EFFECTIVENESS OF A LOCALLY ASSEMBLED MOBILE PHONE-BASED ANTI-THEFT DEVICE

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ABSTRACT

This research mainly aimed to determine the effectiveness of the locally assembled mobile phone-based anti-theft device for motorcycles. The device is an innovated vehicle security system. It utilizes an old cellular phone (keypad type) which served as the modem of the system. It has the feature to initiate a call to the cellular phone of the vehicle owner whenever there is an intrusion into the vehicle, in that case, the owner is immediately notified and take preventive measures against thieves the soonest time. Likewise, the owner can turn off the running engine of the motorcycle automatically through his/her handheld cellular phone to save it from hands of the thieves when the latter forcedly take the vehicle.

This research study made use of a project development method of research in innovating a device. It also used the descriptive research method, specifically, the evaluative research design.

Fifteen (15) experts in electronics/ automotive technology, and twenty (20) knowledgeable end-users evaluated the innovated device in terms of its construction assembly (design and materials), effectiveness (functionality and reliability), and their perceptions on the device in comparison to the commercial type security alarm system available locally in the market.

The salient findings of the study are: (1) The evaluators rated the innovated device with an “Excellent” rating in terms of construction assembly, and effectiveness. (2) The experts and end-users “Strongly Agreed” that the innovated device is more effective, more reliable, more affordable, yields lesser false alarm, needs minimum maintenance cost, and more durable than the locally available commercial one. (3) There is no significant difference in the overall assessment of the experts and end-users in terms of the quality of the device. Similarly, there is no significant difference in their perceptions on the device in comparison to the commercial one available locally in the market.

Based on the findings, following conclusions are formulated: (1) The locally assembled mobile phone- based anti-theft device is effective and reliable to use for motorcycles. (2) The two groups of evaluators have the same assessment on the quality of the innovated device. Hence, they unanimously agreed that it is comparable to the commercial one available locally on the market.

Relative to the findings and conclusions, the following recommendations are forwarded: (1) Further improvement of the device should be considered like adding an access point for the

adjustment of its sensitivity; its packaging size to make more compact;, and other features to be integrated like making the switch to a full automatic in shifting from run mode to park mode, and vice versa. (2) Motorcycle owners should be encouraged to utilize the innovated device as protection from thieves and carnappers to their vehicles. Moreover, (3) The effectiveness of the device to a four-wheel vehicle should be tested.

Introduction

Background of the Study

Technological innovations and inventions have brought convenience and satisfaction to human beings. With the advent of these inventions, human life has become fulfilling. They have performed miracles for man's daily living- from households to communication systems, up to transportation systems.

In this fast changing age of technology, transportation system worldwide has become developing rapidly, engineers in the whole world continuously innovating and developing those existing vehicles for their efficiency in terms of fuel consumption, and effectiveness in terms of power.

In the Philippines, most of the citizens want to have their car or motorcycle for their necessity rather than a luxury. Despite recent oil price increases, most average middle-class families prefer to drive their vehicles in going to work or school. Despite of the high demand for automotive vehicles, the country also faces the uprising crime rate, specifically, carnapping and other forms of vehicle theft. The offense has generated losses in properties, valuables, money and even lives of people.

Vehicle theft is one of the social problems in the society. Statistics of the Philippine National Police reveal that two cars and fifteen motorcycles on average are stolen daily as carnapping incidents nationwide. Latest government data also showed that January to June 2014, 3,170 cases was reported, up to 68.5 percent from the 1,881 cases were reported in the same period last 2013. Motorcycles were the usual targets, with thieves making off with at least 2,866 motorcycles compared to the 304 incidents of cars, vans, and other four-wheeled vehicles stolen (Dinglasan, 2014).

One of the ways to minimize or prevent this crime is the use of security system or the Anti -Theft Alarm System. However, the present security systems available in the market is not efficient due to the following reasons: 1.) the distance (covered area) is limited, the siren cannot be heard over a long distance and in buildings; 2) almost the same sound (siren) for most of the vehicle's alarm that leads false alarm; and 3) not 100 percent secured (Rodzi, 2006).

To address the above-mentioned problems, the researcher thought of designing an innovative, cheaper, and locally assembled anti-theft device, in which an old cellular phone is incorporated as the modem of the system. In this feature of a security system, aside from producing an alarming sound to frighten the would-be-thief, the device will send a call to the owner of the vehicle. Thus, he or she will be notified immediately whenever there is somebody trying to steal his or her vehicle. In this way, he/she can take preventive measure to check his/her vehicle if it is stolen and report immediately the case to the police department.

Also, if tested, the device will not only be used for vehicles, but it is also used

as an anti-theft device to any valuable thing in the house, in the office, in school, or in banks.

Objectives of the Study

This study aimed to determine the effectiveness of a locally assembled mobile phone- based anti-theft device.

Specifically, it sought to answer the following questions:

1. What is the design feature of the locally assembled mobile phone –based anti-theft device in terms of:

   a. Description of the device,
   b. Working drawing plan, and
   c. Overview of the operation of the whole circuit of the device?

2. What is the assessment of the evaluators on the quality of the device in terms of the following criteria:
   a. Construction Assembly
      a.1. Design, and
      a.2. Materials;

   b. Effectiveness
      b.1 Functionality, and
      b.2. Reliability?

3. What is the perception of the experts and end-users on the device in comparison to the commercial type security alarm system available locally in the market?

