emotive language arouses emotion, especially when the speaker expresses approval or disapproval of a person or an activity (Fredrickson, 2006 in MacIntyre & Gregersen, n.d.).

In social media context as online posts, chats, or tweets, some people use different language devices and emotive language to persuade others of their views or opinions. According to Ptaszynski et al. (2008), emotive language's emotive function is realized through parts of speech as exclamations, hypocrisis (endearment), vulgar language, mimetic expressions.

Many studies found emotive language as a persuasive technique itself. In academic settings, varied human emotions represent the internal states tied to physical and sensory feelings (Lazarus, 1999 Pekrun et al., 2002; Pishghadam et al., 2016).

In language learning, positive emotions broaden attention to new experiences and learning. With the absence of negativity, positive emotions actively produce health and wellbeing (Fredrickson, 2006 in MacIntyre &

Gregersen, n.d.).

Positive emotions activate global and negative emotions. Speakers in a positive mood use more abstract words to describe events, while speakers in a negative mood tend to use more concrete words; positive emotions broaden attention (Forgas, 2012 in Out, Goudbeek, & Krahmer, 2019).

Macagno & Walton (2010) found emotive language reasonable in argumentation based on values; however, vulnerable to fallacious, critical questioning. By classifying and labeling emotive verbal expressions, people can better understand how language is used (Gerholm, 2018). For instance, learners experience different emotions like anger or shame in listening activities; enjoyment and pride in speaking; hope, boredom, hopelessness in writing and listening; and anxiety in overall language skills (Pishghadam et al., 2016).

In online interactions, Richter et al. (2011) observed that colloquial text-based emotive language is advantageous in successful negotiations and helps combat cyberbullying. Nayel and Saloomi (2020) found that persuasive techniques like attacks, rhetorical questions, anecdotes, and alliteration evoke emotions.

This study aimed to analyze the emotive language and the devices used in a virtual environment among the Hiligaynon speakers. The study's concern is to identify and

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promote emotive languages to use online to contribute to mental and emotional wellbeing among the readers.

The Framework of the Study

Figure 1 shows the flow of the study. Emotive language in virtual interaction may be positive or negative as reactions to the viral FB posts. This emotive language is present in different language devices used by the participants. Optimism and empathy are evident in hypocoristic/ endearment and appeal, while sarcasm and disgust manifest in attacks, humor, colloquialism, interjections, and vulgar vocabulary. Both the positive and negative emotions are present in rhetorical questions, repetitions, intensifiers, imperatives hyperbole, and cause and effect devices. Language plays a role in the person’s emotions that lead him to react to the written texts as explained by Conceptual Act Theory (Barrett, 2006) and the theory of positive emotion “broaden and build” by Fredrickson (2006) differentiates the functions of positive and negative emotions (Fredrickson, 2006 in MacIntyre & Gregersen, 2012).

Purpose of the study

The study identified the emotive language and devices used in an online conversation.

The study answered the following questions:

(1) What emotions are revealed in the online conversation with issues on learning from home? and (2) What emotive language devices are used by Hiligaynon speakers in online interaction?

Conceptual Act Theory (Barrett, 2006) which supports the study explains that language plays a role in

emotion. The language supports the conceptual knowledge used to make meaning of emotions or feelings in a given context. The theory suggests how it can be applied to understanding emotional response concordance in the context of individual, contextual and temporal variations in emotional responses (Quigley & Barrett, 2014). Further, the theory of positive emotion “broaden and build” by Fredrickson (2006) acknowledges that negative emotions’ action tendencies powerfully dispose a person to a specific action.

METHODOLOGY

The study utilized the qualitative research method, precisely, linguistic discourse analysis, which analyzes how specific language features contribute to the interpretation of online texts in their various contexts.

The research object is the participants’ online posts as responses to the viral posts on learning from home issues: the face-to-face or online classes, modules as an alternative mode of teaching, and wearing the school uniforms while learning online. Three hundred relevant online comments expressing different emotional tropes were gathered and analyzed using different persuasive language techniques.

The study involved the Hiligaynon speakers’ online comments on the viral news posted by Facebook users. The users include the students, parents, and professionals. The posts are dated July to October of the current year. The participants’ online comments were gathered and documented. As to ethical consideration, the researcher concealed the identity of the posters to observe confidentially and anonymity. The names or titles of the persons mentioned in the news article were strictly protected by hiding them to preserve their dignity and

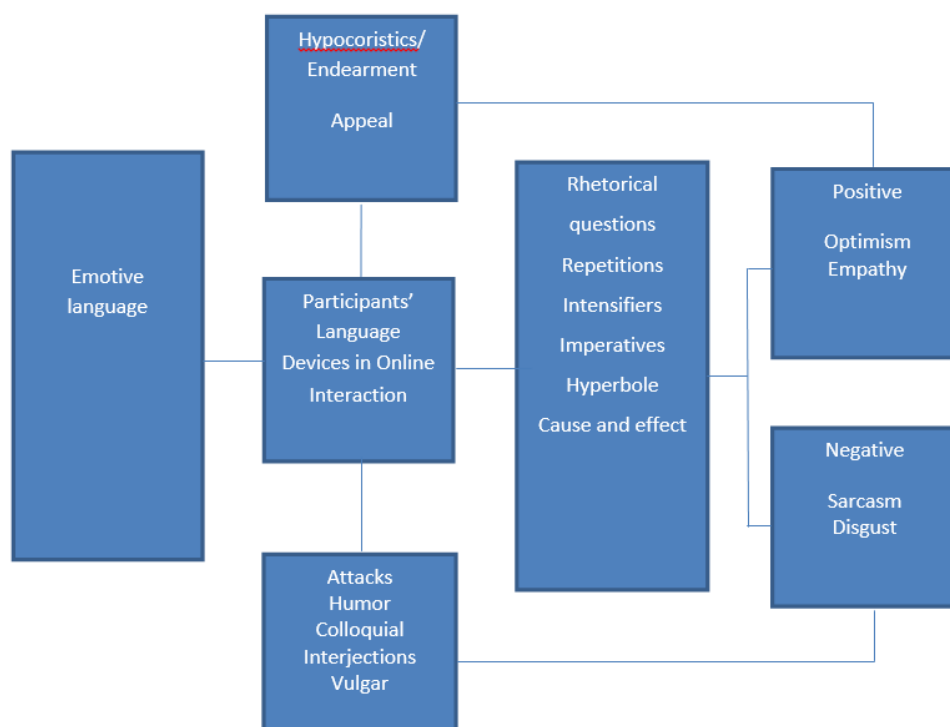


Figure 1. Study framework

privacy. Using data mining, around 1000 comments were collected from the viral news posted by local online newspapers in Iloilo City – Bombo Radyo, DYRI RMN, and Aksiyon Radyo. Only the relevant posts were considered for content and discourse analysis.

The responses were categorized and analyzed individually based on the dominant emotions they reveal and the language device. Common themes as to figurative languages used were grouped using matrix. The emotive language is categorized into positive and negative feelings of the FB users.

RESULTS AND DISCUSSION

Four main emotive languages emerged as themes in the participants' virtual post on learning from home: Sarcasm, disgust, optimism, and empathy. To express these emotions, the participants used various language devices as attacks, humor, rhetorical questions, repetitions, intensifiers, interjections, colloquialism, imperatives, hyperbole, hypocoristics/ endearment, cause and effect, vulgar vocabulary, and appeal as language techniques.


Sarcasm

In response to the viral news on learning from home, the participants showed sarcasm as the most emerging emotive language. The participants' sarcastic responses to the online posts include: *"Ambot kun ano ang ginahuna - huna kag plano SA DEP Ed sec nga atat nga atat gid sugdan ang klaseclass na."*; (What made the Dep ed secretary think being so excited for the school to open.); *"Pila naman ayhan ila mabulsa hahaha."* (How much will they earn, hahaha). The participants used the attack as a language device in expressing their sarcasm. Mainly, the participants used attacks in response to the viral news relevant to learning from home they read online. This language device is an assertion of the writer's viewpoint. For instance, they are attacking the unreliable, dishonest, and unqualified (Nayel & Saloomi, 2020).

The participants also responded to the posts with sarcasm through humorous written texts, categorized into puns, irony, and satire. Using humor to make fun of these views could be particularly persuasive (Argyropoulou, 2017). A pun is a joke that makes a play on words. These are the participants' reactions: *"Wla na mahimo si toyang ermitanya....sulod nalang balik sa kweba lolaky ka delikado."* (Tayang ermitanya can do nothing, get inside the cave, grandma, it is too dangerous.)

"Amu ni na obra namon... bisan mga mutaon pa mga estudyante kag wala kapanghusay basta naka uniform wala gamu." (These, we do, with a speck in eyes, messy hair, as long as we wear a uniform, that is fine.); *"Bakli soft drinks kag tinapay para matulon nya, kmo abi basa b nyo mahapos lang."* (Buy her soft drinks and bread so she can swallow, you do read, do you think it is easy); *"Suksok man kmi ID kay basi kigan kami ka guard."* (We will also wear ID so that the guard will not reprimand us.)

In terms of irony or the opposite of the literal meaning, the participants sarcastically expressed the

following: *"Sadya gid ni, naka-uniform ta sa babaw tas boxers lang sa idalom HAHAAAAHA."* (Seems funny, in uniform on top, and boxers down HAHAAAAHA.); *"Maski ga online job gani na mga dalagko company magmeeting iban ga boxer short lng pero xempre ang bayo tshirt eh haha."* (Even the big companies wear boxers shorts while having online meetings, but they wear t-shirts, of course.); *"Amo na gani gn tawag nga school uniform kay para lng sa school nd para sa balay dba."*; (It is what they call wearing the school uniform at home, right.); *"Um-uma dolsi tanawon ta kon hindi ka tulon laway ya."*; *"Kon hindi ma tulon idupla!!!"*  *"Ano abi kay hambal mo walo lng gin himo mo nga pulo!!!"* (Take candy and you can swallow your saliva, if not, spit it out; ah, you said eight, but you gave ten.)

The participants showed sarcasm in satire, which is a literary work holding up human vices and follies. *"Palihog lang saylo kmu ni AÑO sa MARS! pls lang, gigil nyo ko."* (Please move to MARS with ANO. Please....teeth gritting). *"Kung magsugod na online class may manukot pagid alamutan bakal silhig kg floor wax ni."* (When class starts, collect some money for floor wax.); *"Ngkacovid na ata mga utok sg Phil government officials, ahay na anu sila."* (Government officials' heads got infected by covid); *"Focus tani janay kung pano ma solbar ang pandemic indi na janay ang uniform. Negosyo nm nsg mga sastre kay tpos na iya sng mga barrier ka motor. Hahahaa!"* (Income for dressmakers, done with motorcycle drivers' barriers.)

Their sarcasm was also present in some rhetorical questions. These are questions that do not require an answer and are asked for effect only. The answer to such questions is clear, which leads the audience or the reader to a particular conclusion (Nayel, & Saloomi, 2020).

The following reactions express a feeling of sarcasm: *"Ano gid dinali mo man...d kw kahulat nga mag ok ang pandemic?"* (Why hurry, can't you wait till this pandemic ends?); *"Isa lang gusto nila buot silingon mag sul-ob sang matarong nga panapton maski naga online Class lang, gets???"* (It simply means that you have to wear formal clothes while attending online class, do you get it?); and *"Na iwan ang kalibutan?"* (What is happening to the world?)

Other participants often repeat words and phrases to emphasize particular ideas. They used intensifiers to reveal sarcasm. *"Grbe gid epekto sg COVID19 sa DepEd no."* (Such an extreme effect of Covid 19 on education.); *"Budlay mn katama mn k alam mga bata sa pilipinas."* (It is also a problem if all children in the Philippines are brilliant.); *"Utok nila daw sobra pa coronavirus bah."* (Their brains are more than coronavirus.) These utterances were sarcastic. Intensifiers in the Hiligaynon language appear in the form of *"gid," "man," "daw," "dun," "mas."* Adjectives and adverbs enhance the intensity of the emotion in the utterances.

Through repetition, the participants' responses also showed sarcasm, *"Bsi dugay² lain naman na ang guidelines."*; *Nyawaaa padugang² sa ralabhan."*; *"salama tanan tanan buhay buhay lang."* (Maybe later, new guidelines come. Hell, more laundry; be fair to all, that is life.)

Sarcasm was also present in interjections. Wierzbicka (1999 in Goddard, 2013) stated that all languages have 'emotive interjections,' expressing cognitively based feelings. Interjections have an expressive function, rather than the representational or symbolic function characteristic of ordinary words and sentences (Bühler, 1990 in Goddard, 2013).

The participants were sarcastic with the posts and reacted by saying, "*Naka school uniform na tapos nakamask pa kag Faceshield!* (Wearing face shield while in school uniform!).

In imperative expressions, sarcasm was also present, "*Pabakuna na sa Chinese*"; (Have vaccine with the Chinese.); "*Butangi bala nova or piattos tupad ya para maganahan sya mag basa with matching milo or milk. lantawon ta kng indi ya matulon laway ya.*" (Give her Nova, piattos, and milk. She will be inspired to study. She will find it easier to swallow her saliva.); "*Ahay intindiha nyo man ang ginatawag nga pandimya subong*"; "*Nan, si mam patunla ka laway mo ga.*" (Try to understand the pandemic. Let Mam swallow your saliva.)

On the other hand, the participants' hyperbolic or exaggerated expressions also showed sarcasm, "*Nag labot na gle sa utok ang virus.*" (Virus reached their head.); "*Amu ni bgo nga symptoms sg covid19, naga mala ang utok.*" (Brain getting dry is a new covid symptom.); "*Dw malupok muning q ka tudlo sa 5 q ka hinablos.*" (My genital is going to burst teaching my nieces.); "*Aqun bata ga tangis gani sakit iya kamot ka sulat kunu.*" (My children mourn in pain while writing.)

Some expressions which denote cause and effect reveal sarcasm, especially in the following utterances: "*Kun mag-online class ka nakasando kag brief or panty lang indi manami lantawon kag basi ibully ka pa sang mga classmates mo.*" (If you wear sleeveless shirts and just undergarments, others will bully you.); "*Maski ako guro indi man katulon laway kung mother tongue na.*" (I, myself, can't even swallow my saliva, using my mother tongue.)

Vulgar vocabulary is also seen in the participants' online interactions. Sarcasm was the emotion that prevails. "*Kadtuan ta na lang kada kag duplaan covid.*" (Will come and spew you covid); "*Nd tanan nga graduado educado kag ma aram iban tana pag graduate nagbusong namana.*" (Not all educated are intelligent; others get pregnant and marry.)

The participants' primary emotive language was sarcasm, usually expressed using attack and humor as language devices. Sarcasm is a way of pointing out or criticizing while intending to be humorous or funny (Pexman, 2018). It is described as a double-edged sword instigating conflict, but it can be a catalyst for creativity. When participants express sarcasm toward or received sarcasm from a trusted other, creativity increased, but the conflict did not (Huang, Gino, & Galinsk, 2015). In sarcastic tweets, Wang (2013) revealed that aggressiveness is manifested by more positive emotion words than ironic expressions. The degree of aggressiveness sugar-coats

positive emotive language, which makes sarcasm appear ironic. Scathing criticism is less destructive than literal criticism, and sarcastic compliments or "ironic praise" was less favorable than literal criticism (Pickering, Thompson, & Filik, 2018).

Disgust

For the participants, disgust, or a strong feeling of dislike, was an emotive language that also emerged in response to the viral news. A feeling of disgust or dislike is dominant in the following utterances: "*Daw maalam pa ya grade 1 section 6 sang ginapabatyag nila sa mga tawo aw.*" (Even the Grade 1 section 6 would understand their motive.); "*Kis-a daw gusto ko nalang mangin virus tapos tapikan ang mga ungo nga mga taga deped.*" (Sometimes, I wish I were a virus so I could infect the Deped people.) The participants used the attack as a language device in expressing their feeling of disgust.

They expressed disgust through rhetorical questions, "*Masuksok pa kami? Bilog nlq nga adlaw ma suksok kami uni tpos ikaw palabhon namun? Sugot ka?*" (Should we still wear? The whole day, should we wear the uniform, then you do wash our uniform? Do you agree?); "*Mapatahi pa kami sang bag o nga uniform ya? Basi online class pa suksokon mo pagid kami facemask kag faceshield??*" (Do we need a new uniform? And you let us wear facemask and face shield during online class?); "*Kay wala gani pambayad kuryente mga ginikanan, pambakal pa ayhan uniform... jussssskkkkooo, wala nagid ni ya consideration ang Dep Ed?*" (We cannot afford to pay our electric bills, and yet you want us to get a new uniform. God, why so inconsiderate, you from Dep Ed?)

Disgust was also evident in the following repetitive utterances: "*Kamo ya mga witi-witi amo imo inyo.*" (You are nonsense.); "*Atubangon pagd na namon ang kuris2 nyu nga storya*" (Such an absurd idea to entertain.); "*Pakadlaw-kadlaw lang kamo!*" (You are ridiculous!)

Feeling of disgust is evident in the following using intensifiers as language device: "*Sulumpa-an gd ya ang situation subng para sa tanan.*" (The situation is, indeed, miserable for all.); "*Kabudlay magtudlo xa bata ko. Daw ga mugo pasinsya ko.*" (It is so hard to teach children, I become impatient.); "*Ideya plang gani nga "online class" galibog dun ulo ka studyante kag manunudlo.*" (The thought of online class troubles both the students and teachers.) Intensifiers in the Hiligaynon language appear in the form of "*gid*," "*man*," "*daw*," "*dun*," "*mas*," and the use of adjectives and adverbs to enhance the intensity of the emotion in the utterances.

Disgust was also evident in the following interjections, "*Chamba sang mga palalagaw!!!*" (What a big chance for strollers!); "*Indi na katulon laway bata mo!*" (Your child has difficulty swallowing her saliva!); and disgust in the following utterances: "*Anay wala nko lalabhan uniform!*" (Glad having no laundry!); "*Hayyy du ma kadu ulo ko ah!*" (I am going crazy!); "*Di na gid maagwanta!*", "*Ahay, pandemic, perwisyo gid timo!*" (This pandemic is such an unbearable burden!)

For emotive interjections, the most common approach is functional labeling using emotion words, saying, for example, that Wow! and Yuck! express surprise and disgust, respectively (Goddard, 2013).

Imperative statements that show disgust include: *"Dapat panindugan nya kung masarangan nyo kong indi a."* (Is she able or not, she ought to tell us); *Kamo to suksok dula na uniform ko."* (You wear my uniform, I already lost it.) Imperatives are sentences used to issue a command or instruction, make a request, or offer advice.

In some vulgar utterances, the feeling of disgust was present: *"Kng di kaman ya mango eh."* (If you're not an idiot); *"Ay dpota nga utok na."* (Son of the bitch, that brain); *"Bwisit kamo inyo ya."*; (You are a shit); *"Utok nyo unod damog."* (Brain that looks like a pig's food).

The participants showed disgust to express their emotive language reactions to the viral issues using mainly attack, rhetorical questions, and repetitions as language devices.

Haidt (2003 in Widayarni, 2017) described disgust as a condition where a person reacts intuitively and emotionally to moral norms violations as caring, justice, authority, and purity. It is a reaction to violations of divinity - religious and natural order, contempt with community violations, meaning the duties and obligations of a social role, and norms about the body (Rozin et al., 1999 in Russell & Giner-Sorolla, 2013). Disgust decreases egocentric perspective taking; the more potent the disgust, the easier it is to adapt to the disgusted person's perspective (Todd et al., 2015 & Out, Goudbeek, Krahmer, 2019).

Optimism

Optimism refers to a positive feeling, high morale, a positive expectation, a belief that adverse events may have positive progress, or the bright side of the negative situation (Peterson 2000; Balci and Yilmaz, 2002; Kumcagiz, Çelik, Yilmaz, & Eren, 2011). It is a direction in which individuals experience their daily lives with an optimistic perspective, a more positive way, and expect more positive results (Chang, Sanna, and Yang, 2003; Kivimaki, Elovainio, Singh-Manoux, et al., 2005 in Jenaabadi, and colleagues 2015).

Optimism as an emotive language was evident in the following hyperbolic utterances: *"Ang kabuhi isa lng."*; (You only live once.); *"Ang edukasyon ara lng na ya."* (Learning never stops.); *"Maayo man to sang tyempo giyera, wala man eskwela, alam man mga tawo sa una."* (No war can hinder people to learn.); *"Swerte ko gd sang una nga wla ko na ma abtan mga amo ni nga plastada."* (I am fortunate I never experienced this plight.) A hyperbole is an exaggeration (Argyropoulou, 2017).

The following statements with intensifiers as language devices reveal optimism, *"Amon sang una pila pa ka libro basahon."* (We read more books during our time.); *"Kami sang una damo GD na agyan ko sa ginikanan ko."* (I experienced hardship with my parents.) Intensifiers in the Hiligaynon language appear in the form of *"pa"* and *"gid,"*

and adjectives and adverbs to enhance the intensity of the emotion in the utterances.

Positive emotion is shown in the colloquial expression, *"Ok lang"* (It will be all right) revealing optimism. Colloquialism is an expression. Writers use exaggeration to excessively represent something to make it more noticeable or observable (Aristotle, 1976 in Al-Tufail & Al-Jobori).

Optimism prevailed as an emotion revealed by the following utterances, appealing: *"Tani indi na magliwat desisyon ni President bah."*; (I hope the president's decision will not change); *"Pwede man irequire nyu sa mga ginikanan nga mahatagan sila allowance bisan, online class?"* (They may urge the parents to give them their allowance during an online class.); *"Pwd mn gru ang bayu nga desente ka mn tulokun nd na kinanlan mg uniform."* (They may wear decent clothes instead of school uniform.) An appeal is an earnest request for aid, support, sympathy, mercy, entreaty or petition. In the statements, the words *"tani"* (I hope, I wish), *pwede man* (It will/It can) signal that the participants are appealing.

Some imperatives show optimism as *"Hindi mag tinamad para man na sa imo."* (Do not be lazy, it is for your good.); *"Himakas ka gid pag- eskwela."* (Strive hard.)

