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Hazard Assessment on Households Electrical System of Barangay Sinabbaran, Angadanan, Isabela, Philippines

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Abstract

Electricity is the most adaptable energy; it is one of the best gifts for humanity. Barangay Sinabbaran, Angadanan, Isabela, an adopted barangay of the Isabela State University Angadanan Campus, had 42 registered member-consumers. Its constituents requested assistance to fix the electrical system, hence this study was conducted; specifically, it sought to: know the personal profile of the registered consumers; inspect and record load conditions; and assess the electrical system in terms of safety, efficiency and reliability. A questionnaire and walk through audit were administered for data collections using total enumeration. Frequency and percentages were used to interpret data. Using energy-saving lighting fixtures was noted among consumers. Most households received acceptable voltage levels, while efficiency and reliability conditions were good enough based on instrument reading and interview results.

Their present system can supply the possibility of future loads. However, most occupants made extension lines violating PEC and local electric provider best practices. The use of undersize or inappropriate materials was significant; such materials were preferred for economic reasons setting aside safety considerations. An indication that most residents were not responsive to their actions posting hazard or threat to life, living, and property; hence immediate measures for repair and replacement of electrical parts are necessary.

Index Terms: *Electrical Technology, hazard assessment, inspection and walk through audit, Sinabbaran, Angadanan, Isabela, Philippines*

I. INTRODUCTION

Electricity is the most versatile form of energy. It can be transformed into another form by way of devices as converters of energy. Its applications are immense, and it is one of the best gifts to man. The Isabela 1 Electric Cooperative Inc. (ISELCO 1), a local electric service utility, provides electricity for central and southern Isabela, including Barangay Sinabbaran, Angadanan, Isabela. This community was identified and adopted by Isabela State University Angadanan Campus as the center of its extension activities and had 42 registered member-consumers of ISELCO 1.

One of the concerns for any connected household entity after the energization of any barangay is the maintenance and monitoring of their electrical system, wherein this is no longer a concern of the service provider.

From there on, these consumers start to increase electrical loads. Aside from this is the possibility to make extension outlets to meet their higher electricity demand. Most of the time, extension lines were done by a handyman or even the occupant themselves without examining the effects of extension lines. These practices often violate provisions of the Philippine Electrical Code (PEC)and other national codes about the safety of

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using electricity. As regularly noted, no special attention on the electrical system as long as they can pay their monthly bills unless there were troubles in their electrical system. According to Blades (2006), after ten years or more of continuous use, wire insulation dries out and cracks, contacts become loose, light sockets degrade from heat, switches lose their spring, and numerous other aging process takes their toll.

One of the identified extension activities during the consultative meetings with barangay constituents is the review of the household electrical system; hence, this study aimed to review the existing household system if it can still guarantee the safe use of electrical energy. Also, from this study, it helps identify potential hazards in electricity and for researchers to give suggestions on how to improve the electrical system to be more efficient, reliable, and safe.

II. OBJECTIVES

Specifically, it is the objectives of this study to:

1. Know the personal profile of the registered consumer in terms of Income status; a house built, number of end-user per household;

2. Inspect and record load conditions of the individual home and;

3. Asses household electrical system in terms of safety, efficiency, and reliability.

Significance of the Study

The researcher believes that this study is beneficial to the following:

Resident End-users. Results of system inventory serve as the basis for system improvement for every household. Most of all, the study may identify the electrical hazard and eventually avoid severe injuries to occupants and safeguard properties against improper use of electricity.

Electric Utility. The system assessment would be helpful on the part of the electric provider since troubles that can ring unnecessary brownouts were avoided; a healthy household electrical system can mean a significant impact on the reliability of the whole franchise system of the utility.

Fire Authorities. The output of this study will help them strengthen the implementation and compliance of the provisions of the fire code of the Philippines, particularly on the safety and prevention issues of community members.

Institution. The involvement of teachers and students will give them an idea of how to maintain the electrical system. These bridge the gap between theories and actual practice for better learning.

Researchers. The findings may be the basis for other similar studies. The study can also encourage other researchers to study the electrical system of different barangays, even with a more significant population.