4. Is there a significant difference in the assessment of the experts and the end-users in terms of functionality and reliability of the device?

5. Is there a significant difference in the perceptions of the experts and end-users on the device in comparison to the commercial type security alarm system available locally in the market?

Hypotheses

The following are the hypotheses of the study based on the problems raised.

1. The locally assembled mobile phone based anti-theft device is effective and reliable to use for motorcycles.

2. There is no significant difference in the assessment of the experts and the end-users on the quality of the locally assembled mobile phone based anti-theft device in terms of functionality and reliability.

3. There is no significant difference in the perception of the experts and the end-users on the constructed device in comparison to the commercial type security alarm system available locally in the market.

Related Works and Studies

The following are the different works and studies which are related to the research under study:

Ahmed, S. et.al. 2010 designed an Austere Theft Prevention System. The defining feature of their device is that it can be activated from any remote location by making use of mobile communication technology. Their device consisted of a cellular phone, Main circuit (microcontroller), Braking module, External Audio-Visual alarm, and Internal Alarm. This cellular phone, embedded in the car, is connected to a microcontroller. From this

microcontroller, the device will manipulate two major systems in the car to immobilize it; the braking system and the ignition system. Firstly the microcontroller will send out a signal to an audio system that will give an audible warning to the driver of the car, and then another signal will be sent to the headlamps that will cause them to blink continuously. After the warnings have been given, the braking module (installed with the device) will be activated which will automatically make the car brake over a period of maximum 3 minutes. Considering the car is stopped after 3 minutes of calling on the phone, the microcontroller will cut off the ignition via a relay installed in the ignition circuitry of the car.

In comparison to the work of Ahmed, S. et.al 2010 with the device under study, both used cellular phone to be the prime source in activating the whole circuits, both have the same objectives that is-for theft prevention, but, in contrast, aside from the components used which are entirely different with one another, there are so many distinctions between the two, different model of cellular phones were used to these two devices, for the project of Ahmed, S. et.al 2010, they used Huawei model while the device under study used nokia model. Another distinction is, Ahmed et. al. took the primary pulse from the vibration motor of the cellular phone to be the input of the whole system, while the device under study, the pulse is taken from the audio output from the earpiece of the cellular phone. Another differences are the features of the two devices, Ahmed's work focused only on immobilizing the vehicle by triggering the braking system module and to cut the ignition system through cellular phone, while the device under study, it is more innovative in the sense that it will make a call to the owner and at the same time creating a siren when intrusions occur to the vehicle just to be notified immediately, thus, the owner will do preventive measures. Aside from that, the owner can also immobilize his vehicle through his cellular phone. And no other cellular phones can trigger the device except the owner's cellular phone.

Another related work was conducted by Mohd Rosmanizam Bin Hamad Rodzi in 2006. His work entitled: An Enhancement Of Vehicle Security Alarm System Via Short Message Service (SMS). His project focused on developing an existing vehicle security alarm system by adding a SMS feature to alert vehicle owners whenever intrusion occurs. In his book, he said that, through his device, instead of a human to human telecommunication, the system creates a new entity which is a machine to human telecommunication. The system will manipulate a mobile phone to send SMS. His project involved hardware and software parts construction. The main hardware component in his system is a programmable chip PIC16F873A.

In comparison to this device with that of the device under study, both again used cellular phones as the means of communicating between the owner and his vehicle. But, in contrast, Rodzi's device use SMS feature to alert the owner, whereas, the device under study uses the call feature to alert the owner. Different model of cellular phones were also used to these two devices. Another distinction is, Rodzi only added/improvised an SMS feature to the commercially type Vehicle security alarm system, while the researcher designed his own circuit using components which are locally available only. Another one is, for Rodzi's device, you cannot remotely control his device via cellular phone to activate/deactivate the system, rather the device will only send an alert message to the owner, while the device under study, the cellular phone of the owner will serve as the

remote control of the device to turn on and off the system.

Conceptual Framework

As illustrated in the paradigm (Figure 1) in the construction of a Locally Assembled Mobile Phone Based Anti-Theft device, the inputs included the different materials locally available and classified as used/old materials, new materials and the DIY material. Other inputs of the study were the tools and equipment needed. The process involves designing of the circuit, assembling of the device, testing and evaluating of the device. Moreover, the Output includes the overall quality of the device based on the evaluation of the experts and end-users in terms of its construction/assembly (design, and materials), and effectiveness (functionality and reliability); and, the perceptions of the evaluators on the device in comparison to the commercial type security alarm system available locally in the market. This conceptual framework was adapted from the study of Palma, 2012.

