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EDITOR'S NOTE

Amidst adversities, the Cagayan State University at Aparri continuously engaged in the generation of new science-based knowledge, innovations in fisheries and aquatic sciences, as well as community-oriented researches.

The funded project of the team led by Dr. Molina was able to document existence and level of heavy metal content and other contaminants in freshwater clam caught from the wild and organically-cultured clams. The significance of the project greatly impacts food security and sufficiency in the area. Meanwhile, the team of Prof Del Rosario provided us robust insights and relevant findings on glass eel gathering at Gonzaga Cagayan. They concluded that glass eel gathering is both a livelihood opportunity and a threat to biodiversity, leaving recommendations for policy implementations. Processing procedure has been presented in the product development of fish powder by Dr. Molina based on locally produced flying fish. Still on product development, Dr. Velasco formulated an aramang-based spread and documented consumer acceptability in the paper. Dr. Javier revealed in his paper management practices, issues, and concerns relating to management of Aramang fisheries as basis for designing and developing IT solutions. Another product development project headed by Dean Battung has formulated aramang-based baked products with malunggay. The team headed by Dr. Javier presented an analysis of the assessments made in the study InFORMS – an IEC initiative to Knowledge-sharing and utilization. In support to food security, Dr. Malana ventured in her paper DNA barcoding of marine bivalve Meretrix Karibuyo in Northern Cagayan. Dr. Mata documented in her paper factors of sexual and non-sexual risk-taking behaviours of College students.

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Multi-purpose Dryer and Toaster

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ABSTRACT: This study generally aimed to design, construct and test a multi-purpose drying machine to possibly help address one of the problems of fish preservation. The study made used of Project Development Method (PDM) and descriptive evaluation method of research. The data on the acceptability of the developed multi-purpose dryer in terms of design and construction, functionality, durability and safety were gathered through questionnaire checklist. Results of the study revealed that the modified dryer has a total volume of 12,393 cubic inches outside dimension. Furthermore, it has a gross weight of 30 kilograms including the combustion chamber which is detachable and made up of a bricks and clay to store more heat during drying. Meanwhile, the modified dryer has intake and exhaust fans with a diameter of 3 inches which is rated at 1 watt with a voltage supply of 12V DC to produce air in igniting the charcoal faster than the existing dryer. The drying trays are made up of stainless steel with a capacity of 3 kilos of hairtail. Likewise, the thermometer to indicate the temperature is an automobile temperature gauge which ranges from 40 oC. centigrade to 12 oC. centigrade. The findings of this study also revealed that the modified Multi-Purpose Dryer attained the set temperature reading faster (x=3.75 min.) than the commercial dryer (x=6.43). As manifested in the data, the result of the independent t-test emphasized the heating efficiency measured in terms of the number of minutes lapse time. The modified fish dryer is significantly faster than the commercial dryer with a probability of 0.010. To assess the effectiveness of the dryers in drying, they were tested on hair tail Lepturacanthus savala. The said samples dried were fried as subjected to the sensory evaluation on odor, flavor and texture. Analysis of the finding revealed the comparison of flavor made between sundried fish and fish dried in the modified dryer. The t-test showed that the flavor of fried hairtail Lepturacanhus savala dried under the modified Multi-Purpose Dryer is significantly better (P 0.0026) than that of the commercial dryer. The modified dryer has a mean of 5.59 and the sundried has 5.11 respectively. While the odor of fried samples dried from the modified Multi-Purpose Dryer was higher than that of the sundried, it was found out that the two samples are not significantly different (P 0.655). The modified dryer recorded no significant difference in terms of the odor as compared with traditional sun drying. The study shows that the texture of the fish dried in the modified dryer was evaluated to be significantly better than the samples dried by the commercial dryer. The sensor panel of evaluators commented that the product of the modified Multi-Purpose Dryer is crispier than that of the other dryer.

***Keywords*:** *Modified Dryer, Fish Preservation, Descriptive evaluation*

I. INTRODUCTION

A specific provision of Section 10 in Article XIV states that: “Science and Technology are essential for national development and progress. The State shall give priority to research and development, invention, innovation and their utilization; and science and technology education, training and service. It shall support indigenous, appropriate and self-reliant scientific and technological capabilities and their application to the country’s productive systems and national life.” One of the challenges in the fisheries sector is in fish preservation during its peak season since fish is considered as an extremely perishable food which in most cases according to Adedeji et al. (2012) become inedible within twelve hours at a tropical temperature like in our locality. Thus, fish preservation is a very important aspect of the fisheries especially when fishes are caught in numbers, greater than the amount of consumption; their preservation becomes a necessity for their future use. Drying is one of the traditional preservation methods used by many fishermen and this is done by drying fish under the sun for a longer shelf life of fish. This practice of preservation is considered the simplest and low cost of preservation especially during summer months. However, there are some species of fish that is abundant during rainy season so it is also important to have an alternative or technology to be used in drying aside from the traditional method. Abetti (1989) postulated that technology is a key strategic resource that can be fabricated or purchased. So, it if feasible to fabricate a new drying materials design for fish. In this case, constructing a portable modified drying machine out of local materials is one of the most effective measures to preserve a fish. The use of mechanical drying systems offers so many advantages over sun drying like maintenance of paddy quality, safe drying during rain and at night, increased capacity, easy control of drying parameters and the potential for saving on labor cost that it is surprising that so few mechanical dryers are being used.

Various studies have therefore focused on the factors that led to the necessity of designing or innovating mechanical drying systems. This dryer can speed up the drying process and ensure more consistent results at the same time the apparatus enhance instruction along with fish preservation. The study could highlight the creativity of the Filipinos in making design and innovation of machines as well as equipment that could be patented and commercialized. Furthermore, this project could build up a partnership between the academe and the business sectors. Hence, they will be aware of academic programs of Cagayan State University, Aparri Campus Industrial Technology and Fishery that could feed business requirements in terms of food preservation and manpower development along with inventions of tools and equipment. Likewise, this modified dryer can be used for the students

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in drying and baking activities. It has been found out this apparatus is also useful in post-harvest of agricultural commodities such as fruits and vegetables.

Finally, it helps to elevate the production of the income-generating project of the university. The relationship between industry and academe must be strengthened to build a stronger foundation for economic development.

OBJECTIVES

This study generally aimed to design, construct and test a multi-purpose drying machine to possibly help address one of the problems of fish preservation in Cagayan. The study sought to answer the following specific questions: 1.) What are the technical specifications of the proposed dryer?; 2.) What is the performance in terms of heating efficiency of the two driers; 3.) Is there a significant difference on the heating efficiency of the two driers?; 4) How do technical experts evaluate the dryer?; 5) How do panel evaluators assess the output of the dryers in terms of : odor, flavor and texture?; and 6) Is there a difference in the assessment of laboratory panel evaluators on the odor, color and texture of hairtail fish (Lepturacanthus savala).

II. METHODOLOGY

Below are the supplies and materials in the construction of the Modified Multi-Purpose Fish Dryer.

A. Supplies and Materials

Table 1. Bill of Materials

Quantity	Unit	Name and Description of Supplies	Unit cost	Amount
1	Pc	Aluminum Tubular Bar 1 inch x 1 inch x 20 ft.	Php 480.00	Php 480.00
1	Pc	Aluminum Angle Bar ¾ inch x ¾ inch x 20 ft.	Php 280.00	Php 280.00
1	Sheet	Aluminum(stucco)3ft x 6ft gage 31	Php 390.00	Php 390.00
1	Pc	Aluminum Tubular Bar holder 1”x4”x10ft	Php 580.00	Php 580.00
1	Pc	Aluminum holder	Php 50.00	Php 50.00
1	Pc	Aluminum angle bar 1”x1”	Php 250.00	Php 250.00
1	Sheet	Stainless Plain 4ft x 8ft x 0.7 m	Php3,000.00	Php3,000.00
6	Pcs	Stainless rod 1/8 inch x 10 ft.	Php 140.00	Php 840.00
3	Pcs	Stainless rod 3/16”x 10 ft.	Php 180.00	Php 180.00
8	Pcs	Bricks 1”x4”x8”	Php 10.00	Php 80.00
6	Pcs	Bricks ¾ x 3”x6”	Php 8.00	Php 42.00
1	Gross	Metal Screw 6 x 8 mm	Php 75.00	Php 75.00
2	Pcs	Caster (metal) 2”	Php 200.00	Php 400.00
3	Pcs	Hinges 1”x3”	Php 50.00	Php 150.00
1	Pc	Glass (clear) ¼”x17”x29”	Php 140.00	Php 140.00
1	Pc	Temperature gauge	Php 700.00	Php 700.00
6	Ft	Rubber seal	Php 50.00	Php 300.00
3	Pcs	Blower 12 v dc	Php 100.00	Php 300.00
500	Pcs	Blind rivet 1/8” x ½”	Php 0.50.00	Php 250.00
TOTAL				**Php 8,487.00**

B. Designing and Layout

The researcher spent some time reading related literature and studies on similar fabricated machines to gather effective concepts in materializing the project.

The following are activities in the conceptualization and construction of the Multi-Purpose Machine:

For the design and lay-out of the machine, the following was taken into considerations:
1. The multi-purpose machine should be suited to the students’ level of understanding.
2. It will be constructed using locally and commercially available supplies and materials.
3. It should be operated with a 220 AC/ V power supply.
4. It should have features different from the existing fish dryers.

C. Construction of the Project

This machine was constructed by following the procedures below.

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1. Prepare all tools and materials needed,
2. Cut all aluminum tubular bars according to its measurement,
3. Cut all aluminum stucco sheets according to its measurement,
4. Cut all stainless sheets according to its measurement,
5. Cut all aluminum angle bars according to its measurement
6. Bend all stainless sheets according to its measurement,
7. Bend all aluminum stucco sheets according to its measurement,
8. Assemble the frame with the angle bars and tubular aluminum bars according to its design,
9. Assemble the door of the housing according to its design,
10. Make a hallow on top of the housing with a dimension of 9”x12” as an exhaust and mount and fasten a blower fan in perpendicular position near the exhaust
11. Place the drying platform beneath the drying chamber.
12. Put a blower in front of the drying platform.
13. Fasten all the holders of the tray inside the housing,
14. Connect the power supply of the blower to 220 v ac power line
15. Test the assembled multi- purpose machine.

D. Tools and Equipment Used in Constructing the Multi-Purpose Machine

In the construction of the modified fish dryer the following tools and equipment and their uses are included as follows:

Tool	**Functions**
File	Used for finishing and smoothening the rough surfaces and edges of the metal.
Drill Bit	Used for drilling holes in the drill press and lathe machine.
Steel Rule	Used in measuring dimensions.
L-square	Shaped device used for checking the squareness of the work piece.
Center Punch	Used in marking the piece of work before drilling operations.
Pliers Snipe	All-around gripping tool used for working with Clips and pins. Used in cutting aluminum and stainless sheet.
Machines and Equipment	
a. Electric hand drill	Used to drill holes on the pieces of metals
b. Miter Saw	Used to cut tubular aluminum metals.
c. Sheet Bender	Used for bending sheet metals.

E. Multi-Purpose Machine, Design and Features

The fish dryer is made up of seven main parts namely: the base frame which is fabricated from locally purchased materials of an aluminum angular bar with dimensions of 1”x 1” square bar; the combustion chamber measuring 7” in depth, 8 ½” in width and length of 13”; the drying chamber with cubical size of 12” x 17” x 28”. The fan housing which is composed of two blower fans measuring 3 inches in size; and the heating element which is consisted of the biomass resources either charcoal, bamboo, wood chops, etc. as available in locality; the drying pan which is made up of stainless rod with a dimension of 12” x 15 ½ “; the power supply/converter which is a step-down transformer from 220 volts primary voltage to 12 volts dc output.

1. <u>The Base Frame</u>

It is fabricated angular aluminum bar with dimension of 1x1 inches. The frame is fastened with screw to shape and provides support for other component parts of the dryer.

2. <u>The Combustion Chamber</u>

The combustion chamber is a charcoal filled cubical rectangular container made up of bricks/clay enclosed with stainless steel sheet from where heat energy is generated.

3. <u>The Drying Chamber</u>

The drying chamber is rectangular in shape. It has double walls made up of stucco aluminum sheet (gauge 31) measuring 17” width and 12” depth and 28” in height with fiberglass (insulator) in between to reduce heat loss across the wall. It has an air inlet which is located around the chamber at the bottom end. This provision allows air into the chamber. At the left side of the chamber is a hinged main door which permits easy access to the drying cage. On this main door a clear glass was used to shield the heat in fish to be dried.