Some of the participants' expressions denote cause and effect. For instance, the following show optimism: *"Mas maayu gani qng Indi lngg anay madayun karun nga tuig ang klase para safety gid ang mga istudyante."* (It is better to suspend classes this year for the safety of the students.); *"Ok Gid ko nga indi lang anay mag klase kay kabudlay man sa amon bilang estudyante."* (It is just fine to stop school for it is so difficult for us.); *"Kon malatnan kami sang virus wala man may mabulig sa amon kundi ang amon lang man."* (Nobody will help us if we get infected with the virus.); *"lindi ya anay ipakita tanan nga module kag kon matapos ang isa amo pag pa gwa ka isa kag hatag siya time nga maka rest anay ya bata."* (Do not show all the modules yet; give her one at a time so that she can rest.)

Participants also showed optimism emotive language in response to the viral news. They expressed this positive emotion using hyperbole, intensifiers, colloquialism, appeal, and cause and effect. Jenaabadi et al. (2015) revealed that optimism is a positive sense of mental welfare associated with positive life affection, absence of negative affect, and life satisfaction. Optimists have better-coping strategies, which result in higher-level general health. Gordon et al. (2016) asserted that optimistic individuals could successfully regulate their emotions are less prone to negative interpretations even under angry mood states. Their optimism level is a predictor of positive emotional intelligence (Kumcagiz et al., 2011).

Empathy

Empathy is the process of sharing and understanding the person's "state of mind" or emotion, also, his subjective experiences. Empathy is a capability that all people must develop to progress and continue with their life (Pedersen, 2007; Loannidou & Konstantikaki,

2008).

Some positive emotions are seen in the following empathetic written utterances using repetition as a language device: "*Amat2 lang ah, maubos mu gd n basa.*" (Take it easy. You will finish reading.); "*Isa lang ka subject, indi kay ipaubos tanan2x sa isa ka adlaw.*" (Just finish only one subject each day.); "*Akon ya mga bata mato- mato lng cla kay wl ako sa tupad nila,*" (My children just learned to manage because I am far from them.); and "*Ahay kaluoy man, budlay2x gd tna pg module* 😞😞😞." (How pitiful, module is such a burden.) On the other hand, positive emotions like empathy are present in the following utterances with intensifiers, "*Subra gd mn v kbodlay ang module mo.*" (Answering the module is really difficult for them.); "*Daw ndi gd na mgsulod xa ulo nila kong amo na kbodlay subton nila.*" (They can hardly understand the difficult tasks.); "*Mas kaluoy ang mga bata nga wala sang ginikanan sa tupad.*" (Children whose parents are far are more miserable.); "*Mabudlay gani kis- a sa teachers kuhaon ang focus sang mga bata nga ara na sa sulod sang klasroom, ano pa...ayhan kon online.*" (Sometimes, teachers find it challenging teaching the students face-to-face, holding their attention, how much more in an online class.)

Intensifiers in the Hiligaynon language appear in the form of "*gid,*" "*man,*" "*daw,*" "*dun,*" "*mas,*" and the use of adjectives and adverbs which intensifies the emotion in the utterances.

Empathy was also evident in hypocoristic or endearment expressions. Crystal, 1999; Bardsley, 2010 in Imamović (2019) defines hypocoristic as flattering, adulatory, sweet-talking names, words, euphemisms, and diminutives. It is related to affection or "loyalty" embedded in these words and directed to the addressee, hypocoristics as pet names (Vujaklija, 1980 in Imamović, 2019). Empathy or kindness and caring for others and their wellbeing leads to valuing and investing in close relationships. This emotive language is revealed in the following utterances: "*Ahay a, sige na palangga, start na kita wala lng hibi hibi.*" (Just keep on, do not cry.); "*Manghod ko na.*" (She is my sister.); "*Tuon lng mayad, gamay lng nga sakripsyo maging ok gd ang tanan.*" (Study well, everything will be all right.); "*Maswerte kapa gani kay ara c nanay mo nga nagabulig tudlo.*" (You are blessed to have a Mom who can help you.)

Empathy was also apparent in the utterances showing cause and effect, "*Normal lng ina ya sa amo nga mga pangidaron ang maghibi kon pabasahon,*" (Normally, kids cry being forced to read.) Cause-and-effect arguments may claim a cause-and-effect relationship when there is just a relationship, and other factors should be considered (Argyropoulou, 2017). Empathy also emerged as the participants' positive emotive language in response to the viral news. They used language devices like repetitions, intensifiers, hypocoristic or endearment, and cause and effect.

Empathy increases when the person avoids the tendency to interpret another's behavior from one's cultural orientation and be conscious about self and others' attitudes (Chen, 2013). In teaching, Jeffrey (2016) stressed that empathy should be person-focused, which prompts

an action to help others. Empathic teaching is discerning from students how they learn best from methodologies. It is showing them the concept of both self and "other," and the perception of "my neighbor as me" (Franzese, 2017).

CONCLUSION AND RECOMMENDATION

An emotive language is a beneficial tool in stimulating the person's emotional reactions towards an intended action. Negative emotive language like sarcasm and disgust can cause positive effects, challenging people to do something. With appropriate language devices, the readers can express their feelings and sentiments towards an issue. Attacks and humor are useful language devices where people can express their sarcasm and disgust, which point out human follies or vices. On the other hand, optimism and empathy are the common emotive language, especially in hypocoristics or endearment and appeal. The study promotes these positive emotions for it stimulates resilient and productive reactions to stressful events. In language learning, emotive language broadens the students' attention and thinking towards new learning. Positive and negative emotive language may be explored further, especially on sarcasm and disgust, leading to stress and affecting one's psychological well-being. Optimism and empathy are positive feelings that may be given a favorable interest in online interaction or other communication situations. Online readers may consider observing protocols while posting their views or opinions to safeguard others' privacy and reputation and maintain the respect of human dignity. Educational institutions and other agencies may establish clear, effective social media policies to guide the readers on responding appropriately to online viral posts.

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Energy Audit of an educational building: College of Engineering

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ABSTRACT

Educational buildings are the most suitable type of building for the application of energy audit. Such measures can promote sustainability and ensure a comfortable and healthy environment for educational purposes. This study aimed to assess energy efficiency and conservation of the College of Engineering specifically the lighting system of the building. A walkthrough audit was made to acquire preliminary assessment on the building. A luxmeter was used to measure illumination (lux). The study showed that the illumination levels did not meet proper standards. Through data logger and theoretical calculations, it was determined that lighting system consisted 44% of total power consumption. These led to the development of a new lighting system (room E209 selected as a sample) composed of F28T5 lamps which improved lighting levels and saved more energy than the old F40T12 lamps. Through calculations, the new lighting systems showed an annual savings of Php5708 for room E209 alone with payback period of 2 years and 3 months.

Keywords: Energy, Energy Audit, Energy Efficiency

INTRODUCTION

Energy is as important as any other commodity in today's civilization. In developing countries like the Philippines where energy crisis is common, the need for efficient usage of energy is highly regarded. Consuming energy efficiently is of prime importance in any sector of the economy. Energy cost is a significant factor that affects every economic activity on par with factors of production like capital, land and labor (Noah et al., 2011). Reducing energy consumption and cost is becoming central to planning, construction, and use of buildings from an environmental and economic point of view (Sapri et al., 2010).

In order to assess the efficient consumption of energy, a process called energy audit is applied. An energy audit (EA) is a process aimed at the detection of problems in operations, improvement of the comfort of occupants, and optimization of energy usage of existing buildings. Furthermore, it identifies the opportunities for energy conservation. The process has a periodic nature. It assesses the possible changes in building use, the condition of existing equipment, and the applicability of new energy-efficient technologies (Alajmi, 2011).

In this study, the energy efficiency of the College of Engineering building is assessed through an energy audit. It is necessary to be able to know the status at which the building has been operated energy-wise. A walk through assessment is conducted in order to survey important points that could be seen directly upon inspection. An energy analyzer is also used to record and perform analysis of the energy consumption of the building.

This study aimed to have an assessment of the energy efficiency of the College of Engineering building, Central Mindanao University through an energy audit.

Specific objectives

To acquire the profile of the College of Engineering through a walk-through assessment; to analyze how efficient the energy consumption of the building and determine the possible energy saving measures for further efficiency; to know the financial viability of applying energy-efficient techniques on the operation and maintenance of the College of Engineering building

MATERIALS AND METHODOLOGY

The building improvement of energy efficacy was improved based on load profile assessment and the energy consumption behavior was analyzed. The analysis was the basis in the development of a new lighting system.

1. Load profiling
2. Walk-through assessment

The building under study for efficacy of energy consumption is the College of Engineering building through a walk-through audit. The important points in the usage of the lighting system was assessed and data was revealed in Table 3 and 4.

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Lighting systems

A luxmeter was used to measure the light intensity of the rooms. The number of lights and their corresponding types was also investigated.

Energy Analysis Data gathering

The data on the building's energy consumption and its behavior was gathered through an Energy Analyzer. The illumination of the rooms was also gathered through the use of luxmeter. The rooms were divided into equal spaces (2m by 2m).

Data analysis

The energy consumption data that has been gathered was analyzed. The study consolidated all data from the walk-through assessment to the Energy Analyzer.

The following data have been acquired:

- Building energy consumption obtained from utility;
- Building performance obtained from site measurements;
- Equipment/system characteristics obtained from site surveys;
- Equipment/system performance data obtained from site measurements; and
- Equipment/system operating conditions based on design and/or general engineering practices.

New Lighting System

A new lighting design was created in order to improve the illumination levels and minimize the energy consumption. F28T5 lamps were selected as replacement for the current F40T12 and Compact Fluorescent Lamps (CFL).

Energy Consumption

The energy consumption of the new and old lighting system was calculated. In this calculation, the ballast loss considered was equal to 20 percent of the energy consumption of a lighting fixture. Also, Demand factors and load factors was used to determine the energy consumption.

Financial Viability

After identifying the possible fixtures that can be installed and used to measure the energy consumption, financial viability followed and analyzed the old and new lighting system. The analysis was based using the simple payback period.

Simple payback method

Through this method, the quantity or duration of time for an investment to be paid back is illustrated. The payback period can therefore be determined through the cost of investment per annual saving.

RESULTS AND DISCUSSION

Walkthrough assessment

The building audited was the College of Engineering building (Central Mindanao University). The two-storey building has five laboratories (2 of which are computer laboratories), one drafting room, one conference room, and 11 classrooms. The building had been operated 12 hours per day, five days per week but classes were occasionally held during weekends.

Lighting system

All the luminaires installed at the building were single-lamp fixtures of fluorescent lamps, CFL and some pin-type/recessed CFL (at E112). The number of lamps and their corresponding lamp types are shown in Table 1.

Load History

The figure below shows the graphical representation of the energy consumption of the College of Engineering building from January of 2010 to July of 2013 from FIBECO data. It can be noticed from the graph that the behavior of the energy consumption of the College of Engineering building was erratic. It was due to the fact that many factors such as school activities and the number of days without classes in a specific month could have made a major effect on the energy consumption of the building.

Load Characteristics

As seen in figure 2, the curve started to rise at around 7:00 AM but sagged at around 11:00 AM to 1:00 PM which was indicative of the effect on the energy usage of lunch break. From 2:00 to 4:00 PM would then be the

Table 1

Types of Luminaires Installed

Type of Lamps	Number of Luminaires	Number of Functional Luminaires	Number of Busted Luminaires	Rating (W)
F40T12	114	83	31	40
CFL	170	121	49	24
Pin-type fixtures	36	36	0	25

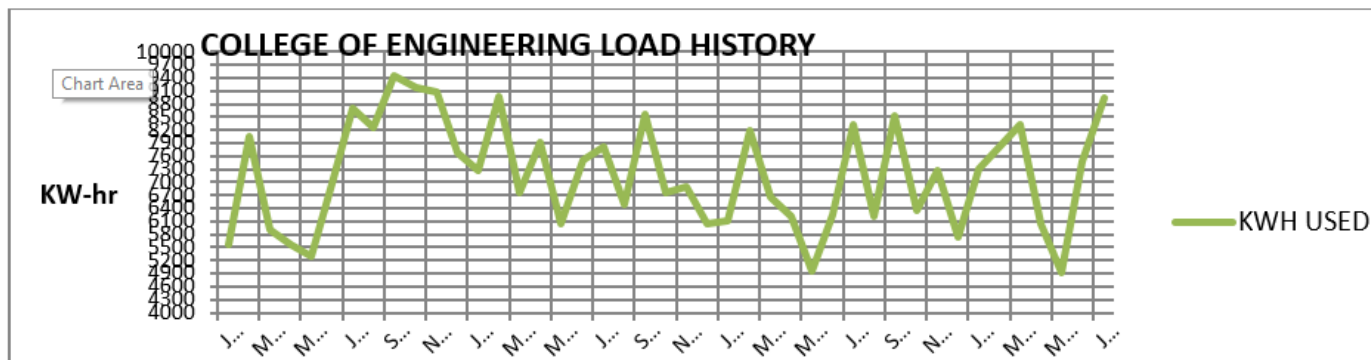


Figure 1. Past Energy Consumption of the College of Engineering building

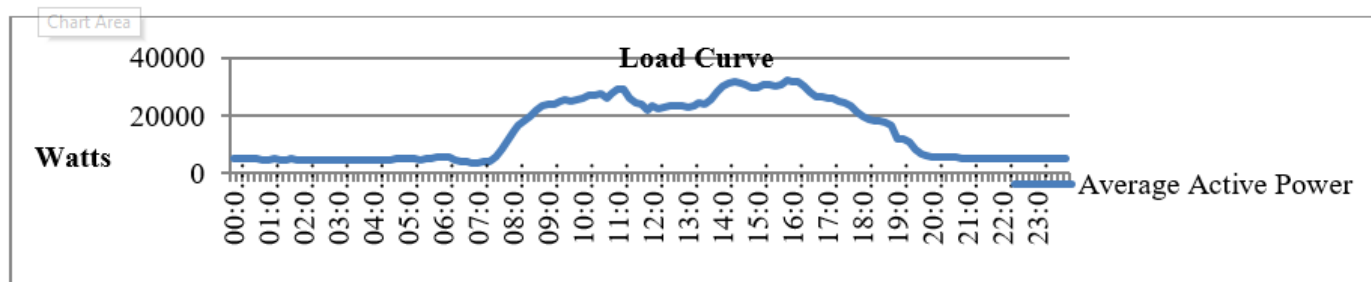


Figure 2. Daily load curve of the college of engineering building on a ten-minute interval

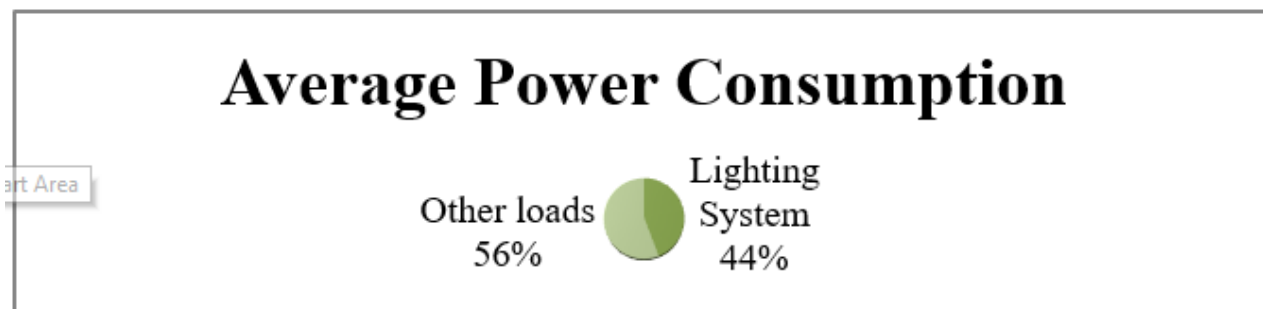


Figure 3. Percent power consumption of the lighting system to the other loads

peak hours of the building. The energy consumption then started to lower down at around 6:00 to 7:00 PM since classes started to dismiss around this time. The average power consumption during these hours (7:00 AM to 7:00 PM) was calculated to be 23,572 watts.

From the figure below, the theoretical lighting system power consumption (10416 W) is 44 percent of the total loads. The other loads were comprised of the HVAC systems and other appliances such as computers.

3.5 Room Illumination Levels

Daytime Illumination

Despite the availability of daylight, 72% of the classrooms still did not reach the standard illumination level for classrooms as per Indian Standard IS - 3646 I: 1992 and IESNA standards which require an illumination level of 200-500 lux.

Old and New Lighting System

The lamps in the room were suggested to be replaced by F28T5 lamps in a louver-type luminaire.

3.6.1 Energy Consumption

Table 3 shows the current and new total connected lighting loads in watts for Room E209. The watt saved by improving the lighting system is 168 watts.

Energy consumption (per month) was then calculated by multiplying the load factor to the product of the maximum demand and the number of hours of operation (per month) as shown in table 4. The result was 28 kW-hours for the old lighting system and 19 kW-hours for the new lighting system.

New Illumination Levels

As shown in Table 5, the daytime illuminance for Room E209 increased from 185 lux to 324 lux while the nighttime illuminance increased from 161 lux to 212 lux. Both of these new values are within the standard range as per IESNA and Indian standards.

Financial Viability Simple Payback

Investment cost comprises is Php12899.7. The kilowatt saved (168 watts) was divided by 1000. The cost per kilowatt-hour as per FIBECO is Php7.865 and

Table 2

Walk-Thru Audit form for Room E209

Types of Fixtures	Fluorescent lamps	Compact fluorescent lamps
Number of Fixtures	9 fixtures	3 fixtures
Number of lamps per fixture	1 lamp per fixture	1 CFL per fixture
Watts per fixture	40 watts	24 watts
Fixtures height from work plane	2.0 m	1.955 m.
Lamp brand	GE, Phillips	Omni, Phillips
Number of functioning lamps	8	3
Number of defective lamp	1	none

Table 3

Current and New Total Connected Loads for the lighting system in E209

Type	Quantity	Rated Watts	Ballast Factor (W)	Load (W)
Compact Fluorescent Lamp (CFL)	3	24		72
Fluorescent Lamp	9	40	8	432
			TOTAL	504
New lighting (T5)	12	28		336
			TOTAL	336

Table 4

Energy consumption of the lighting systems applying demand and load factor

Lighting System	Total Load	Demand Factor	Load Factor	Maximum Demand	Hours of Operation per month	Energy Consumption (kWh) per month
Old	504	0.5	0.26	302	360	28
New	336	0.6	0.26	202	360	19
Energy Savings						9

Table 5

New illumination levels for Room E209

Particulars	Intensity of Light			Remarks
	Existing Average Illumination (Lux)	Recommended Standard (Lux)	Percentage of Inadequacy and Adequacy of Light(%)	
Daytime	324	200	62%	Adequate
Nighttime	212	200	6%	Adequate

the number of hours of operation is 4320 hours a year if the lighting system is operated twelve hours a day. From that, the annual savings can be calculated (Php 5708). The calculated payback period for the new lighting system was 2 years and 3 months.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

It is necessary to manage and minimize energy

costs while considering the comfort of the occupants (faculty, students, staff, etc.) which is related to their productivity. The lighting system was found out to be 44% of the total demand of the building. Also in this study, only the classrooms were considered which showed that most of the classrooms were below standard illumination levels even during daytime. The overall average illumination levels were 175 lux and 87 lux for daytime and nighttime respectively. The values obtained were below the IESNA standards for illumination (200-500). As seen, 200 lux was selected as the standard illumination level.

A new lighting system design was done in Room E209 (EE laboratory). The lamps were replaced with more efficient F28T5 lamps in a louver-type luminaire. The new lighting system increased the illumination level (324 and 212 lux for daytime and nighttime respectively) and reduced the energy consumption of the room. From this, a savings of 9 kW-hrs monthly was achieved. This led to an annual savings of Php5708 in room E209 alone with a payback period of 2 years 3 months. This is an affirmation of the improvement of the energy efficiency after the installation of the new lighting system.

Recommendations

For the better assessment regarding this study, it is recommended that energy-saving design for general and task lighting be created. It is necessary to create a rather task-oriented approach in offices, laboratories and drafting rooms in order to efficiently utilize the illumination provided by artificial light sources. This is done by focusing the illumination in the work plane and avoiding excess lighting on areas where light is less needed (e.g. lobbies).

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NON-DESTRUCTIVE ON-FIELD DETERMINATION OF PINEAPPLE (*Ananas comosus* L.) MATURITY USING ACOUSTIC IMPULSE IMPEDANCE TECHNIQUE

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ABSTRACT

This study was conducted to develop a model for non-destructive, on-field determination of pineapple maturity using acoustic impulse impedance technique. A total of 150 randomly sampled pineapple fruits from DOLE Philippines were used to evaluate the acoustic, physical and physiological properties of the fruit for calibration. The acoustic property (Hz) was determined using an improvised acoustic property tester and normalized the sound signal using a computer software. The physical properties evaluated were fruit height, weight, diameter, specific gravity and color. The physiological properties, i.e. sugar content, translucency, acidity, pith diameter and thickness of the rind were determined by cutting the pineapple fruits. Correlation and regression analyses revealed that there is a relatively good correlation between the sound frequency and number of days with R^2 equal to 0.57. The regression model generated was then used to predict the maturity of the fruit using the frequency (Hz) during validation and it gave a RMSE equal to 3.2. Regression analysis between maturity and all non-destructive properties (i.e. acoustic and physical) was then performed and it showed a relatively strong relationship R^2 equal to 0.72 ($\alpha = 0.01$). Furthermore, model generated from regressing maturity and destructive maturity indices (i.e. translucency, sugar content, acidity, pith diameter and thickness of the rind) is highly significant ($\alpha = 0.01$) in predicting pineapple maturity with adjusted R^2 equal to 0.83. These findings could draw interest among researchers and pineapple farmers alike on the potential of using acoustic impulse impedance technique together with other non-destructive properties in determining pineapple maturity.

Keywords: Acoustic impulse impedance technique, pineapple maturity, non-destructive maturity determination

INTRODUCTION

Pineapple dominates the world trade of tropical fruits and is the eleventh most cultivated fruit with just over 24.8 million tons produced in 2013 (FAOSTAT 2015). With an increased consumer demand for fresh pineapple and juice amounting to nearly 30 billion pounds a year, the pineapple export industry has developed into a complex supply chain (FAO 2008). In the Philippines, an estimated area of 60,000 hectares is planted with pineapple, majority of which is situated in the provinces of northern and southern Mindanao. Nearly 70% of this total production is consumed as fresh fruits locally and the remaining 30% is intended for export. Of the total volume for export, only about 20% is fresh and the 80% is aimed at processing (UNCTAD, 2016). Importing roughly 65% of fresh pineapple shipment from the Philippines, Japan serves as the biggest export market for the Philippines followed by China, South Korea and Singapore (Balito, 2011).