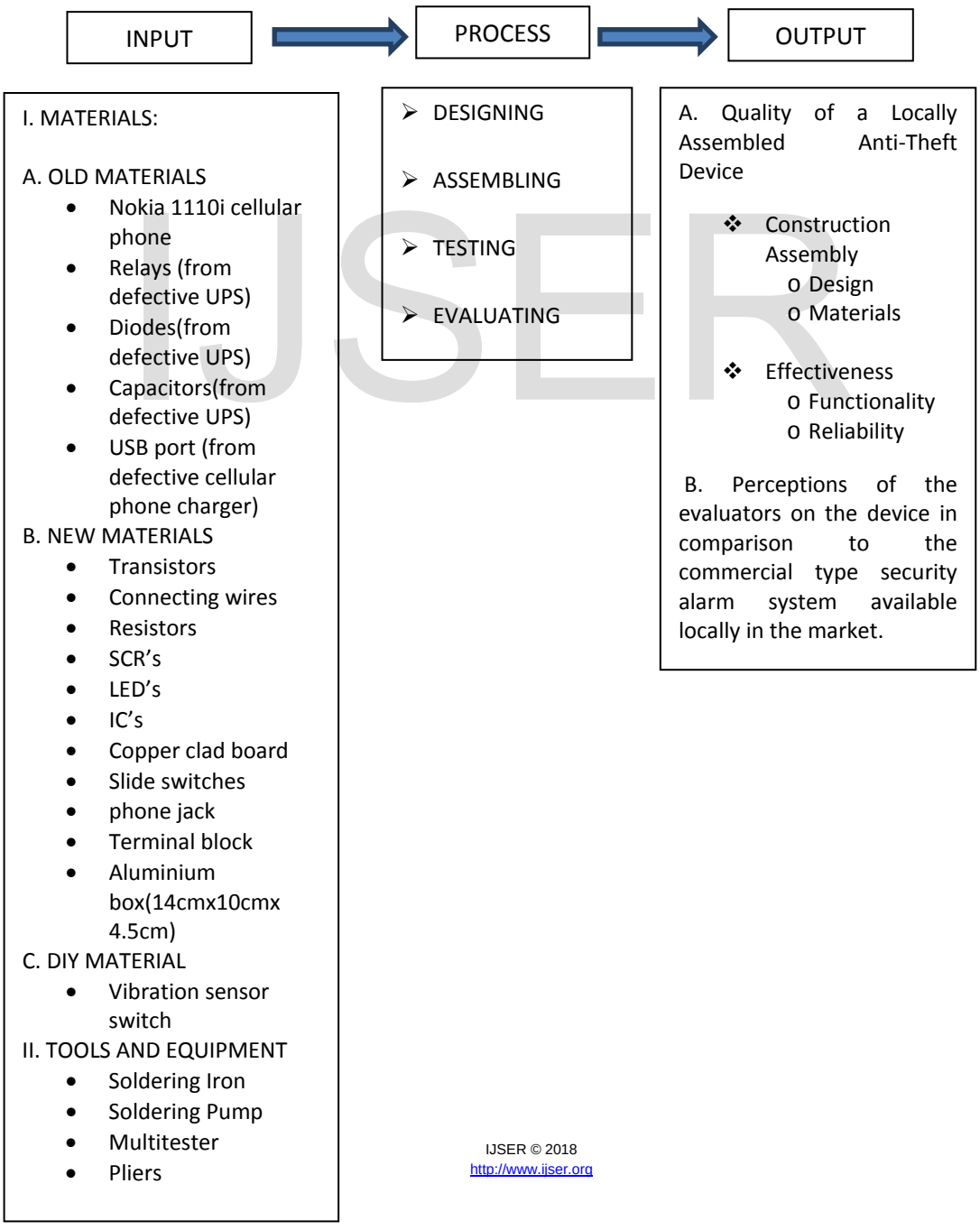
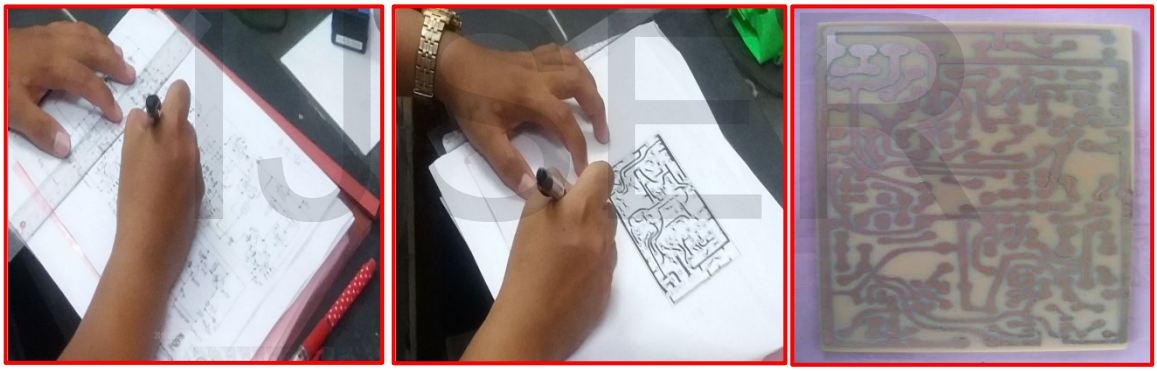


Figure 1. The Research Paradigm

Research Methodology

This study made use of a project development research design. It also employed the descriptive research method, specifically, the evaluative research design. This study was conducted in three phases namely: designing of the circuit and printed circuit board (PCB) layout, assembling and constructing of the device, and, qualitative testing and evaluating of the device in terms of its construction assembly (design and materials), and effectiveness (functionality and reliability).

Phase 1. Designing of the circuit and PCB layout. (Some methods of laying out the PCB were adopted from the book of Enriquez, 2004.)



Phase 2. Assembling/Constructing of the device.

Phase 3. Testing and evaluating of the device conducted by 15 experts in electronics and automotive technology, and 20 knowledgeable end-users. The

constructed device was then incorporated to a motorcycle, specifically, the Suzuki Smash 110 (2009 model), to test and evaluate its effectiveness.