4. The Drying Pan

To hold the fish in its place is a drying pan which measures (12"x15.5") and is constructed with a stainless wire mess of 1/8 inch diameter. The cage has a removable drying tray so that fishes are spread for treatment and handling during and after drying process to prevent contamination. It has also a hinged door which permits easy access inside the cage for loading and unloading the fishes before, during and after drying.

5. The Fan Housing

In order to effectively control the temperature in the drying chamber, there exists a 2 blower fan of 7 blades measuring 3 inches mounted on the top of the housing in perpendicular position to serve as the exhaust and chimney of the dryer.

6. The Heating Element

The energy required for drying process shall be generated form locally available biomass energy sources such as wood, charcoal and other agricultural.

7. The Power Supply/Converter

To supply the needed power for the blower fan.

F. Budgetary Allocation

Sources	Cost
Supplies and Materials	Php 8,487.00
Labor Cost	Php 3,394.8.00
Overhead Cost	Php 1,188.00
Total Production Cost	**Php 13,069.00**

G. Labor Cost

The cost of this project was computed by getting 40 percent based on the total expenditures for supplies, materials and other technical requirements of the project.

H. Overhead Cost

This was computed by getting 10 percent of the total cost of supplies and materials and labor cost.

I. Characteristics of the Project

1. Made out of locally available materials, specifically from junks.
2. Easy to assemble and dismantle.
3. Easy to operate
4. Simple in design
5. Durable and strong
6. Safe to use

J. Capabilities of the Project

1. Drying
2. Roasting

K. Operating Procedures for Fish Drying

1. Place ¼ kilo of charcoal in the combustion chamber kindle the charcoal and switch on the blower.
2. Ignite the charcoal until about 50 percent is fired.
3. Insert the combustion chamber beneath the drying chamber.
4. Place the product to be dried in the drying tray and insert the tray to the chamber, 1st, 2nd, 3rd, 4th, 5th chamber.
5. Close the door and lock firmly.
6. Monitor the temperature gauge at 50-60 degrees centigrade.
7. If the temperature rises above 60 degrees centigrade open the exhaust and switch on the blower on the top of the drying machine.
8. Observed the products to be dried in the lowest chamber and when slightly dried,
9. Transfer the product to the top most chambers.
10. Transfer the second to the next chamber and follow the same procedure.

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L. Testing and Evaluating

Two groups of evaluators consisting of instructors and students evaluated the multi-purpose machine as to its acceptability in terms of design, construction, functionality and safety. A sensory panel of evaluators was used to evaluate the odor, flavor and texture of hair tail Lepturacanthus savala while a simple reference test was used to evaluate the dried bagoong granules.

M. Revising

Revision was done for the observed defects and then the machine was reassembled until it became functional and acceptable.

RESEARCH DESIGN

This research study used the Project Development Method (PDM), wherein the researcher conceptualized the design and specifications of the multi-purpose machine. The machine was constructed and the parts were assembled in conformity to the design. Subsequently, a revision was made for any observed defects and then the device was reassembled until it will be found functional and acceptable. The modified dryer after perfectly assembled and tested was compared to an existing dryer in terms of:

a) length of time attained and recorded highest temperature,
b) drying time in (hrs.) of bagoong granules and hair tail
c) the hygienic quality of aroma of the product.

Meanwhile, the data on the acceptability of the developed multi-purpose machine in terms of design, construction, functionality and safety the data was gathered through questionnaire-checklist from the two groups of respondents.

DATA ANALYSIS

A five-point Likert's rating scale will be used to determine the descriptive meaning of the indicators of the variables used. Furthermore, the Weighted Average Mean (WAM) will be used to interpret the equivalent meaning of the data gathered.

Data on technical evaluation was analyzed using the 5- point scale below:

Rating	Scale	Qualitative Description	Interpretative Description
5	4.20-5.00	Strongly Agree	Excellent
4	3.40-4.19	Moderately Agree	Very Good
3	2.60-3.39	Agree	Good
2	1.80-2.59	Disagree	Poor
1	1.00-1.79	Strongly Disagree	Very Poor

Meanwhile, the data on sensory panel evaluation and reference test was analyzed using the following scale;

Rating	Scale	Qualitative Description
7	6.2-7.0	Extremely better
6	5.26-6.1	Much better
5	4.5-5.25	Slightly better
4	3.56-4.4	No difference
3	2.8-3.55	Slightly inferior
2	1.86-2.7	Much inferior
1	1-1.85	Extremely inferior

DATA GATHERING PROCEDURE

Permission was sought for the conduct of the study from the Campus Executive Officer, instructors/professors and students of Cagayan State University-Aparri Campus. After permission was granted, administration of the questionnaires was done. Directions in relation to the accomplishment of the questionnaires were done individually. Copies of the questionnaire-checklist were retrieved after being accomplished by the respondents.

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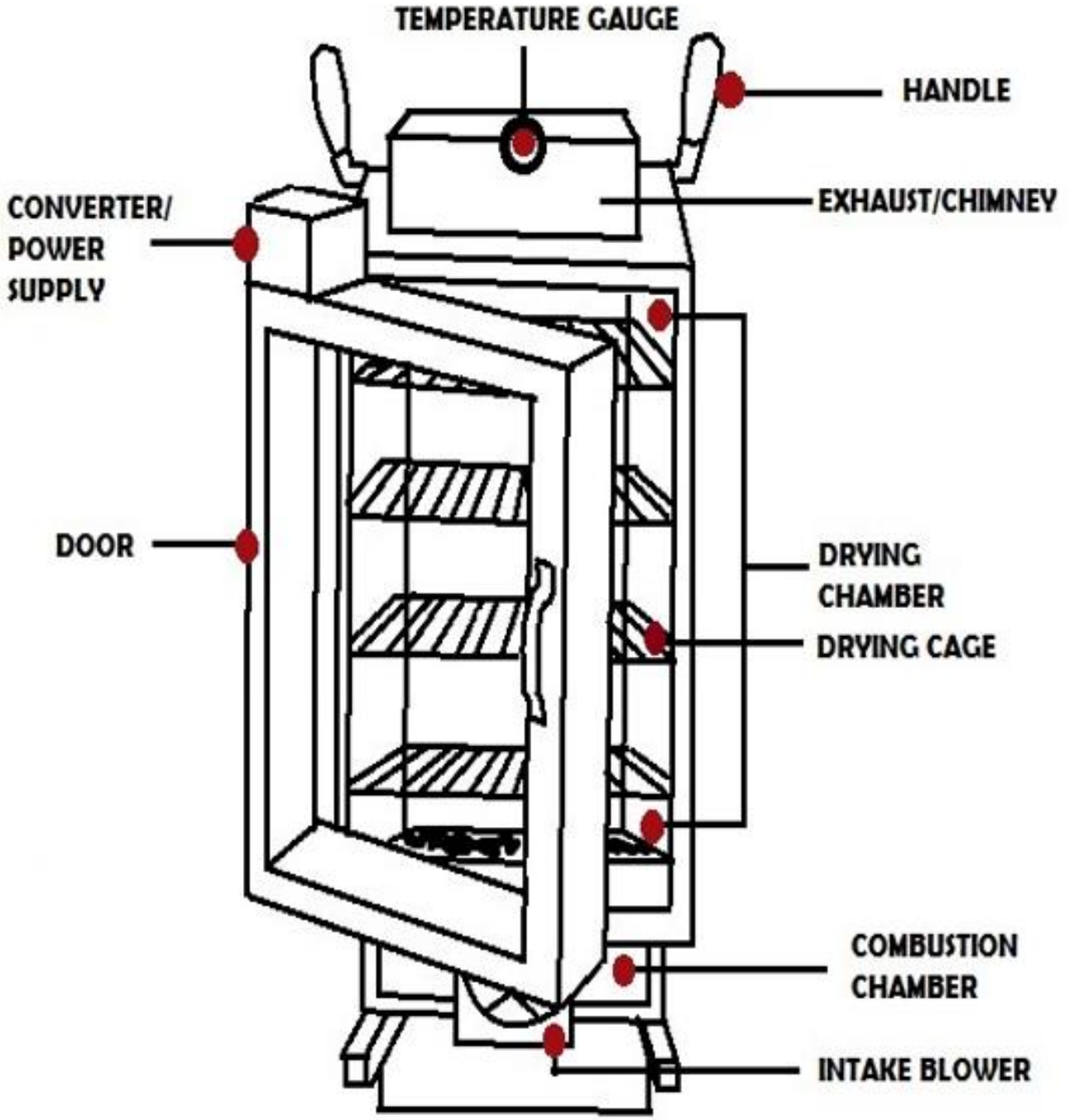
ISOMETRIC VIEW OF THE MULTI-PURPOSE FISH DRYER



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III. RESULTS AND DISCUSSIONS

Technical Specification of the Modified Dryer

Based from the table below, the modified dryer has a total volume of 12,393 cubic inches outside dimension. This goes to show that the modified dryer is bigger in size. Furthermore, it has a gross weight of 30 kilograms including the combustion chamber which is detachable and made up of bricks and clay to store more heat during drying. Hence, the modified dryer is lighter by 10 kilograms that made it easier to transport as compared to the existing dryer. Meanwhile, the modified dryer has intake and exhaust fans with a diameter of 3 inches which is rated at 1 watt with a voltage supply of 12V DC to produce air in igniting the charcoal faster than the existing dryer. This is an advantage of the modified dryer over the existing dryer in the length of time in drying. The combustion chamber can load 2 kilograms of charcoal proven bigger than the existing dryer which loads only 1 and one-half kilos of charcoal. The load of the chamber is a factor to consider in the temperature. On the other hand, the drying trays which are made up of stainless steel with a capacity of 3 kilos of hair tail. Likewise, the thermometer to indicate the temperature is an automobile temperature gauge which range from 40° centigrade to 120° centigrade respectively.

Table 2. Technical Specification of the Modified Dryer

Description	**Measurement**
Total Height	40.5 inches
Total Length-front	18 inches
Total Width-side	17.75 inches
Gross Weight	30 kilograms
Drying Chamber	8111.81 cubic inches
Intake fan	1x1watt
Exhaust fan	2x1watt
Heating Chamber Capacity	2kg charcoal
Drying trays	5 pcs x 12 inches x 15.50 inches
Temperature Gauge	40-120°Centigrade
Combustion Chamber	6”x8.5”x13.5”

Performance of the Proposed Dryer

The table shows the heating efficiency of the modified dryer as compared to the commercial dryer. In order to test the heating efficiency of the modified Multi-Purpose Dryer, the lapsed time was recorded at 50°-120° centigrade. The time in minutes was compared with the commercial dryer at different trails using 50 grams of charcoal. The findings of this study reveal that the modified Multi-Purpose Dryer attained the set temperature reading faster (x=3.75 min.) than the commercial dryer (x=6.43). It is attributed to the steel wool that was placed on the top of the heating chamber and the modified dryer serving as conductor of heat and filter to the ashes. An even faster time was achieved when the intake fan and the exhaust fan were switched on. It could also be inferred that since its faster attain high temperature the modified Multi-Purpose Dryer is thereby more economical to use in drying fish and other fishery resources.

Table 3. Heating Efficiency of the Modified and Commercial Dryer

Type of Dryer	**Time lapsed to attain different temperature**				**Mean**
Modified	0.0038	0.0065	1.0028	1.00033	3.75
	3.101	4.5	7.916	0.0066	
	1.0045	2.0043	3.0073	5.004	
	8.0018	15.15	0.005	1.083	
	2.0018	2.009	4.0026	6.0078	
	12.0026	0.0038	0.0065	1.0028	
	1.00033	3.101	4.5	7.916	
	0.0066	1.0045	2.0043	3.0073	
	5.004	8.0018	15.15	0.005	
	1.083	2.0018	2.009	4.0026	
	6.0078 1.0028	12.0026 1.00033	0.0038 3.101	0.0065 4.5	
	7.916	0.0066	1.0045	2.0043	
	3.0073	5.004	8.0018	15.15	

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	0.005	1.083	2.0018	2.009	
	4.0026	6.0068	12.0026		
Commercial	1.001	3.0053	6.0085	10.0095	6.43
	14.0091	20.0011	24.0066	0.004	
	1.0043	2.0091	4.0098	8.0061	
	0.0048	1	1.0066	2.483	
	4.006	9.0076	1.001	3.0053	
	6.0085	10.0095	14.0091	20.001	
	24.0066	0.004	1.0043	2.0091	
	4.0098	8.0061	0.0048	1	
	1.0066	2.483	4.006	9.0076	
	1.001	3.0053	6.0085	10.0095	
	14.0091	20.0011	24.066	0.004	
	1.0028	2.0091	4.0098	8.0061	
	0.0048	1	1.0066	2.483	
	4.066	9.0076	1.001	3.0053	
	6.0085	10.0095	14.0091	20.0011	

Testing significant difference on heating efficiency

The result of the independent t test as shown in the preceding table showed that the heating efficiency measured in terms of the number of minutes lapse time. The modified fish dryer is significantly lower than the commercial dryer (Probability 0.010). Therefore, could effectively reach higher temperature at lesser time and has better heating efficiency.