With the increasing demand for fresh pineapple in the world market, Mindanao-based agribusiness companies were prompted to expand their capacities (Balito, 2011). Expansion came in the form of increasing production area, improving production technologies, and minimizing losses. There were continuous increases in area harvested of pineapple from Del Monte, Lapanday, Asian Hybrid, Mt. Kitanglad Agricultural Development

Corporation, Davao Ventures Corporation and DOLE in Bukidnon in the 2nd half of 2011 (DA, 2013). Mechanizing pineapple production has also become widespread leading to improved production technologies. Unfortunately, one of the most crucial challenge in pineapple production is on minimizing the losses in the form of rejects against international quality standards of the importing countries. While rejected fresh pineapple are not at all losses since there is still high patronage within the local market, improved quality assurance procedure can greatly help in securing high production of fresh pineapple with export quality.

Presently, most pineapple producing companies employ visual and destructive method of determining maturity. Multinational pineapple companies employ external (visual) and internal (destructive) inspection of mature pineapple fruit on the field. Depending on the market on demand, a set of criteria like color and size, dictate the quality of marketable pineapple. Right colored, wrong sized, and conversely, will be sold to other markets

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mostly at lower price. Right colored, right sized pineapples will undergo internal inspection. It will be cut and checked if the internal has the right color and translucency. This specific color is characterized by different maturity index like sugar content, acidity, soluble solids – acceptable to the market. For fresh pineapple export, not all the fruits are examined internally making it more vulnerable to standards. Any method, therefore, that employs non-destructive test for on-field quality inspection can optimize harvest productivity. This study aimed to evaluate the potential of acoustic impulse impedance technique in determining pineapple maturity.

METHODOLOGY

The research study was conducted in the machinery laboratory of the Department of Agricultural Engineering, College of Engineering, CMU, Musuan, Maramag, Bukidnon and samples were taken randomly from the pineapple plantation of DOLE Philippines, a nearby pineapple company in San Miguel, Maramag, Bukidnon.

A total of 150 fruit samples were collected and examined for this study. Sampling was done at 140 days to 160 days after pollination in 5-day increment, each with 30 fruit samples. The harvested pineapple fruits were transported on the same day to the laboratory where the fruit samples were subjected to different property tests. An improvised method of testing acoustic property was employed for the determination of the acoustic property of each fruit sample. The testing of acoustic property was done inside the laboratory room where isolation from unnecessary noise was secured. Then, a calibrated impact force was applied to 4 different locations around the fruit equator using an impact rod. The sound produced was recorded using ZOOM H1 Handy Recorder at a distance of not more than 10 cm from the fruit sample (Terdwongworakul, et al., 2009). The recorded sound frequencies were then normalized and digitized in a personal computer using the STEINBERG: WAVELAB LE software. This was done to determine the highest resonant frequency and to eliminate unwanted sound (noise) that was captured during the recording.

The physical properties taken from the fruit samples were the following: fruit height (H), which was determined by measuring the top to bottom part of the pineapple (without crown) using a Vernier caliper; fruit diameter (D), which was measured using a Vernier caliper through the horizontal diameter of the pineapple that is cut vertically; fruit weight (W), which was determined using a digital weighing scale; specific gravity (SG), which was taken as the fruit density to water density ratio; fruit color (C), which was determined using the DOLE Revised MG3 Fresh Pineapple Color Standard Guide.

To determine the physiological properties like translucency, sugar content, acidity, pith diameter and thickness of the rind, each fruit was cut and opened. Fruit translucency (T), which is a standard method for determining ripeness used in most pineapple plantations was determined using the float method where the fruit sample is submerged in water. Sinkers were identified as translucent while floaters are not. As to the degree of translucency, DOLE Premium Select Pineapple Translucency Chart was used as reference. Sugar Content (SC), measured in brix value ($^{\circ}$ Brix) – a specification parameter for pineapples – was obtained by conducting Brix test using a handheld refractometer. The acidity (A) of the fruit juice was determined using a digital pH meter. The pith diameter (PD) and thickness of rind (TR) were measured using a Vernier caliper.

Regression analysis was then performed to develop a mathematical model using the acoustic impulse as maturity index with characterization using the other properties. Additional 21 pineapple fruit samples were then used for validation. The predicting performance of the model was assessed by comparing measured or observed values and model predictions for the data in the independent validation set. The statistics for the performance assessment were R² and standard error.

RESULTS AND DISCUSSION

Acoustic Properties of Mature Pineapple fruit

Figure 1 shows the acoustic property of the pineapple samples in Hertz (Hz) with respect to maturity

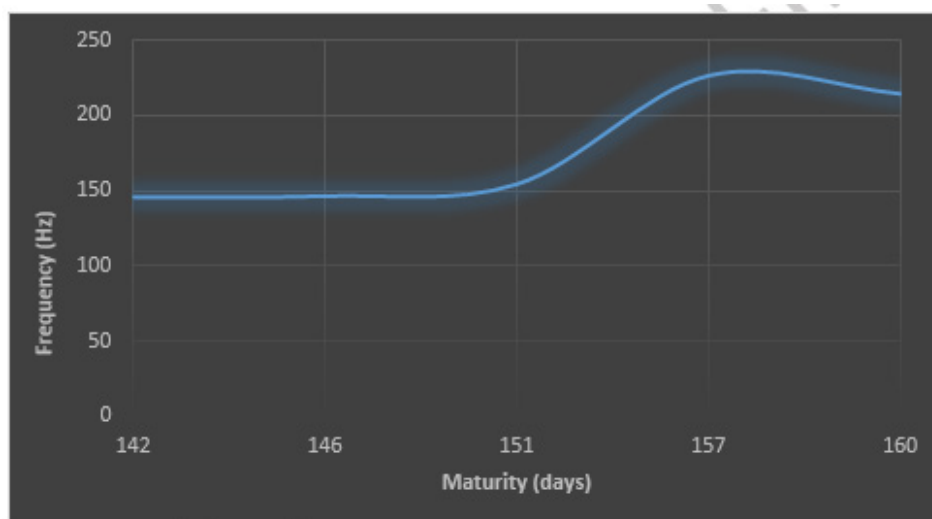


Figure 1. Recorded frequency with progressing days after pollination

Table 1

Physical properties of pineapple samples.

Days	Height (cm)	Diameter (cm)	Weight (kg)	Color
142	17.31	12.90	2.05	0
146	17.02	12.83	1.97	0
151	16.78	13.05	2.05	1
157	16.41	12.78	1.97	3
160	16.68	12.99	2.01	4

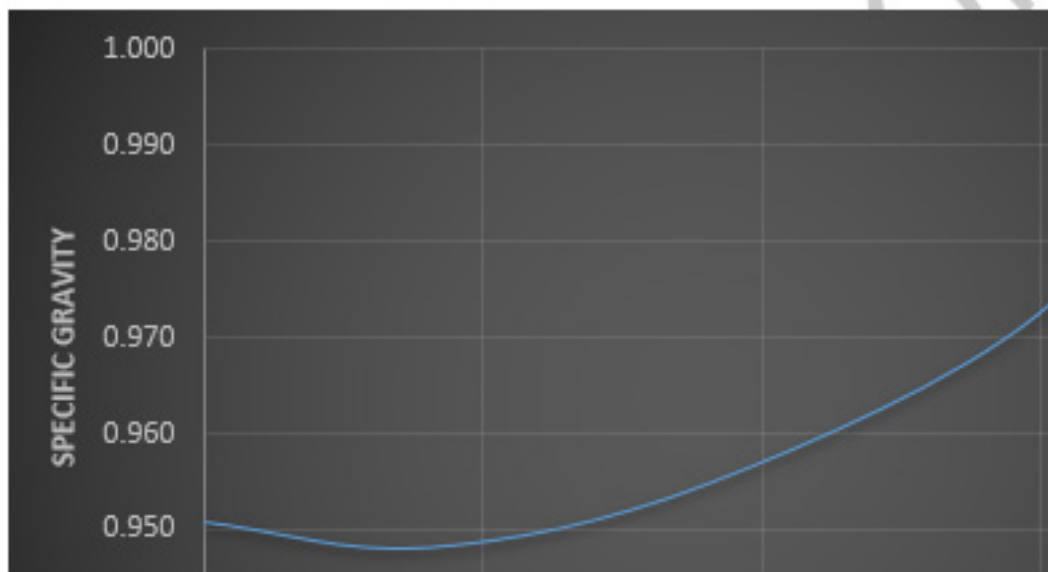


Figure 2. Graph showing the specific gravity of the pineapple fruit versus maturity

(days after pollination). The recorded frequency value ranges from 51 Hz to 305 Hz. At 142 days after pollination, the average frequency resulted to 144.605 Hz which increased significantly to 160.191 Hz at 146 days after pollination. The value continued to rise linearly until 157 days after pollination with a frequency of 237.82 Hz. A slight decrease was then observed at 160 days after pollination. This may be due to the fact that pineapple is non-climacteric, meaning that the pineapple does not exhibit any burst in respiration rate during its postharvest life. The pineapples collected on the 157th day were all considered as fully matured and since the pineapples collected were from the same area, any pineapple collected hereafter would mean that it is slightly overmatured, which could be the reason for that slight drop in resonant frequency. Another possible explanation for this is that at 142 days, pineapple is still on the final stage of its immature stage, therefore means that it is firm. The rind is harder compared to the ones at full maturity; hence, a lower resonant frequency. Generally, the sound frequency showed an increasing trend with progressing days after pollination.

Physical Characteristics of Mature Pineapple Fruit

Table 1 summarizes the recorded average values of the physical properties of the fruit samples specifically the fruit height without crown (cm), diameter (cm), weight (kg) and color which was based on the color chart given by

Dole Philippines. The value of the weight ranges from 1.4 kg. to 2.5 kg. while its height ranges from 14.0 cm. to 20.72 cm. and the diameter ranges from 11.27cm to 14.51cm. At 142 and 142 days, majority of the fruit samples had color classified as 0 which is characterized by fruits with all eyes green and no color break. At 151 days, most fruits turned to shell color 1 which means the center of some eyes are beginning to show color break or one to seven eyes were observed with color break. The samples then shifted to shell color 3 at 157 days where majority (25% to 50%) of the eyes with color change. At 160 days, most of the fruit samples had majority of its eyes turned yellow (more than 50%), with some green color in between eyes which is classified as shell color 4.

Moreover, the value of specific gravity (Sg) of the fruit samples ranges from 0.91914 to 1.195 and it showed a generally increasing trend as the number of days progresses as shown in Figure 2.

Physiological Properties of Mature Pineapple Fruit

The physiological properties recorded include translucency (T), acidity (Ac) and sugar content (Sc) of the fruit juice and pith diameter (PD) and thickness of the fruit rind (TR). Table 2 presents the translucency grade of the fruit samples and its corresponding percentage in relation to the total number of fruit samples subjected to tests. The

Table 2

Translucency grade of the fruit samples and its corresponding percentage with respect to the total number of samples.

No. of Days	Translucency	Percentage (%)
142	1	100
146	1	80
151	2	46.49
157	3	74.17
160	3	83.33

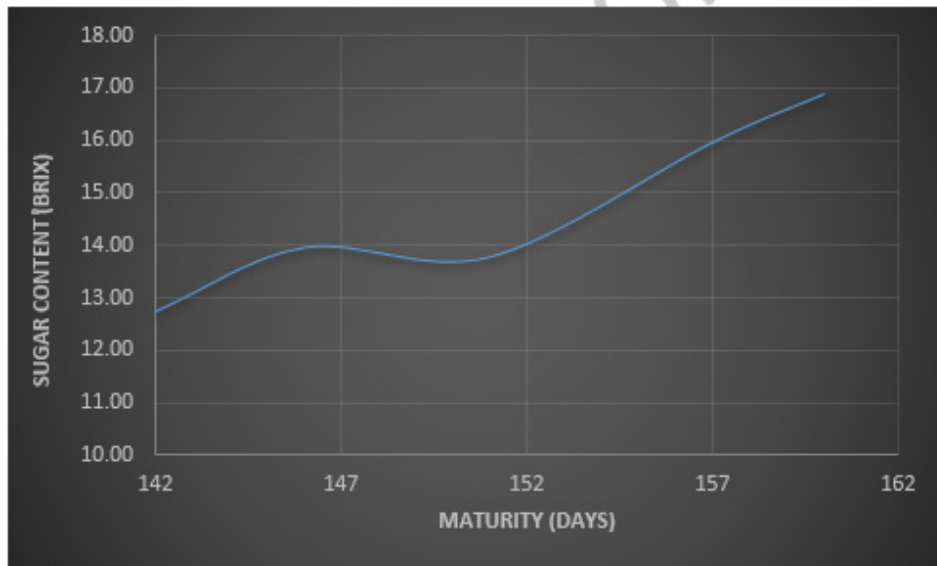


Figure 3. Graph showing the sugar content of the fruit with number of days after pollination

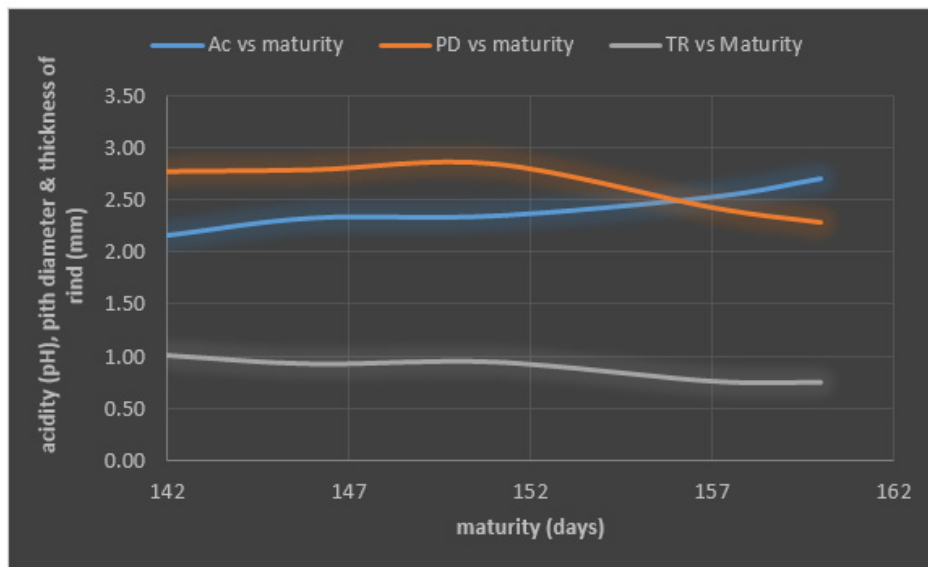


Figure 4. Graph showing the fruits' acidity, pith diameter and thickness of rind with respect to maturity

said rating was made using the translucency chart provided by the Dole Philippines. At 142 days, 100% of the fruit samples are graded 1 wherein the white flesh of the fruits is beginning to show traces of yellow color. The said rating remained as the majority grade (80%) of the fruit samples at 146 days. The rating rose to grade number 2 at 151 days comprising 46.49% of the total samples this means up to

50% of the fruits' flesh shows yellow color. Translucency grade number 3 was found to be the majority rating of the fruit samples at 157 and 160 days which consisted 74.17% and 83.33% of the total samples, respectively. This mark is characterized by fruit flesh that is 100% yellow with very light traces of darkened yellow watery tissue.

The sugar content (°Brix), on the other hand,

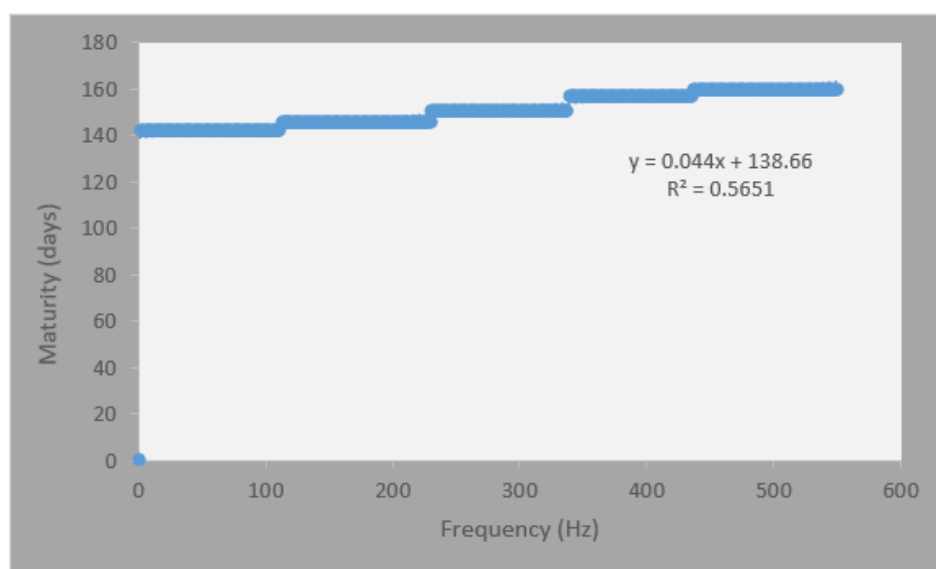


Figure 5. Graph showing the correlation of acoustic property vs. maturity.

Table 3

Regression model parameters for non-destructive maturity indices.

Source	Value	Standard error	t	Pr > t
Intercept	116.167	7.1600	16.2244	< 0.0001**
Frequency (Hz)	0.0164	0.0026	6.2262	< 0.0001**
Height w/o crown (cm)	-0.3770	0.2351	-1.6034	0.1094 ^{ns}
Diameter (cm)	1.0205	0.5912	1.7260	0.0849 ^{ns}
Weight with crown (kg)	0.6468	1.8139	0.3566	0.7215 ^{ns}
Specific Gravity with crown	19.8307	3.3964	5.8388	< 0.0001**
Color	2.6482	0.0953	27.7991	< 0.0001**

* =significant

**=highly significant

ns= not significant

showed a generally increasing trend with increasing number of days after pollination as shown on Figure 3. Its value in °Brix ranges from 10.6 to 18.8.

Figure 4 shows the distribution of the acidity of the pineapple juice, pith diameter, thickness of the rind with time. The pH level of the fruits' juice showed an increasing movement as the number of days after pollination increases. At 142 days, the value was 2.15 and linearly increased to 2.324 at 146 days, then 2.343 at 151 days, 2.52 and 2.702 at 157 and 160 days respectively. Thickness of the rind on the other hand showed a decreasing trend with value 1.0113cm at 142 days, 0.928cm at 146 days and continued to decrease significantly at 151 days with a value of 0.75cm and then reached an average value of 0.747cm at 160 days. The pith diameter displayed an increasing movement from 142 days to 151 days but dropped significantly at 157 days until 160 days with values to equal 2.43cm. and 2.29cm., correspondingly. Pith diameter and thickness of the rind decreases with progressing days of maturity.

Correlation and Regression Analysis

Maturity versus Frequency

Figure 7 displays the correlation between the

maturity (in number of days) and the acoustic property (Hz). The line shows a good relationship as validated by its coefficient of determination, R^2 which is equal to 0.57. This states that almost 60% of the variability of its maturity (days) is explained by the sound frequency (Hz).

The regression analysis between the number of days and acoustic property of the fruits (Hz) also revealed good relationship with R^2 equal to 0.22 and the model generated was *Maturity (days)*=0.05041×*frequency (Hz)*+141.97306. This equation was then used to predict the maturity of the pineapple to validate the model. A root mean square error equal to 5.93 during calibration and 3.20 during validation was eventually calculated based on the predicted and true value.

To further check the model significance, the results of analysis of variance for its regression analysis was evaluated and it showed that the probability corresponding to the F value is lower than 0.0001 which means there is lower than 0.01% risk in assuming that the null hypothesis (no effect of the explanatory variable) is wrong. Hence, the explanatory variable, Hz is significant. The residual plot also showed no identified pattern or trend which means the model is correct and there are no autocorrelations in the residuals.

Table 4

Regression model parameters for destructive maturity indices.

	Coefficients	Standard Error	t Stat	P-value
Intercept	122.533	2.3993	51.070	3.2E-216**
Translucency (Sliced)	3.1155	0.2072	15.033	2.43E-43**
Sugar Content/Total Soluble Solids (BRIX)	0.8912	0.0974	9.1452	1.01E-18**
Acidity	6.6534	0.7083	9.3939	1.33E-19**
Pith Diameter (cm)	-1.1848	0.3538	-3.3492	0.000863**
Thickness of Rind (cm)	-3.92719	0.9917	-3.9599	8.43E-05**

* =significant

**=highly significant

ns= not significant

Maturity versus non-destructive properties

To further check whether or not there is a possibility of predicting pineapple maturity using all non-destructive properties which includes acoustic and physical properties, a multiple linear regression analysis was performed using all these non-destructive properties versus fruit maturity. As shown on Table 3, the independent variables that are statistically significant in explaining the variation in fruit maturity are the frequency (Hz), specific gravity with crown and the color, as indicated by the calculated t statistics that exceed the critical values and the calculated p-values that are less than the significance level of 1%. Other independent variables do not add not significantly in explaining the variation in fruit maturity.

The results of regression analysis also revealed that the adjusted coefficient of determination, R^2 , showed good relationship with value equal to 0.72 which means 72% of the variability of maturity (days) is explained by the frequency (Hz), specific gravity with crown and fruit color.

Maturity versus non-destructive properties

Table 4 presents the regression model parameters obtained from performing regression analysis of destructive maturity indices versus the days of maturity. As shown, the model generated indicates that all destructive maturity indices (i.e. translucency, sugar content, acidity, pith diameter and thickness of the rind) are highly significant ($\alpha = 0.01$) in predicting pineapple maturity with adjusted R^2 equal to 0.83. This coincides with most of the pineapple company's conventional, destructive way of determining maturity by cutting the pineapple fruit and evaluating its physiological properties.