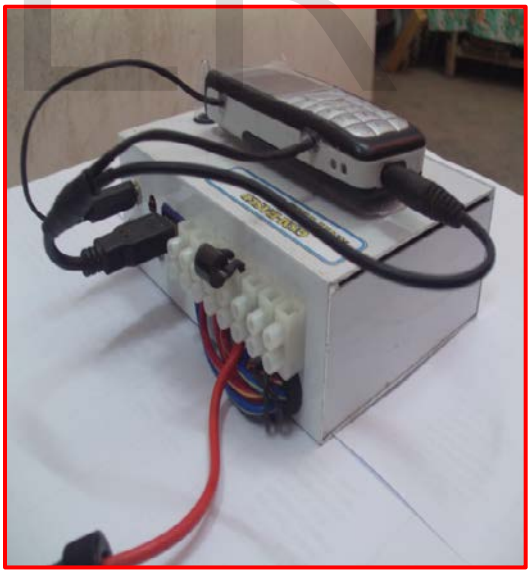



Results and Discussion

The following are the answers addressed to each of the problems raised in this study.

Problem 1. What is the design feature of the locally assembled mobile phone based anti-theft device in terms of the following: a) description of the device, and b) the working drawing plan?

a.) Description of the device.



This Locally Assembled Anti-Theft Device is an innovated version of those commercial type security alarm system available locally in the market. It is called GSM (Global System for Mobile Communication) or Mobile Phone–based anti-theft device because it uses cellphone which served as the modem of the system. It has two major features: 1.) During “parked mode” aside from producing a deterring sound when the motorcycle is touched by would-be thief, the device immediately sends an alert call to the owner’s cellphone, in that case, the owner can monitor his/her

motorcycle from any part of the world as long as there is a signal from the network provider and must have a load balance of at least 20 pesos (eight pesos for a nationwide coverage) of the SIM (subscriber's identification module) card of the cellphone-modem. 2.) During "run mode", when thieves forcedly take away the motorcycle from the owner, he or she can automatically turn off the engine of the running motorcycle to immobilize it, in that case, the motorcycle will be saved from the hand of these thieves. All components used are locally available in the market; others can be easily found in certain defective electronic appliances. The device used an old cellular phone- keypad type cellphone, which served as the modem. The size of the whole module is compact, measures 14cm x 10cm x 4.50cm (5.5"x4"x1.75").

b.) The Working drawing plan of the device. The figure below was the design and layout of the device