Table 3a. Comparison of Modified and Commercial dryer in terms of heating Efficiency

	Mean	**t- value**	**Probability**	**Inference**
Modified	3.75			
		2.61	0.010	Highly Significant
Commercial	6.43			

df = 94

Evaluation of the Dryer by Technical Experts

a. On the design of the modified dryer

Table 4 shows the weighted mean and descriptive rating of the design of the machine by the faculty and technical experts. (see Profile in Appendix A). As presented, the design indicator which is "The parts of the machine are replaceable" has the highest weighted mean of 4.921 or described as "Excellent." Two design indicators such as "The design is suited to the tertiary students" and "The parts of the machine are strategically located" have equal weighted mean of 4.808 or described as "Excellent." The other 2 design indicators such as "The parts of the machine are visible"; and "Parts/ supplies/ materials of the machine are available in the auto supply and hardware" also both received the highest descriptive rating of "Excellent that their weighted means are 4.752 and 4.651 respectively. In general, the evaluation design of the machine received a very impressive evaluation with a descriptive rating of "Excellent" and a weighted mean of 4.768.

Table 4. Summary of Evaluation on the Design of the Machine

INDICATORS	**Weighted Mean**	**Descriptive Rating**
1. The design is suited to the tertiary students.	4.808	Excellent
2. Parts/supplies/materials of the machine are available in auto supply and hardware.	4.651	Excellent
3. The parts of the machine are strategically located.	4.808	Excellent
4. The parts of the machine are visible.	4.752	Excellent
5. The component of the machine are replaceable.	4.921	Excellent
OVER ALL MEAN	**4.768**	**Excellent**

b. On the construction of the machine

Table 5 shows the weighted mean and descriptive rating of the construction of the machine. As gleaned, the construction indicator which is "The multipurpose machine is built properly" has the highest weighted mean of 4.876 or described as "Excellent." The other construction indicators such as "All the attachments are purposeful and functional"; "The multipurpose machine is portable"; "The setup of the machine is well organized"; and "The attachments of the parts are neatly arranged" also have the highest descriptive rating of "Excellent" that their weighted means are 4.865, 4.842, 4.786, and 4.561 respectively. As a whole, construction of the machine was evaluated with a very high weighted mean of 4.786 described as "Excellent.

Table 5. Summary of Evaluation of Construction of the Machine

INDICATORS	Weighted Mean	Descriptive Rating
1. The set-up of the machine is well-organized.	4.786	Excellent
2. The attachments of the parts are neatly arranged.	4.561	Excellent
3. All the attachments are purposeful and functional.	4.865	Excellent
4. The multi-purpose machine is portable.	4.842	Excellent
5. The multi-purpose machine is built properly.	4.876	Excellent
OVER ALL MEAN	**4.786**	**Excellent**

c. On the functionality of the Machine

Table 6 shows the weighted mean and descriptive rating of the evaluation of the functionality of the machine. As shown, the functionality indicator which is "The machine is effective for instructional use" has the highest weighted mean of 4.910 or described as "Excellent." Next is "The machine can perform the desired activities" with a weighted mean of 4.876 or also described as "Excellent." Another functionality indicator which is "The machine can perform several activities and operations" received the highest descriptive rating of "Excellent" that it has also a high weighted mean of 4.842. Two functionality indicators such as "The machine is easy to operate and manipulate" and "The machine can perform simple to complex activities the least, though still high equal weighted mean of 4.831 or both are described as "Excellent". As a result, since the overall weighted mean of the evaluation of the functionality of the machine is very high with 4.856, then it has also a very impressing descriptive rating of "Excellent". This implies that the modified fish dryer is highly functional. Hence it could be easily used both for instructional and commercial used especially in drying fish and other fishery resources.

Table 6. Summary of the Evaluation of Functionality of the Machine

INDICATORS	Weighted Mean	Descriptive Rating
1. The machine is effective for instructional use.	4.910	Excellent
3. The machine can perform the desired activities.	4.876	Excellent
4. The machine is easy to operate and manipulate.	4.831	Excellent
5. The machine can perform simple to complex activities.	4.831	Excellent
OVER ALL MEAN	**4.856**	**Excellent**

d. On the safety of the Machine

Table 7 shows the weighted mean and descriptive rating of the evaluation of the safeties of the machine. As presented, the safety indicator which has the highest weighted mean of 4.943 or described as "Excellent" is "Movable parts of the machine are properly installed with safety guards." There are 2 safety indicators such as "The machine stand, frame and base are stable" and "The parts are designed for 220 VAC source" also received an equal weighted mean of 4.910 or described as "Excellent". However, as revealed, all the safety indicators have the highest descriptive rating of "Excellent" that last 2 such as "The machine is equipped with safety electrical devices" and "The installation of electrical circuits makes the machine safe for demonstration" also received high weighted means of 4.898 and 4.876 respectively. In general, the evaluation of safeties of the machine has a very high weighted mean of 4.907 or described as "Excellent" Hence the modified dryer could be easily used with safety precaution which is one of the highest considerations in selecting a dryer suited for drying of fish and other fishery resources.

Table 7. Summary of Evaluation of Safety of the Machine

INDICATORS	Weighted Mean	Descriptive Rating
1. The machine stand, frame and base are stable.	4.910	Excellent
2. The parts are designed for 220 VAC source.	4.910	Excellent

3. The machine is equipped with safety electrical devices.	4.898	Excellent
4. Movable parts of the machine are properly installed with safety guards.	4.943	Excellent
5. The installation of electrical circuits makes the machine safe for demonstration.	4.876	Excellent
OVERALL MEAN	**4.907**	**Excellent**

Assessment of the dryer by sensory panel evaluator

In order to test the effectiveness of the modified multipurpose dryer in drying fish, it was tested actually on hair tail Lepturacanthus savala. The said samples dried were fried was subjected to the sensory evaluation on odor, flavor and texture has shown in table 8. It was found out that the samples dried using the modified multi-Purpose Dryer was evaluated better in terms of color, flavor and texture.

As gleaned in the table below, the modified dryer has a mean of 5.59 and the sundried has 5.11 respectively.

Table 8. Sensory evaluation on hair tail

	Odor		**Flavor**		**Texture**		**Mean**
Sundried	5.67		5.45		4.20		5.11
Modified	6.15		6.03		5.58		5.59

Sensory evaluation on Odor

While the odor of fried samples dried from the modified multi-Purpose Dryer was higher than that of the sundried, it was found out that the two samples are not significantly different (P 0.655).

As gleaned in the table below, the modified dryer recorded no significant difference in terms of the odor as compared with traditional sun drying.

Table 9. Test of Difference in the Modified versus Sun Dried Hair Tail

ODOR	**Mean**	**t –test**	**Probability**	**Inference**
Sundried	5.67			
		1.90	0.655	**Not Significant**
Modified	6.15			

Table 10. Test of Difference in the Modified versus Sun Dried Hair Tail

FLAVOR	**Mean**	**t –test**	**Probability**	**Inference**
Sundried	5.45			
		3.22	0.0026	**Highly Significant**
Modified	6.03			

Sensory evaluation on Texture

The table below shows that the texture of the fish dried in the modified dryer was evaluated to be significantly better than the samples dried by the commercial dryer. The sensor panel of evaluators commented that the product of modified multi-Purpose Dryer is crispier than that of the other dryer.

Table 11. Test of Difference in the texture of fried samples

TEXTURE	**Mean**	**t –test**	**Probability**	**Inference**
Sundried	4.20			
		4.77	0.000	**Highly Significant**

Modified	5.58			

Table 12. Test of Difference in the Modified versus Sun Dried Hair Tail

FLAVOR	Mean	t –test	Probability	Inference
Sundried	5.45			
		3.22	0.0026	**Highly Significant**
Modified	6.03			

Sensory evaluation of Bagoong Granules using the two dryers.

In order to test the output of the modified mix dryers. The sample reference test was used. The sensory panel was asked whether the samples dried using the modified multi-purpose dryer was better or not as compared to the samples dried under the commercial dryer.

As shown in the table, majority of the evaluators (45.83%) deemed that bagoong granules dried using the modified multi-purpose dryer were much better as to odor than those dried used the commercial dryer.

Likewise, majority (45.83%) of the sensory panel also assessed that the bagoong granules have slightly better color than those dried using the commercial dryer.

Table 13. Reference Test of Panel Evaluator on Bagoong Granules

	Odor	Percentage	Color	Percentage
Extremely Better	4	16.67	2	8.33
Much Better	11	45.83	5	20.83
Slightly Better	5	20.83	11	45.83
No Difference	1	4.17	1	4.17
Slightly Inferior	1	4.17	5	20.83
Much Inferior	1	4.17	0	
Extremely inferior	1	4.17	0	

SUMMARY

This study was conducted to design, construct and evaluate a modified Multi-Purpose Dryer to help address one of the problems of fish preservation. The study used the project Development Method (PDM) and was conducted at Cagayan State University at Aparri. The modified dryer has a total volume of 12,393 cubic inches outside dimension. This goes to show that the modified dryer is bigger. Furthermore, it has a gross weight of 30 kilograms including the combustion chamber which is detachable and made up of bricks and clay to store more heat during drying. Hence, the modified dryer is lighter by 10 kilograms that made it easier to transport as compared to the existing dryer. Meanwhile, the modified dryer has intake and exhaust fans with a diameter of 3 inches which is rated at 1 watt with a voltage supply of 12V DC to produce air in igniting the charcoal faster than the existing dryer. This is an advantage of the modified dryer over the existing dryer in the length of time in drying. The combustion chamber can load 2 kilograms of charcoal proven bigger than the existing dryer which loads only 1 and one-half kilos of charcoal. The load of the chamber is a factor to consider in the temperature. On the other hand, the drying trays are made up of stainless steel with a capacity of 3 kilos of hairtail. Likewise, the thermometer to indicate the temperature is an automobile temperature gauge which ranges from 40° centigrade to 120° centigrade respectively. The findings of this study also revealed that the modified Multi-Purpose Dryer attained the set temperature reading faster (x=3.75 min.) than the commercial dryer (x=6.43). It is attributed to the steel wool that was placed on the top of the heating chamber and the modified dryer serving as conductor of heat and filter to the ashes. An even faster time was achieved when the intake fan and the exhaust fan were switched on.

As manifested in the data, the result of the independent t-test emphasized the heating efficiency measured in terms of the number of minutes lapse time. The modified fish dryer is significantly faster than the commercial dryer with a probability of 0.010.

To assess the effectiveness of the dryers in drying, they were tested on hair tail Lepturacanthus savala. The said samples dried were fried as subjected to the sensory evaluation on odor, flavor and texture. Analysis of the finding revealed the comparison of flavor made between sundried fish and fish dried in the modified dryer. The t-test showed that the flavor of fried hairtail Lepturacanhus savala dried under the modified Multi-Purpose Dryer is significantly better (P 0.0026) than that of the commercial dryer.

To test the effectiveness of the modified multi-purpose dryer in drying fish, it was tested actually on hair tail Lepturacanthus savala. The said samples dried were fried and were subjected to the sensory evaluation on odor, flavor and texture has shown in table 9. It was found out that the samples dried using the modified Multi-Purpose Dryer were evaluated better in terms of color, flavor and texture.

The modified dryer has a mean of 5.59 and the sundried has 5.11 respectively. While the odor of fried samples dried from the modified Multi-Purpose Dryer was higher than that of the sundried, it was found out that the two samples are not significantly different (P 0.655). The modified dryer recorded no significant difference in terms of the odor as compared with traditional sun drying. The study shows that the texture of the fish dried in the modified dryer was evaluated to be significantly better than the samples dried by the commercial dryer. The sensor panel of evaluators commented that the product of the modified Multi-Purpose Dryer is crispier than that of the other dryer.

