Development and Factorial Validation of Cell Phone Maintenance Training Modules

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Abstract

This study focused on the development and factorial validation of cell phone maintenance training modules. The study was conducted in Lagos State of Nigeria. Four research questions guided the study while three null hypotheses formulated were tested at 0.05 probability level. The study adopted Research and development (R&D) design. The population for the study was I78 which comprised 35 lecturers and 14 instructors of electrical/ electronic technology from the Departments of Electrical/Electronics Technology, Yaba College of Technology and Lagos State Polytechnic, Ikorodu, 21 supervisors in MTN, Globacom, Airtel, 9mobile and Samsung and 108 roadside cell phone technicians. The sample for the study was I37 subjects. These were purposively sampled 67 literate roadside cell phone technicians, all the 35 lecturers, 14 instructors in the polytechnics and 21 supervisors in telecommunication industries in the study area. A structured questionnaire titled Cell Phone Maintenance Training Module (CMTM) questionnaire was used as an instrument for data collection. The instrument was validated by three experts. Content items were subjected to factor analysis, using 0.50 as factor loading at 10% overlapping variance. Three out of 143 content items were discarded. Cronbach's alpha reliability method was adopted to determine the internal consistency of the questionnaire items, a Cronbach's alpha coefficient of 0.82 was obtained. Out of one hundred and thirty-seven copies of the questionnaire administered on respondents, only one hundred and four copies of the questionnaire (representing 75.91 per cent return rate) were retrieved and analyzed using mean, while, Analysis of Variance was used to test the hypotheses of no significant difference at 0.05 level of significance. The study found that 11 objectives, 140 contents of cell phone maintenance modules, 46 facilities for maintenance of cell phones, and 33 evaluation techniques and activities were required for assessing cell phone maintenance modules. Recommendations include that the developed and validated cell phone maintenance modules should be employed to train out of school youths and other interested individuals at Skill Acquisition Centers.

Keywords: Maintenance, Cell phone, Modules, factor loading, Validation, Mobile Communication Technologies

1. Introduction

Mobile communication technologies are modified computers with communication features. They are capable of receiving, processing, transmitting data, voice and video signals through a wireless link. Darby (2005) stated that mobile communication technologies are those technologies which depend upon the broader phenomenon of internet protocol (IP) convergence when data, voice and video travel over a single

channel. Examples of mobile communication technologies or devices are handheld audio and multimedia guide, handheld game, personal audio players and mobiles or cell phones.

A cell phone is also called a mobile phone, handphone, handset or mobile. It is a portable telephone that uses wireless cellular technology to send and receive phone signals, Hahn and Kibora (2008) described cell phone as an electronic device used to make mobile telephone calls across a wide geographic area. David (2011) said that cell phone is a cordless telecommunication device. Business Link (2011) reported that a cell phone can make and receive telephone calls to and from the public telephone network which includes other mobiles and fixed-line phones across the world. Cell phones are of different types, manufactured by different companies with their trademarks or brands. Some are Nokia, Samsung, Motorola and Philip products among others. They have a number of features in common, but manufacturers also try to differentiate their own products by implementing additional functions to make them more attractive to consumers. Waard, Schepers, Ormel and Brookhuik (2010) said that cell phones have features beyond sending text messages and making the short or long distance voice calls, the other features include internet browsing, Moving Picture Experts Group Layer-3 Audio (MP3) playback music, email, personal organizer, built-in cameras, multimedia messaging (MMS), short messages service (SMS), call registries, built-in games, voice mails, downloading, video call, blue-tooth and infrared.

Cell phones help in selling and buying of goods and services with ease but have created some management problems for the users in the areas of maintenance (James, 2011). Most of the users could not easily locate efficient technicians who can repair and service faulty cell phones thereby making users whose cell phones are bad to abandon them for the purchase of new ones. Efficient technicians who can repair or maintain cell phones are few. Few technicians found repairing cell phones are not formally trained and therefore use trial by error approach and sometimes cause more problems to cell phones contracted to them (Bakare, 2014). There is also no valid cell phone maintenance training modules for equipping individuals on how to repair or service different kinds of cell phones. There is need to develop and factorially validate cell phone maintenance modules for training individuals for effective maintenance of all kinds of faulty or malfunctioned cell phones. This could be used to solve the problem of shortage of technicians currently facing the cell phone users. It will also reduce continuous spending of money and electronic wastage which could cause health problems such as cancer to people especially where bad cell phones are disposed of carelessly.