Scope and Delimitations of the Study

The primary focus of the study is to assess the electrical system conditions for all households using electrical energy. The study covers registered and non-registered ISELCO 1 members of Barangay Sinabbaran, Angadanan, Isabela. Technical considerations are sizes of circuit protection and wires, actual or connected electrical lighting and appliances, approved wiring methods, and accessories used. A significant analysis of the study is to determine if the electrical system set-up is adequate for existing and possible future loads. Another scope of the study is the application and observation of constituents' cost-saving measures.

Review of Related Literature

The U.S. National Fire Protection Association estimates that there were 38,300 residential fires of electrical origin in 1998, resulting in 284 deaths and 1184 injuries and $ 668M in direct property damage (NFPA's U.S. Home Product Report, January 2002). In the Philippines, a 2012 study done by the DOH –

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Health Emergency Management Staff (HEMS) revealed that fires constituted 39% of all events reported to the Health Emergency Alert Reporting System (HEARS). The report is quite high, considering many causes of emergency cases. Figure 1 shows fire events by reason. The causes of the majority of fires were undetermined at the time the HEARS Plus Report, but a specific data given was faulty electrical wiring and neglected open flames as the most common causes of fires reported at 2.9% and 2.4%, respectively.

Further reports said that most fires frequently occurred in NCR. Quezon City and Manila remained the cities with the most number of reported fires in the country. The majority of 10 fires involved residential areas at 70.2%, followed by commercial regions at 16.9%. Table 1 shows fire events by the area affected.

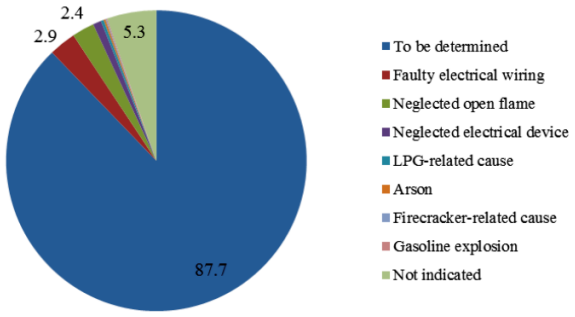

Figure 1.Fires by cause (%)

Table 1. Fire and Fire-Related Casualties by Cause

Cause	Fires		Casualties		Deaths		Injuries	
	No.	%	No.	%	No.	%	No.	%
To be determined	774	87.7	720	87.4	236	85.5	479	88.2
Faulty electrical wiring	26	2.9	13	1.6	8	2.9	5	0.9
Neglected open flame	21	2.4	29	3.5	9	3.3	20	3.7
Neglected electrical device	8	0.9	12	1.5	0	0.0	12	2.2
LPG-related cause	3	0.3	2	0.2	0	0.0	2	0.4
Arson	2	0.2	7	0.8	3	1.1	4	0.7
Firecracker-related cause	1	0.1	0	0.0	0	0.0	0	0.0
Gasoline explosion	1	0.1	5	0.6	5	1.8	0	0.0
Not indicated	47	5.3	36	4.4	15	5.4	21	3.9
TOTAL	883	100.0	824	100.0	276	100.0	543	100.0

Two to three massive fire cases are reported each year in the country, said Renato Sy, deputy fire chief of the Binondo-Paco Volunteer Fire Brigade, as quoted by the Institute of Integrated Electrical Engineers of the Philippines, Inc. (IIEE) magazine. Nearly 30 percent of the fires are "electrical in origin." IIEE President, Armando Diaz, launched the Electrical Safety Enforcement and Awareness Campaign, accordingly, it was designed "to enhance the enforcement of the Philippine Electrical Code to ensure electrical safety in residential buildings, build capacity for the improvement of local electrical inspectors' skills, and increase public awareness of electrical safety." Meanwhile, BFP-NCR statistics show that most of these electrical-caused fires occur in informal-settler communities.

Related research in August 2013 by the London Fire Brigade shows that vulnerable people are 18 times less likely to have a fire if they receive a home fire safety visit from firefighters. Accordingly, 4000,000 visits were done for the last six years and estimated that these visits had prevented around 5,000 fires from homes. Cooking, cigarettes, and candles cause the majority of fires in homes. About 700,000 homes in London are more at risk from fire. Among those identified at risk are usually affected by the physical and mental conditions of occupants. The need for fire safety visits is, therefore, necessary for every household.