CONCLUSION

Based on the aforementioned findings of the study, the following conclusions were drawn:

It could also be inferred that since its faster attain high temperature the modified Multi-Purpose Dryer is thereby more economical to use in drying fish and other fishery resources.

Therefore, could effectively reach a higher temperature at a lesser time and has better heating efficiency. The findings of the study showed that the modified Multi-Purpose Dryer attain a certain temperature at a shorter span of time. Further statistical test also reveals that the odor, flavor and texture of hairtail Lepturacanthus savala dried by the modified dryer are significantly better. The modified multi-purpose dryer is economical in the use of charcoal as fuel. It has been found out that 700 grams of charcoal can effectively dry 2 kilos of hairtail in seven hours. Whereas, in sun drying it takes two days to dry 2 kilos of hairtail.

Likewise, when the dryer was tested in bagoong granules, the sensory evaluation also revealed that those dried under the modified dryer was better in odor and color using a simple reference test.

In terms of its hedonic evaluation, t-Test showed that the sundry and modified dryer resulted to not significant. Flavor and texture of the modified dryer was found highly significant over the sundried.

On the design of the modified dryer, it shows the weighted mean and descriptive rating of the design of the machine by the faculty and technical experts. As presented, the design indicator which is “The parts of the machine are replaceable” has the highest weighted mean of 4.921 or described as “Excellent.” Two design indicators such as “The design is suited to the tertiary students” and “The parts of the machine are strategically located” have equal weighted mean of 4.808 or described as “Excellent.” The other 2 design indicators such as “The parts of the machine are visible”; and “Parts/ supplies/ materials of the machine are available in the auto supply and hardware” also both received the highest descriptive rating of “Excellent that their weighted means are 4.752 and 4.651 respectively. In general, the evaluation design of the machine received a very impressive evaluation with a descriptive rating of “Excellent” and a weighted mean of 4.768.

RECOMMENDATIONS

Based on the findings and conclusions made, these are highly recommended:

1. Additional drying tray must be made in the drying chamber
2. Design the combustion chamber good for 100 grams of charcoal when drying hair tail to maintain the temperature to 50 oC.
3. The blower should be equipped with automatic temperature control.
4. The modified dryer should be equipped with an automatic alarm system when the temperature reaches above 50 oC and below 40 oC.
5. There should be maximum utilization of heat expelled at the back of the exhaust blower for preheating purposes.
6. Use the dryer for other fish species and other agricultural products such as fruits and vegetables.

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Development and Evaluation of an Android-Based Instructional Material for the Computer Systems Servicing

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ABSTRACT: The study developed an android – based instructional material based from the needs of the students conducted at Technical Education Schools Development Authority (TESDA), Ilagan, Isabela and tested the developed instructional material in terms of usability and functionality by thirty (30) respondents includes Supervisor, Computer System Servicing (CSS) Assessors / Trainers, IT Specialist, and students. The study utilized an Agile development model. A survey questionnaire, based on International Standard Organization (ISO) 9126, was used to evaluate the developed application in terms of usability and functionality. A 5 – point Likert scale was used to interpret the assessment. The functionality of the application obtained an over-all rating of 4.43 and the usability obtained 4.36 which imply that respondents strongly agreed on the applications performance on functionality and usability. With an overall rating of 4.40, the functionality and usability of the application was found Outstanding.
Results of the study recommended the adoption of the developed instructional material for utilization of the students and trainers

Keyword: *Android – based Instructional Material, computer systems servicing, development and evaluation of android, instructional material*

I. INTRODUCTION

The CSS performance results guide decision makers in formulating policies relative to the progression and promotion of students. These will also determine the performance of the students that need further intervention. Results of this indicator will help them formulate appropriate interventions that aimed the improvement of the education system.

The TESDA-ISAT Ilagan, Isabela aimed to respond to such intervention in order to improve instruction and consequently, improve the performance of the students. This intervention has resulted to the use of mobile technologies as it is now being utilized due to its convenience and simplicity. It is not limited to media of communication or entertainment but it is also been utilized as a learning tool. Wirawan (2011) stated that the use of mobile phone technology has not only focused on a media of communication or entertainment but also has been used as a learning media.

As majority of students and teachers are using mobile phones in the learning process, the android-based instructional manual for CSS was conceptualized. The application can be used anywhere
and anytime. Hence, students and teachers would be benefited in the teaching and learning process.

OBJECTIVES

The study aimed to develop and evaluate an android-based Instructional Material for Computer Systems Servicing. Specifically, it aimed to:

1. Develop an android-based instructional material for the computer systems servicing that will be based from the needs of the students and with the following features:
    a. Application for the user;
    b. Application for the administrator;
    c. Category-based structure;
    d. Complete user interface for the administrator; and
    e. Real-time update.
2. Test the developed application in terms of the following:
    a. Functionality and
    b. Usability.

II. PROJECT DESIGN AND METHODOLOGY

The following presents the development model and approach, respondents of the study, locale and population of the study, data instrumentation and research instrument that were utilized in the study.

The study used a two-phased process method: the development of the android-based application and its consequent evaluation. The method ensures not only that the application is develop but the development output was assessed as to its congruence use.

The development phase included systems analysis, design and development suitable for a development model.

The evaluation phase focused on the usability and functionality of the developed android application.

Development Model

The study made used of an Agile development model by Wijayamanna, 2015. This model promotes continuous iteration of development and testing throughout the software development lifecycle. The method consists of five phases which include planning and requirements analysis, design phase, build phase, testing phase, and evaluation phase which were discussed below:

1. Planning and Requirements Analysis

The researchers collected the instructional material for CSS which were used for the development of the android-based application with emphasis on the needs of the students on the result of their performance. The different features of the application were also identified. Also in this phase, the needed hardware, software and target users were analyzed and validated. The following are the list of software and hardware that were used in the development and implementation of the application.

Hardware Requirements

The hardware requirements used for the development of the application include a laptop with 4GB RAM, Intel Core i5 2.6HHz processor, and a screen resolution of 1366 x 768. During deployment, any device with a minimum Android OS of Lollipop with at least dual core 1.2 GHz processor, 1 GB RAM at least 20 MB free data storage.

Software Requirements

The software requirements used for the development of the application include Java, XML, and Android Studio. The android studio was used to develop the mobile application and it used two programming language the Java and XML. The XML was used for the design and framework of the application. On the other hand, Java was added to provide interactivity of the application.

User and User Interfaces

The target users of the application were the teachers and students in CSS. The users should know the basic knowledge in using android phones.

2. Design Phase

The researchers created the framework of the application including the design and user interfaces.

3. Build Phase

Actual coding and programming were performed using different tools like Java, XML and Android studio in developing the application.

4. Testing Phase

Unit testing and integration testing were performed wherein the individual components were combined and tested as one application. This testing methodology checked if the application works properly as a whole.

5. Evaluation Phase

The application was evaluated by the respondents in terms of usability and functionality.

Respondents of the Study

The respondents of the study were the TESDA-ISAT Supervisor, two (2) CSS Assessors/Trainers, five (5) IT Specialists, and 22 CSS students.

Locale and Population of the Study

The study was conducted at TESDA-ISAT Ilagan, Isabela. Purposive sampling was employed among the respondents. A total of 30 served as respondents of the study.

Data Instrumentation

Survey questionnaire was used to evaluate the application in terms of usability and functionality. The survey forms were personally distributed to the respondents after they have navigated the functionalities of the application.

Data Analysis

The Likert scale was used to interpret the assessment of the respondents in the developed application. It has five (5) – point scale which has an equivalent scale and rating as presented in Table 1.

Rating Scale	Point Range	Description
4.21 – 5.00	4.21 – 5.00	Strongly Agree
3.41 – 4.20	3.41 – 4.20	Agree
2.61 – 3.40	2.61 – 3.40	Undecided
1.81 – 2.60	1.81 – 2.60	Disagree
1.00 – 1.80	1.00 – 1.80	Strongly Disagree

Weighted mean was used to tally the rating given by the respondents.

Software Criteria

The software criteria used were based on the ISO 9126 – Software Quality Characteristics. Functionality of the application included the interoperability and accurateness. It measures the capacity of the application on the manner on how it is accessed, interactive and purposive when the application was served. Usability was used to measure the application in terms of understandability, learnability and operability. The physical design covers the layout, graphics, color and text was also considered in this criterion.

III. RESULT

This presents the android-based application developed which include the features and results of evaluation.

Application Development

Features / Functionalities of the Application

The application can be shared via SHAREit or Bluetooth. Once shared, install the application. Run the application after its installation.

a. Application for the user

The developed android-based application provides access for the user as illustrated in figure 1. Click on the icon to get started.

Figure 1. Getting Started to AIMCSS: Android-based Instructional Materials of CSS

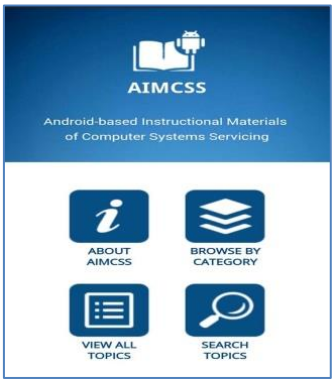

Figure 2. AIMCSS for the user

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Figure 2 provides information about the instructional material and the contact persons on the partner agency. The About AIMCSS contains information about the contacts on the identified agency. The Browse Category allows the user to browse the instructional material by category or topic. Included in the browse category is the search button for further searching of the information. The View all Topics allow the user to view all the topics contained in the application. The Search Topics allows the user to search information about the CSS instructional material.

b. Application for the Administrator

The developed android-based application provides access for the administrator as illustrated in figure 3. Click on the icon to get started.

Figure 3. AIMCSS for the Administrator

c. Category-based structure

The application used a category-based structure. The structure was based on the result of the research about students' performance on CSS.

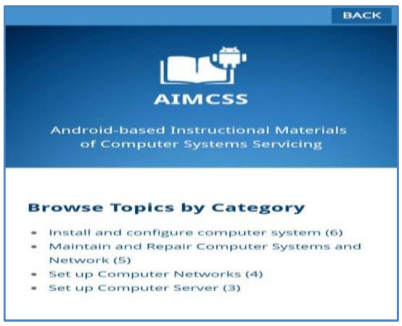

Figure 4. Category-based structure of the AIMCSS

d. Complete user interface for the administrator

Figure 5 displays the dashboard for the administrator. To add or edit content of the learning material, select on the learning material.

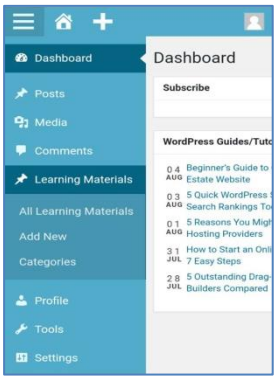

Figure 5. Dashboard for the Administrator

Figure 6 allows the administrator to add new topic to the learning material. Enter the title of the material and its contents. You can select on the options to publish the material added.

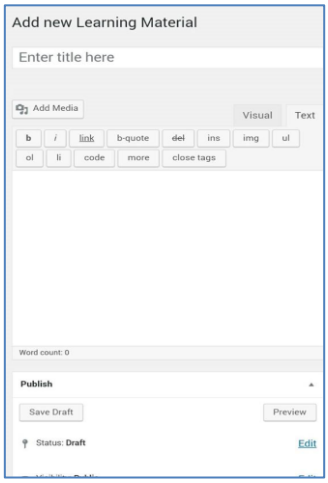

Figure 6. Add New Topic for the Learning Material

Figure 7 allows the administrator to add a new category or title to the learning material. Click on the Add new Category button and enter the name of the category or title.

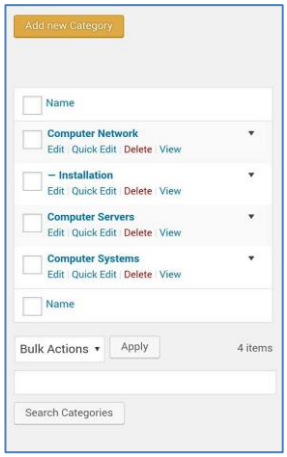

Figure 7. Add New Category/Title for the Learning Material

e. Real-time Update

After adding or editing content of the learning material, select publish for real time update. Once publish, the material can be viewed by the user.