CONCLUSIONS

The sound frequency recorded from pineapple samples at different maturity showed a generally increasing trend but slightly dropped at 160 days which may be due to the fact that the pineapples collected on the 157th day were all considered as fully matured; since

fruits collected were from the same area, any pineapple collected thereafter would mean that it is slightly over matured which could be the reason for that slight drop in resonant frequency. At 142 days, pineapple is still on the final stage of its immature stage; the flesh is more firm. The rind is harder compared to the ones at full maturity; hence, the resonant frequency is low. The weight, height and diameter of the fruits were not affected by its maturity since for that variety of pineapple, the company made sure that the fruits produced are of similar sizes for exportation purposes. On the other hand, the specific gravity increases as the days of maturity increases. The fruit becomes more dense and translucent. The sugar content and the acidity of its juice also rises as the fruit matures which is opposite to its pith diameter and thickness of the rind that both decreased with progressing days of maturity.

The correlation of the fruits' maturity and resonant frequency showed good relationship with R^2 equal to 0.57. Also, the model generated by regressing the acoustic property and maturity was able to predict the maturity of pineapple during validation stage with root mean square error equal to 3.20. A multiple linear regression analysis using all non-destructive properties versus fruit maturity was also performed and the model showed good relationship with value equal to 0.72 but has a greater value of RMSE (17.96) during validation compared to the first model. Moreover, the regression analysis of all destructive maturity indices (i.e. translucency, sugar content, acidity, pith diameter and thickness of the rind) versus maturity revealed that the conventional destructive methods is still the best indicator of maturity for pineapples with R^2 equal to 0.83 at $\alpha = 0.01$.

The acoustic impulse impedance technique is a widely used technique in various fields and is found to have potential on agricultural application. With the established method of employing the technique, any development for a tool, device or apparatus emanating from the potential of the said technique can reduce losses due to subjective fruit maturity identification; thus, enhancing pineapple production in the country.

RECOMMENDATIONS

Develop a more mechanized acoustic property tester that could better simulate the tapping force produced by a human finger. While this can be addressed by normalization, it would cancel any further bias attributed to human error. Use other softwares that can be purchased online, e.g. the spectrum analyzer pro, instead of Wavelab LE, which came free with the recording device. Lessen the collection interval from 5-day increments to 3-day increments starting from 130 days to 160 days and extend to over mature pineapples until 170 days. Extending data collection to 170 days could give insight on how the pineapple's explanatory variables behave at an over mature state. Determine mechanical properties to further characterize ripeness. This property was discarded during the study since the universal testing machine procured was not yet calibrated.

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RAPID RIPARIAN ASSESSMENT OF SELECTED CRITICAL RIVERS IN MISAMIS ORIENTAL, PHILIPPINES

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ABSTRACT

Due to threats of agricultural expansion and urbanization, riparian areas of rivers are on the brink of deterioration impacting their ecological functions such as the attenuation of flood disasters. In the urbanizing cities and municipalities of El Salvador, Gingoog and Jasaan in Misamis Oriental in southern Philippines, rivers are considered critical due to its high risk to flooding occurrence. In order to implement appropriate river management practices in sustaining its ecological services, understanding the rivers' riparian status is necessary. Hence, this study was conducted to evaluate the current status of Molugan, Solana and Odiongan rivers riparian condition. Using a check list as a guide, abiotic and biotic components of the upstream, midstream and downstream sites of the rivers were rated and evaluated. Other factors such as land use and land cover pattern, population density, stream order and slope were also taken to account in the assessment. Results showed that all rivers are still in the sub-optimal conditions implied with minimal disturbance and deterioration. However of the three rivers, Odiongan was with the least ideal general riparian habitat condition which may be attributed to the river's larger size and accessibility to disturbance. Regardless of the good results, conscious regulation for the expansion of agricultural cultivation especially in the upstream areas of the watersheds is still recommended. In addition, appropriate land use zoning must be implemented giving emphasis on the establishment of appropriate riparian vegetation buffer widths and integrating natural conservation strategies.

Keywords: Abiotic component, biotic component, land cover/land use, riparian, rivers

INTRODUCTION

Riparian is the transition area between the uplands and water starting at the river and extending across the area influenced by the waterway (Garssen et al., 2017). Varying in width and extent, riparian land diversifies in soil, biological and physical characteristics that exerts influence to and is influenced by water and hydrological processes (The City of Calgary, 2014). Riparian areas can be characterized through its traits of hydrology as it involves both groundwater and surface water as driving forces behind the physical, chemical and biological processes; connectivity in allowing the transfer of materials between terrestrial and aquatic ecosystems; and its big influence to aquatic ecosystems as it is regarded as the most influential among all land cover types (The City of Calgary, 2014). Its uniqueness holds a variety of economic and ecological services (Iakovoglou et al., 2012). One of its major hydrological functions is being a natural storage of excess water that helps attenuate floods (Aldridge, 2011).

The occurring riparian fragmentation brought about by the continuing introduction of environmental stressors disrupts ecosystem services. Riparian areas are among the most disturbed and threatened ecosystem due to the expanding human developments and agricultural cultivations mostly concentrated in these areas (Lubos et al., 2015; Iakovoglou, et al., 2012; Poff et al., 2012). River banks are usually modified and there is removal of riparian vegetation that leads to stimulation of erosion, siltation, and degradation of water quality. The resulting

changes in river morphology may aggravate flooding situations where storm water overflows shallow rivers with no definite banks affecting urbanized and cultivated floodplain areas. Rivers with degraded riparian areas are associated to increased flood risks in rivers due to the reduction of vegetation which supposed to buffer floods. Agricultural expansion and urbanization are the common problems in rivers threatening riparian areas. This observation is also true to the rivers in Misamis Oriental namely Molugan, Solana and Odiongan which are considered critical due to their high risk to flooding as experienced in the past years. Assessing the riparian condition will indicate the current status of each river's capacity to provide optimum ecological services including its function as flood control. Moreover, understanding the hydrologic and ecological conditions is necessary in implementing appropriate restoration plans and management practices to sustain the rivers' ecological services (Amper et al., 2019). Hence, this study was carried out to evaluate the current status of the riparian habitat condition in Molugan, Solana and Odiongan rivers to be used as bases for restoration and conservation measures. Specifically, this study aims to evaluate the abiotic and biotic component conditions of the river, assess other contributory factors considered significant in shaping

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up the condition of the riparian areas, and provide recommendations for the restoration and conservation of the riparian areas of selected rivers in Misamis Oriental.

METHODOLOGY

Study Area

Riparian habitat was assessed in Molugan, Solana and Odiongan rivers located in El Salvador, Jasaan,

and Gingoog City in the province of Misamis Oriental, Philippines (Figure 1). Molugan river geographically lies 8° 27' to 8° 32' north latitudes and 124° 26' to 124° 31' east longitude. It has an approximate catchment area of 64.71 square kilometers (km²), 15.37 kilometer (km) long and an average width of 4.11km. Molugan drains to Macajalar Bay. Solana watershed geographically lies in 8° 35' to 8° 39' north latitudes and 124° 45' to 124° 54' east longitude. It has a total area of approximately 67.65 km². Its river is about 17.60 km long and with an average width of 3 km.

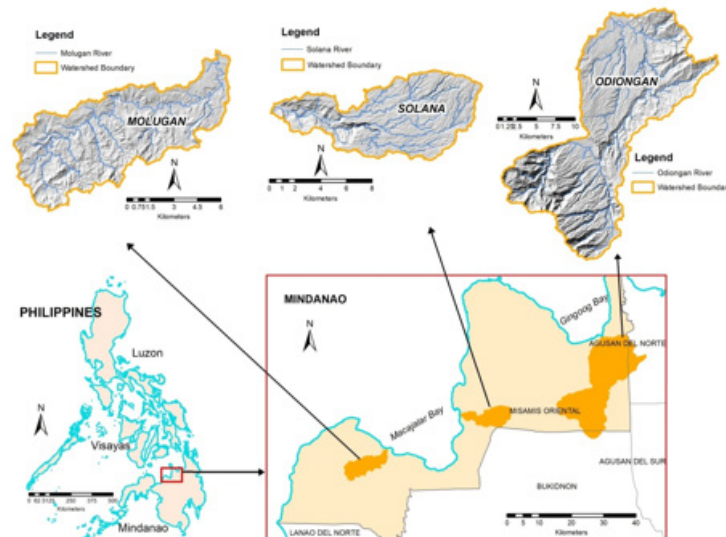


Figure 1. The geographic location of Molugan, Solana and Odiongan Watersheds.

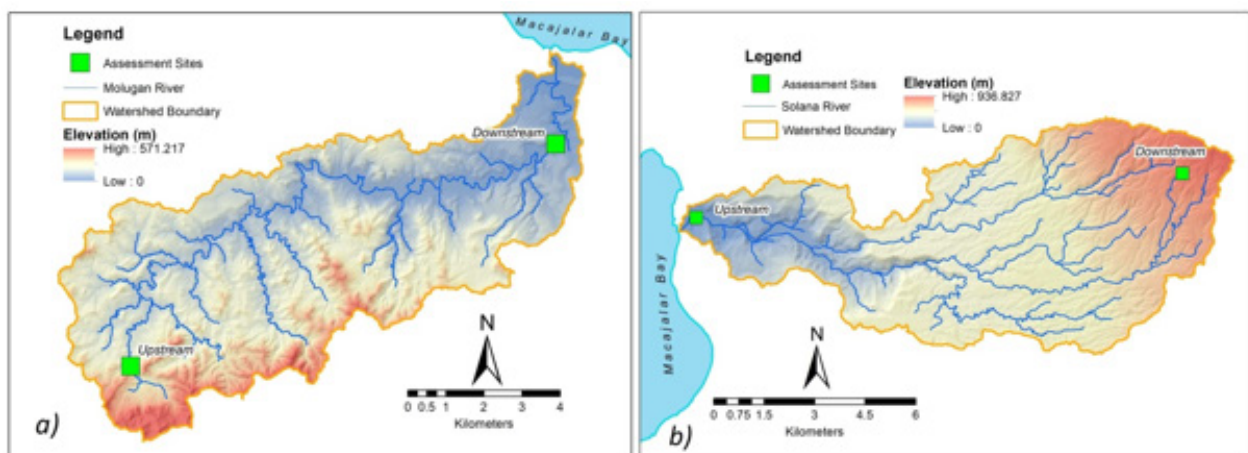


Figure 2. Location of assessment sites in the (a) Molugan and (b) Solana watersheds



Figure 3. Location of assessment sites in the Odiongan watershed

Solana river traverses the municipalities of Claveria and Jasaan and eventually drains to Macajalar Bay. Odiongan watershed geographically lies within 8°33' north to 8°51' north latitudes and 124°48' east to 125°17' east longitude. It has an approximate drainage area of 367 km² and around 13km average river width and 29km long. Odiongan drains to Gingoog Bay.

Two locations in Molugan and Solana watersheds were selected for the rapid riparian assessment to represent the upstream and downstream sites (Figure 2). One additional assessment site was selected to represent the midstream section for Odiongan watershed due to its larger catchment area (Figure 3).

Assessment of abiotic component

The landscape, physical and hydrological conditions of the riparian habitat of the rivers including hydrologic connectivity, bottom substrate, embeddedness, channel alteration and bank stability were assessed. A checklist based on Barbour et al. (1999) which was also utilized in other related studies (Amper et al., 2019; Opiso et al., 2015) was used as a guide for the assessment. Each parameter under this component was evaluated through ocular survey and was rated from 1 to 20 based on its condition with 1 as lowest and 20 as the highest classified as poor, marginal, sub-optimal or optimal. Overall condition of the component was determined by summing the scores of each parameter and interpreted according to the rating scheme in Table 2.

Water quality assessment

Water quality was one parameter considered under the abiotic component. Collection of data was conducted every three months from April 2017 to March 2019. A multi-parameter water quality meter probe (Horiba U-G) was utilized to measure the basic water quality parameters such as pH, temperature, dissolved oxygen (DO) and total

dissolved solids (TDS). The probe was dipped in the water for less than a minute until it stabilizes and automatically analyzes and store data in a data logger. Water samples were collected to examine additional parameters such as Total Suspended Solids (TSS), and nitrates analyzed at the Chemical Testing Laboratory of Department of Science and Technology-Regional Office 10 at J. Serina St, Cagayan de Oro, Misamis Oriental and Soil and Plants Analysis Laboratory (SPAL) of the College of Agriculture, Central Mindanao University at Musuan, Maramag, Bukidnon. Three replicates were collected in every assessment. Collected data were compared with the DENR Administrative Order (DAO) 2016-08's water quality guidelines and general effluent standards of 2016 (DENR, 2016), DAO 34 (DENR, 1990), and Philippine National Standards for Drinking Water (PNSDW, 2007).

Assessment of biotic component

This component constitutes vegetation condition including canopy cover, bank vegetative protection, streamside cover, and riparian vegetative zone width, presence of biotic condition stressors, vegetative horizontal patch structure and vegetation vertical structure. A checklist based on Barbour et al. (1999) and also utilized in previous studies (Amper et al., 2019; Opiso et al., 2015) was used as a guide in evaluating the parameters under this component. The same with the other component, each parameter was assessed through ocular survey and rated from 1 to 20 with 1 as the least ideal condition and 20 as the best optimal condition. The general condition for this component was determined by summing up the scores and interpreted according to the rating scheme in Table 2.

Contributory factors

Factors namely stream order, slope, land cover/land use (LULC) pattern, and population density that contribute to riparian habitat condition were assessed. Stream order was determined through watershed delineation using

Table 1

Rating scheme for the general habitat condition for abiotic component.

Scores	Component condition	Interpretation
0-45	Poor	Most disturbed, loss of function
46-80	Marginal	Disturbed
81-135	Sub-optimal	Less suitable, less disturbed
136-180	Optimal	Most suitable condition, least disturbed

Table 2

Rating scheme for the general habitat condition for biotic component.

Scores	Component condition	Interpretation
0-34	Poor	Most disturbed, loss of function
35-80	Marginal	Disturbed
81-106	Sub-optimal	Less suitable, less disturbed
107-180	Optimal	Most suitable condition, least disturbed

geoHMS extension tool of HEC-HMS in ArcGIS 10.2.2. The slope was derived using the Interferometric Synthetic Aperture Radar (IfSAR) Digital Elevation Model (DEM) from NAMRIA processed using ArcGIS 10.2.2. The land use/land cover was derived from the Sentinel-2 2016 image, a remote sensing product of Sentinel-2 satellite of European Space Agency (ESA) (Wang et al., 2016), using eCognition software and enhanced in ArcGIS 10.2.2. A population density map was generated in ArcGIS 10.2.2 using the latest available population data of the Philippine Statistics Authority (PSA, 2015).

RESULTS AND DISCUSSION

Abiotic Component Condition

Figure 4 shows the results of the assessment of riparian habitats focusing on the abiotic component in the rivers of Molugan, Solana and Odiongan. Of the three, Odiongan has the lowest score falling within the marginal to sub-optimal thresholds while Molugan and Solana thrives at sub-optimal to optimal conditions. General conditions of the abiotic component of Molugan, Solana and Odiongan riparian habitats are optimal, optimal and sub-optimal, respectively implying a suitable abiotic condition with very minimal disturbance for Molugan and Solana, and a less suitable with observable disturbance in Odiongan.

Hydrologic connectivity mostly referred to transfer of matter, energy and substances through water mediation (Pringle, 2003) was rated optimal in both Molugan and Solana rivers. This is based on the adequate hydrology in the streams inundating the floodplains. Meanwhile, Odiongan was rated marginal for this parameter due to the observable modified floodplain disconnecting access

of stream to the natural floodplain.

Stressors to the landscape condition were identified in these rivers. Molugan was considered at optimal condition due to the relative absence of stressors in areas of the assessment sites. Solana was rated sub-optimal for this parameter as characterized by the presence of stressors in less than 10% of the assessment areas. Some of the observed stressors are the transport corridor, low intensity to moderate ranching, presence of sports fields and parks, industrial and commercial buildings and urban residential which are mostly found in the river's downstream assessment site. Odiongan river is rated marginal for this parameter due to the presence of thriving stressors in around 10% of the assessment areas. Observed stressors were the presence of orchards/nurseries, existing dry land farming, low intensity to moderate ranching, physical resource extraction mining/quarrying, presence of transport corridor and urban residential. Houses along rivers are potential sources of pollution from domestic wastes. Moreover, the presence of road can incite threat of recreations and urbanization mostly associated to mining, forest harvesting and agriculture and potentially is a source of sedimentation and/or pollution (Poff et al., 2012).

Hydrologic condition stressors in the rivers were likewise identified. Molugan was rated optimal for this parameter while Solana and Odiongan are both rated sub-optimal condition. Hydrologic conditions stressors that were identified in Molugan are only in minimal areas. These are non-point source discharge such as urban runoff and farm drainage, and point source discharges and other non-storm water discharge which are also common to Solana and Odiongan. The two other rivers are observed with presence of hydrologic stressors in less than 10% of the assessment areas. Ground water extraction is an additional

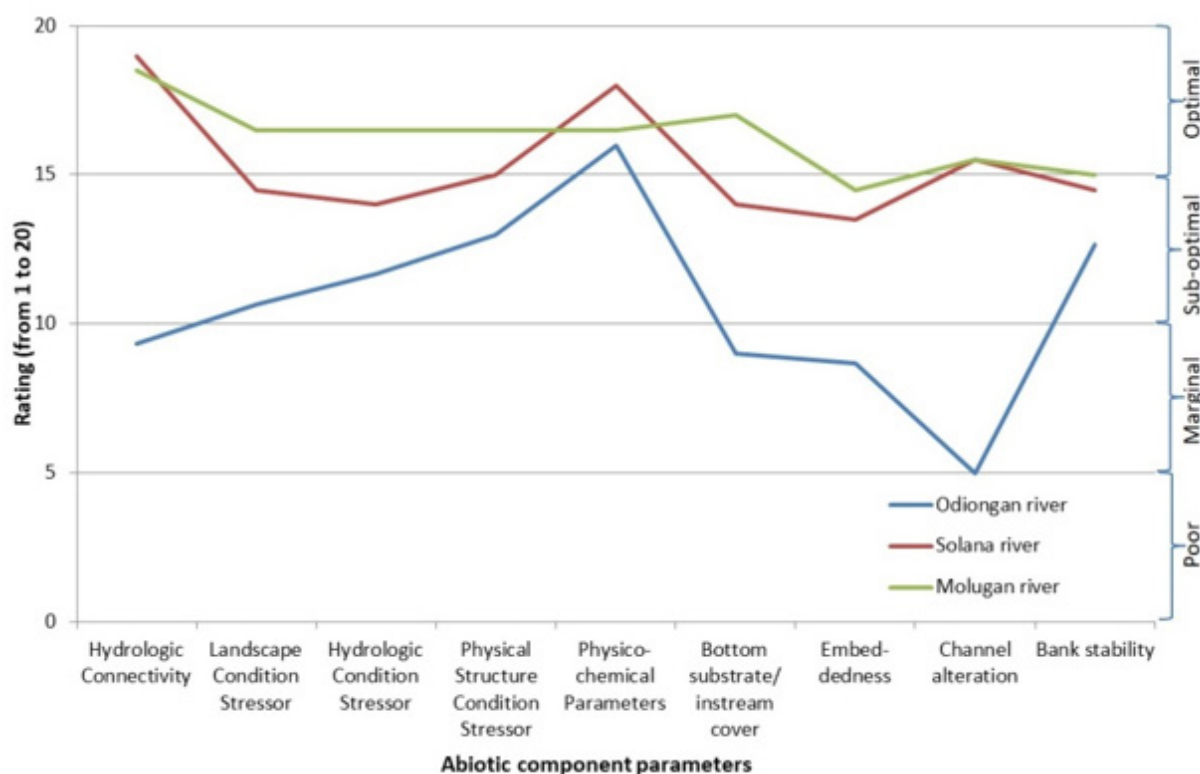


Figure 4. Rating of the parameters under the abiotic component

Table 3

Physico-chemical water properties in Molugan, Solana and Odiongan rivers.

Parameters	Molugan				Solana				Odiongan					
	Upstream		Down-stream		Upstream		Downstream		Upstream		Midstream	Downstream		
DO (mg/L)	8.67	P	8.14	P	8.13	P	8.46	P	9.06	P	8.99	P	8.69	P
Electrical Conductivity (mS/cm)	0.46	n/a	0.57	n/a	0.09	n/a	-18.08	n/a	0.1	n/a	0.11	n/a	0.12	n/a
Nitrate (mg/L)	0.74	P	0.78	P	1.81	P	0.72	P	0.66	P	0.73	P	0.67	P
ORP (mV)	238.58	n/a	246.7	n/a	336.83	n/a	284.42	n/a	288.92	n/a	289	n/a	263.75	n/a
pH	8.71	F	8.48	P	6.78	P	8.14	P	7.58	P	8.07	P	8.13	P
pHmV	-131.17	n/a	-18.18	n/a	-45.83	n/a	-98.17	n/a	-84.92	n/a	-92.33	n/a	-111.25	n/a
Salinity (ppt)	0.2	n/a	0.26	n/a	0.03	n/a	0.08	n/a	0.03	n/a	0.03	n/a	0.03	n/a
TDS (g/L)	0.3	P ^b	0.37	P ^b	0.06	P ^b	0.12	P ^b	0.07	P ^b	0.07	P ^b	0.08	P ^b
TSS (mg/L)	5.96	P	39.8	F ^a P ^{a+}	2.66	P	7.8	P	2.49	P	16.23	P	30.9	F ^a
Turbidity (NTU)	3.99	P ^c	26.64	F ^c	4.62	P ^c	6.42	F ^c	0	P ^c	17.12	F ^c	32	P ^{a+}
Temp. °C	26.75	P	29.34	P	25.39	P	28.63	P	25.26	F	25.49	F	26.93	P

P-passed; F-Failed; n/a-not applicable/no set standard; ^a based on DAO 2016-08 river class AA; ^{a+} based on DAO 2016-08 river class A and B; ^b based on DAO 34; ^c based on PNSDW

observed stressor in Solana. In Odiongan, other observed stressors were flow diversions or unnatural inflows such as restrictions and augmentations, flow obstructions due to presence of culvert and paved stream crossings, dredged inlet/channel, and ground water extraction.

Stressors to the physical structure of the rivers were also evaluated. Molugan was rated optimal for this parameter while both Solana and Odiongan were considered as sub-optimal. The same with the previous stressors, relative absence of stressors in minimal area was observed in Solana, while approximately less than 10% of the assessment sites were observed with stressors in the Molugan and Odiongan rivers. Presence of trash and traces of pesticides are the common stressors observed in the three rivers. Unsustainable vegetation management practices were also observed in Molugan and Solana rivers, while resource extraction of sediment and gravel and excessive sediment due to erosion and slope failure were observed in Odiongan river.