In the 2014 Fire Incidence in the Philippines, most causes of the fire were the electrical connection due to short circuits of appliances. Out of 15,897 recorded fires, 4,116 cases (26%) were electrical related incidence, and billions of pesos worth of properties were turned into ashes. Aside from this, thousands of families were directly and indirectly affected by the same catastrophe. Table 2 shows the number of deaths and injuries for the succeeding years.

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Table 2. Fire incidents in the Philippines

Year	Total Recorded Incidents	Electrical Origin	Percentage
2014	15,897	4,611	29.01
2015	17,138	4,555	26.58
2016	19,292	5,374	27.86
2017	14,197	5,366	37.80
2018	16,681	5,861	35.14

Source: BFP Annual Reports

The Philippine Electrical Code serves as a guide for safeguarding persons and property against hazards for using electricity; its provisions contain minimum requirements to ensure safety and reliability of household electrical system upon installation. The Code highly recommends that for future expansion of electrical use, a licensed electrical practitioner shall be consulted for any electrical requirements, including changes. Failure to do so may result in fire, serious injury, electrocution r death. It is further recommended that the wiring system is inspected and tested by the same authority at least once a year for a wiring system of more than three (3) years in installation (PEC 2009).

According to the Canadian Centre for Occupational Health and Safety, all electrical systems have the potential to cause harm. The voltage of the electricity and the available electrical current in regular businesses and homes has enough power to cause death by electrocution. Even changing a light bulb without unplugging the lamp can be hazardous.

A hazard is any source of potential damage, harm, or adverse health effects on something or someone under certain conditions at work. A hazard can cause injury or adverse effects (to individuals as health effects or organizations as property or equipment losses). At the same time, the risk is the chance or probability that a person will be harmed or experience an adverse health effect if exposed to a hazard. It may also apply to situations with property or equipment loss (CCOHS, 2016).

Hazard Assessment is the process of evaluating and ranking potential hazards. Code and standard are the bases for the evaluation of this study.

Conceptual Framework of the Study

The study made use of the Input-process-output (IPO) model. Essential information like personal and electrical load profiles was gathered using survey questionnaires. The researchers personally conducted the interviews as this work needed technical expertise on load surveys. Inspection is also essential and requires knowledge and skills to relate concerns of residents regarding electrical conditions. As a result, an individual assessment was obtained. After the interview, an occupant can immediately receive the technical status of his/her residence based on data and inspection are done.

INPUT :Profile of Barangay Residents Load Survey Interview Inspection Related Literature and Studies Code and Standard

PROCESS: Assessment and Technical Analysis of Individual Household Electrical System

OUTPUT : Controlled and safe electrical system

III. METHODOLOGY

A walk-through-audit, as defined by Thumann and Younger (2008), was used for this study. Data gathering on the electrical system and inspection was done. Technical questionnaires were floated to the resident respondents using total enumeration. Semi-structured interviews were also held, and two representatives from the community accompanied the enumerators. Other methods were analyses of present and possible loads to assess for future expansion. A data was obtained from the Barangay Management Information System (BMIS) for Sinabbaran, Angadanan, to establish the descriptive statistics on the personal profile of the respondents. Technical parameters were obtained using voltmeter and ammeter; statistical frequencies and percentages were used to evaluate electrical system conditions.

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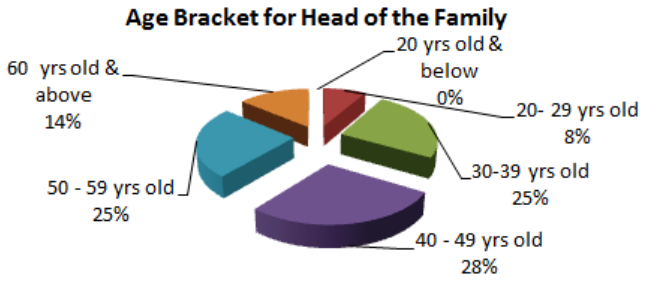
Data Gathering Instrument

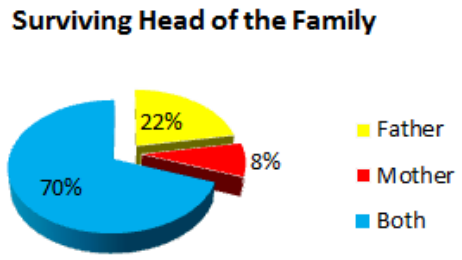
A survey questionnaire form was floated to the 42 household respondents; the team, together with barangay kagawad and barangay health worker, had personally administered the technical survey, interviews, and inspection. The content of the questionnaire was information about the materials and methods used, lighting, and appliance loads. Comments and suggestions of constituents regarding the specific electrical system conditions were noted.