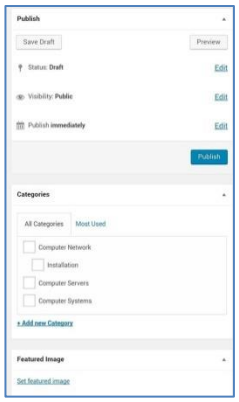

Figure 8. Publish the learning material to show the real-time update

Evaluation of the Application

Table 1 reflects the respondents rating on the functionality of the application. As reflected in the table, the functionality of the application obtained an over-all rating of 4.43 which implies that the respondents strongly agreed

on the developed application in terms of its function. The result can be attributed to the performance of students, faculty members, and the availability of facilities.

Table 1. Respondents' Rating on the Functionality of the Application

Functionality	Weighted Mean	Description
1. The application provides access to the users.	4.55	Strongly Agree
2. The application provides access to the administrator.	4.55	Strongly Agree
3. The application is organized in a category-based structure.	4.55	Strongly Agree
4. The application provides complete user interface for the administrator.	4.25	Agree
5. The application provides real-time update.	4.25	Agree
Overall Weighted Mean	**4.43**	**Agree**

Table 2 reflects the respondents rating on the usability of the application. As reflected in the table, the usability of the application obtained an over-all rating of 4.36 which implies that the respondents strongly agreed on the developed application in terms of its use. The result can be attributed to the users as they are knowledgeable in the necessary information needed for the CSS.

Table 2. Respondents' Rating on the Usability of the Application

Usability	Weighted Mean	Description
1. There is a consistency in the application's color combination, screen layout and font styles.	4.45	Strongly Agree
2. The application is easy to use.	4.43	Strongly Agree
3. The application is simple and elegant.	4.23	Agree
4. The information contained in the application is organized and clear.	4.28	Agree
5. The application provides a clear and simple path to the other contents of the application.	4.23	Strongly Agree
Overall Weighted Mean	**4.36**	**Agree**

Table 3 reflects the respondents' summary rating on the functionality and usability of the application which has a weighted mean of 4.40. This implies that the respondents strongly agreed on the functionality and usability of the application.

Table 3. Respondents' Summary Rating on the Functionality and Usability of the Application

Software Criteria	Weighted Mean	Description
1. Functionality	4.43	Agree
2. Usability	4.36	Agree
Overall Weighted Mean	**4.40**	**Agree**

CONCLUSION

In the context of application development and evaluation, the following conclusions were drawn:

1. The developed android-based instructional material for the computer systems servicing were based from the result of the computer systems servicing performance of the students and other features were incorporated to motivate the interest of the students and have met the following features:

a. Provided access for the user;
b. Provided access for the administrator;
c. Category-based structure;
d. Complete user interface for the administrator; and
e. Real-time update.

2. Based on the evaluation conducted, the respondents strongly agreed on the functionality and usability of the developed application.

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Sex Difference in the Level of Mental Health: Basis for Employee Assistance Program

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ABSTRACT: This study sought to determine the sex difference in the level of mental health of a university in Northern Philippines. There were 105 employees who participated in the study whereby the Employee Assistance Program Inventory was used as the main gathering tool. T-test result showed that there is a sex difference in mental health particularly on work adjustment scale. Further, age, highest educational attainment, occupational group, category, salary grade, and classification showed a relationship to self-esteem problems. Highest educational attainment, occupational group, category, salary grade and classification are related to anxiety. It was established that highest educational attainment, occupational group, category and salary grade has a bearing on work adjustment. Only highest educational attainment was found to be related to interpersonal conflict and only salary grade has a bearing on depression.

Keywords*: Profile, Mental Health, Employee, Northern Philippines*

INTRODUCTION

In the latest update of the World Health Organization-Philippines, 300 million people are living with depression during the period 2005-2015 wherein more than 3 million Filipinos are suffering from depression and anxiety. There were at least 2558 reported Filipino suicide cases in 2012 due to mental health issues only (Tugade, 2017). Moreover, there are seven Filipinos who commit suicide daily and one in every five adults suffer from mental disorder (ABS-CBN News, 2018). Various studies across the world show that there is a sex difference when it comes to mental illness. In Psychiatry, sex difference in mental disorders is one of the most intriguing findings. Differences is evident on prevalence, symptomatology, risk factors, influencing factors and course. Women have a greater lifetime incidence of mood or anxiety disorders than men (Rossler, 2016). The findings of Eaton (2011), for Americans, women are more likely to be diagnosed with anxiety or depression, while men tend toward substance abuse or antisocial disorders. Furthermore, he also found that women with anxiety disorders are more likely to internalize emotions, which typically results in withdrawal, loneliness and depression while men, are more likely to externalize emotions, which leads to aggressive, impulsive, coercive and noncompliant behavior. A study conducted in Iran showed that among adult population, women were more often exposed to stressful situations and emotional problems and more often faced with negative conditions and feelings (Svetlana, 2013). For Filipinos, between 17 to 20 percent of Filipino adults experience psychiatric disorders, wherein other mental health disorders in the list are depression, anxiety disorder, schizoaffective disorder, acute and transient disorder, and stimulant-related disorder. Suicide is another problem in the Philippines. In 2012, there were 2,558 Filipinos who committed suicide, and 2009 of them were males. (Magtubo, 2016).

Health providers are now preoccupied conducting trainings related to mental health. The Pambansang Samahan sa Sikolohiyang Pilipino theme in 2018 conference is, “Katinuan, Kalinisan, Kalusugan: Ang Mental Health sa Konteksto ng Kultura, Lipunan at Sikolohiyang Pilipino (Pambansang Samahan sa Sikolohiyang Pilipino, 2018). The Psychological Association of the Philippines which is one of the advocates of the law conducted its professional summit on August 31-September 1, 2018. One of the topics included in the learning sessions was, “The Mental Health Law in Psychology Practice.” (Psychological Association of the Philippines, 2018). Likewise, the Philippine Guidance Counselors Association which is the accredited professional organization of guidance counselors as seen in its official Facebook page, continues to post mental health advocacy materials even before the passage of the mental health law (Philippine Guidance and Counseling Association, 2018).

The Philippine Mental Health Law or RA 11036 was enacted into law on June 18, 2018. The law calls for employers to promote mental health education in workplaces (Gutierrez, 2018). Chapter 5 Section 24 of the Mental Health Law which is the mental health promotion in educational institutions, requires educational institutions to develop policies and programs for educators and other employees while section 25 which is the promotion and policies in the workplace, requires employers to develop appropriate policies and programs on mental health in the workplace.

In response to the national government call for the promotion of mental health at work, as a starting point, the findings of this study will serve as a baseline data in designing mental health program for employees which is responsive for both sexes. Determining the mental health concerns of both sexes will eventually lead to effective intervention of the university through its campus employee assistance program.

OBJECTIVES

The study aimed to determine the sex difference in the level of mental health of employees at Cagayan State University. Specifically, it sought answers to the following questions:

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1. What is the profile of the respondents in terms of the following variables:
   a. Sex
   b. Age
   c. Civil status
   d. Highest educational attainment
   e. Position
   f. Category
   g. Salary grade level
   h. Classification
2. What is the level of mental health of the employees in the five dimensions: anxiety, depression, self-esteem problems, interpersonal conflict, and work adjustment?
3. Is there a significant difference in the mental health of male and female employees?
4. Is there a significant relationship between the profile of the employees and their level of mental health?

Research Hypothesis

This study tested the following hypotheses:

1. There is no significant difference in the level of mental health of male and female employees.
2. There is no significant relationship between the profile of the employees and their level of mental health.

Conceptual Framework

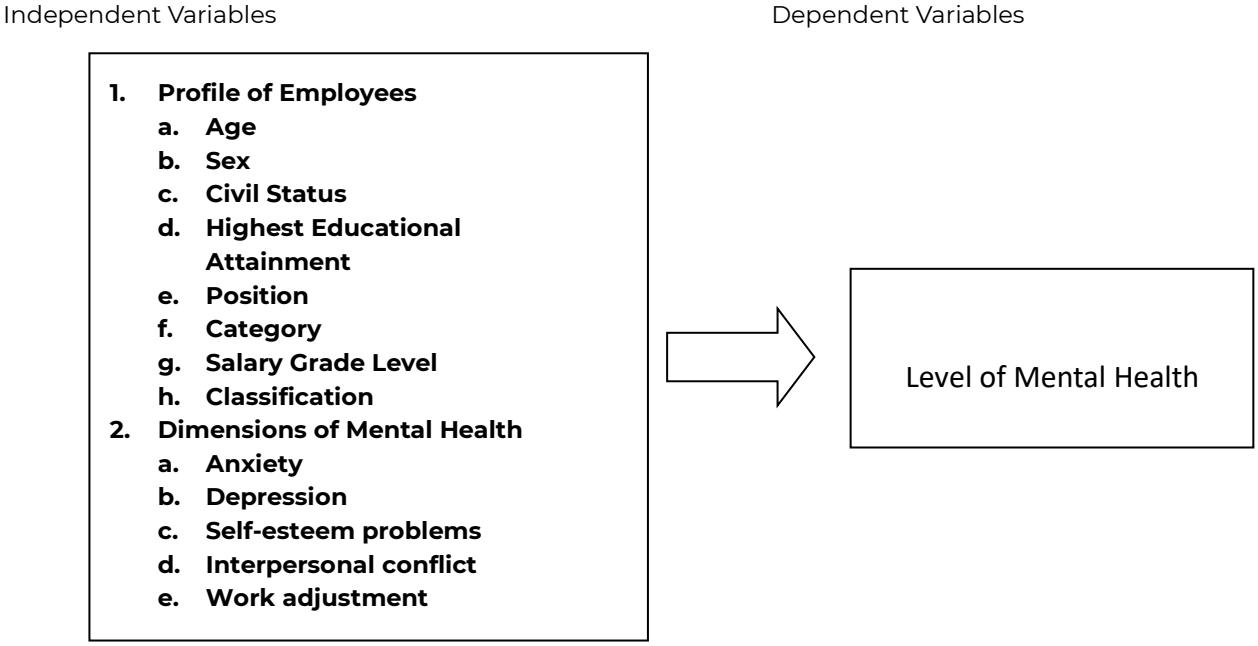

Figure 1. The relationship between the independent and the dependent variables.

Research Design

The descriptive – correlational method of research was utilized in the study. The profile of the employees such as, sex, age, civil status, highest educational attainment, position salary grade level, and the level of mental health were obtained. The study is also correlational as it analyzed the level of mental health in relation to their profile. Likewise, the sex difference in the level of mental health of employees.

Locale of the Study

The study was conducted at the Northern most part of Cagayan, in the municipality of Aparri, particularly at the Cagayan State University (CSU) Aparri Campus. CSU Aparri is located at Maura, Aparri, Cagayan. It was formerly known as Aparri School of Fisheries and Aparri Institute of Technology before it became Cagayan State University at Aparri. CSU Aparri is one among the eight campuses of CSU. The campus is composed of seven colleges with more than one hundred employees.

Respondents and Sampling Procedure

The respondents of the study were the one hundred five employees of CSU Aparri. There were fifty-one faculty members and fifty-four non-teaching staff. Total enumeration was targeted, however, those who were in study leave during the gathering of data were not included.

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Data Gathering Procedure

After a special order to conduct the study was provided by the Research and Development Office, the researcher sought the approval of the Campus Executive Officer, for the floating of questionnaire and administration of the Employee Assistance Program Inventory (EAPI). Records in the training office was utilized in completing some missing data in the questionnaire. The data gathered through the questionnaire and office records were then tabulated and treated using chi-square analysis. For the data collected using the EAPI, the responses were checked, scored, coded and interpreted by the researcher.

Data Gathering Tools

There were three main tools in gathering the data. Questionnaire, the Employee Assistance Program Inventory (EAPI) and through document analysis. The questionnaire was used in gathering the employees' personal data, the EAPI in the measurement of present mental well-being and document analysis for personal data that the employees fail to fill out in the questionnaire and it served as a verification on the data filled out by the employees.

The EAPI is a standardized test which consists of 120 items, intended for existing employees/working adults within the age bracket, 18-76, and could be administered in 25-30 minutes. The EAPI facilitates the rapid identification of common problems and can be used to guide either referrals or short-term interventions. The EAPI is the first clinical instrument specifically targeted for use in Employees Assistance Programs, as well as by all mental health professionals who provide counselling and other services to working adults.