Physico-chemical analysis of water is another parameter considered under the abiotic component. All rivers were considered to have an optimal condition for its water quality based on its physico-chemical properties with only 1 or 2 parameters failing to qualify water quality standards. Table 3 shows the results of the water quality assessment through physico-chemical analysis for the three rivers. These are the average of the four water quality test and sampling. For Molugan in particular, pH slightly

went beyond the standard range of 6.5-8.5 of DAO 2016-08. Turbidity and TSS also failed in the downstream site of Molugan. Turbidity went beyond the allowed maximum threshold of 5 NTU based on PNSDW while TSS failed the maximum allowed level of 25mg/L of DAO 2016-08 for river class AA but passed for other river classes A, B and onwards. For Solana river, water quality in the upstream site passed the set standards of DAO 2016-08, DAO 34 and PNSDW. In downstream site, turbidity slightly went beyond the maximum level of 5NTU. For Odiongan, temperature in the upstream and midstream sites slightly went below the lowest set standard range. Turbidity in upstream site is within acceptable threshold level while in midstream and downstream sites, turbidity is very high going beyond the set maximum level. TSS is within an acceptable level in midstream but failed in downstream site. Generally, waters in the Molugan, Solana and Odiongan are still with good quality conditions classified as class A or Public Water Supply Class II water source requiring conventional treatment to meet latest PNSDW (DENR, 2016). However, turbidity remains a common problem in the three watersheds. Along with TSS, it acts as primary indicators of deteriorating water quality.

Bottom substrate which also known as the instream cover refers to the presence of materials in the stream that could serve as the habitat for organisms. These include large woody debris and litters that are necessary for the productivity of organisms in this habitat as influenced by the physical, chemical and biotic characteristics of the river

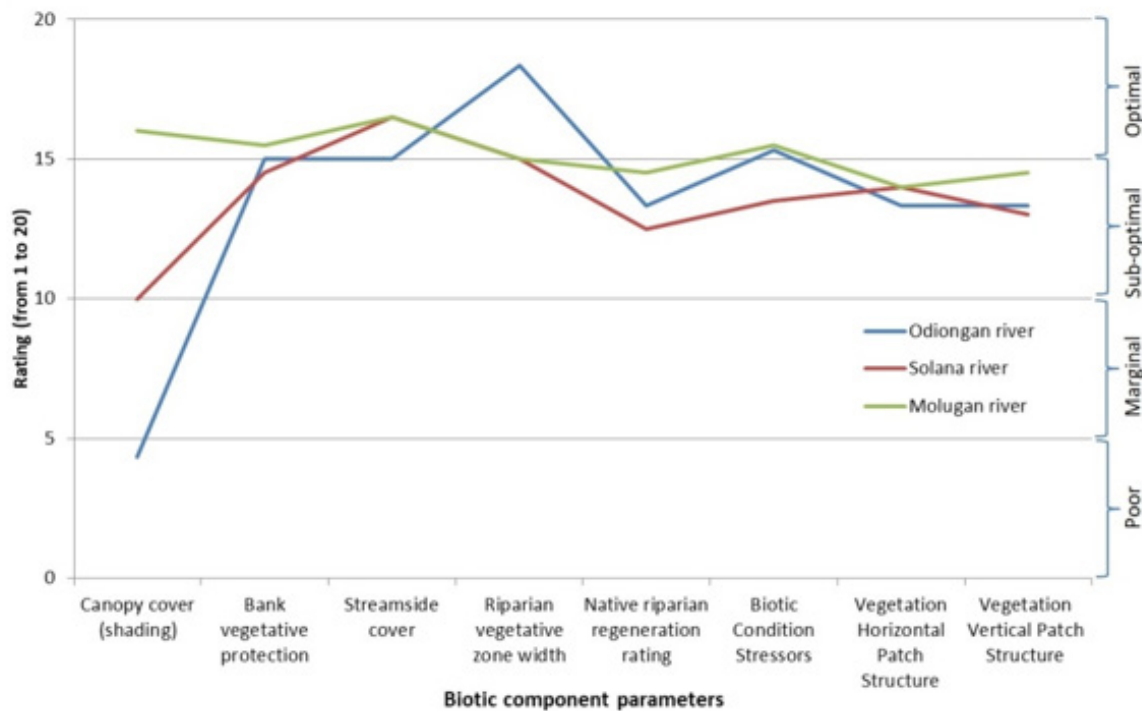


Figure 5. Rating of the parameters under the biotic component.

(Poff et al., 2012). Of the three rivers, Molugan attained the highest rating still considered as optimal, followed by Solana at the sub-optimal condition and lastly by Odiongan rated marginal in condition. Molugan assessment sites are observed with greater than 50% of mix gravels with submerged logs, undercuts banks and other stable habitat in the stream. Solana is with only around 30-50% of mix substrates present in the assessment sites while around 10-30% were only observed in the streams of Odiongan.

Embeddedness is the parameter that refers to the presence of fine sediment in the river bed determined through the extent to which rocks are buried by these fine sediments. Both Molugan and Solana are considered at sub-optimal condition with the rocks in the river surrounded by 25-50% fine sediment. Odiongan was rated marginal observed with 50-75% of fine sediments in the river bed. Embeddedness is one factor used in characterizing stream bed which is commonly associated to degraded habitat (Sennatt et al., 2006).

Channel alteration is another parameter considered in the assessment of the rivers in Misamis Oriental. The change of course of rivers which may result from eroding banks and increased deposition of the gravel and sediment bars in the stream can be an indicator of degraded river. Molugan and Solana rivers were rated sub-optimal for this parameter as characterized by an observable formation of sand bars most from coarse gravel with presence channelization or changing course of water flow. Odiongan on the other hand was rated poor considered as having a degraded condition as characterized by heavy deposits of fine material, increased bar development and extensive channelization. Bank stability which refers to the stability of the river banks against erosions were assessed and found out at sub-optimal condition for all the three rivers characterized with moderately stable with infrequent occurrence and presence of small erosions in some areas. The stability is significant in regulating flow and sediment

routing (Amper et al., 2019).

Biotic Component Condition

Biotic component of riparian areas in this study refers to the vegetation as one of those which constitutes the ecosystem that provide a variety of ecological services such as the filtering out of sediments, nutrients, pesticides, wastes and other non-point source pollution (Poff et al., 2012). Different parameters in touch with this component were assessed. Figure 5 shows the results of the assessment of riparian habitats focusing on the biotic component in the rivers of Molugan, Solana and Odiongan. The rivers general riparian habitat biotic conditions are all at optimal which imply suitable biotic condition with very minimal disturbance.

Canopy cover is a parameter used as an indicator of vegetation stand density in the riparian areas of the rivers. Of the three rivers, Odiongan obtained the lowest rating classified as poor due to relative lack of canopy with full sunlight reaching the water surface. This is mainly due to the larger width of the river, disenabling full coverage of the canopies in the river. Molugan is rated optimal with a mixture of canopy cover conditions with some areas of water surface fully exposed to sunlight and with some areas shaded with filtered lights reaching the water. Solana was rated marginal for this parameter due to absence of canopy especially in the downstream site of the river. Absence of shading may result to increased river water temperature affecting aquatic biota (Iakovoglou et al., 2012).

Bank vegetative protection which is evaluated through the coverage of vegetation in the streambank surfaces is all at sub-optimal in three rivers. Molugan, Solana and Odiongan streambanks are generally covered with 70-89% vegetation. For the streamside cover, both Molugan and Solana are rated optimal in condition as characterized by the presence of shrubs and some trees are the dominating vegetation in the streambanks.

Odiongan on the other hand is rated sub-optimal with presence of some shrubs and trees on the streambanks. Riparian vegetative zone width refers to the width of vegetation cover in the riparian areas. Molugan and Solana were rated sub-optimal with existing vegetation cover width of 12-18m from the river banks towards adjacent riparian areas. Odiongan river however was rated optimal and has an observed vegetation width of more than 18m. The presence and extent of width of riparian forest buffers play significant roles in denitrification process reducing introduction of nitrates in streams, hence protecting water quality (Iakovoglou et al., 2012).

Native riparian regeneration rating parameter refers to the presence of saplings and seedling trees with obvious regeneration in the riparian areas. All rivers are rated sub-optimal as seen in the presence of scattered seedling patches with 1%-5% cover in the assessment areas.

Activities in the surrounding riparian areas considered as stressors to biotic condition were identified in this assessment. All rivers were rated sub-optimal with several stressors observed in the sites. Biotic condition stressors identified in Molugan are presence of exotic plant species and the lack of vegetation management to conserve natural resources. In Solana, observed stressors are presence of mowing, grazing and herbivory, excessive human visitation, and habitat destruction by domestic livestock. Excessive human visitation, habitat destruction by domestic livestock and presence of exotic plant species were also observed in Odiongan river.

For vegetation horizontal and vertical patch structures parameter, all rivers are rated sub-optimal as characterized by the presence of moderate degree of vegetation patch diversity for the horizontal structure and the presence high structure forest with shrubs and herbs for the vertical patch structure. The types of vegetation determine the capability of the riparian zone to regulate flooding by slowing transit of rainwater in the catchment. With more diverse and higher structure vegetation comes with more "roughness" which can hold back flood peak in high flows (Opiso et al., 2015).

Land Use/Land Cover

The land cover/land use pattern in the watersheds of Molugan, Solana and Odiongan (Figure 6) were mapped and derived from Sentinel-2 satellite image of ESA using eCognition software and ArcGIS 10.2.2. Figure 7 subsequently shows the percent coverage of classified land cover/land use patterns in each watershed. Trees classification which may interchangeably refer to as forest is the most common land cover pattern in the three watersheds. Specifically, Molugan watershed is dominantly covered by tree and brushland classifications. Moreover, a considerable area is grassland followed by coconut and fallow/cultivated areas. Meanwhile, the majority of Solana is covered by fallow and/or cultivated land. Tree forest only covers a small portion. In Odiongan watershed, over half of the watershed area is covered with trees. Other dominating land cover classification is brushland and coconut.

Land use and land cover change is considered as one of the most detrimental factor in impacting soil loss and deteriorating water quality (Sharma & Tiwari, 2009; Dumago et al., 2018). Of the three watersheds, Solana is most prone to soil loss due to the large area occupied by the cultivated land. However its impact is not directly observed in the riparian areas of Solana which is still considered optimal in condition for both the abiotic and biotic components. Urban cover which includes the residential and road classifications is relatively low in percent coverage for each watershed. However, it must be taken note that the increase of urban land use in watershed also increases degradation or removal of riparian vegetation (Iakovoglou et al., 2012).

Population Density

Population growth is one factor that drives physical modification of the watershed through changes of land cover and land use patterns among others placing strain to the environment. Figure 8 illustrates the density of human population in the watersheds of Molugan, Solana and Odiongan. The downstream areas along the watersheds' outlets are all with dense populations. In Molugan watershed in particular, the barangays or the smallest

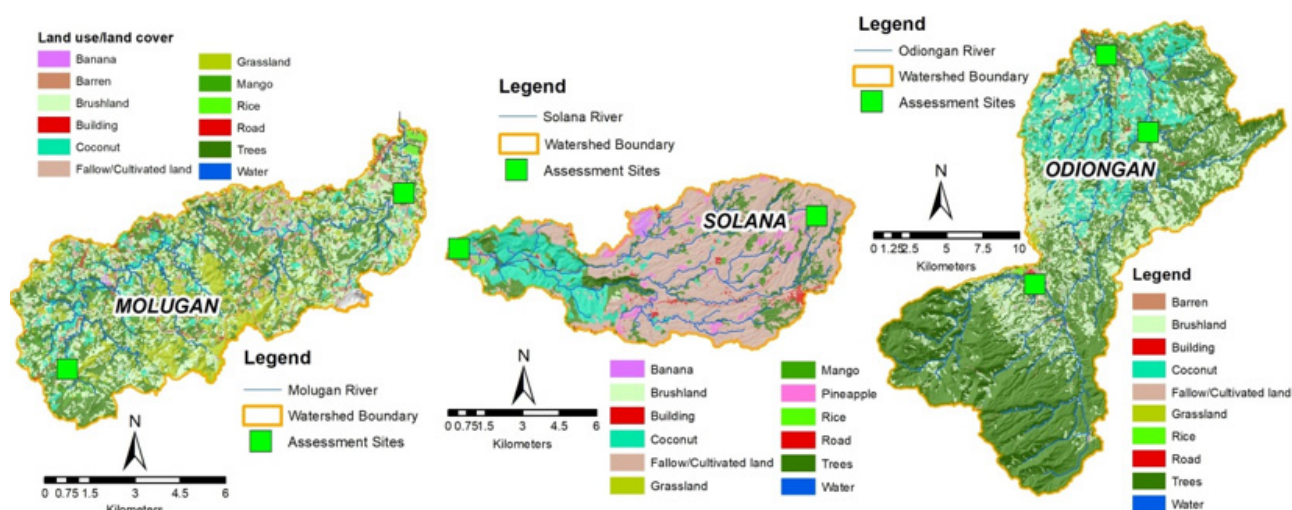


Figure 6. Land cover and land use pattern in Molugan, Solana, and Odiongan.

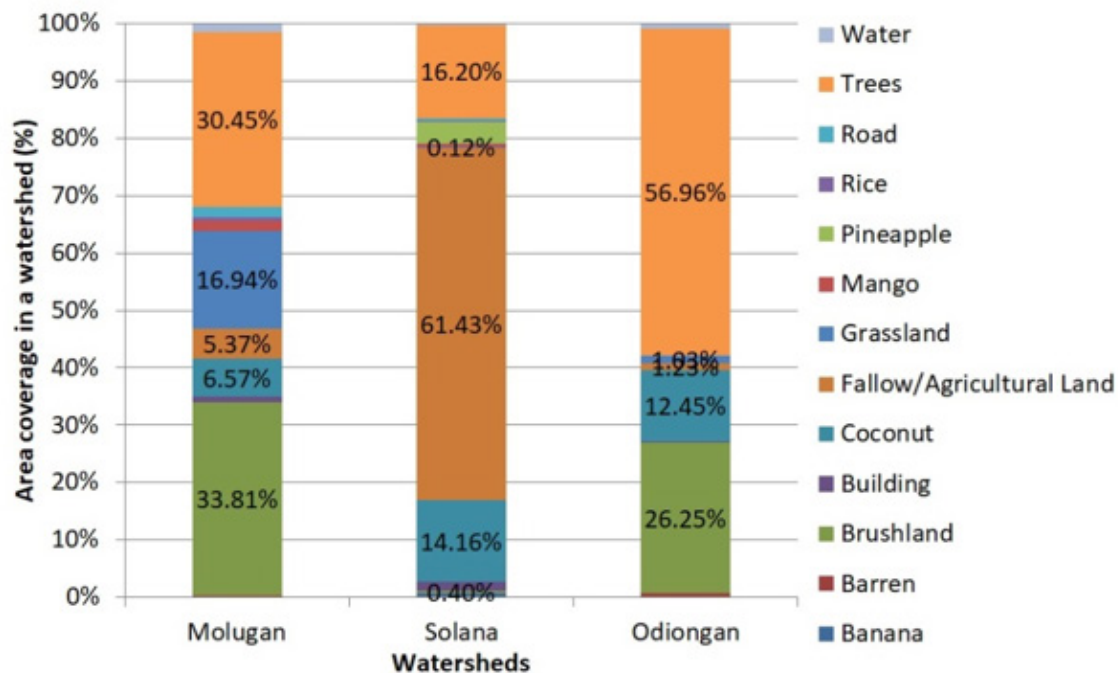


Figure 7. Percentage of land cover/land use classifications in Molugan, Solana, and Odiongan watershed.

administrative divisions in the country with the highest population is in the downstream section of the watershed with a population reaching up to over 5000. Conversely, barangays in the upstream section are with the lowest population. In Solana watershed, the downstream portion of the watershed is likewise with high population. However, population in a portion of the watershed's midstream and upstream is also considerably dense. Lastly, Odiongan's downstream areas are also with dense population. A small portion in the midstream and upstream areas are also with high population. Lowest population is located in the lower midstream section of the watershed.

Population is expectedly high in the coastal areas where most of the establishments are built and national road network is established. The growth of population is translated to the reduction of forest covers due to its conversion to settlements and agricultural cultivation. Even worse, the change in the environment may lead to environmental hazards and exacerbates disasters (Weng, 2010; Wang et al., 2012). Human interventions which maybe indicated by the density of population, type of land cover and use pattern, and other human driven stressors are regarded as critical as it has cumulative effects to riparian ecosystems (Poff et al., 2012). Moreover, with population explosion, water quality degradation in adjacent stream networks is expected. However, for the case of all the study sites, results of river waters are still in good quality.

Stream Order

The stream order represent the longitudinal dimension of the river (Ekness & Randhir, 2007) which was determined using the delineated stream network derived from IfsAR DEM using GIS approach. The ArcGIS 10.2.2 and HEC-geoHMS tool were used in the watershed delineation. The stream ordering was based on the Strahler (1957) ordering system. In this study, identified stream order of

assessment site was until 4th order which is mostly the most disturbed stream with the greatest size. Figure 9 illustrates the stream orders of reaches in Molugan, Solana and Odiongan watersheds.

The upstream site in the Molugan is a 2nd order stream while the downstream site is a 3rd order stream. Solana's upstream site is a 1st order stream which is the lowest in all assessment sites while the downstream site is a 4th order stream. The upstream site in Odiongan is a 3rd order. The midstream and downstream sites are classified as 4th order.

The lowest stream orders are those smaller in size mostly located in the upstream areas as the head waters while high stream orders are those near the drainage mouth. Due to its remote location from possible disturbances, lower stream orders are associated mostly with riparian habitat condition. This is in conjunction with the result of this study where scores for both abiotic and biotic components are higher as implied with better habitat condition in upstream than the downstream sites. Moreover, upstream sites in each watershed are scored higher than the downstream sites for the water quality assessment because almost all of the parameters passed the set water quality standards.

Stream order, along with other factors, influences habitat quality for animals. Streams with higher orders are less likely to have less protection for the natural animal inhabitants. Moreover, it is much suggested that habitat protection must focus on the headwaters with lower stream order for the benefit of the whole drainage basin (Ekness & Randhir, 2007). Especially in Solana basin where cultivated land dominates even in the upstream site of 1st order, management must be critically considered to protect downstream sections of the watershed.

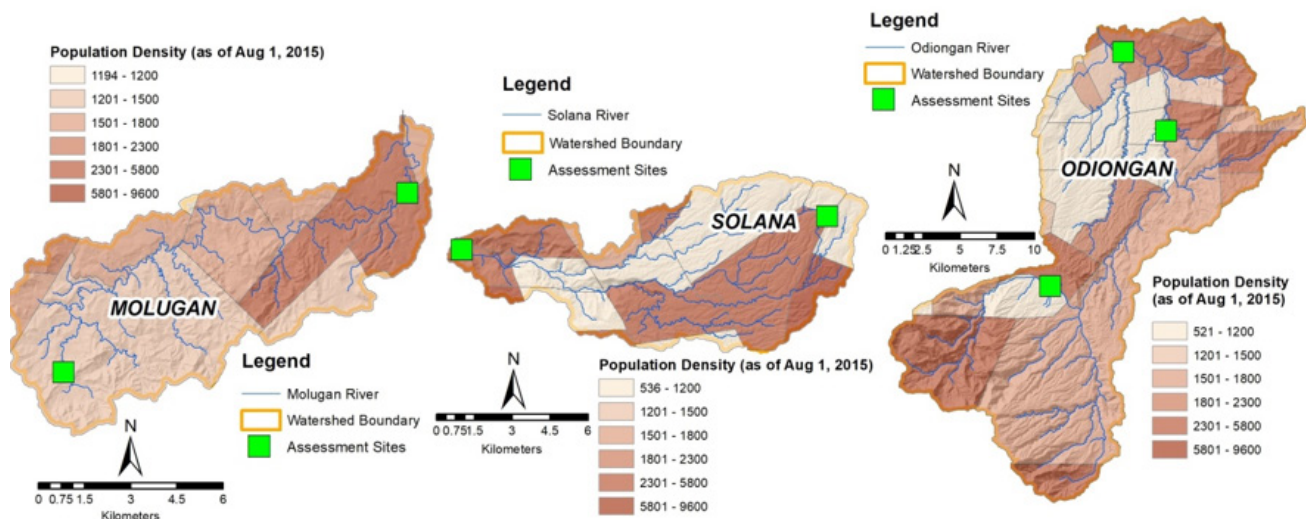


Figure 8. Density of Population in Molugan, Solana and Odiongan watersheds according to PSA (2015)

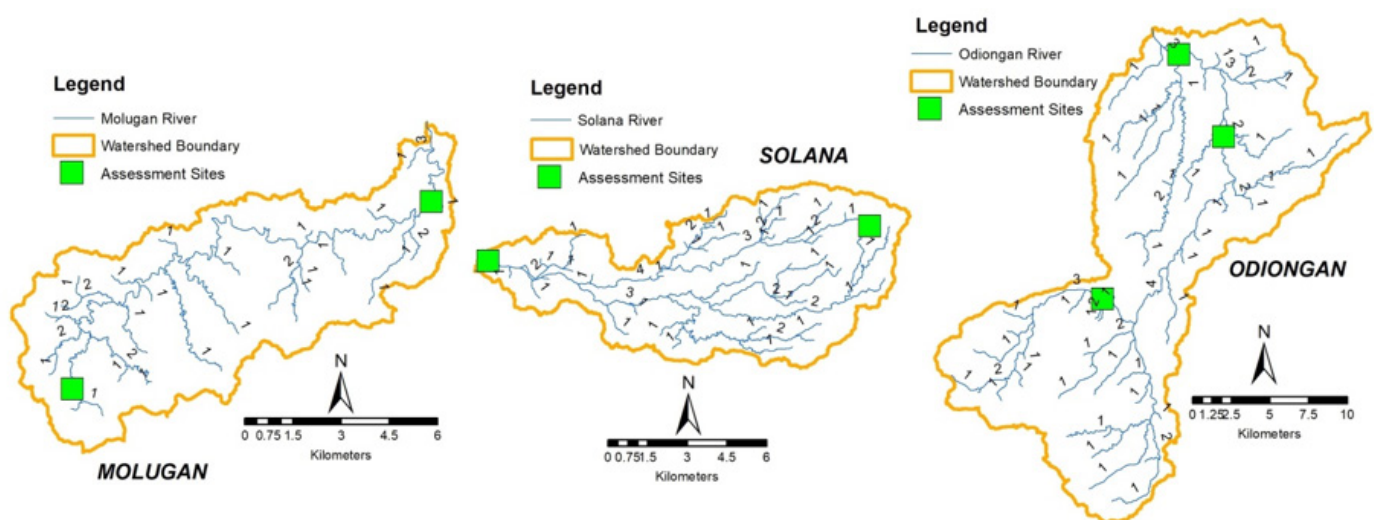


Figure 9. Stream order of the tributaries of Molugan, Solanam and Odiongan watershed.