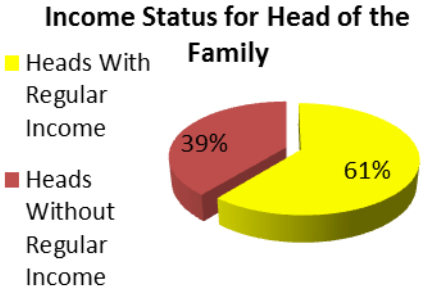
Presentation, Analysis, and Interpretation of Data

Profile of the Respondents

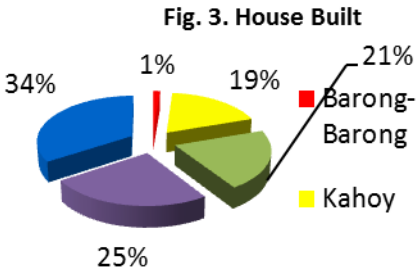
The age bracket for the head of the families was customarily distributed (figure 2a). Most numbered head of the family belongs to the range of 40 – 49 years old with a twenty-eight percent (28%) followed by 30-39 years old, and 50-59 years old, the least with 60 years old and above while no recorded number for the head of the family for 20 years old, and below. During the inspection process, there were young couples who still prefer to stay with their parents, even if they were married already. It was clear that with this distribution of ages, most heads of a family (40-49) can better deal with electrical hazard situations as compared with elders (60 and above) in the barangay.

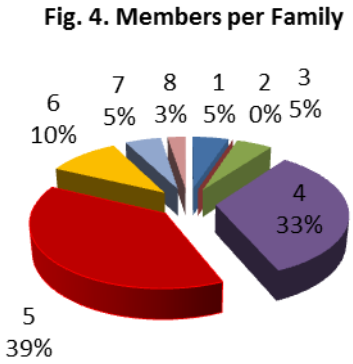






Figures 2a, 2b, and 2c. Profile for Head of the Family





Among the surviving head of the family (figure 2b), 70% of the families at Barangay Sinabbaran have both father and mother, 22% are single fathers, and only 8% for single mothers. Most heads of the family engaged in farming and other labor-related works such as construction workers and janitors in nearby municipalities. Others were having no regular income (figure 2c). These findings manifest their simple living. In terms of house construction, five house classifications were established, most families lived in houses made of combined concrete at wood (34%), and others are pure concrete (25%). At the same time, the rests are kawayan, pawid at sawali (21%), with wood (19%), and barung-barong (1%), as seen in figure 3. The result strongly

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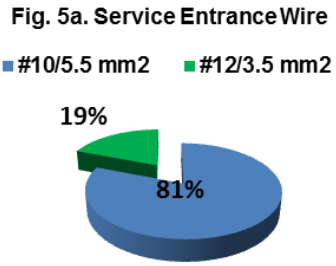
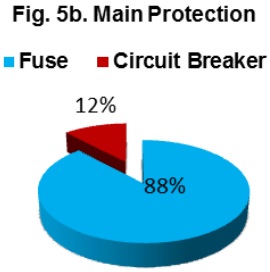
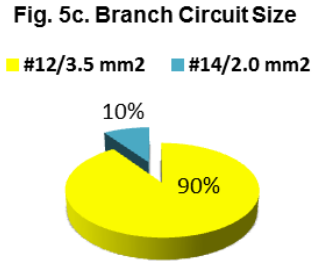
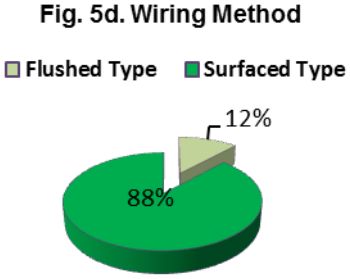
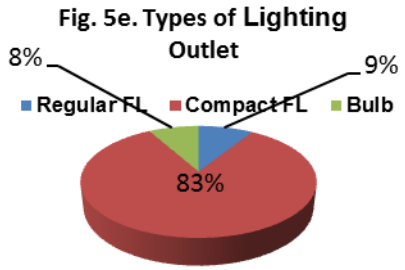
recommends for electrical inspection because most were made of light materials as frequently classified by fire authorities to be vulnerable to shack fires. Figure 4 presents the number of end-user per family having five members at most per family. This number typically will increase, and the increase in power consumption is inevitable. Hence, the necessity to assess future electrical loads is necessary.