It assesses problems in ten (10) areas: anxiety, depression, external stressors, marital problems, work adjustment, effects of substance abuse, interpersonal conflict, problem minimization, self-esteem problems and family problems. Document analysis was done in obtaining profile data. Formal communications addressed to the office of the Campus Executive Officer was made for the conduct of the data gathering. For the administration, scoring and interpretation of the EAPI test, the researcher took charge of it. Data gathered was tallied and tabulated for statistical treatment. The correlational analysis was used to treat the data gathered.

Statistical Treatment

For the descriptive part of the study, frequency counts, mean, percentage and standard deviation were used. Pearson product moment correlation rho (r) and t-test were used to determine relationships, utilizing .05 level of significance.

RESULTS AND DISCUSSIONS

Profile of the Employees

Table 1 shows that there were fifty-five (52 percent) female employees and fifty (48 percent) male employees who participated in the study. Out of the 105 employees, fifty percent belong to age bracket 40-59, forty-two percent belong to 20-39 and only eight percent belong to 60 and older. The mean age of the employees is 42.86. This data reveal that half of the population are in their middle age. Majority (78 percent) of the employees are married.

Table 1. Profile of the employees in terms of sex, age, and civil status.

Category	Frequency (n=105)	Percent
Sex		
Male	50	48
Female	55	52
Age		
20 – 39	44	42
40 – 59	53	50
60 & older	8	8
Mean = 42.86		
Civil Status		
Single	21	20
Married	82	78
Widow/widower	2	2

As shown in table 2, majority (80 percent) of the employees have at least finished a college degree and the remaining twenty percent of the employees had experienced to be in college, high school or elementary.

Table 2. Profile of the employees in terms of highest educational attainment, position, category, salary grade level and status.

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Category	Frequency (n=105)	Percent
Highest Educational Attainment		
Doctoral Graduate	24	23
Doctoral Level	19	18
Master's Graduate	11	10
Master's Level	2	2
College Graduate	28	27
College Level	4	4
Vocational Graduate	2	2
High School Graduate	8	8
High School Level	1	1
Elementary Graduate	1	1
Elementary Level	5	5

Based from the Philippine standard occupational classification (2012 Philippine Standard Occupational Classification, 2021), forty-seven percent are classified as professionals, eight percent as managers or supervisors and the remaining forty-five percent are classified as technicians, service workers, clerks and laborers. Among the respondents, 51 or 49 percent are teaching staff and 54 or 51 percent are non-teaching staff.

Table 3. Profile of the respondents in terms of occupational group, category, salary grade level and status.

Category	Frequency (n=105)	Percent
Occupational Group		
Managers/Supervisors	8	8
Professionals	49	47
Technicians	2	2
Service Workers	11	10
Clerks	19	18
Laborers and unskilled	16	15
Category		
Teaching staff	51	49
Non-teaching staff	54	51

As revealed in table 4, more than half (52 percent) of the employees belong to salary grade eleven and higher. This finding implies that their estimated monthly basic salary ranges from P23,000.00 to P182,000.00. The fifty employees (48 percent) have a basic monthly salary of P12,000 to P21,000.00 (SSL 5 Table First Tranch, 2021). As regards classification of employees, 49, 36 and 20 are classified under VSL, TL and COS respectively. The data imply that majority are in permanent position and almost fifty percent are enjoying their vacation and sick leave.

Table 4. Profile of employees in terms of salary grade level, and classification.

Category	Frequency (n=105)	Percent
Salary Grade Level		
5 and below	40	38
6-10	10	10
11-15	31	30
16-20	18	17
21-25	5	5
26-30	1	1

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Classification		
VSL	49	47
TL	36	34
COS	20	19

Scores on the individual scales reveal specific areas in which the employees may be experiencing difficulty. Scores on anxiety scale reflect how much a client is experiencing the physical and psychological correlates of anxiety. Table 5 reveals that 24 (23 percent) are classified under high and very high. These high scorers are likely to be experiencing muscle tension, increased vigilance and scanning in their environment, and such signs of autonomic hyperactivity, as rapid and shallow respiration. They may also have undue concerns and worries about real or expected life events, which they may experience as unwanted thoughts.

When it comes to depression, among the 105 employees, 52 of them are experiencing physical and psychological correlates of depression. These employees may be easily or chronically fatigued and may have lost interest or pleasure in normally enjoyable activities. They may be affected by feelings of sadness and hopelessness that they cannot seem to combat on their own. They may withdraw from their friends and peers. They also be experiencing suicidal ideation.

The scale on self-esteem problems is a measure of general self-esteem. There are 28 (27 percent) of the employees who scored high and very high. These employees tend to be self-critical and dissatisfied with their perceived skills, abilities, or achievement in comparison to their peers. They may see themselves as unassertive, excessively sensitive to criticism from others, or physically or sexually unattractive.

For interpersonal conflict, this reveals the extent to which an individual experiences conflict with or expresses hostility towards co-employees and superiors. Among the 105 employees, 24 or 23 percent have high to very high scores. These employees may reflect a distrustful, argumentative ways of relating to both coworkers and superiors. They may even blame them for their pressing concerns at work.

Work adjustment is an indicative of the level of satisfaction an employee finds with such features of work as pay, opportunity for advancement, working conditions and sense of control over one's job. There are eighteen (17 percent) employees who suffer dissatisfaction with their job. These workers are likely to be dissatisfied and manifest a poor fit with working environment. They tend to have low motivation and may perform their job below par.

Scores on the scale of problem minimization suggests how much a client belittle the extent the seriousness of a concern. There are eighteen employees who externalize responsibility for their problems and they may even become defensive when confronted about their issues. They may also tend to be resistant to receive help for their problems including to counselors and other professionals.

Lastly, the scores on effects of substance abuse, manifests how much a person is experiencing difficulties in social, and vocational performance as a result of substance abuse. As reflected in table 5, there are 23 (22 percent) among the employees who may be experiencing guilt or shame about their substance use or embarrassment about behaviors they engaged in while they are in the influence of alcohol or drugs. Moreover, there may be disagreement with friends or loved ones as a result of consumption of drugs or alcohol. In addition, there may be physical health hazards as well. Absenteeism form work and associated job performance may also arise.

Table 5. Level of mental health of employees.

Category	**Frequency (n=105)**	**Percent**
Scales		
Anxiety		
Low	52	50
Average	29	28
High	17	16
Very High	7	7
Depression		
Low	9	9
Average	44	42
High	36	34
Very High	16	15
Self-esteem Problems		
Low	34	32
Average	43	41
High	23	22
Very High	5	5
Interpersonal Conflict		

Low	50	48
Average	31	30
High	17	16
Very High	7	7
Work Adjustment		
Low	48	46
Average	39	37
High	13	12
Very High	5	5

Table 6 shows that among the five scales of mental health, only work adjustment reflects that there is a significant relationship between male and female employees. Moreover, this signals that there is no sex difference when it comes to concerns on anxiety, depression, self-esteem problem, and interpersonal conflict.

Table 6. T-test results comparing male and female on mental health.

Variables	Mean	S.D.	t-value	Prob.	Statistical Inference*
Scales			-1.377	.172	Not significant
Anxiety					
Female	1.67	.993			
Male	1.95	.931			
Depression					
Female	2.47	.827	-1.413	1.61	Not significant
Male	2.71	.875			
Self-esteem problem					
Female	1.86	.941	-1.857		
Male	2.18	.772		.066	Not significant
Interpersonal conflict					
Female	1.81	.932	-.209	.835	Not significant
Male	1.85	.970			
Work adjustment					
Female	1.60	.791	-2.092	.039	Significant
Male	1.96	.881			
tested at 0.05 level of significance					

Age is significantly related to self-esteem problem. The older an individual, the lesser the concerns when it comes to self-esteem problems.

Table 7. Relationship between age and mental health

Scales of mental health	r-value	Prob.	Statistical Inference*
Anxiety	-0.067	.500	Not significant
Depression	0.103	.296	Not significant
Self-esteem problem	-2.87	.003	Significant
Interpersonal conflict	-0.33	.741	Not significant
Work adjustment	-0.41	.677	Not significant
tested at 0.05 level of significance			

Civil status has no bearing on any of the five scales of mental health, anxiety, depression, self-esteem problem, interpersonal conflict and work adjustment.

Table 8. Relationship between civil status and mental health.

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Scales of mental health	df	Computed x^2	Probability	Statistical Inference*
Anxiety	6	2.996	0.809	Not Significant
Depression	6	3.185	0.785	Not Significant
Self-esteem problem	6	3.408	0.756	Not Significant
Interpersonal conflict	6	4.320	0.633	Not Significant
Work adjustment	6	3.313	0.769	Not Significant
**tested at 0.05 level of significance*				

Among the five scales of mental health, there were four which is significantly related to highest educational attainment. The findings suggests that educational attainment has an influence to an employee, mental health particularly on the four scales, anxiety, self-esteem problem, interpersonal conflict and work adjustment.

Table 9. Relationship between highest educational attainment and mental health.

Scales of mental health	df	Computed x^2	Probability	Statistical Inference*
Anxiety	30	51.140	0.009	Significant
Depression	30	40.421	0.097	Not Significant
Self-esteem problem	30	56.129	0.003	Significant
Interpersonal conflict	30	48.326	0.018	Significant
Work adjustment	30	58.210	0.002	Significant
***tested at 0.05 level of significance**				

The occupational group an individual belongs to influences mental health on three scales: anxiety, self-esteem problem and work adjustment.

Table 10. Relationship between occupational group and mental health.

Scales of mental health	df	Computed x^2	Probability	Statistical Inference*
Anxiety	12	25.077	0.014	Significant
Depression	12	19.416	0.079	Not Significant
Self-esteem problem	12	41.538	0.000	Significant
Interpersonal conflict	12	13.513	0.333	Not Significant
Work adjustment	12	27.496	0.007	Significant
***tested at 0.05 level of significance**				

The category whether an employee is a teaching or non-teaching has a bearing on mental health particularly on the scales, anxiety, self-esteem, and work adjustment as shown in table 11.

Table 11. Relationship between category of employees and mental health.

Scales of mental health	df	Computed x^2	Probability	Statistical Inference*
Anxiety	15	26.485	0.033	Significant
Depression	15	21.243	0.129	Not Significant
Self-esteem problem	15	44.461	0.000	Significant
Interpersonal conflict	15	21.425	0.124	Not Significant
Work adjustment	15	28.638	0.018	Significant
***tested at 0.05 level of significance**				

Salary grade is significantly related to the four scales (anxiety, depression, self-esteem problem and work adjustment) of mental health.

Table 12. Relationship between salary grade and mental health.

Scales of mental health	r-value	Prob.	Statistical Inference*
Anxiety	-.297	.002	Significant
Depression	-.251	.010	Significant
Self-esteem problem	-.438	.000	Significant
Interpersonal conflict	-.093	.348	Not Significant

Work adjustment	-.225	.021	Significant
tested at 0.05 level of significance			

Only anxiety and self-esteem problems are influenced by the classification where an employee belongs. Classification means whether an employee is enjoying a vacation sick leave, teacher's leave or a contract of service classification.

Table 13. Relationship between classification of employees and mental health.

Scales of mental health	**df**	**Computed x^2**	**Probability**	**Statistical Inference***
Anxiety	6	13.108	0.041	Significant
Depression	6	6.004	0.423	Not Significant
Self-esteem problem	6	19.558	0.003	Significant
Interpersonal conflict	6	6.260	0.395	Not Significant
Work adjustment	6	9.339	0.155	Not Significant
tested at 0.05 level of significance				

SUMMARY AND CONCLUSIONS

- The older a person, the better its work adjustment
- Employees' profile has a bearing on mental health

RECOMMENDATIONS

The training officer must utilize the findings of this study for employees' enhancement. Moreover, it is highly recommended that another test be given to validate the findings of this research.

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Mapping of Drinking Water Resources in Aparri, Cagayan: Its implication to a design of a Decision Support System

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ABSTRACT: Water quality and assessments, being the primordial health need of a person have attracted many researchers across the globe. This study focused on the mapping of drinking water thru GIS, and its assessment as a primary input to yield an inhibiting factor to evidence-based decision making. The study utilized the software development method and descriptive research design in the data collection, and data analysis. System development utilized the Design Science Research (DSR) model and integrated GIS tools. Concerned LGU personnel and members of the community households including owner or recipient of sources of drinking water were surveyed and interviewed to elicit problems and issues. The assessment of the proposed system as regards its extent of compliance to ISO 25010:2011 software quality characteristics was obtained through a validated 5-point Likert survey questionnaire administered to 10 IT experts, Sanitary Inspector and staff, and Barangay officials. Drinking water maps obtained from GIS-based results were beneficial in providing meaningful and reliable information to governing bodies to unveil facts on the status of sources of drinking water as well as to implement effective monitoring, managing, and operation in ensuring the quality of water. The findings of the study would serve as baseline data for decision-makers to implement strategies towards sustainability. This project would provide a decision-support tool in tracking the health risks of drinking water resources in Aparri, Cagayan, Philippines.