Cell phone maintenance training module (CMTM) conceptualized in this study is a package of information that its elements such as objectives, contents, facilities, and evaluation techniques and activities are arranged and organized in order to train individuals for maintenance of all kinds of cell phones. Objectives are brief, clear statements that describe the desired learning outcomes of instruction: that is, the specific skills, values, and attitudes students should exhibit that reflect the broader goals (Sommefeldt and Briggs, 2002). Objectives of cell phone maintenance training modules indicate what individuals will be able to do as a result of exposure to the contents of modules.

Content is defined as what the teacher and the students pay attention to when they are teaching and learning. Kapoma and Namusokwe (2011) described content as a list of subjects, topics, skills, themes, concepts or works to be covered by the teacher and his students. The contents of the CMTM, therefore, include skills in troubleshooting, repairing, servicing, configuring, flashing, upgrading, coupling, unlocking and jailbreaking of malfunctioned or faulty cell phones. These contents are best taught by using relevant facilities.

Facilities are physical objects to facilitate a given piece of work or activity. Facilities according to Okorie (2000) are physical items and structures such as buildings, offices, equipment, tools, machines and other materials that can facilitate teaching and learning.

Adequate and relevant training facilities make the learning process more satisfying. Various facilities such as set of screwdrivers, infrared rework station, soldering irons, cutting pliers, vacuum cleaners, magnifying desk lamp, flashing software, booster chargers, fluxes and analogue/digital multimeters could be used for maintenance of cell phones and implementation of cell phone training modules.

Evaluation according to Olaitan (2003) is a means of ascertaining the success or failure of an enterprise by measurement or assessment of change in the behaviour of the learner. Learning outcomes are evaluated using different techniques. Evaluation techniques are tools employed by a teacher, trainer or an evaluator to evaluate learning outcomes. Osinem (2008) identified techniques that could be used to evaluate training outcomes to include oral questions, multiple choice, essay test and procedure testing. Evaluation of (CMTM) involves activities design to determine the extent to which the objectives of the training modules have been achieved. Such activities, therefore, may include giving tests, quiz, interview, assignments, home works, debate, essay questions and objectives questions. Development and factorial validation of cell phone maintenance modules will help in solving maintenance problems facing the users.

1.1. Statement of the Problem

Cell phone maintenance training module is a training package to equip individuals with skills and knowledge required for maintenance of all kinds of cell phones. Lack of CMTM to train individuals gives rise to various forms of management problems for users of cell phones. Most of the users could not easily locate skilled and efficient technicians who can repair or service their faulty cell phones thereby making users whose cell phones are bad to abandon them for the purchase of new ones. Unavailability of CMTM to train individuals for maintenance of cell phones indirectly amounts to the continuous spending of money and electronic wastage which can cause health problems such as cancer to people especially where they are disposed carelessly.

Available GSM maintenance modules are not valid and were not empirically carried out. These modules are dominated by basic knowledge but lack skills in troubleshooting, repairing, servicing, upgrading, coupling, jailbreaking, and configuring all kinds of malfunctioned cell phones for the users. These situations emphasize the need for cell phone maintenance training modules. This need, in turn, necessitates the development of cell phone maintenance modules. The main purpose of this study, therefore, was to develop and validate cell phone maintenance training modules.

The following research questions guided the study:

- ✓ What are the objectives of cell phone maintenance modules?

- ✓ What are the contents of cell phone maintenance modules?

- ✓ What are the facilities required for maintenance of cell phones?

- ✓ What are the evaluation techniques and activities that could be used for assessing each cell phone maintenance module?

The following null hypotheses were tested at 0.05 level of significance:

H01: There is no significant difference in the mean responses of lecturers, instructors, cell phone technicians and supervisors in telecommunication industries on the objectives of cell phone maintenance modules

H02: There is no significant difference in the mean responses of lecturers, instructors, cell phone technicians and supervisors in telecommunication industries on the facilities required for implementing cell phones maintenance modules

H03: There is no significant difference in the mean responses of lecturers, instructors and supervisors in telecommunication industries on the evaluation techniques that could be used for evaluating each of the cell phone maintenance modules.