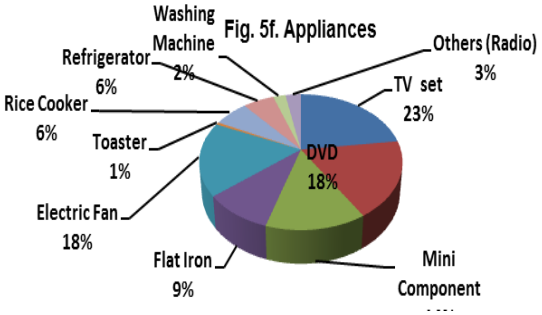












Technical Findings

According to BMIS, there were Eighty-two (82) households at Barangay Sinabbaran. Forty-two (42) were registered ISELCO I consumers. A comprehensive assessment, both visual and diagnostic approaches were presented on figures 5a-5f. It can glance that there were violations on Philippine Electrical Code (PEC) provisions for the house wiring installation when these houses were first wired. Accordingly, for service entrance size of the wire, 19% of registered end-users used the undersize service entrance. The ampacity of wire shall conform to the size of the kilowatt-hour meter (kWHm). For future consideration, if there are short circuits, the cable must be capable of handling conditions at a specific period until a protective device will be activated to isolate any abnormal condition.

Mostly, Class 2 kWHm up to 30 amperes were installed (97.62%), only one energy meter (2.38%) had 100 amperes capacity. It indicates that residences have a typical way of living normally for an average family in the said barangay, this claim is also analogous from the actual power demand for each household having an average of 350 volt-

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ampere. This existing demand, even if it will be doubled in the future, could still guarantee a manageable load and demand conditions.

The primary protective device used was the fuse box with a thirty-ampere rating. It means that almost all have a surfaced-type wiring method using a non-metallic sheathed cable or commonly called duplex wire; this claim is also reflected in figure 3 on the house built where this method is recommended. Compact fluorescent was the favorite lighting fixture for the occupants with a high margin followed by the use of fluorescent and incandescent bulbs. It means that they are aware of the benefits of using compact fluorescents, such as the economy, wattage consumption per unit time, and longer burning hours. The data also revealed a slight difference between the preference for a fluorescent tube and an incandescent bulb.

Almost every household had television sets, and this means that entertainment has become part of the residents, especially at night time. Likewise, DVD units nearly equaled the number of TV sets; it means that residents are fond of viewing movies. Another appliance having a remarkable number is the electric fan; for ventilation, especially at night time, this unit was preferred. No resident was recorded using an airconditioning unit for ventilation. Also, no registered resident using electrical equipment or power hand tools to facilitate works or use for livelihood activities.

Table 3. Households Electrical System Summary of Information for Brgy. Sinabbaran, Angadanan, Isabela

Areas of Concern	Identified Electrical Hazard/s	Percentage (%)	PEC Violation/s	Risk Level
Service dropped and entrance wires	1. Over sag	17.24	1.10.1.12 1.10.2.2 2.30.2.2	
	2. Broken/cracked wire insulation			
	3. No electrical tape/insulation for live wire			
	4. Damaged live wire/grounded			
	5. Open wire			
Kilo-Watt Hour meter	6. Fire prone location	6.9	1.10.1.12	
	7. Dusty and open terminals			
Circuit breaker and safety switch	8. Broken and defective	13.79	1.10.1.12	
	9. Loose terminal screw/broken handle			
	10. Defective/cracked porcelain base			
	11. Improvise fuse			
Branch circuit and extension wire	12. Defective lighting outlet circuit	24.14	1.10.1.12 2.30.2.3(b) 3.30.2. 4(b)(1) 3.10.1.5	
	13. Defective conv. outlet circuit			
	14. Undersize wire			
	15. Hanging wires			
	16. Use of speaker cord			
	17. Too many/octopus extensions			
	18. Telephone cable as extension wire			
Lighting fixtures	19. Frequent busted bulb	10.34	1.10.1.12 4.10.1.3	
	20. No socket altar bulb for kitchen lighting			
	21. No FL tube holder			
Electrical accessories (switch, outlet, receptacle, socket and	22. Temporary and exposed switches		1.10.1.12 Art 3.14 Art 4.6(b)	
	23. Hanging conv. outlets (for relocation)			