Keywords: *Mapping, Drinking Water, Decision Support System*

INTRODUCTION

Water quality and assessments, being the primordial health need of a person, have attracted many researchers across the globe. Unfortunately, it is becoming more difficult to provide potable water to the rapidly expanding human population due to the depletion of water sources and increasing pollution making it toxic to the environment and the increasing population. Water pollution has a very negative effect that is regarded as detrimental to public health that it should never be compromised.

Primary drinking water standards regulate microbial pathogens which is the most critical. These standards set a limit-the Maximum Contaminant Level (MCL)-on the highest concentrations of certain microbial content allowed in the drinking water supplied by a public water system (COTF.edu, 2004).

Water Quality Assessment in the Philippines. Israel (2009) in his paper, Local Service Delivery of Potable Water in the Philippines: National Review and Case Analysis mentioned that the available data on access to safe drinking water in the Philippines have been conflicting. As earlier mentioned, ADB (2007) stated that for the Philippines in 2004, overall water supply coverage achieved was 85 percent. On the other hand, surveys of the National Statistics Office (NSO) indicated only a slight improvement in access to safe drinking water from 80.0 percent in 2002 to 80.2 percent in 2004 while the Joint Monitoring Program for Water Supply and Sanitation of UNICEF and the World Health Organization (WHO) showed a declining trend from 87 percent in 1990 to 85 percent in 2004. Based on the conflicting data on access to safe drinking water in the Philippines, it appears that nationally the MDG of 86.6 percent of the population.

The issues associated with water potability and health. In the study of Aryal, J., it was concluded that coliform contamination, a microbiological analysis, to be the major problem with drinking water. He further says that morbidity and mortality rates from water-borne diseases are considered high particularly among Children below the age of five. Water pollution is the most serious public health issues. As stated by Aryal, it was recently proven to be the biggest health threat worldwide.

To address this, the widest dissemination of information and management on potable water through technological advancements could be made. Thus, GIS-based mapping on drinking water is timely and must be developed to support the assessment of potable water in Aparri in terms of its microbiological attributes, specifically E.Coli and coliform, by consolidating all available datasets under a relational database, facilitating quality control and data entry, offering easy access to raw data, and providing processed results or generated reports.

Objectives

General Objectives:

This study aims to review the prevailing status of the quality of drinking water at Aparri through water analysis to be integrated into the design, development, and implementation of a Geographic Information System with a decision support system.

Specific Objectives:

Specifically, this study aims to provide answers to the following problems:

1. What are the practices, processes, and management of the quality of water in Aparri, Cagayan?
2. What is the assessment of the accredited laboratories on the water samples along with their microbiological qualities?
3. What proposed system can be developed to address the identified problems and issues?
4. What is the level of compliance of the developed system to ISO 25010:2011 software quality standards as assessed by the experts and end-users in terms of software characteristics?
5. What enhancement can be done to improve the water quality?

REVIEW OF LITERATURE/CONCEPTUAL FRAMEWORK

National to Local Thrust

Millennium Development Goals (MDGs) target that 86.6 percent of the population of countries would have adequate access to safe drinking water by 2015 (NEDA 2007). UNDP set the 17 Sustainable Development Goals (SDGs) including Goal 6: Ensure Access to Water and Sanitation for All (Sucuano, 2019). National Water Resource Board (NWRB) Listahang Tubig (Water Register) program, United States Agency for International Development (USAID)-Be secure (Water Security for Resilient Economic Growth and Stability) has committed to surveying 6 focus provinces: Cagayan, Iloilo, Leyte, Misamis Oriental, Maguindanao, and Basilan. (Listahang Tubig, n.d.)

Health Issues

The United Nations Development Program (UNDP), one of the 10 facts and figures it stated is, each day nearly 1,000 children die due to preventable water and sanitation-related diarrheal diseases. In the region, it is important to note that the DOH statistical report on water-borne diseases significantly increased to 20.57% as of 2018 compared to 2017, from 1123 to 1354 cases of acute bloody diarrhea.

In Aparri, survey results consolidated at the office of the Sanitary Inspector shows that acute gastroenteritis is among the ten leading diseases in Aparri. Further, mortality and morbidity status of water-borne diseases ranked 6th and 5th among the leading ten diseases with their rates of 24.36% and 10992.23% respectively. Specifically, Acute Gastroenteritis, Amoebiasis, Typhoid, Diarrhea, Intestinal Parasitism, and Dermatitis were the most listed water-borne diseases in Aparri Hospitals (W. Selby Hospital; Toran District Hospital). The pathogens that cause these mortality and morbidity rates include E. coli, E. hystolytica and amoeba, which comes from the environment and animal and human feces.

Geographical Information System

Geographic Information Systems (GIS), remote sensing, and mapping have a role to play in all geographic and spatial aspects of the development and management in an environmental parameter. Satellite, airborne, ground, and undersea sensors acquire much of the related data, especially data on temperature, current velocity, wave height, chlorophyll concentration, and land and water use. GIS is used to manipulate and analyze spatial and attribute data from all sources. It is also used to produce reports in map, database, and text format to facilitate decision-making (Kapetsky & Aguillar-Manjarez, 2014). Meanwhile, GPS technology helps with traffic routing, underwater surveying, navigational hazard location, and integrated mapping (Hentry, Rayar, Saravanan, Chandrasekar, & Raju, 2011).

According to Alum-Udensi, Egesi, & Uka, (2016), a global positioning system (GPS) and Global Information Systems (GIS) are becoming a widely used tool in agriculture. Its usefulness in land and water mapping, flood and pollution management, disease monitoring, species ecology, and conservation studies is only limited by the proficiency of the users. Radiarta, et.al (2011) exclaimed that with the development of the geographic information system (GIS) and availability of remote sensing data, it is now possible to select environmentally suitable areas rapidly and systematically.

In the age of information and technological advancements, location awareness is becoming a key feature in the management of natural resources. Geospatial mapping is a location-based study and is a part of intelligence GIS which is expected to be a useful tool for aquatic resource managers and policy planners in developing and planning strategies in India. In a 2011 study performed on the mapping using GIS with critical geographic dimensions data of West Bengal was accessed and integrated with different sources at the district level. Data will be tabulated using Microsoft Excel and then joined to digitize Map of West Bengal to enable mapping using Arc info 9.3 GIS software. This was further synchronized and integrated to generate four thematic maps based on different criteria. With mapped information, planners and various stakeholders will have readily accessible district-level data on various components of fisheries of West Bengal, thereby facilitating better planning, management, and development of the fisheries sector (Singh, Pandey, & Sinha, 2011).

Geographical Information System - based spatial planning gives us the projection scenarios of various physical and biological parameters and will help the scientists to come out with suggestions on species suitability for cages, carrying capacity of the water body, stocking density of the cages and the best feeding strategies and feeding schedules incorporating all chemical, biological and physical features. GIS projections are capable of resolving conflicts for space and resources between stakeholders and also to help to understand the social acceptability and

the economic implications of mariculture. According to Dinesh, babu, Thomas, & Rohit (2014), spatial planning and modeling with GIS, especially in marine systems in India, is still in a nascent stage.

The global economy is at a pivotal point and as economies realize the importance of leveraging geospatial technologies to stimulate economic growth and bridge the evident socio-economic gaps, the need to assess and evaluate the geospatial preparedness of the country becomes imperative.

From the above literature, the study aims to address the necessity of effectively monitoring, managing, and operating of Geographic Information System-Based mapping of drinking water resources in Aparri, Cagayan, and its implication to a design of a decision support system to promote awareness of the community especially to the poor and waterless areas in Aparri. It further deems necessary as a basis for better decision-making in sustainable development for water resources.

PROCEDURE/METHODOLOGY

The study utilized the software development method and descriptive research design wherein data collection, data analysis, and system development and integrate GIS-DSS tools.

Along with data collection, the researcher interviewed the concerned offices, specifically the office of the Sanitary Inspector. Water source owners/recipients were also included in the interview process for validation. Further, document analysis was done by requesting sample documents about monitoring water sources. The researcher was also personally involved in getting water samples subjected for testing.

As to the evaluation of the system, the data were gathered with the use of a survey questionnaire to describe the assessment of the respondents regarding the system, Geographic Information System-Based Mapping of Drinking Water with Decision Support System.

RESULTS AND DISCUSSIONS

This chapter presents analysis and interpretation of data, results, and findings in the light of the specific objectives of the study. Discussions are provided after each tabular presentation of the treated data.

I. Summary of the Current Practices/Processes and Management Involved in Monitoring Drinking Water Resources

The current practices/processes and management in the monitoring of drinking water resources in terms of their quality for the consumption of the community are presented in the succeeding paragraphs. From the interview, triangulation validation, and document analysis, the following were the issues and problems noted:

1. The monitoring of drinking water sources carried out by the Sanitary Inspector cascaded to the barangay health workers was conducted through a survey which comprised of the different types of water sources, the number of households, and populations served. The results were written on loose sheets. These were consolidated and generated for reporting purposes. They were posted via the bulletin board.
2. Water refilling stations were regularly subjected to laboratory testing. The Sanitary Inspector reached out to Purified Water refilling stations, got a sample with its corresponding fees for testing in an accredited laboratory. He also evaluated the laboratory results if the water station complied with the standards and conducted a regular or immediate sanitary survey during the existence of a potential cause of contamination. This is in conformance to the mandate to continue providing capacity building programs and technical assistance to WSPs on water and sanitation. The United Nations Development Plan (UNDP) set the 17 Sustainable Development Goals (SDGs) including Goal 6: Ensure Access to Water and Sanitation for All (Sucuano, 2019). The results were just kept in a filing cabinet. There were no pronouncements of issues on the quality of drinking water in the locality and no releasing of necessary corresponding advisories. The water consumers generally acknowledged that water from water refilling stations has always been microbiologically tested and free from contaminants.
3. The water sample laboratory testing was only done to purified water refilling stations. All other water sources, home wells (shallow pump well and open dug well), were not tested and no assessment mechanism was applied. Water consumers using this type had a notion that they were “used to it” without checking and testing for safe consumption. This is a non-compliance with the SDG Goal 6: Ensure Access to Water and Sanitation for all; national strategies cascaded to the LGU to monitor potable water supply of selected poor communities through Tap Watch Program, and complete the groundwater resource inventory/assessment in major urban areas and surface water in rural areas. Hence, the Sanitary Inspector convinced owners/recipients to do some laboratory testing but it was not prioritized due to financial constraints though they were willing to undergo such process. Even though, owners/recipients may request for disinfection-by-products like Chlorine from the Municipal Health Unit.
4. The LGU provided pump wells to different barangays but there was no regular and strict observance of remedial technical measures to correct the deficiency of the water system. This practice was not in compliance with the law mandated specifically on the sharing of responsibility of providing local quality drinking water service among local government units. Section 17 of the law mandated the barangays to maintain water supply systems; the municipalities and cities should put up small water-impounding projects,

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artesian wells, spring development, rainwater collectors, and other water supply systems. Such non-compliance was due to no follow-up monitoring on the maintenance of provided pumps. Home wells (shallow pump well and open dug well) were treated using the usual/traditional way of maintenance.

5. Barangay Health workers used to conduct an informal interview with the water source owners/recipients but sometimes they gathered inaccurate data due to inability or unwillingness to provide actual data by the Well owners and even denial of the actual scenario like the real source of their drinking water and its effects.
6. There was no geographical point location on the sources of drinking water in Aparri where people could easily locate areas of the quality source of drinking water and make it known or available to the poor and waterless households.
7. There was no enforcement of local policies concerning the implementation of water quality surveillance programs like conferring the designation of the members of TWG for proper monitoring. Like EO 421 of 2005 that refocused the LWUA's mandates, functions, and organizational structure as envisioned in EO 279. Likewise, there was no endorsement for annual work and financial plan on water quality surveillance to the municipal council. Moreover, there was no regular meeting to conduct a water quality audit.