2. Methodology

The study adopted Research and Development (R & D) Design. Gall, Gall, and Borg (2007) described Research and Development as an industry-based development model in which the findings of the research are used to design new products and procedures which are systematically field-tested, evaluated, and refined until they meet specified criteria of effectiveness, quality, or standards. The R & D design was appropriate for this study because it aimed at development and factorial validation of cell phone maintenance training modules.

The study was carried out in Lagos State. The population for the study was 187 which comprised of all the 35 lecturers and 14 instructors of electrical/electronic technology from Department of Electrical/Electronic Technology, Yaba College of Technology, Lagos State Polytechnic, Ikorodu, 21 supervisors in MTN, Globacom, Celtel, Etisalat and Samsung and 108 cell phone technicians in Lagos State. The sample for the study was 137 respondents. These were purposively sampled 67 literate cell phone technicians, all the 35 lecturers, 14 instructors in the polytechnics, and 21 supervisors in telecommunication industries in the study area.

A structured questionnaire titled: Cell phone Maintenance Module Questionnaire (CMMQ) was used as an instrument for data collection and was on the 5-point Likert scale. The structured questionnaire had 234 items developed for collecting data in accordance with the research questions. The instrument was in four sections A-D. A centred on objectives of cell phone maintenance modules, B was on contents of cell phone maintenance modules, C dealt with facilities maintenance of cell phone while D centred on evaluation techniques for assessing the modules. The instrument was face validated by three experts. Two of the experts were from Department of Electrical/Electronic Technology, Yaba College of Technology and one from Department of Electrical/Electronic Technology, Lagos State Polytechnic, Ikorodu.

To determine factorial validation of the modules and content items suitable for the development of cell phone maintenance training modules, the items were subjected to a factor analysis using 0.50 as factor loading at 10% overlapping variance (Ashley, Boyale, & Haile-Gabriel, 2007). In the result, 3 content items with factor loading less than 0.50 were discarded while 140 with a factor loading of 0.50 and above were selected for the study. The internal consistency reliability coefficient of 0.82 was obtained for CMMQ using Cronbach alpha technique. Out of one hundred and thirty-seven copies of the questionnaire administered to the respondents with the help of three research assistants, only 104 copies were duly retrieved which represent 75.9l per cent return rate.

The data collected from the study were analyzed using Mean for answering research questions one, three and four. A cut-off point of 3.50 was used for decision making. Any item whose mean was 3.50 or above was judged as agree or required while any item whose Mean was less than 3.50 was judged as disagree or not required. Any item with Analysis of Variance (ANOVA) was employed for testing all the null hypotheses at 0.05 and relevant degrees of freedom. The null hypothesis of no significant difference was accepted for any item whose P- value was greater than the 0.05, but it was rejected for any item whose P-value was less than 0.05.

3. Results

The results of the study were obtained from the research questions answered through data collected and analyzed.

The researchers ascertained the objectives of cell phone maintenance training modules. Results of data analysis in Table 1 reveal 11 objectives of cell phone maintenance modules. The means for the objectives ranged from 3.56 to 4.40. Each Mean was above the cutoff of 3.50 indicating that all could be the objectives of the cell phone maintenance modules. The Table also showed that 11 objectives had their P-values greater than 0.05.

This indicated that there was no significant difference in the mean responses of lecturers, instructors, cell phone technicians and supervisors in electrical electronic industries on the objectives of cell phones maintenance modules. Therefore, the null hypothesis of no significant difference was upheld for all the objectives.