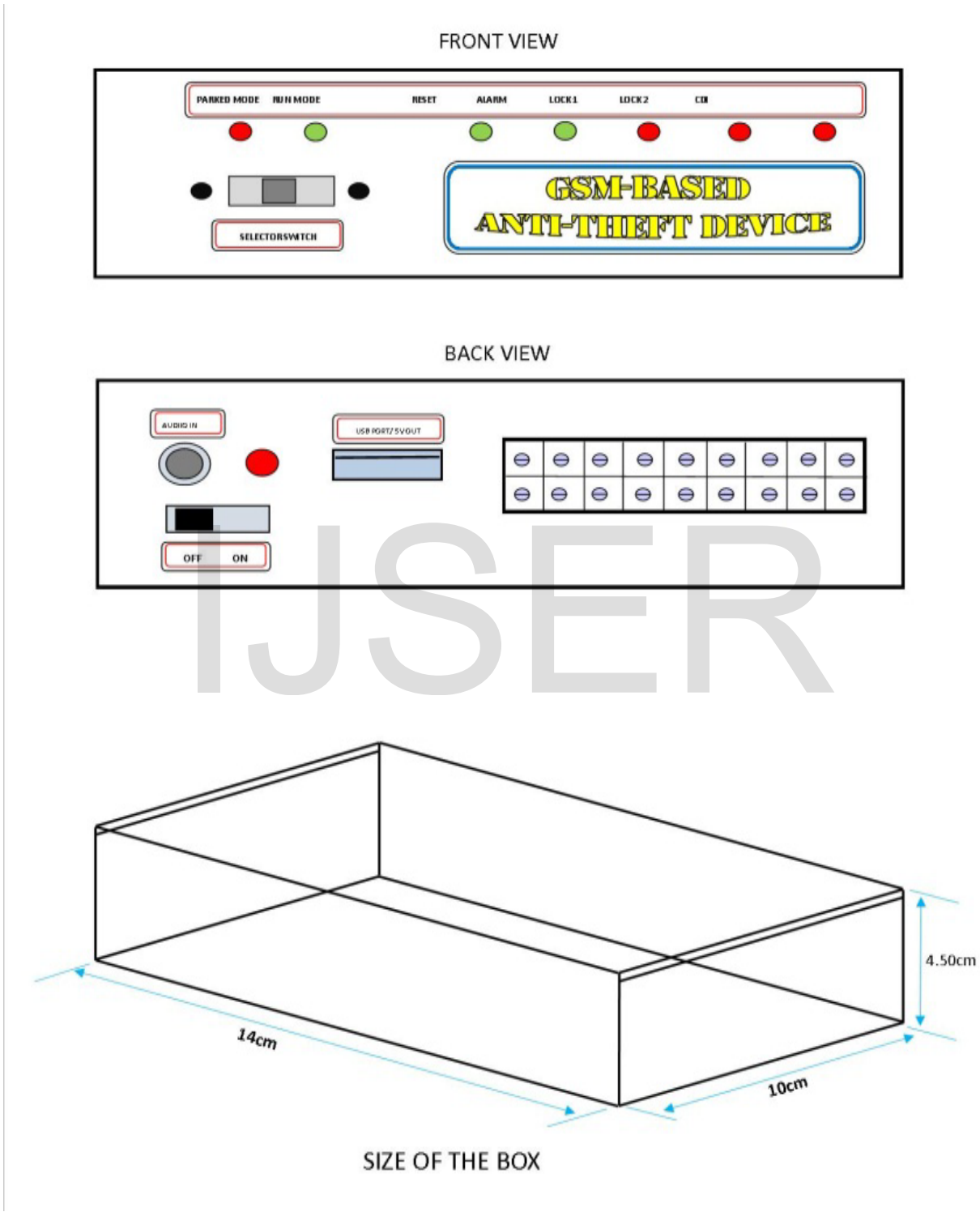


Figure 2. Design and Layout of the Device

c.) Overview on the operation of the whole circuit of the device.

Below is the complete block diagram of the device:

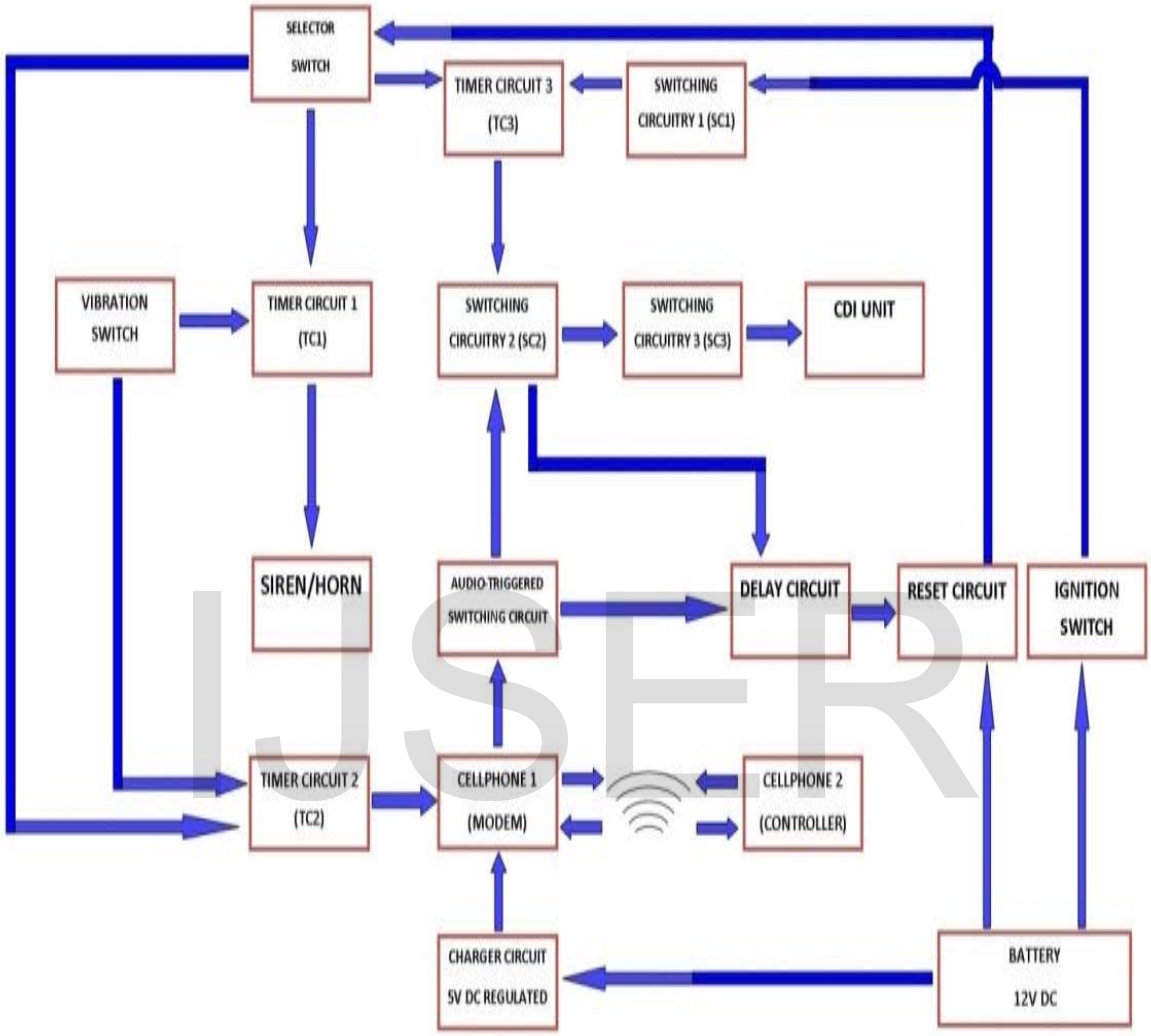


Figure 3. Complete Block Diagram of a Locally Assembled Mobile Phone-Based Anti-Theft Device

As illustrated in Figure 3, there are so many sections or blocks that comprise the whole circuitry of the device. First, the selector switch, this switch is used to select the mode of the device, either in parked mode or run mode. Next, the vibration switch. This sensor switch has two contact terminals, and when the motorbike is moved by somebody, its two terminals connect each other momentarily, causing the TC1(timer circuit 1), and TC2(timer circuit 2) to activate. Then, this TC1, when activated, the siren/horn turns on immediately, thus creating a very loud sound to frighten the would-be thief.