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plug)	24. Defective/loose outlets	20.69	4.10.1.3	
	25. No socket/improvise socket			
	26. Improvise plug			
Junction/ termination	27. No junction box	6.9	Art 3.14	
	28. No utility box			

Legend: Acceptable Risk Tolerable Risk Unacceptable Risk

Issues and Concerns

There are concerns to address during the inspection. Service drop wires, for instance, were damaged and no insulation for live wire, loose, broken insulator due to overuse and undersize entrance wires. Below is the summary of the inspection done.

For table 3, among the identified concerns, branch circuit and extension wire had the highest percentile to address concern (24.14%). It indicates that most residences tried to remedy their circuits in response to their unexpected needs like additional electrical loads by way of an extension line were usually an option. Based on the inspection, undersize and improper materials were utilized for the purpose. Likewise, inexperienced electrician or do-it-yourself homeowners often do extension lines; as a result, these were not correctly installed and improperly spliced.

Electrical accessories (switches, outlets, receptacles, sockets, and plugs) were considered second among the electrical concern with 20.69%. It was noted that 88.10 % of the consumers had surfaced-type wiring methods. This preference is more convenient for electricians. However, it was found that many installations were temporary and needed to be relocated. The worse scenario was the improvisation method as a substitute for other accessories. The likelihood for occupants to electrocution using improvised plugs, outlets, and sockets can be high, leading to severe injuries if not death.

Broken wire insulations or no electrical tape was observed for service drop, and entrance wires ranked third (17.24%) among the concerns. Since these were electrically exposed, immediate attention is necessary.

While Kilo-Watt Hour meter and junction/termination got the least concern having both 6.90%, however, ten (10) households are dependent or have their power source tapped from their neighbors. The 4th column of the table presents the PEC violations of the electrical system under inspection. The individual hazard causing the condition of households were assessed using BS 8800 BSI 2004 as a reference and categorically classified into three (3) risk level as follows: Acceptable Risk (6 cases), Tolerable Risk (11 cases) and Unacceptable Risk (11 cases). This data reveals that immediate control should be administered (fig. 6).

CONCLUSIONS

The use of energy-saving lighting fixtures was noted, that they are aware of the economic benefits of using them. The use of electrical instruments indicates that most households receive tolerable to the average supply voltage level. Aside from these, no complaints were recorded regarding inconvenience on the supply of electric power to their premises. It means that the efficiency and reliability condition of the ISELCO 1 system is fair enough based on inspection and interview results.

Their present system can support the overall households' condition to expand for future loads like appliances and lighting fixtures. However, installed extension lines are against the PEC (table 3), and regulation of the electric utility provider. With this,

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the use of undersize and inappropriate materials affecting the safety of life and properties is not an alarming issue for homeowners. The preference for substandard and improvise electrical fixtures was for necessity and economic reasons setting aside safety considerations. It indicates that most residents were not responsive to the impact of their actions posting hazards or threats to their life and living are a clear violation of the RA 9514 or Fire Code of the Philippines. This finding is similar to the study of Thinda (2009) on community hazard and vulnerability assessment. She cited the Asian Disaster Preparedness Center (2001) that supported the idea that poverty, as an indicator of lack of access to resources and income opportunities, is one of the several dimensions of vulnerability. These findings are similar to the observations of

Marcial (2012) that electrics are the most dangerous cause of fires, and often these are easily overlooked.

Recommendations

(1) Electrical related hazard and vulnerability awareness campaigns for preventive measures should be conducted by inviting resource speakers from the Local Bureau of Fire Protection and Isabela 1 Electric Cooperative, Inc.

(2) There is a necessity to perform a direct control method through elimination and substitution before abnormalities will occur to prevent dangerous incidents.

(3) Since there were no registered barangay electricians or technicians, there must be technical training to be conducted to attend instantly for the repair and maintenance of the household electrical system. Candidates would be head of the family having no regular job, an opportunity for additional income.

(4) Ten households were advised to have their meters.

(5) Other barangays may pattern their studies to analyse their electrical system for further improvement.

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