Table 1. Mean Responses of Lecturers, Instructors and Supervisors and Roadside Cell Phone Technicians on the Objectives of Cell Phone Maintenance Training Modules

S/N	Objectives of Cell Phone Maintenance Module: On Completion of This Module the Trainees Should be Able to:	$\bar{X}$	P-values	Remarks	NS
1	Identify various parts of cell phones and their functions	3.94	1.16	Required	NS
2	State the steps in troubleshooting various faults in cell phones	4.07	0.76	Required	NS
3	Repair different kinds of faulty or damaged cell phones	3.77	0.87	Required	NS
4	Service all kinds of malfunctioned cell phones	4.40	0.76	Required	NS
5	State various steps in configuring different types of cell phones	3.96	0.80	Required	NS
6	List various steps in Flashing various types of smart cell phones	3.56	0.78	Required	NS
7	Upgrade various smart or high ends phones	4.18	0.79	Required	NS
8	List the steps for unlocking cell phones	4.19	0.85	Required	NS
9	State the steps in jailbreaking cell phones	3.74	0.98	Required	NS
10	State the functions of the facilities for the maintenance of cell phones	3.90	0.89	Required	NS
11	Use all kinds of facilities required for the maintenance of cell phones	4.24	0.76	Required	NS

Keys: X Mean of Respondents, S= significant, NS= Not significant, H0 = Hypotheses, N= Number of the Respondents

Table 2. Summary of the Outcome of Factor Analysis used for Answering Research Question Two

S/N	Contents of Cell Phone Maintenance Training Modules	Factor Loading at 0.50	Remarks
A	***Functions of the Major Component of Cell Phones***		
1	Read-only memory and flash memory chips provide storage for phone's operating system and customizable features	0.69	Required
2	Subscriber identity module allows users to retain information after switching handset on	0.79	Required
3	Circuit board allows all parts of the phone to communicate with one another	0.86	Required
4	Digital signal processor performs signal manipulation calculation at high speed	0.85	Required
5	Radiofrequency handles power management and recharging battery	0.65	Required
6	Software serves as an interface between the user and cell phone	0.66	Required
B	***Symptoms of Major Faults in Cell Phones***		
7	Microphone faults result to caller not hearing the receiver or receiver's voice is distorted to the caller	0.78	Required
8	Symptoms of hardware faults in cell phone include dead set condition, no charging, battery empty and auto turn off	0.81	Required
9	Symptoms of software faults in a cell phone are no signal, dead set to display, test mode and not charging.	0.73	Required
10	Symptoms of setting problems include call divert, SIM lock, and security code country lock	0.76	Required
11	Auto turn off of a cell phone indicates the old age of major components in the mobile	0.76	Required
C	***Remedies of Possible Faults in Cell Phones***		
12	Identify the causes of the faults	0.72	Required
13	Identify bad components in the cell phone	0.84	Required
14	Recommend solutions to each of the faults	0.80	Required
15	Relate each symptom to faults in the cell phone	0.85	Required
D	***Safety Precautions in using Cell Phones***		
16	Clean cell phone with a correct solvent like alcohol	0.69	Required
17	Use soft materials to clean cell phone	0.69	Required
18	Take cell phone away from water or foods	0.82	Required
19	Charge the battery of a cell phone at moderate	0.88	Required
20	Use recommended battery charger for a cell phone	0.85	Required

Keys: *N = Number of the Respondents*

Table 2. (Continued)

S/N	Contents of Cell Phone Maintenance Training Modules	Factor Loading at 0.50	Remarks
E	*Safety Precautions in maintaining Cell phones*		
21	Remove the battery of the phone before servicing	0.75	Required
22	Use extreme care when disassembling cell phone for any reason	0.75	Required
23	Apply right pry tools and screwdrivers when changing faceplates or other components	0.74	Required
24	Remove the battery of a cell phone using recommended tools	0.76	Required
25	Gently pry parts of cell phone until they come loose on their own	0.76	Required
26	Use correct tools to open a cell phone	0.78	Required
27	Dismantle cell phone on a smooth place	0.80	Required
28	Use appropriate tools to remove bad components from a cell phone	0.86	Required
29	Apply recommended soldering iron when working on cell phones	0.77	Required
30	Leave the terminals of a battery open always	0.77	Required
31	Do not repair or service a cell phone if not conversant with the mode of operation	0.76	Required
32	Install software onto the cell phone in case of smartphones	0.83	Required
33	Observes, solely rules relating to soldering while soldering components in a cell phone	0.62	Required
34	Handles motherboard with care while working on a cell phone	0.56	Required
F	*Skills in troubleshooting faulty cell phones*		
35	Take down the history of the faults from the cell phone user	0.81	Required
36	Identify the facilities for troubleshooting faulty cell phone	0.60	Required
37	Test the faulty cell phone in the present of the owner	0.69	Required
38	Recognize the symptoms of all the possible faults	0.92	Required
39	List all the possible causes of the problems	0.91	Required
40	Check the list of possible causes against the list of the symptoms	0.90	Required
41	Rank the remaining causes in order of likelihood	0.70	Required
42	Reveal the result of the troubleshooting to the owner of the cell phone	0.69	Required
43	Use tested okay unit to replace the bad unit of the same capacity if the fault is obvious	0.86	Required
44	Test the unit or component one by one using appropriate tools or equipment	0.72	Required
45	Record down the outcome of the troubleshooting	0.65	Required
46	Tackle the likeliest causes in the order of the complexity, cost and /or time required to check them	0.54	Required
G	*Skills in repairing cell phones*		
47	Dismantle the cell phones	0.65	Required
48	Split out the casing of the cell phone	0.67	Required