At the same point, when TC2 is activated, it sends a 3-second pulsed signal

to the CELLPHONE 1 (CP1)(modem) to call up the CELLPHONE 2 (CP2)(owner's cellphone). When Cellphone 2 is reached successfully, the owner is notified. Thus he/she can take preventive measures to check his/her motorcycle. Also, (especially when the device set to "run mode") the owner can automatically turn off the engine through his cellphone(CP2) by sending a call to CP1(modem), how? The voltage output from the speaker terminal of CP1 will be converted to a command signal through the Voltage-triggered switch circuit section. This command signal will be sent to Switching Circuitry 2 (SC2) to activate that section, and then Switching Circuitry 3 (SC3) will immediately deactivate causing the Capacitor Discharge Ignition (CDI) unit to turn off. And, at the same point, from the output of the Voltage-triggered switch circuit, there is a Delay-circuit section connected in series with the Reset-circuit section. This Delay-circuit section is also a timer circuit which interruptions the command signal output of the Voltage-triggered switch section going to Reset-circuit section during the first miscall attempt to the CP1 to avoid the immediate resetting of the unit. Otherwise the electronic locking process of the device for the motorcycle will repeatedly cycle. In other words, only the second miscall attempt applies the resetting process of the device to be ready again for the next round.

On the other hand, if the thief tries to bypass the ignition switch, or he/she will forcedly switch on using other key thinking that he/she could start the engine, but, in doing so, SC1 will be triggered, causing to activate the automatic immobilizer feature of the device through TC3(timer circuit 3).This TC3 sustains the supply of the SC2 and the SC3 for a given period, (SC2 and SC3 are responsible for activating and deactivating the ignition system, specifically the CDI of the motorcycle). When this period runs off, their supply will be cut off causing the CDI to be deactivated. Thus the engine will suddenly stop.

Another section found in the block diagram is the charger circuit which is needed to keep the battery of the CP1 fresh and fully charged all the time. This circuit has a 5v DC regulator IC to have a maintained output of 5v dc going to the CP1 from the 12v battery of the motorcycle.

Lastly, the additional feature of this device is, without the battery, the engine will never be started because of the switching circuitries of the system that control electronically the ignition system of the motorcycle. So, if the thief thinks that, by removing the battery so he could deactivate the system totally, he would just get fooled by himself in that way.

Problem 2. What is the quality of the device in terms of the following criteria:

a. Construction Assembly
a.1. Design, and
a.2. Materials;

b. Effectiveness
b.1. Functionality, and
b.2. Reliability?

Table 1 shows the results of the assessment made by the expert evaluators on the quality of the innovated device in terms of construction assembly.

Table 1
Assessment of the Expert evaluators on the Quality of the Locally Assembled Mobile Phone-Based Anti-Theft Device in terms of Construction Assembly

INDICATORS ALONG CONSTRUCTION ASSEMBLY	$\bar{x}$	SD	DR
A. DESIGN			
1. The size of the box (5.5"x4"x1.75") used for the device is fit and compact and be easily installed to any motorcycle brands.	4.667	0.488	**E**
2. All components of the device are arranged neatly and properly, and soldered firmly into the printed circuit board.	4.600	0.632	**E**
3. The design of the block diagram of the device is easy to understand.	4.467	0.640	**VG**
Mean:	**4.578**	**0.583**	**E**
B. MATERIALS			
1. Proper size of wires are used for its intended purpose.	4.800	0.414	**E**
2. Correct specifications of all components of the device are used.	4.867	0.352	**E**
3. The box of the device is durable.	4.733	0.458	**E**
4. The materials used for the device are accessible/available locally.	4.667	0.488	**E**
Mean:	**4.767**	**0.427**	**E**
Overall:	**4.686**	**0.506**	**E**

Legend:

4.50 – 5.00	Excellent (E)	3.50 – 4.49	Very Good (VG)	2.50 – 3.49	Good (G)
1.50 – 2.49	Poor (P)	1.00 – 1.49	Very Poor (VP)		

The quality of the device in terms of its construction assembly is assessed by the expert evaluators only. They evaluated the device with more or less the same rating score. Their general assessment on the design and materials used is "Excellent", this claim is backed up by the obtained overall mean score of 4.686 and an overall SD of 0.506.

Table 2 presents the assessment of the experts and end-users on the quality of the constructed device in terms of its effectiveness (functionality and reliability)

Table 2
Assessment of the Experts and End-Users on the Quality of the Locally Assembled Mobile Phone-Based Anti-Theft Device in terms of Effectiveness