II. Assessment of the accredited laboratories on the water samples along with their microbiological qualities?

Table 1. Samples' GPS Locations and E.Coli and Coliform counts

Type	Samples	N	E	E. Coli	Coliform
ODW	S1	18°18'16.5"	121°39'31.0"	35	65
ODW	S2	18°19'06.5"	121°39'17.0"	6	21
ODW	S3	18°19'08.7"	121°39'16.4"	0	3
SPW	S4	18°19'15.4"	121°39'15.6"	0	0
ODW	S5	18°19'38.2"	121°39'08.9"	2	2
SPW	S6	18°19'47.7"	121°39'06.5"	0	0
SPW	S7	18°20'01.5"	121°39'01.8"	0	0
SPW	S8	18°20'14.1"	121°38'55.8"	0	0
SPW	S9	18°20'31.4"	121°38'42.8"	0	0
SPW	S10	18°20'31.3"	121°38'43.2"	0	0
SPW	S11	18°20'45.8"	121°38'29.7"	0	0
SPW	S12	18°20'46.0"	121°38'30.0"	0	0
SPW	S13	18°20'47.1"	121°38'29.7"	0	0
SPW	S14	18°20'56.7"	121°38'38.3"	0	0
SPW	S15	18°20'56.0"	121°38'37.6"	0	0
SPW	S16	18°20'56.3"	121°38'38.3"	0	1
SPW	S17	18°20'32.7"	121°38'50.6"	0	0
WPS	S18	18°20'54.1"	121°38'30.1"	0	9
WPS	S19	18°20'53.6"	121°38'30.5"	0	1
WPS	S21	18°20'43.6"	121°38'37.3"	0	4
WPS	S22	18°19'45.4"	121°39'07.2"	7	72

*Legend: **ODW**–Open Dug Well, **SPW**-Shallow Pump Well, **WPS**-Water Purifying Station*

III. Geographical Information System (GIS) - based Drinking Water Mapping with Decision Support System, (GISWaterMap)

The analysis, design, development implementation of the system were fully customized integrating effective, efficient, and secured data management of drinking water as well as the implementation of a decision support mechanism. A comprehensive information bulletin feature was developed to address the identified problems and issues in the existing system. After a careful review of the documents, practices, testing, and result of the interview made, a viable information system (GISWaterMap) was developed which aims to aid the Sanitary Inspector and other implementing bodies in addressing the identified problems and issues encountered in this study. It also serves as an advocacy material for possible health implications acquired from contaminated drinking water and generates

accurate information for policy-makers to take action on the said issues and problems regarding the monitoring of quality drinking water.

The Developed System – GISWaterMap

The overall functionality of the system, powered by Google Maps API, enables users to view the locations in satellite mode dynamically; provides information as to who owns or the responsible person for the water source; includes display the health implications based on datasets inputted; provides visual statistical views on the exceedance level of contaminants found on the sample, and manages accounts. It enables the users to add, edit, delete, search and print records depending on the account type of the current user.

The figure presents the screenshots of the developed system. The database schema defines the back-end of the system. The system can be accessed via smartphones, desktops, and laptops. Furthermore, it can be viewed without issues with the compatibility of browsers. It is compatible with almost all browsers.

The developed web application, GISWaterMap, is a MySQL database-driven portal coded, available and accessible online with the aid of the XAMPP development framework. This system integrates the live Google Maps API; dynamically includes live maps, degree of contamination, physical attributes, and more importantly the health implications.

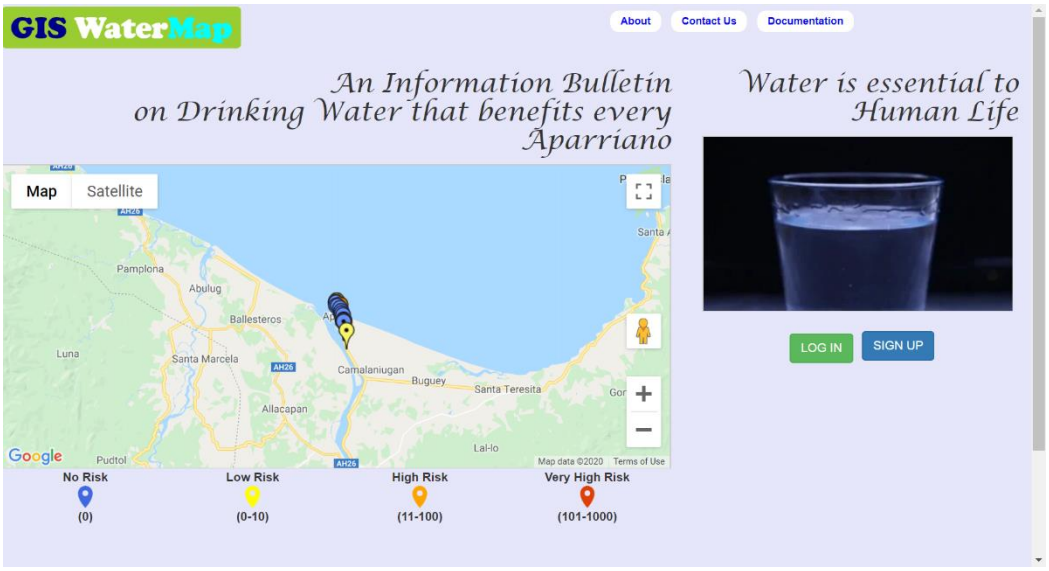

Figure 1. The System's User Interface

The GISWaterMap's home page is presented in figure 8. It provides live maps displaying pinned water source locations with some of its attributes (longitude-latitude, barangay location, type of water source, and responsible person); login/sign-up form; information about the system; and details on how to be in contact with the administrator. The color-coded pinned locations are an output of the Decision Tree Algorithm implemented considering the level of microbiological contamination of the sample tested on those specific locations. This serves as an information bulletin that by merely looking at the map with the color display it easily recognizes the status on the quality of drinking water.

IV. Extent of Compliance of the Developed Application to the ISO 25010 Software Quality Standards

This finding implies that the system is well suited to convenience and ease of access. This finding agrees with the result of Sobejana (2014) in his study "Electronic Maternal, Neonatal, Child Health and Nutrition with GIS and DSS" particularly in providing a choice of compatible interfaces in utilizing the system.

Table 1. Summary Table of the Assessment of IT Experts on the Extent of Compliance of GISWaterMap to ISO 25010

Criteria	IT Experts (N=10)	
	Weighted Mean	**Descriptive Interpretation**
1. Functionality	3.72	High Extent
2. Reliability	3.78	High Extent
3. Usability	3.82	High Extent
4. Efficiency	3.87	High Extent
5. Maintainability	3.92	High Extent
6. Portability	3.90	High Extent
7. Security	3.48	High Extent
8. Compatibility	3.57	High Extent
Overall Mean	**3.76**	**High Extent**

The overall assessment of the IT experts is presented in table 14. Results show that the developed system is compliant to a high extent in all the criteria set by ISO 25010. This is in line with Marzanah, et al. (2013) in his study "Assessing the usability of university Website from user's perspectives". The study opined that different perspectives derived from the area of specialization give a different evaluation. Similarly, the assessment made by the different groups of participants is consistent with the standards, making the developed system adhere to the known norm of software quality worldwide, the ISO 25010 (Forouzani, Chiam, et. al 2017). This implies that the GISWaterMap has sustained a significant level of conformity to software quality standards. Similarly, the perceived compliance with the norm reflects the overall positive impression (Ahmed, Espinosa, et al, 2015).

V. Suggested Enhancement that can be made for the Developed System Application

Based on the suggestions made, additional features to be integrated to enhance the developed GISWaterMAp include automatic SMS notification updates on the status of drinking water and a more mobile-friendly interface. On the lighter side, the drinking water consumers highly appreciated the developed GISWaterMap for providing processed information that served as an input for better monitoring strategies; for the sustainability of drinking water sources, and for ensuring water quality for public consumption.

SUMMARY AND CONCLUSIONS

Summary

The ultimate goal of the study was to analyze, design, develop and implement a viable system web application for the Sanitary Inspector and the staff of the Municipal Health Office – LGU Aparri. This included modules such as GIS-based mapping as well as a decision support system associated with health risks. Based on the results of the study, the following is the summary of findings:

1. Evidenced by the series of interviews, and document reviews, problems exist in the current monitoring and management of operations about drinking water surveillance based on the assessment of the water consumers, the end-users, and IT experts. These include discrepancies and even lack of reports, inefficiency in the recording and report generation along with drinking water surveillance, data loss, and time-consuming generation of needed reports for management purposes. Participants assessed the current management of drinking water with varying perspectives. In particular, the unavailability of the scientific update along with geographic location, laboratory testing to determine the level of contamination, and trends associated with drinking water crucial to health risks among water consumers was highlighted. Besides, the inability of cause identification, information for policy-makers, safety and security, and timeliness associated with the reports of the status of drinking water as well as the inability of the Sanitary Inspector to closely monitor the location, status, and health trends were emphasized.
2. Going through the system development process, the Geographic Information System (GIS)-Based Mapping with Decision Support System or GISWaterMap was developed following thoroughly the processes incorporating mapping from GPS tag points and decision-support system thru decision tree algorithms as well as utilization of tools including Google API, and Google Maps that derive the features of the live system.
3. The assessment on the extent of compliance of the GISWaterMap to ISO 25010:2011 and ISO 25023:2016 have been conducted to ten IT Experts involving seven qualified IT Faculty Members of the College of Information and Computing Science and IT personnel from the LGU, the Sanitary Inspector and staff of LGU Aparri, and the Barangay Captains with their Barangay Health Workers of the three barangays where the researcher piloted the study.
4. The system application, GISWaterMap, has been generally found compliant with the software quality criteria of the ISO 25010 software quality to a high extent or satisfactory as assessed by the IT Experts. This suggests the overall usefulness, completeness, functionality, and performance of the developed application in support of the operations and management in monitoring the location, status, and health implications of drinking water in Aparri.
5. The usability acceptance level as assessed by the user implies that the users highly recognize the potential of the GISWaterMap in providing useful information to the water consumers.
6. Additional features to be incorporated in the enhancement of the developed GISWaterMap include the provision for reminder notification thru the portal along with the status and surveillance report without the Sanitary Inspector visiting all the persons responsible for water sources; thus, saving time and resources. The Sanitary Inspector and staff also commended the provision of the GISWaterMap ably supporting their monitoring, data management, and the improvement of the delivery of services to the community through channels in Aparri.

Conclusion

Based on the findings of this study, the researcher concludes that the developed Geographical Information System (GIS)-Based Mapping of Drinking Water, as a decision-support and management can greatly address the prevailing issues and problems along with monitoring operations and management of drinking water. The results of this study could be very useful and valuable to concerned authorities to be more proactive and responsive in ensuring quality drinking water.

Recommendations

From the findings and conclusion made, the following recommendations are highly suggested:

1. Upon approval of the local government unit and concerned officials, the Municipal Health Unit – Sanitary Inspector Office may utilize and maintain the developed GISWaterMap for monitoring, management, and provision of an information bulletin and advocacy material thru the portal of drinking water in Aparri. It is hereby recommended to link this web application to the current LGU portal (www.aparri.gov.ph) to reach wider audiences and to improve accessibility.
2. A training may be conducted on the use of the system by the Sanitary Inspector and its staff, and all barangay officials and barangay health workers. The MHU may require all responsible persons to attend the training to increase their awareness and to assist them in the monitoring and management of the quality of drinking water as well as the provision of a relevant, client- specific content uploaded in the GISWaterMap web application.
3. The limitation of this study revolves around water parameters needing further innovation to include multi-parameter measuring device to be connected to the developed system. This, however, may be done by doing another relevant study utilizing advanced tools/devices/equipment.
4. With the continuous use of the GISWaterMap, the SI may institute a policy that may require all water source owners/responsible persons to register and be included in the database for faster monitoring and decision-making, synchronizing and continually updating drinking water-related data without fear of data loss and inconsistencies especially in the report generation.
5. A budgetary allocation may be considered and be stipulated in the local ordinance most especially the provision of intermediary measures on the maintenance, and the testing fees of the water sources. Commercial water providers must have a strict compliance with the rules and regulations imposed by the LGU thru the Sanitary Inspector, that penalties for violators need review. Hence, the LGU and MHU may look into a multi-sectoral review of the local ordinance considering sustainability issues on drinking water.

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