Slope

Figure 10 depicts the slope classified according to DENR (2008) slope classification. The Molugan upstream specifically the surrounding 500m is mostly made of 30-50% slope followed closely by 18-30% slopes characterized by a very steep and steep slope, respectively. Majority of downstream site of Molugan is level to gently sloping which is the category with the lowest slope percent. Moderate slope follows which occupies 33% of the surrounding area of the assessment site. Almost half of the upstream site in Solana is dominated by moderate slope with slope within 8-18%. Moreover, the downstream site is mostly with level to gently sloping topography. More than half of Odiongan upstream site consists of level to gently sloping areas. The midstream site meanwhile is almost equally distributed with varying slope classification. For the downstream site of Odiongan, majority of the area is level to gently slope.

Slope is inherently a landscape factor that affects environmental conditions and disturbance regimes (Mendez-Toribio et al., 2016). Mostly, presence of stressors to habitat condition are available on lower reaches of hill slopes especially in moderate slope of less than 7% slope and near human settlements which may be attributed to

slope instability with higher slopes being more unstable than those with lower slope (Mendez-Toribio et al., 2016; Punchi-Manage et al., 2013). In all downstream sites of the three watersheds including the upstream site of Odiongan, majority are with level to gently sloping topography. As mentioned, these areas are mostly exposed to disturbance of anthropogenic activities. Moreover, the moderate slope to steep including the very steep slopes in in some assessment sites areas may imply the less access of these areas to disturbances such as human visitation and grazing of animals.

CONCLUSIONS

This study revealed that the Odiongan river has the least ideal general riparian habitat condition followed by Solana and lastly by Molugan. The presence of different stressor indicators in Odiongan specifically in the midstream assessment area pose as the threat to the condition of the riparian habitat. Moreover, the relative size of the river particularly from the midstream section down to the mouth of the river makes it harder to regulate occurring erosions along the river banks, siltation and occurring channelization which are the worse observed deteriorations in this river. This problem is exemplified in

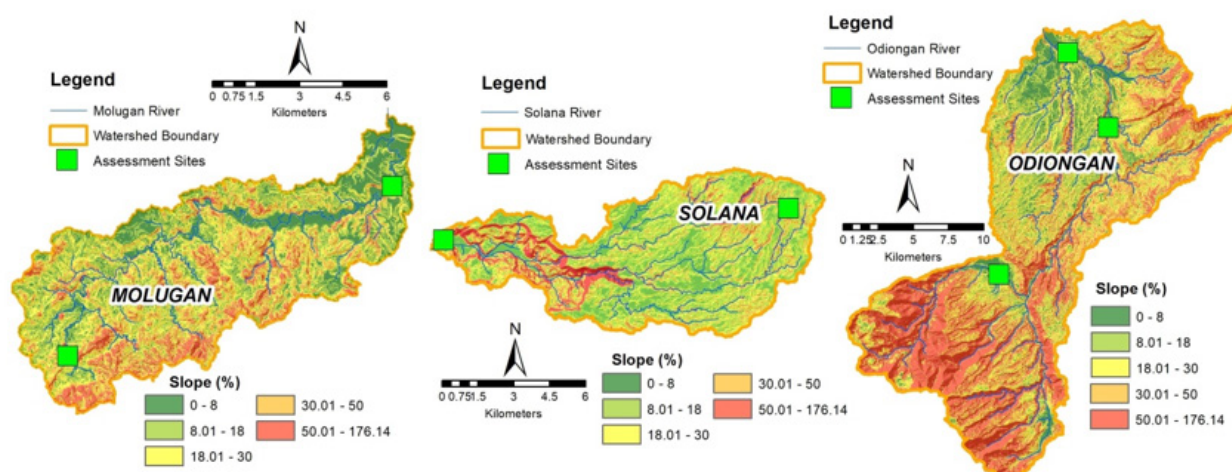


Figure 10. Slope map of Molugan, Solana and Odiongan watersheds.

the water quality condition of the river which failed in set standards for the turbidity and TSS parameters. Moreover, in between the two components considered in the assessment, the abiotic component appears to be more disturbed in Odiongan river than the biotic component.

Hence, recommendations in managing the watershed of Odiongan should put weight more on the abiotic component with the regulation of stressors such as the presence of residential houses, dry land farming, ranching and physical resource extraction or quarrying along the stretched of the river. Conversely, the biotic component of the riparian areas appear to be more disturbed than the abiotic component observed both in Molugan and Solana rivers. Therefore, management practices in these rivers should focus more on conserving riparian vegetation without neglecting the regulation of the stressors existing in the watershed.

Water quality assessment revealed that the water in Molugan, Solana and Odiongan rivers are recognized as applicable for domestic use when applied with conventional water treatment classified as class A water body. However, turbidity is the common problem in the three watersheds going over the maximum allowed set standard specifically on the downstream sites of the three rivers including the midstream site of Odiongan. TSS is also very high and failed in the downstream sites of Molugan and Odiongan which along with turbidity are primary signs of water deterioration. Conservation measures to improve water quality conditions must be implemented in the downstream portions of the rivers. These measures may include the establishment of a riparian buffer such as planting of shrubs and trees and maintaining the prescribed buffer width. Moreover, the encroachment of residential houses should be regulated in these areas.

Of the three watersheds, Solana showed the greatest percentage of cultivated land hence conservation measures must be placed with utmost attention for this watershed through appropriate agricultural practices and the maintenance of vegetation buffer in stream networks. The implementation of greenbelt establishment must be stricter in the downstream portions of the watersheds

where the population is denser and the slope is more level giving the greatest accessibility for disturbance.

Generally, all watersheds are still considered with suitable riparian habitat conditions with the presence of minimal disturbances. However, it is still recommended that conscious regulation for the expansion of agricultural cultivation must be observed especially in the upstream areas of the watersheds. Moreover, appropriate land use zoning must be implemented giving emphasis on the establishment of appropriate riparian vegetation buffer widths along stream networks and the integration of natural conservation strategies. Through these measures, riparian areas will be repopulated with vegetation restoring ecological functions especially in attenuating flood scenarios among others.

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The Adaptability of Public School Teachers amidst the Pandemic

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ABSTRACT

This study focused on the adaptability of public-school teachers from a national high school, in a city schools division in Laguna, Philippines during 2019 – 2020. Using a descriptive type of research design, the study was conducted among 90 respondents (with 24 males and 66 females) with the use of survey. The instrument was adopted, modified, and validated by pool of experts with reliability analysis carried out and yielded a Cronbach's alpha of 0.901 which shows the questionnaire reached an excellent reliability. For the statistical tools, the study include frequency, percentage, mean, and standard deviation. The study found that the respondents' adaptability was "High" in terms of self-awareness, personal management, problem-solving and decision-making, attitude, and knowledge of competencies. Male respondents appeared to be more adaptable than females. Respondents with age greater than 50 obtained a very high adaptability level compared to the rest of the age groups. Respondents with teaching experience 16 – 20 and greater than 30 years got very high adaptability. In conclusion, the participants were highly adaptable even when they are experiencing the pandemic COVID-19. Thus, it is recommended that teachers should communicate with the persons concerned using any medium and understand their situations, and pursue performing their responsibilities.

Keywords: Adaptability, Public School Teachers, Pandemic

INTRODUCTION

Teaching is known to us as a noble profession. It is a happy thing to become a teacher who molds the learners and helps them achieve their dreams. When learners have reached their life's ambition, the first ones who are joyful are the teachers. However, the novice and even experienced teachers also left this profession. It is evident in the international literature that neophyte teachers and even with years of experience leave the profession for few reasons (Borman & Dowling, 2008; Ingersoll, 2002; Sass et al., 2012; Struyven & Vanthournout, 2014).

What the international teachers experienced might also have been experienced by most of the Filipino teachers. Some teachers left the profession for a job that is different from the field. Based on the researcher's observation, some teachers have applied and worked in industry and production, Business Process Outsourcing, or in the call center, and others. In contrast, others have remained in the profession and become adaptable (Novio, 2019).

We knew that this COVID-19 pandemic brings people so much weariness and anxiety. It makes them shift from a standard way of living into something chaotic, and the situations turn into challenging ones. The usual things a person is doing have shifted. Facing a situation different from the usual one is not that easy. A person needs to be adaptable to survive in his lot.

The Filipino teachers are one of the groups of people affected by the pandemic. In a study by Asio (2021), the author stated that faculty and staff work productively

before the COVID-19 pandemic. They are the front liners in the delivery of the lessons. They are the ones responsible for the success and failure of the learners. Students' both success and failure in the academic performances would somehow depend on the teachers' efforts. Still, they must make efforts for their learners even during pandemic.

The study's result would give some recommendations to the teachers facing varied situations, particularly situations during the COVID-19. Thus, the teachers would learn what to do in performing their responsibilities amidst the pandemic. This aimed to determine the teachers' adaptability in Gulod National High School, Division of Cabuyao, Laguna, in the school year 2020-2021.

Literature Review and Framework

The survival of the fittest theory is also known as adaptation theory. According to King (2018), it is an organism's ability to adapt to changes in the environment and regulate over time. Cherry made the point that adaptation means adjusting to new information and experiences. Additionally, learning is about the environment and adapting to changes in the environment are linked. Behavioral patterns can be adopted in order to accommodate change (Cherry, 2017).

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The research and Career Development Theory were connected. The theory presents a method for both comprehending vocational behavior across the life cycle and for clients to help them attain long-and-a successful careers and work as they age progresses. Its scope involves three vocational orientations: differential, developmental, and dynamic. from an individual differences' perspective, it examines the characteristics of vocational types. The study of developmental psychology looks at human adaptation and tasks at work, occupational changes, and work-related problems. For the purposes of the narrative psychology, it explores how life's thematic details color career goals and why people gravitate toward them in distinct ways. Plans for career development incorporates three basic principles: 1) how the individual cultivates their character as they shape their job; 2) work-based career alignment; 3) functional adaptation (Savickas, 1997).

This study is close to one of the education philosophies, pragmatism. The pragmatic principle goes that only what is experienced or noticed is real. They believe that reality shifts, and that we learn best through integration of our experiences and problems. Formal pragmatism is derived from the Peirce's belief that ideas must lead to action rather than remain only in theory. According to John Dewey, people must adapt to their environment and learn from each other. the approach of schools should stress the themes of social experience every bit as much as on place as time (Cohen, 1999).

These were connected to the present study considering that teachers are facing different work-related changes like making and submitting various reports to the superiors, attending webinars, preparing lessons, presentations, and teaching students from different learning modalities, virtually communicating with the learners, parents, and guardians, and others. Thus, if teachers could not adapt to the activities and rapid changes in the workplace, they tend to quit the profession and seek another job.

Adaptability is a person's skill to change his actions, course, or approach to suit a new situation. People are changing their lifestyles constantly because our world is always changing. When there is a shortage of a commodity in the market, they switch their demand to substitute goods. It is not only about adjusting to a situation or changing something. It covers being able to effect changes during action with smoothness and timeliness, without any significant setbacks. It is necessary to acquire this skill if there are many uncontrollable factors in our environment, such as laws and economic factors (cleverism.com, 2018).

Collie et al. (2018) stated that experiences of change, novelty, and uncertainty are prevalent to all earthlings. These include major events such as moving out of home, beginning school, and beginning a new job. They also include everyday events such as a shift in job role, think of alternative transport when a flat car battery strikes, or have unexpected guests join for dinner. The extent to which we can adjust our thoughts, actions, and emotions to respond successfully to these situations is known as adaptability. It involves adjusting the way we think about the situation to consider different options, undertaking

different actions to better navigate the situation, and minimizing emotions that may be unhelpful or distracting.

Half (n. d.) noted that very few successful people or organizations or organizations got to where they are by only doing the same thing. He added that great leaders seek out change and pursue it feverishly, understanding that to be truly innovative and ahead of trends, one must embrace change. However, being adaptable is not just about embracing change, and being adaptable means being a perpetual optimist and exhibiting extraordinary resilience. Adaptability skills can be possessed both in attitude and action, and one cannot exist without the other.

Boss (2015) stressed that people, teams, and organizations' ability to adapt to changes in their environments, stay relevant, and avoid obsolescence are the defining characteristic between success and failure, growth and stagnation, business, and bankruptcy. To stay relevant as an organization, one needs to think and act adaptively; one needs the right people in the right places, which only comes from how leaders shape their environments.

It appears that adaptable workers are more highly valued than highly skilled workers but may not be as open to change. Solutions must be open to alternatives when the first concept does not work. Other than that, he must be prepared to undertake new activities even if they are outside of his training, flexible enough to find solutions or conceive of ideas, and appreciative of unexpected developments. In addition, he must maintain his composure when things are happening quickly or in a state of stress and demonstrate the competence to perform even while adjusting. Trades, factories, factories, and mining will exist, and technical skills will be required to maintain their employment. Nonetheless, soft skills are becoming increasingly important for workers in all occupations. As two of the most important soft skills will emerge are adaptability and flexibility (Whitehead, 2016). While other studies emphasize on workers', this one's focus is on teachers' adaptability.

Adaptability is vital for teachers. Collie and her colleagues (2018) underlined that just as public life is full of fluctuations, uncertainties, working life is full of new situations for men. The term "just as working life's path is changeable, public service has to them" for instance, in the workplace, teachers come across many learners to whom they must adapt, and respond to changing requirements, as well as unexpected scenarios in the classroom, and colleagues, as well as well as meet, and students, and parents, and all at the same time. These situations call for teachers to be handled in an adaptive manner. Increasing student attention might be done by keeping the lesson on schedule, tolerating failure when a lesson does not go as planned, or adjusting teamwork with new coworkers.

The authors further explained that instructional content must be tailored to students' varying needs, which should be accompanied by changes in learning support as students advance in their understanding of content, and classroom management strategies adjusted as the

students' level of expertise develops. Teachers also need to keep up with changes in the entire school by effectively responding to the demands of their students. Teachers must be able to make changes to their work settings if they are to perform optimally at work (Collie & Martin, 2016).

Jiggs et al. (2014) asked more than 1,100 employers and educators what they thought about the state of employability skills in the UK. The results show that adaptability and communication skills were seen by employers as having grown in importance over the last ten years. More than 60 percent of employers felt adaptability had become more critical over the previous decade. When asked about the importance of skills right now, employers ranked problem-solving as the most important of the seven skills; 19 percent of those surveyed put problem-solving in the first place. Creativity follows (ranked as most important by 17 percent of employers), leadership, and adaptability (both with 16 percent). It suggests that when employers look back over a decade of labor market change or look forward to future changes, communication and adaptability are at the forefront of their minds. In addition, a study showed that teachers have established sleep and religious tasks routines (Asio & Jimenez, 2021).

Researchers stressed that adaptability is something teachers require regularly, and it likely plays a vital role in helping them navigate the demands of their work. Collie and Martin's (2017) prior research found support for this. They found that when teachers are more adaptable, they tend to report better well-being. They also examined whether there were additional connections with students' achievement. Results showed that when teachers were more adaptable and had better well-being, their students had higher achievement (Collie & Martin, 2018). Thus, teachers' adaptability is very significant and much needed in typical situations and pandemic times.

Researchers asked 164 secondary school teachers in Australia to rate their adaptability, their experiences of labor disengagement, and their job commitment. The results showed that teachers tended to report lower work disengagement and, in turn, more outstanding job commitment when they were more adaptable. Adaptable teachers can effectively navigate the constant change, novelty, and uncertainty that occur in teaching. It may aid the teachers avoid the outlooks of helplessness that lead to disengagement. They also asked teachers about the extent to which they felt the principal listens to teachers' perspectives and supports their initiative and innovation. The findings showed that when teachers reported principal support, they tended to be more adaptable (Collie & Martin, 2018).

METHODOLOGY

Research Design

The researcher utilized the descriptive research design through survey questionnaire to gather the profile and the respondents' level of adaptability.

Population and Sampling

The researcher conducted the study at Gulod National High School, City Schools Division of Cabuyao, Laguna. Before the survey's conduct, the researcher sent a permission letter to survey with the Schools Division Superintendent. He also sent a letter to the school head of the responding school and sent the Google Form link to the volunteer-teacher for the survey with an attached consent letter.

Since the researcher distributed the survey through a digital platform, not all target participants have responded with it. Out of 110, there were only 90 or 82% teachers volunteered and answered the survey.

Instrumentation

The researcher used a survey questionnaire that was composed of two parts. The first part was for the respondents' profile. The second part was an adopted questionnaire to measure the respondents' adaptability (Morgan, 2011). The researcher carried out the reliability analysis on an adaptability skills scale comprising 28 items. Cronbach's alpha (0.901) showed the questionnaire reach excellent reliability (Munda & Tamban, 2019). The questionnaire was modified so that it would fit the current situation experienced by the respondents. The research instrument has undergone content validity by asking specialists in the field to judge the appropriateness of the items on the instrument.

Statistical Analysis

The researcher retrieved the responses after one week and generated the spreadsheet from the responses in Google Form. Then, he transferred the data into SPSS version 25 for analysis.

The researcher used the frequency and percentage to determine the profile in terms of sex, age, and teaching years. He used the mean, and standard deviation to describe the respondents' level of adaptability, including the adaptability in terms of sex, age, and years of teaching.

RESULTS AND DISCUSSION

Results

The researcher sought to determine the teacher-respondents' demographic profile in terms of sex, age, and teaching years in public school. Provided below were the results of the study. The profile of teacher-respondents, according to sex, was presented in Table 1.

Table 1 presents the distribution of teacher-respondents when grouped according to sex. We could observe that female teacher-respondents were greater in quantity than males. From the 90 or 82% respondents out of 110 population of Gulod National High School, City Schools Division of Cabuyao, 24 or 26.7% were males while 66 or 73.3% were females.

Table 2 shows the age distribution of the

Table 1

The Profile of Teacher-respondents according to Sex.

Sex	Frequency	Percentage
Male	24	26.7
Female	66	73.3
Total	90	100.0

Table 2

The Profile of Teacher-respondents according to Age.

Age	Frequency	Percentage
21 – 25	9	10.0
26 – 30	18	20.0
31 – 35	22	24.4
36 – 40	17	18.9
41 – 45	14	15.6
46 – 50	4	4.4
> 50	6	6.7
Total	90	100.0

Table 3

The Profile of Teacher-respondents according to Years of Teaching Experience.

Age	Frequency	Percentage
1 – 5	45	50.0
6 – 10	31	34.4
11 – 15	8	8.9
16 – 20	3	3.3
21 – 25	0	0
26 – 30	1	1.1
> 30	2	2.2
Total	90	100.0

Table 4

The Level of Adaptability of Teacher-respondents in terms of Self-awareness

Self-awareness	Mean	SD	Descriptive Interpretation
1. I can articulate/express my special abilities, talents, and skills.	3.96	0.67	High
2. I know what I have to do to regain my confidence when I temporarily lose it.	4.02	0.67	High
3. I have a strong sense of self-esteem and generally feel good about myself.	4.00	0.64	High
4. I can identify and communicate my weaknesses and the ways that I work with or around them.	3.97	0.53	High
5. I have a vision for my life that gives it meaning and purpose.	4.49	0.55	Very High
6. I know what is important to me and use this knowledge in making decisions.	4.46	0.56	Very High
Overall Self-awareness	4.21	0.48	High

Legend: 4.50-5.00 = Very High Level; 3.50-4.59 = High Level; 2.50-3.49 = Average level; 1.50-2.49 = Fair level; 1.00-1.49 = Poor level

Table 5

The Level of Adaptability of Teacher-respondents in terms of Personal Management

Personal Management	Mean	SD	Descriptive Interpretation
1. I take responsibility for managing my teaching responsibilities.	4.53	0.55	Very High
2. I can see how my job fits into the bigger picture of my life plans.	4.33	0.60	High
3. I have a personal financial plan, which I evaluate regularly based on my current situation.	4.20	0.67	High
4. I have contingency plans, a second option if my first plan does not work out.	4.12	0.71	High
5. I assess my strengths and weaknesses, outline ways to grow, and establish short and long-range goals for my job.	4.20	0.62	High
Overall Personal Management	4.37	0.49	High

Legend: 4.50-5.00 = Very High Level; 3.50-4.59 = High Level; 2.50-3.49 = Average level;
1.50-2.49 = Fair level; 1.00-1.49 = Poor level

Table 6

The Level of Adaptability of Teacher-respondents in terms of Problem-solving and Decision-making

Problem-Solving and Decision-making	Mean	SD	Descriptive Interpretation
1. I have emerged stronger and have learned personal strategies to deal with change because of my life changes.	4.20	0.58	High
2. I can organize my surroundings and prioritize tasks, even in stressful times.	4.11	0.61	High
3. I can find and mobilize necessary resources in a crisis or new situation.	4.06	0.64	High
4. I can usually think of several alternatives to solving a problem.	4.17	0.64	High
5. When experiencing stress in one area of life, I can contain it within that area.	3.86	0.66	High
Overall Problem-solving and Decision-making	4.03	0.54	High

Legend: 4.50-5.00 = Very High Level; 3.50-4.59 = High Level; 2.50-3.49 = Average level;
1.50-2.49 = Fair level; 1.00-1.49 = Poor level

respondents of the study. The table shows 31-35 got most of the respondents' age with 22 or 24.4% teachers while 46 – 50 got the least among the age groups of respondents with 4 or 4.4% teachers.

Table 3 presents the profile of teachers according to years of teaching experience. The teaching experience with the highest frequency was 1 – 5 years with 45 or 50% teachers while 26 – 30 years of teaching experience got the least frequency with 1 or 1.1% respondents with 26 – 30 years. In addition, there were no respondents with teaching experiences from 21 to 25 years.