INDICATORS ALONG EFFECTIVENESS	EXPERTS (n=15)			END-USERS (n= 20)			OVERALL (n= 35)		
	$\bar{x}$	SD	DR	$\bar{x}$	SD	DR	$\bar{x}$	SD	DR
A. FUNCTIONALITY									
1. The vehicle owner can monitor his/her vehicle against theft wherever he/she goes as long as there are signals for cellular phone.	4.800	0.414	**E**	4.900	0.308	**E**	4.857	0.355	**E**
2. The device produces enough sound (siren) to frighten the intruder.	4.867	0.352	**E**	4.750	0.444	**E**	4.800	0.406	**E**
3. The time period for immobilizing automatically the motorcycle is accurate or ideal.	4.933	0.258	**E**	4.600	0.502	**E**	4.743	0.443	**E**
4. When it is set to parked mode, the device will immediately send a call to the owner‘s cellphone when the motorcycle is moved (with force) by somebody.	5.000	0.000	**E**	4.750	0.444	**E**	4.857	0.355	**E**
5. When it is set to “run mode”, the engine will suddenly stop when the owner calls up one time the cellphone modem of the device through his cellular phone only.	5.000	0.000	**E**	4.900	0.308	**E**	4.943	0.236	**E**
6. The device’s alarm and its “call feature” will only be activated when somebody bits or moves the motorcycle with force.	4.867	0.352	**E**	4.750	0.444	**E**	4.800	0.406	**E**
OVERALL:	**4.911**	**0.286**	**E**	**4.775**	**0.419**	**E**	**4.838**	**0.374**	**E**

B. RELIABILITY									
1. The device will be reset only using the specified SIM card through the cellular phone of the owner.	4.800	0.414	**E**	4.900	0.308	**E**	4.857	0.355	**E**
2. The owner can forcedly immobilize/turn off the engine of the motorcycle using the specified SIM card through his cellular phone only.	4.933	0.258	**E**	4.950	0.224	**E**	4.943	0.236	**E**
3. The device consumes minimum power (1.2 watts- standby mode).	4.800	0.414	**E**	4.650	0.671	**E**	4.714	0.572	**E**
4. The device may last for considerable period of time.	4.400	0.632	**VG**	4.600	0.681	**E**	4.514	0.658	**E**
5. The device is serviceable by any electronic technician when damaged using the common tools only. It does not require special tools to repair because most of the components used were discrete type.	4.867	0.352	**E**	4.70	0.470	**E**	4.771	0.426	**E**
OVERALL:	**4.760**	**0.460**	**E**	**4.760**	**0.515**	**E**	**4.760**	**0.419**	**E**
GRAND:	**4.842**	**0.382**	**E**	**4.768**	**0.464**	**E**	**4.800**	**0.432**	**E**

Legend:

4.50 – 5.00	Excellent (E)	3.50 – 4.49	Very Good (VG)	2.50 – 3.49	Good (G)
1.50 – 2.49	Poor (P)	1.00 – 1.49	Very Poor (VP)		

The effectiveness of the device was judged by both the experts and end-users. The overall assessment made by the two groups of evaluators is “Excellent” with the gained overall grand mean score of 4.800. Moreover, an overall grand SD of 0.432 indicates that they assessed the device with more or less the same rating. It is further implied their evaluations of the device is the same.

However, expert group’s assessment earned a higher grand mean score and lower grand SD than the end-user group’s assessment. This claim is supported by the computed grand mean scores of 4.842 and

4.768 respectively; and grand SD of 0.382 and 0.464. The results signify that expert evaluators are more knowledgeable and experienced than the end-user evaluators in assessing the device.

Also, in terms of reliability, both groups of evaluators gained the same overall mean score of 4.760 and rated as "Excellent." This result shows that they generally assess the device with the same rating. Though, indicator Number 4- "the device may last for a considerable period of time" got the lowest overall mean score which is 4.514. This result implies that evaluators are not that certain of the durability of the device unless they test it.

Problem 3. What is the perception of the experts and end-users on the constructed device in comparison to the commercial type security alarm system available locally in the market?

In Table 3, it shows the assessment of the evaluators about their perceptions on the overall quality of the device in comparison to the locally available commercial type alarm system.

Table 3
Perception of the Experts and End- Users on the Overall Quality of the Innovated Device in Comparison to the Locally Available Commercial Type Security Alarm System

INDICATORS/ITEMS	Experts (n= 15)			End-users (n=20)			Overall (n=35)		
	$\bar{x}$	SD	DR	$\bar{x}$	SD	DR	$\bar{x}$	SD	DR
1. The constructed device is more effective than the locally available commercial one.	4.733	0.458	SA	4.550	0.605	SA	4.629	0.547	SA
2. The constructed device is more reliable than the locally available commercial one.	4.467	0.640	A	4.550	0.605	SA	4.514	0.612	SA
3. The constructed device is more affordable than the locally available commercial one.	4.733	0.458	SA	4.300	0.801	A	4.486	0.702	SA
4. The constructed device yields a lesser false alarm than the locally available commercial one.	4.600	0.632	SA	4.550	0.510	SA	4.571	0.558	SA
5. The constructed device needs minimum maintenance cost than the locally available commercial one.	4.733	0.594	SA	4.400	0.598	A	4.543	0.611	SA
6. The constructed device	4.53	0.64	SA	4.30	0.73	A	4.40	0.69	A

is more durable than the locally available commercial one.	3	0		0	3		0	5	
OVERALL:	**4.633**	**0.570**	**SA**	**4.442**	**0.646**	**A**	**4.524**	**0.620**	**SA**

Legend:

4.50 – 5.00	Strongly Agree (SA)	1.50 – 2.49	Disagree (D)
3.50 – 4.49	Agree (A)	1.00 – 1.49	Strongly Disagree (SD)
2.50 – 3.49	Undecided (U)		

The overall results on the perceptions of the evaluators gained an overall mean score of 4.524. This implies that all evaluators "Strongly Agreed" that the innovated device is more effective, more reliable, more affordable, yields lesser false alarm, needs a minimum maintenance cost, and more durable than the locally available commercial one. Further, the computed overall SD of 0.620 infers that all evaluators agreed to have more or less the same perceptions on the constructed device in comparison to the locally available commercial one. Nevertheless, indicator number 6 obtained the lowest overall mean score of 4.400 and described only as "agree." This finding denotes that evaluators are not that so convinced about the durability of the constructed device in comparison to the commercial one.