Table 4 shows the level of adaptability of teacher-respondents in terms of self-awareness. The statement that got the highest level of mean, with very high-level interpretation, was "I have a vision for my life that gives it meaning and purpose" ($\bar{X} = 4.49$), while the one that got the least mean, with high-level descriptive interpretation, was "I can articulate/express my special abilities, talents

and skills" ($\bar{X} = 3.96$). The respondents' average mean level of self-awareness was 4.21.

The fifth table presents the level of adaptability of teacher-respondents in terms of personal management. The statement that got the highest level of mean, with very high-level descriptive interpretation, was "I take responsibility for managing my teaching responsibilities" ($\bar{X} = 4.53$) while "I have contingency plans, a second option if my first plan does not work out" got the lowest mean ($\bar{X} = 4.13$) with an interpretation of high level. The overall mean of the respondents' adaptability in terms of personal management was 4.37.

Table 6 shows the level of adaptability of teacher-respondents in terms of problem-solving and decision-making. All the statements got a high level of descriptive interpretation. The statement that got the highest mean ($\bar{X} = 4.20$) was "I have emerged stronger and have learned personal strategies to deal with change because of the

Table 7

The Level of Adaptability of Teacher-respondents in terms of Attitude

Attitude	Mean	SD	Descriptive Interpretation
1. I believe that I always have options and choices, even under challenging situations.	4.38	0.59	High
2. I generally approach life as an optimist.	4.30	0.64	High
3. I have a sense of humor. I can find things to laugh about even in dark times.	4.18	0.76	High
4. I understand there is growth in new experiences and enjoy learning from them.	4.48	0.57	High
5. I expect life to have ups and downs and not always go as I would like it to.	4.58	0.58	Very High
6. I do not spend time worrying about things that are out of my control.	3.93	0.79	High
Overall Attitude	4.03	0.54	High

Legend: 4.50-5.00 = Very High Level; 3.50-4.59 = High Level; 2.50-3.49 = Average level; 1.50-2.49 = Fair level; 1.00-1.49 = Poor level

Table 8

The Level of Adaptability of Teacher-respondents in terms of Knowledge of Competencies

Attitude	Mean	SD	Descriptive Interpretation
1. I would describe myself as a continuous learner.	4.62	0.53	Very High
2. I regularly spend time keeping my knowledge and skills in the progress.	4.34	0.58	High
3. I know the skills that will be required in my job in the next several years.	4.28	0.62	High
4. I know what others in our school expect of me.	4.04	0.70	High
5. I know how my superiors and co-teachers view my current skills.	3.99	0.66	High
6. I know which behaviors and attitudes are rewarded in our school.	4.17	0.72	High
Overall Knowledge of Competencies	4.39	0.51	High

Legend: 4.50-5.00 = Very High Level; 3.50-4.59 = High Level; 2.50-3.49 = Average level; 1.50-2.49 = Fair level; 1.00-1.49 = Poor level

changes in my life," while the one that got the lowest mean ($\bar{X} = 3.86$) was "When experiencing stress in one area of life, I can contain it within that area." The average mean on problem-solving and decision-making was 4.03.

The seventh table shows the level of adaptability of teacher-respondents in terms of attitude. "I expect life to have ups and downs and not always go as I would like it to" got the highest mean ($\bar{X} = 4.58$) with very high-level interpretation while "I do not spend time worrying about things that are out of my control" got the lowest mean ($\bar{X} = 3.93$) with an interpretation of high level. The average mean on attitude was 4.03.

The eighth table shows the level of adaptability of teacher-respondents in terms of knowledge of competencies. The statement "I would describe myself as a continuous learner" got the highest mean ($\bar{X} = 4.62$)

with a very high-level interpretation, which meant that the respondents view themselves as continuous learners. On the other hand, "I know how my superiors view my current skills and co-teachers" got the lowest mean (3.99) with an interpretation of high level. The average mean on knowledge of competencies was 4.39.

Table 9 shows that Knowledge of Competencies got the highest mean ($\bar{X} = 4.39$), while Problem-solving and Decision-Making got the lowest mean ($\bar{X} = 4.03$). The average mean was 4.23, which elucidates that the respondents have high adaptability levels.

The researcher sought to explain the teacher-respondents' adaptability level in terms of sex, age, and the number of years of teaching.

The tenth table shows that both males and females had high levels of adaptability. However, based on the

Table 9

The Overall Level of Adaptability Skills of Teacher-respondents

Problem-solving and Decision-making	Mean	SD	Descriptive Interpretation
Self-awareness	4.21	0.48	High
Personal Management	4.37	0.49	High
Problem-solving and Decision-Making	4.03	0.54	High
Attitude	4.16	0.57	High
Knowledge of Competencies	4.39	0.51	High
Overall Adaptability	4.23	0.42	High

Legend: 4.50-5.00 = Very High Level; 3.50-4.59 = High Level; 2.50-3.49 = Average level;
1.50-2.49 = Fair level; 1.00-1.49 = Poor level

Table 10

The Level of Adaptability of Teacher-respondents according to Sex

Sex	Frequency	Mean	SD	Descriptive Interpretation
Male	24	4.21	0.48	High
Female	66	4.37	0.49	High
Total	90	4.03	0.54	High

Legend: 4.50-5.00 = Very High Level; 3.50-4.59 = High Level; 2.50-3.49 = Average level;
1.50-2.49 = Fair level; 1.00-1.49 = Poor level

Table 11

The Level of Adaptability of Teacher-respondents according to Age

Age	Frequency	Mean	SD	Descriptive Interpretation
21 – 25	9	4.09	0.27	High
26 – 30	18	4.19	0.32	High
31 – 35	22	4.26	0.32	High
36 – 40	17	4.19	0.59	High
41 – 45	14	4.18	0.49	High
46 – 50	4	4.27	0.36	High
> 50	6	4.63	0.37	Very High
Total	90	4.23	0.42	High

Legend: 4.50-5.00 = Very High Level; 3.50-4.59 = High Level; 2.50-3.49 = Average level; 1.50-2.49 = Fair level; 1.00-1.49 = Poor level

results, male respondents ($\bar{X} = 4.28$) appeared to be more adaptable than females ($\bar{X} = 4.21$).

Table 11 shows the level of adaptability of respondents according to age. Respondents with age greater than 50 obtained a very high adaptability level ($\bar{X} = 4.63$) compared to the rest of the age groups. The age group that got the lowest mean ($\bar{X} = 4.09$) was 21 – 25.

Table 12 shows the level of adaptability of respondents according to teaching experience. Respondents with teaching experience 16 – 20 years and greater than 30 got very high adaptability level ($\bar{X} = 4.73$ and 4.50 respectively). Then, respondents with greater

than 30 and 26 – 30 years of experience obtained got a very high level of adaptability with the means 4.50 and 4.60, respectively. Respondents with teaching experience 1 – 5 years got the lowest mean ($\bar{X} = 4.12$).

DISCUSSION

Females were dominant in this study. They belong to 31 – 35 years old and have teaching experience of 1 – 5 years. It was close to the study of Asio (2021), wherein most of his teacher-respondents belong to 21-30 years old, with 1-5 years in service. However, Asio's study was dominated by males and was single.

Table 12

The Level of Adaptability of Teacher-respondents according to Years of Teaching experience

Teaching Experience in Years	Frequency	Mean	SD	Descriptive Interpretation
1 – 5	45	4.12	0.37	High
6 – 10	31	4.32	0.36	High
11 – 15	8	4.18	0.65	High
16 – 20	3	4.73	0.23	Very High
21 – 25	0	0	0	None
26 – 30	1	4.60	0	Very High
> 30	2	4.50	0.71	Very High
Total	90	4.23	0.42	High

Legend: 4.50-5.00 = Very High Level; 3.50-4.59 = High Level; 2.50-3.49 = Average level; 1.50-2.49 = Fair level; 1.00-1.49 = Poor level

The teachers in Gulod National High School, City Schools Division of Cabuyao, are highly adaptable even during the pandemic. They have bendable abilities to face the varied situations in the school, including the drastic changes in situations such as changing from physical or face-to-face teaching into blended and modular distance teaching, distribution of modules and week home learning plan, retrieval of students' answer sheets, communicating with students and parents/guardians virtually, attending virtual seminars, and others. As stated by Collie and her colleagues (2018), these situations call for teachers to be handled in an adaptive manner. Additionally, COVID-19 is a new, changing, and uncertain situation for all. It can be said that adaptability is required today more than ever. For teachers, this could involve adjusting their beliefs and their temperament, for the better or worse, when it comes to how students learn on the internet and helping them find ways, they can use it in teaching (Collie & Martin, 2020).

Further, the mean level of adaptability of respondents according to age were not directly proportional to the age groups, but it was safe to surmise that the more mature teachers are, the more adaptable they are with the changing situations. The survey's findings of ARC Centre of Excellence in Population Ageing Research (2019) supported this study. Australian workers aged 65+ were more likely to say that they work because they enjoy it (71%) or it gives them a sense of purpose (71%) compared to their counterparts aged 45 (46%) and younger (47%). 90% of mature employees over the age of 65 say they actively try to develop their capabilities. Managers aged between 45 and 54 report a more remarkable ability to adapt to change than those in any other age group.

Males were more adaptable than the females. The study of Valdivia et al. (2009) contradicted that females ($X^{\bar{}} = 22.82$) were more flexible than males ($X^{\bar{}} = 21.46$). This study also contradicted Anson's (2012) observation that women are more adaptable than men. Anson observed the differences between men and women based on the percentage of decrease in men's work or labor participation

from 1954 to 2012. Additionally, this report directly countered the assertion made by the CEO of AT&T, USA, Mr. John Donovan. He stated that he is not a supporter of female advocacy, he is simply making commercial decisions. In these instances, women are more likely to change their behavior than men. Donovan discovered that women have an essential quality that enables them to adjust to a rapid-changing environment (Thomas, 2017).

Although the adaptability means on teaching experience were not directly proportional, respondents with long teaching experience were more adaptable to the changing situations than those novices in teaching. This agrees with Reade (2015), which claims that workers with experience are well equipped to deal with workplace distractions. They do not appear to show any decrease in their productivity or workplace accidents. More experienced workers are more careful. Further, Olsen (2020) mentioned Chapman's statement that senior-level employees have gone through throughout their career, such as economic crisis, corporate restructure, natural disasters, and disease outbreaks. These practices improved their adaptability because they allow them to pivot and adjust quickly when change occurs.

CONCLUSIONS

Majority of the respondents were females. They belong to 31 – 35 years old and have teaching experience of 1 – 5 years. The results showed that the teacher-respondents' level of adaptability was high-level in terms of self-awareness ($X^{\bar{}} = 4.21$), personal management ($X^{\bar{}} = 4.37$), problem-solving and decision-making ($X^{\bar{}} = 4.03$), attitude ($X^{\bar{}} = 4.16$), and knowledge of competencies ($X^{\bar{}} = 4.39$). Overall, the respondents are highly adaptable even during the pandemic ($X^{\bar{}} = 4.23$).

Further, the researcher concluded that the male teachers ($X^{\bar{}} = 4.28$) were more flexible than the females ($X^{\bar{}} = 4.21$). Teachers with ages greater than fifty had very

high adaptability ($X^- = 4.63$). Teachers with experience 16-20 and greater than 26 years were very highly adaptable ($X^- = 4.73$) to the pandemic situation. The participants were highly adaptable even when they are experiencing COVID-19, which has become pandemic.

The researcher limited the study to the adaptability of teachers amidst the pandemic. He surveyed at Gulod National High School, City Schools Division of Cabuyao, Laguna, Philippines in 2020-2021. The participants were limited only to the teachers who would voluntarily answer the survey questionnaire.

RECOMMENDATIONS

The following were recommended based on the result and implications of the study:

Teachers should communicate with their co-teachers, superiors, students, and parents or guardians using any medium, and understand their situations. They should consider the students, for they need understanding and empathy. Teachers should be patient, continuously perform the duties and responsibilities, and find all the ways and means to accomplish the assigned tasks.

Superiors should also be considerate of the condition of teachers. When they see teachers tired and stressed, they should give enough time to accomplish the assigned tasks and help the teachers lessen the burden during the pandemic situation.

Students should show respect and cooperation with their teachers, accomplish the activities assigned to them, and ask for guidance from their relatives in performing the tasks. They should ask the teachers when the directions seem vague to them.

Parents should also give their utmost efforts in support for their children by cooperating with the teachers in molding the children to become productive citizens of the community. They should serve as facilitators for their children in answering the activities assigned for without them, children would not have clear directions in performing the learning tasks.

Further research should be made by having the adaptability of teachers correlated with teachers' performance and students' academic performance in certain subjects.

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Setup Reproducibility of Supine Position in Radiotherapy of Rectal Cancer Patients

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ABSTRACT

Setup reproducibility is crucial in the delivery of dose in radiotherapy as it determines the accuracy and treatment success of the procedure. Previous studies reported supine as an alternative to prone; however, the comparison was not straightforward as several factors were overlooked. This retrospective study attempted to determine the setup reproducibility as measured by displacement of bony landmarks in the lateral, longitudinal, and vertical axes of supine position relative to the standard prone position. Sixteen rectal cancer patients were positioned in supine (N=6) and prone (N=10) as per radiation oncologists and medical physicists in 2018. On each daily fraction, the displacement of the bony landmark in the three axes was calculated by the medical physicists and radiation therapists, and a total of 61 measurements were recorded. Results revealed that both supine and prone positions demonstrated an unacceptable reproducibility value. The setup reproducibility did not significantly differ in both positions. Based on the results of the study, the supine position, as reported by previous studies to exhibit superior setup reproducibility than prone position, is still unacceptable in radiotherapy of rectal cancer patients.

Keywords: Prone; Radiotherapy; Rectal Cancer; Retrospective; Setup Reproducibility

INTRODUCTION

Globally, colorectal cancer (CRC) is the third most diagnosed cancer, with almost 861,000 recorded deaths in 2018 (Macrae, 2016). Among the severe types of CRC is rectal cancer. In the Philippines, CRC is the leading gastrointestinal cancer (Afinidad-Bernardo, 2017).

The standard treatment for primary and advanced rectal cancers is preoperative chemoradiotherapy. This method is a combination of chemotherapy and radiotherapy given before the surgical procedure (Kennedy, Vella, Macdonald, Wong, & McLeod, 2015; Wong et al., 2010). During this approach, an external beam radiotherapy unit transmits highly intense radiation to the patient positioned in prone. The dose of radiation is delivered in fraction daily until the total dose needed to treat a specific rectal cancer case is achieved. The multimodal treatment demonstrated a 70-74% survival rate in 5 years (Kye & Cho, 2014).

Despite the therapeutic value of this method, several drawbacks have been reported in the use of prone position. The prone position exhibited less setup reproducibility during the fractional treatments, more considerable patient discomfort, and high risk of fall and injury during the procedure (Bayley et al., 2004; Froseth et al., 2015; Kim et al., 2017). In radiotherapy, setup reproducibility refers to the ability to implement repeated measurements with the same setup procedures, to produce the same result as that of the first reference procedure. This parameter is very crucial in the delivery of dose in radiotherapy as it determines the treatment success of the procedure (Kye, & Cho, 2014). Any deviation from the reference treatment compromises the treatment efficiency; and increases the unnecessary dose to healthy

tissue and exposure and toxicity to the nearby organs at risk (OAR) such as small bowel (Alasti, Petric, Catton, & Warde, 2001; Langmack, 2001).

Several authors recommended patient immobilization as solution to the issue of setup reproducibility (Li et al., 2010; Rosenthal et al., 1993; White, 2014). However, immobilizing devices do not always eliminate all errors and may cause further patient discomfort during the treatment procedure (Dieterich, Ford, Pavord, & Zeng, 2015; Lu et al., 2018). With this, an alternative position to prone is worthwhile to investigate.

The supine is a position in which the back part of the body is lying on the surface. Two studies compared the setup reproducibility between the prone and supine positions. Both reported that the supine position exhibited a statistically higher setup reproducibility as measured by displacement in the lateral, longitudinal, and vertical axes of the bony landmarks compared to the standard prone position (Froseth et al., 2015; Kim et al., 2017). However, only patients undergoing preoperative radiotherapy were included in the study, and the results may not be applicable to other rectal cancer cases. Also, no more than 43% of the measurements were analyzed, which may represent a sampling bias. To date, there is no existing literature that explored alternatives to prone in the Philippine setting, despite the high incidence of CRC.

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In light of these gaps, the present study attempted to determine the setup reproducibility as measured by displacement in the lateral, longitudinal, and vertical axes of the bony landmarks of supine position for rectal cancer radiotherapy using a retrospective research design. In doing so, the study analyzed the displacement of the prone and supine positions in the three axes of the bony landmarks, and compare the displacement values.

MATERIALS AND METHODS

Patient Selection

This study was conducted using a retrospective design. Prior to the study, rectal cancer patients underwent radiotherapy and were treated in either prone or supine position as per the protocol of radiation oncologists and medical physicists. Sixteen patients of a medical center in the Philippines were selected for the review based on the following inclusion criteria: at least four consecutive sessions completed, no hip prostheses, and intact lower limbs. Of the 16 patients, ten were treated in prone, and the remaining six were treated in supine. To ensure confidentiality and anonymity of patients, the given data only contain ordered numbers in the first column of the Microsoft Excel file representing the number of patients enrolled, the reference values in the second column, and the measurement values per fraction in the third to tenth columns.

Reproducibility Metrics

In this study, the setup reproducibility was measured based on the displacement of bony landmarks in the lateral, longitudinal, and vertical axes using the MOSAIQ system and EPID iView software. The individual displacement was calculated by subtracting the measurement value at a given fraction to the reference value. The total displacement was computed by getting the square root of the sum of the individual displacements. A displacement of at most 2 mm is considered as acceptable reproducibility value; however, beyond this value is deemed to be unacceptable (Washington & Leaver, 2015).

Procedure

A communication letter stating the permission to conduct the research was sent to the administrator of the oncology department of the selected medical center in the Philippines. It was given by the researchers personally to obtain immediate approval. It took two weeks before the hospital approved the study.

A total of 61 measurements were collected (37 values for prone and 24 values for supine) from 16 patients. The patients were treated using the Elekta Synergy Linear Accelerator in 2018. On each daily fraction, the displacement in the lateral, longitudinal, and vertical axes was calculated by the medical physicists and radiation therapists and recorded. The recorded data were then analyzed using the appropriate statistical tools.

Data Analysis

Mean was used to determine the average displacement of bony landmarks in the lateral, longitudinal, and vertical axes in supine and prone positions. The Mann-Whitney U test was utilized to determine if there is a significant difference in the displacement of bony landmarks in the three axes between prone and supine positions. A p-value of less than 0.01 was considered significant.

RESULTS AND DISCUSSION

In this study, the setup reproducibility of prone and supine positions as measured by displacement of bony landmarks in the lateral, longitudinal, and vertical axes, was analyzed and compared. Descriptive analysis revealed that both positions have an acceptable setup reproducibility in the lateral axis (Table 1). However, the use of either position demonstrated an unacceptable setup reproducibility in the longitudinal and vertical axes. The total displacement was comparable in both positions. The supine position, as reported by previous studies to exhibit superior setup reproducibility than prone position (Froseth et al., 2015; Kim et al., 2017), is still unacceptable in radiotherapy of rectal cancer patients based on the results of the study. However, other parameters not measured in the study, such as the actual dose received by the patients and dose received by OAR, may be further compared between the prone and supine positions in the future. The BMI of the

Table 1

Mean Displacement of Bony Landmark Axis

Bony Landmark Axis	Position	N	Mean Displacement (mm)	Interpretation
Lateral	Prone	37	1.01	Acceptable
	Supine	24	0.63	Acceptable
Longitudinal	Prone	37	3.27	Unacceptable
	Supine	24	3.85	Unacceptable
Vertical	Prone	37	2.28	Unacceptable
	Supine	24	2.05	Unacceptable
Total	Prone	37	4.84	Unacceptable
	Supine	24	4.84	Unacceptable

Legend: ≤ 2 mm – acceptable, > 2 mm – unacceptable

Table 2

Test of Difference in the Total Degree of Displacement

Bony Landmark Axis	Mann-Whitney U
Lateral	302.00 ^{ns}
Longitudinal	306.50 ^{ns}
Vertical	439.00 ^{ns}
Total	375.00 ^{ns}

Note: ns=not significant

patients and its relationship with setup reproducibility may also be explored.

A test of difference using Mann-Whitney U was employed to compare the displacements of the prone and supine positions (Table 2). The total and individual displacements in the three axes of the bony landmark were statistically the same in both positions ($p > 0.01$).

Setup reproducibility is a vital parameter in radiotherapy of rectal cancer patients. A reproducible reference treatment yields greater treatment efficiency, higher healthy tissue sparing, lower exposure to OAR, and lower toxicity to the patient. In the daily treatment setup, the position of the patient influences the reproducibility of the treatment as defined by the displacement of reference bony landmarks in the lateral, longitudinal, and vertical axes. The study found that the total displacement, as well as displacements in the lateral and vertical axes, has unacceptable reproducibility value. This result corroborated the findings of Froseth et al. (2015), which reported an unacceptable total displacement value in both positions. However, that study calculated higher overall displacement values (7.1 mm for prone, 5.8 mm for supine) compared to the present investigation. This finding may be attributed to the upper Body Mass Index (BMI) values ($> 30 \text{ kg/m}^2$) of the studied patients, which were associated with higher displacement during positioning (Lin et al., 2012; Yoon et al., 2012). It is also noteworthy to report that these patients are more challenging to position in the actual practice. In this study, the BMI of each patient was not measured before and after each daily radiotherapy session. Change of BMI is one of the effects of radiotherapy (Ottosson et al., & Laurell, 2013), and this effect may have an impact on setup reproducibility as observed in previous reports (Lin et al., 2012; Yoon et al., 2012). Future studies may be explored to examine the BMI of the patients and its influence on setup reproducibility.

The setup reproducibility, as measured by displacements of bony landmarks, did not significantly differ in both positions. The results reported by Froseth et al. (2015) and Kim et al. (2017) disproved the results obtained in this study, which found that reproducibility metrics demonstrated a significant difference between the supine and prone positions. In their studies, the comparison between prone and supine positions was not straightforward due to sampling bias. Only patients undergoing preoperative radiotherapy were selected, and no more than 43% of the collected data were included in the analysis. This study addressed these issues and sampled

all cases of rectal cancer and examined all the collected data based on the inclusion criteria. Differing results may be attributed to the inclusion of other cases not selected in the previous studies and sampling of all data available.

Because setup reproducibility determines the accuracy of the dose given to the patient (Hong et al., 2005), the accuracy of dose delivery is statistically equal in both prone and supine positions, as observed in the study. This result supports the study of Gomez et al., (2018), who reported no significant difference in the coverage of treatment volume when patients undergoing rectal radiotherapy are analyzed according to the type of setup position. Moreover, the findings confirmed the results of Surendra et al. (2014), who revealed that there is no significant dosimetric difference to small bowel when positioning rectal radiotherapy patients in prone without a belly board versus supine.

CONCLUSION

The supine position demonstrated an unacceptable reproducibility value based on the total displacement in the bony reference landmark. It was also noted that the typically used prone position exhibited the same reproducibility value as that of supine. The setup reproducibility, as measured by the displacements of bony landmarks, did not significantly differ in both positions. Nevertheless, this study may provide insights into the radiation oncology treatment team in the selection of positions that will offer higher setup reproducibility and greater treatment efficiency. Other treatment positions and devices may be explored in the future.

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Assessment of the Potential of Off-Grid microHydro in an Irrigation Canal in Lower Magsaysay, Kuya, Maramag, Bukidnon to Power Streetlights

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ABSTRACT

This study is about the assessment of a potential microhydro system in an irrigation canal in Lower Magsaysay, Kuya, Maramag, Bukidnon to power streetlights. The assessment showed that the microhydro have enough potential just to power streetlights. The microhydro system designed utilizes cross flow turbine of 6 kW power output and generator with power rating of 6 kW. The microhydro, based on design specifications, can generate maximum power output of 6 kW, which is enough to power streetlights that can cover longer distance based on the guidelines set by the Department of Energy on road lighting. The microhydro turbine and generator have an estimated cost of Php 81,129.00 and the street light system at Php 308,844.00. Realization of these systems can greatly help the residents in the area in terms of accessibility, safety and security.

Keywords: micro hydro power plant, renewable energy, irrigation canal

INTRODUCTION

The need to discover and use safe, cost-effective and sustainable sources of electricity is very much timely, relevant and practical especially for countries like the Philippines, with limited fossil fuel reserves. Reliable new sources of energy are needed as energy costs continue to rise which also leads to the rise of CO₂ level in the atmosphere. Hydroelectric power generation is considered as an effective means of generating clean renewable energy that will continue to be a feasible addition to energy demands. Innovations particularly in the local level like harvesting potential energy from sources we didn't care to utilize is what we need. Rice field irrigation has potential for hydropower generation, this could be utilized by diverting the irrigation water.

On the other hand, well-lit roads and environment particularly at night, provides safety and security to communities and businesses. However, street lighting system is costly in terms of installation, maintenance, and power consumption. In rural areas, most of the farm roads do not have road way lighting systems, which also links to increasing crime rate and accidents due to the absence of lighting. Providing lighting system can greatly affect the way of living in rural areas. The cost of street lighting system can be significantly reduced to only installation and maintenance when own power generating system will be utilized, in this case, the microhydro.

The use of renewable energy would be of great help to decrease the demand from the grid. Utilities are concern in the reduction of emissions from traditional

power plants by using renewable energy and to reduce the high cost of supplying electricity to remote areas (Al-Ammar, 2011). Development of more Small Hydropower Plants gives significant contribution to address electricity demand with a positive environmental impact (Paish, 2002).

Water will still be available for agricultural irrigation and other purposes after diverting and utilizing it to generate electrical power (Hanmandl, 2006). In Japan, early example of generating electricity by using irrigation water is the Momura microHydro power. Water from lakes and rivers through the Man-made irrigation systems for growing rice were utilized for electricity generation (Suwa, 2009).

In Philippines, the very first microHydro project was at the Lateral B Canal of Magat River Integrated Irrigation System (MARIIS) in Barangay San Marcos in San Mateo, Isabela. The project was Funded through a grant from the Japan International Cooperation Agency (JICA), and is jointly undertaken by DA-attached agency NIA and the Department of Energy (DOE) in 2014 (Diega, 2014). There are several papers that presents simple method for Micro Hydro Power (MHP) plant design, Zema, et al., (2016) proposed a method using simple models with reduced input parameters in the initial design stage, this method

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was verified in an existing irrigation system in Calabria, Italy; while Butera, et al., (2015) tested a methodology in Piedmont Region in the United States of America, this method shows the description of irrigation network and identification of higher hydropower potential, it also determines the actual combination between irrigation and hydroelectric usage and hydropower development scenarios.

OBJECTIVES

The main objective of the study is to assess the potential of Off-Grid microHydro in an irrigation canal to power streetlights in Lower Magsaysay, Kuya, Maramag, Bukidnon;

Specific Objectives:

1. Gather data for the design considerations of the microHydro plant;
2. Give the specifications of the turbine and generator for the microHydro plant;
3. Determine the technical potential of a microHydro plant;
4. Design a street lighting system; and
5. Determine the basic cost of the turbine, generator and street lighting system for the microhydro plant in an irrigation canal in Lower Magsaysay, Kuya, Maramag, Bukidnon.

METHODOLOGY

Data gathering: The data gathered included the historical and present data of water level, water flow, discharge, head measurement and the area details;
Calculations: Calculations were made to determine if the resource is capable of producing enough energy since the concept of hydro plant is utilizing the flowing mass of the water from higher elevation or the kinetic energy, which turns the turbine that is directly coupled to a generator to produce electrical energy;

Simulation using the Cross Flow Design Software: Data gathered and calculated were simulated in the software. The technical potential of a renewable energy system was determined by considering the head loss, turbine, and generator specifications through Cross Flow

Design Software;

Designing the Street Lights: The number of streetlights were based on the power capacity potential of the microhydro;

Costing: The installation cost of the turbine and generator of the microhydro power plant and the street lighting was determined and since the development of the microhydro does not provide sale of the power output, only descriptive benefits can be assessed from the microhydro and the street lighting system.

RESULTS AND DISCUSSION

Data for the design considerations of microHydro plant

The data shows that the discharge of the water from the canal averages 0.4775 m³/s.

Cross Flow Turbine Design

After the data are sufficient, the researcher decided to use Cross Flow Turbine for the microhydro. The technical drawing generated from the software can easily be fabricated in local machine shops. The Cross Flow Turbine to be fabricated has the technical specifications shown in Table 1.

Generator Specifications

Since the power output of the turbine is found to be at 6 kW, it is safe to use a 6 kW generator. From the Cross Flow Turbine specifications, the generator speed can be found by using the equation:

----- equ speed

Substituting the values results to approximately 1800 rpm for the generator speed. The summary of the generator specifications is shown in Table 2.

Microhydro Power Plant Design

The design of the microhydro power plant is shown in Figure 1 and Figure 2.

Table 1

Cross Flow Turbine Specification

Parameter	Value
Head	5 m
Flow Rate	0.19 m ³ /s
Runner Diameter	230 mm
Runner Length	410 mm
Turbine RPM	399 rpm
Power	6 kW
Turbine Pulley	36 in
Generator Pulley	8 in

Table 1

Generator Specifications

Parameter	Value
Brand/Supplier	Yunkun Qianwei
Power	6 kW
Generator RPM	1800 rpm
Frequency	60 Hz
Voltage	230 V
Current	21.8 A
Number of Phase	Single Phase

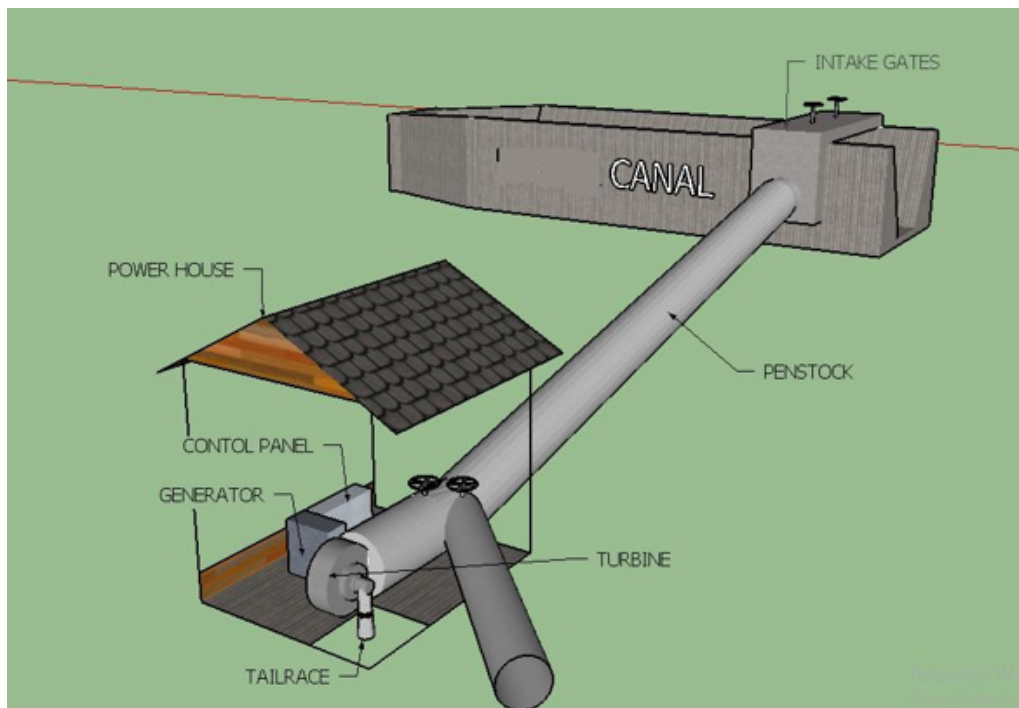


Figure 1. Microhydro Power Plant Design

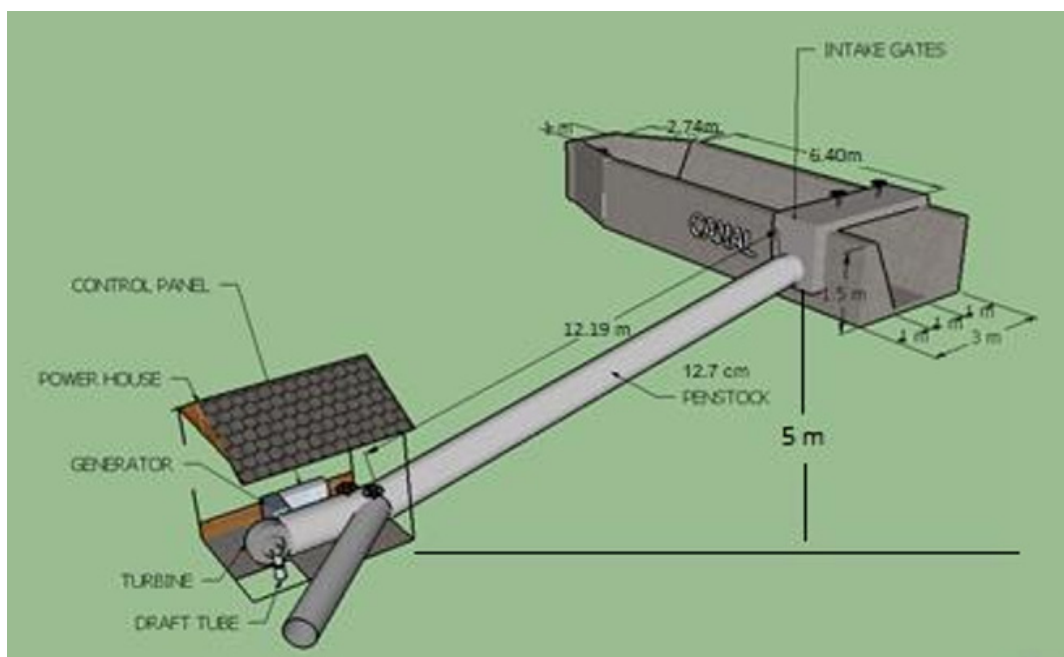


Figure 2. Microhydro Power Plant Design with Measurements

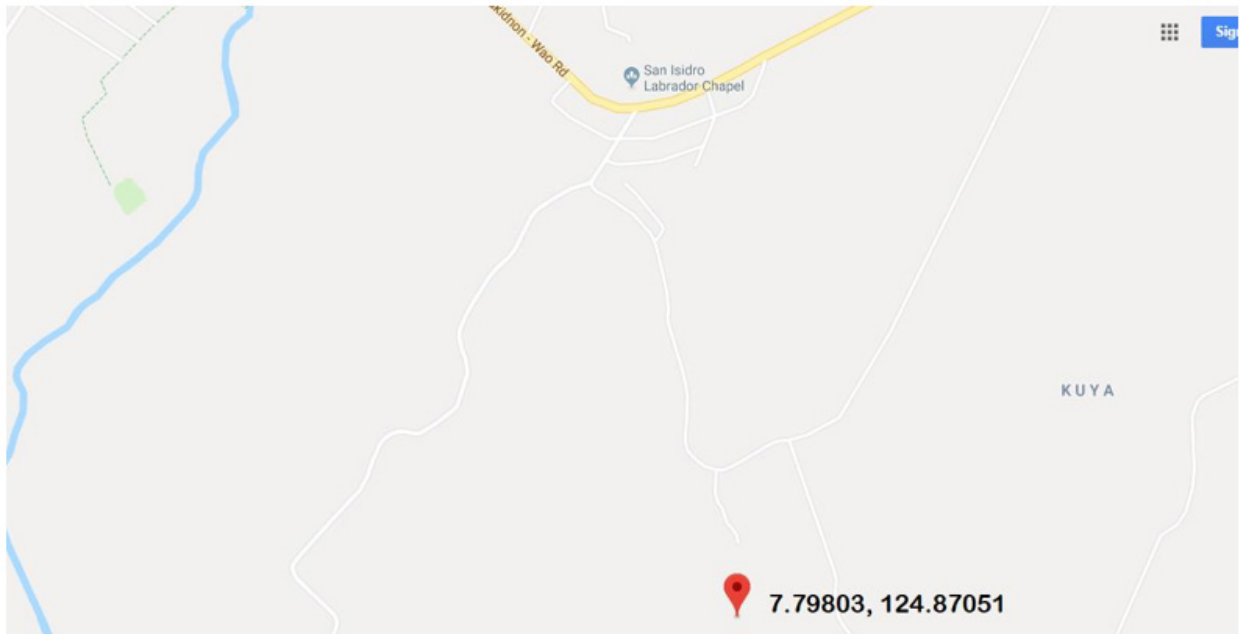


Figure 3. Road Map

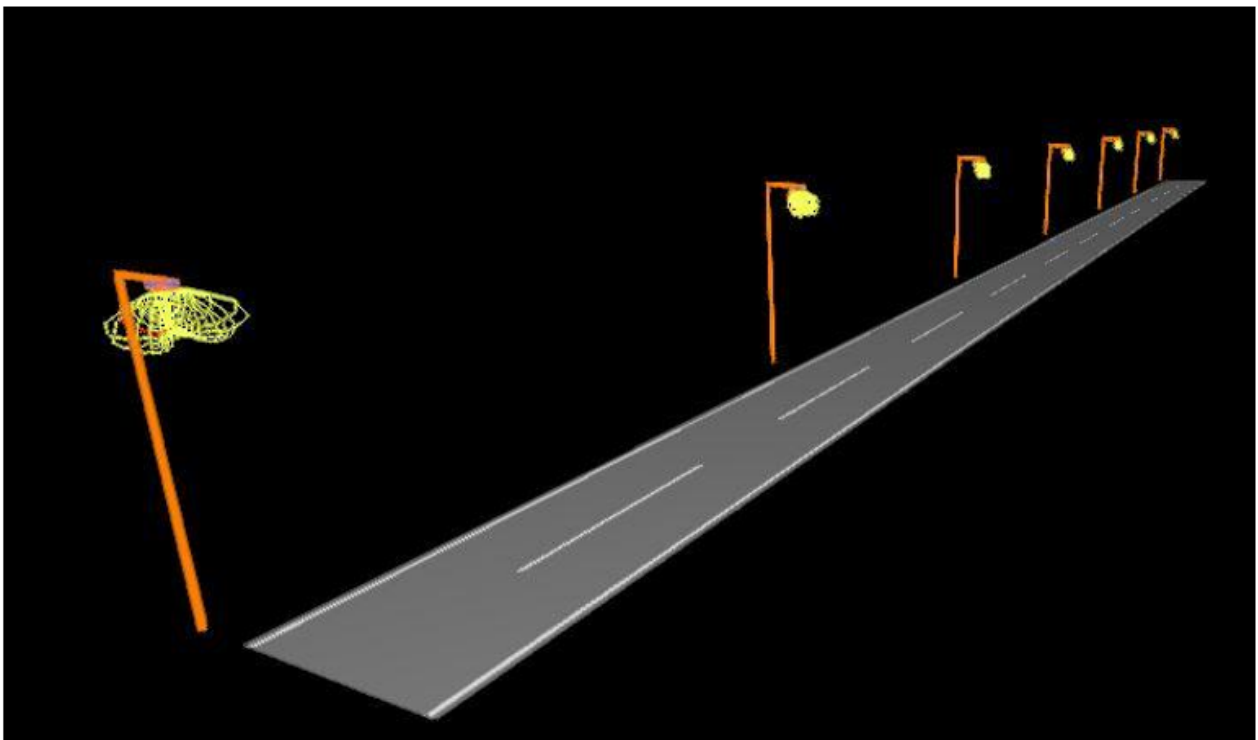


Figure 4. Road Lighting Design

The power house was designed to be 12.19m from the irrigation canal, housing the turbine, generator and control panel.

Street Lighting

The street lighting design was based on the standards set by Department of Energy (DOE). Based on the guidelines of DOE, the road concerned is classified as minor road since it is a local road that is used primarily as an access to the different part of the area. The street lighting will start at the location and coordinates shown in Figure 3. The pinned area with coordinates is the location

of the micro hydro and the road around the area is the road considered for street lighting.

The DOE standards/ guideline for placement or streetlight arrangement and the lighting parameter was consider for this road is a minor road. The street lighting design is shown in Figure 4 and the specifications of the street lighting design are summarized in Table 3. The streetlight used for the design is 80 Watts Philips Aurora SPP202.

Assuming 66.67% efficiency of the microhydro power output at 4 kW, 50 streetlights of 80 W can be placed that can cover a road distance of 1250 m with

Table 3

Street Lighting Design Specifications

Road	Road Width (m)	Arrangement	Lamp Wattage (W)	Luminaire Spacing (m)	Mounting Height (m)	Mast Arm Length (m)
Minor Road	6*	Single Side	80	25	8	1.5

*Assumed Value

Table 4

Street Lighting Design Comparison to Standard

Parameters	Design Values	Recommended Values
Luminance (cd/m ²)	0.66	≥0.60
Overall Uniformity (U _o)	0.57	≥0.35
Uniformity of Illuminance (U _i)	0.85	≥0.40
Glare Threshold Increment (TI)	10	≤15
Edge Illuminance Ratio (EIR)	0.51	≥0.50

Table 5

Microhydro Power Plant Cost

No.	Item(s)	Quantity	Unit	Unit Cost	Total Cost
1	6 kW Cross Flow Turbine	1	pc.	*P 72,000.00	P 72,000.00
2	6 kW Generator	1	pc.	**P 9,129.00	P 9,129.00
Total					P 81,129.00

*Fabrication cost at P 12,000.00 per kW

**Generator price as of September 14, 2018

Table 6

Street Lighting Bill of Materials

No.	Item(s)	Quantity	Unit	Unit Cost	Total Cost
1	Philips Aurora SPP202	50	pcs.	*P 5,402.00	P 270,100.00
2	8 m Galvanize Pole	50	pcs,	*P 541.40	P27,070.00
3	10/2 AWG MC Cable	1250	m	*P 8.12	P 10,150.00
4	Automatic Photocell Control Sensor	3**	pcs.	*P 508.00	P 1,524.00
Total					P 308,844.00

*Prices as of September 14, 2018

**3 pieces of Photocell Sensor of 10 A rating (1 Photocell Sensor for 17 Streetlights)

luminaire spacing of 25 m.

The comparison of street lighting design to the standard is shown in Table 4 which concludes that the design passed the recommended values set by DOE. This shows that the design is a sufficient road lighting system for the area concerned.

Assuming 66.67% efficiency of the microhydro power output at 4 kW, 50 streetlights of 80 W can be

placed that can cover a road distance of 1250 m with luminaire spacing of 25 m.

The comparison of street lighting design to the standard is shown in Table 4 which concludes that the design passed the recommended values set by DOE. This shows that the design is a sufficient road lighting system for the area concerned.

Basic cost of the Turbine and Generator of the

microhydro plant and the street lighting design in the study area.

The cost of the turbine and generator of the microhydro plant and street lighting system were calculated. The cost of the turbine and generator is estimated at Php 81,129.00 considering the breakdown of prices of materials shown in Table 5. The lower cost of turbine is attributed to the established cross turbine design software that can generate the mechanical drawing which is the basis for fabrication.

For the street lighting system, an estimated cost of Php 308,844.00 is calculated as the installation cost considering the breakdown of materials' prices shown in Table 6.

There is no direct monetary benefit that can be generated from the system since the power generated is not for sale and used solely for the street lighting purpose. However, benefits such as free power consumption for streetlights and illumination of the access roads around the area concerned can be expected from the system.

CONCLUSION(S)

The microhydro designed in this research utilizes a cross flow turbine with power output of 6 kW and a single-phase generator with power rating of 6 kW. Therefore, the microhydro can generate a maximum power output of 6 kW which is considered enough when applied to street lighting. Utilizing only 66.67% of the maximum power output of the microhydro it can illuminate a distance of up to 1.25 km through street lighting. This can greatly help the residents in the area since the area is rural and away from the main highway which lacks proper street lighting. Installation cost of the turbine and generator of the microhydro is estimated at Php 81,129.00 and the street lighting at Php 308,844.00 totaling to an amount of Php 389,973.00. The development of the microhydro and the street lighting system can significantly provide assistance to the residents in the area with proper street illumination without worrying about the power consumption cost as long as the microhydro can provide the required power output. Thus, the microhydro has high potential for providing power to the street lighting system and even households around the area of study that are not yet energized by the distribution utility, about more or less

100 households could potentially benefit to the power that would be generated by the microhydro powerplant.

RECOMMENDATION

For further studies, it is recommended to consider the cost of building the power house and other structures; and to calculate the Return On Investment if the powerplant is to operate 24 hours a day 7 days a week and sell the generated energy to consumers.

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