Problem 4. Is there a significant difference in the assessment of the experts and the end-users in terms of functionality and reliability of the device?

Table 4 shows the results on t-test for significant difference in the evaluation of the experts and end-users in terms of functionality and reliability of the device.

Table 4
Results on t-Test for Significant Difference in the Evaluation of the Experts and End-users on the Quality (functionality and reliability) of the Locally Assembled Mobile Phone –Based Anti-Theft Device

QUALITY	df	Mean Diff	t-value		Decision
			Critical α0.05	computed	
A. Functionality ***Experts:** **n=15** **$\bar{x}$ = 4.911** **SD = 0.286** ***End-users:** **n=20**	**33**	**0.136**	**2.035**	**1.081**	**Do not reject Ho**

$\bar{x}$ = 4.775 SD = 0.419					
B. Reliability *Experts: n=15 $\bar{x}$ = 4.760 SD = 0.460 *End-users: n=20 $\bar{x}$ = 4.760 SD = 0.515	33	0.000	2.035	0.000	Do not reject Ho
C. Overall (Functionality+Reliability) *Experts: n=15 $\bar{x}$ = 4.842 SD = 0.382 *End-users: n=20 $\bar{x}$ = 4.768 SD = 0.464	33	0.074	2.035	0.503	Do not reject Ho

The computed t-value on functionality, reliability and the overall quality which are 1.081; 0.000; and 0.503 respectively are very much lower than the critical t-value of 2.035 at 0.05 level of significance. Therefore, all decisions were "do not reject the null hypotheses." This means that there is no significant difference in the assessment made by the two groups of evaluators in terms of functionality and reliability. Hence, their evaluations on the device do not differ significantly.

Problem 5. Is there a significant difference in the perception of the experts and end users on the overall quality of the device in comparison to the commercial type security alarm system available locally in the market?

Table 5 presents the results on the t-test for significant difference in the perceptions of the two groups of evaluators on the overall quality of the device in comparison to the commercial type available locally in the market.

Table 5
Results on t-Test for Significant Difference in the Perceptions of Experts and End-users on the Overall Quality of the Innovated Device in Comparison to the Locally Available Commercial Type Security Alarm System

STATISTICS		Experts (n=15)	End-users (n=20)
Mean $\overline{x}$		4.633	4.442
Standard Deviation (SD)		0.570	0.646
Mean Difference		0.191	
Degrees of freedom (df)		33	
t-value	Computed	0.909	
	Critical	2.035	
Decision		Do not reject Ho	

The computed t-value of 0.909 is lower than the critical t-value of 2.035 at 0.05 level of probability. So, the null hypothesis is not rejected. This means that the assessment made by the experts and end-users has no significant difference. The result further implies that the evaluators have the same perceptions on the overall quality of the constructed device in comparison to the commercial one locally available in the market.

Conclusions

Based on the results presented, the following conclusions were drawn.

1. The locally assembled mobile phone-based anti-theft device is effective and reliable to use for motorcycle.

2. The two groups of evaluators have the same assessment on the innovated device. Hence, they unanimously agreed that it is comparable to the commercial one available locally in the market.

Recommendations

Relative to the results and conclusions made in this study, the following recommendations are forwarded.

1. Though the innovated device was rated with excellent quality, further improvement should be considered like adding an access point for the adjustment of sensitivity of the device; the packaging size of the device to make more compact; and, other features to be integrated like making the switch to a full automatic in shifting from run mode to park mode and vise versa.

2. Motorcycle owners should be encouraged to utilize the innovated device as protection from thieves or carnappers to their vehicles.

3. The effectiveness of the device to a four-wheel vehicle should be tested.

Bibliography

Enriquez, M., et.al, 2004, Simple Electronics (Basic). #25 I. Francisco St., Malinta Valenzuela City Philippines: Andes Mountain Printers

Ahmed, S., et.al, (2010) Austere Theft Prevention System. Published Undergraduate Thesis, Bachelor of

Science in Electronics and Communication Engineering, BRAC University, Dhaka, Bangladesh. Retrieved: April 02, 2015 http://dspace.bracu.ac.bd/.../AUSTERE%20THEFT%20PREVENTION%20SY

Rodzi, M., (2006) An Enhancement of Vehicle Security Alarm System via SMS. Published Undergraduate Thesis, Bachelor of Science in Data Communication And Networking, MARA University of Technology, Malaysia. Retrieved: April 02, 2015 http://ir.uitm.edu.my/679/

Palma, V.G., (2012) Design, Construction, and Evaluation of a Lead-Acid Battery Rejuvenator and Charger. Unpublished Thesis, Master of Arts in Teaching Practical Arts, University of Northern Philippines, Vigan City Ilocos Sur, Philippines.

Dinglasan, R., (2014) Carnapping up 68% in the first half of 2014-PNP, August 19, 2014. Retrieved: April 03, 2015 from http://www.gmanetwork.com/news/story/375499/news/nation/carnapping-up-68-in-the-first-half-of-2014-pnp

Suzuki Smash Revo FK110cc, (Service Manual)