Table 2. (Continued)

S/N	Contents of Cell Phone Maintenance Training Modules	Factor Loading at 0.50	Remarks
49	Separate the keypad from the mechanism	0.66	Required
50	Move the slider down	0.73	Required
51	Lift the connector up to unplug the screen that is attached to the circuit ribbon	0.71	Required
52	Move the slider up in case of the slide phone	0.77	Required
53	Run fingernail along the edge of the front cover to unclip it	0.22	Not Required
54	Remove the front cover of the cell phone	0.74	Required
55	Identify faulty area or components in a cell phone	0.84	Required
56	Test the components with appropriate testing instruments	0.85	Required
57	Remove the component(s) from the motherboard using appropriate tools	0.84	Required
58	Select components of correct specification	0.83	Required
59	Verify the condition of the components before fixing it back to the motherboard	0.96	Required
60	Repair or change the faulty components if totally bad	0.82	Required
61	Fix back the components into motherboard correctly	0.85	Required
62	Apply soldering iron for only 3 seconds if needed	0.83	Required
63	Apply sufficient flux to point(s) being soldered	0.78	Required
64	Couple back the phone	0.78	Required
65	Configure the phone	0.79	Required
H	*Skills in Coupling cell phone*		
66	Fix the electronic panel correctly into the main body	0.69	Required
67	Screw the panel gently without breaking	0.85	Required
68	Fix the screen and keypad correctly with an electronic panel	0.87	Required
69	Fix back the microphone/speaker/mouthpiece gently if removed	0.89	Required
70	Connect the battery and SIM sit to the appropriate position	0.88	Required
71	Insert the SIM card to rest on it sit	0.87	Required
72	Put back the casing correctly	0.89	Required
73	Configure the phone	0.38	Not Required
I	*Skills in Configuring cell phone*		
74	Select appropriate menu	0.80	Required
75	Generate settings	0.85	Required
76	Select configure setting	0.78	Required
77	Identify personal configuration	0.79	Required
78	Select add new in web	0.88	Required
79	Select home page	0.87	Required
80	Write wap.mtnonlineplay.com	0.77	Required
81	Select bearing setting to have a proxy server	0.77	Required
82	Write 8080 on port	0.87	Required
83	Rewrite username and password two times	0.86	Required
84	Select back up and choose options	0.87	Required
85	Activate as web	0.84	Required
86	Browsing to show bookmark	0.85	Required

Table 2. (Continued)

S/N	Contents of Cell Phone Maintenance Training Modules	Factor Loading at 0.50	Remarks
J	*Skills in Flashing cell phone*		
87	Connect the laptop to the internet	0.89	Required
88	Key in the website of the service provider	0.89	Required
89	Download correct software from the website of the service provider	0.89	Required
90	Unzip the downloaded flashing software	0.88	Required
91	Register with the CDMA or GSM carrier in the cell phone	0.89	Required
S/N	**Contents of Cell Phone Maintenance Training Modules**	**Factor Loading at 0.50**	**Remarks**
92	Connect cell phone to the computer with the help of appropriate USB cable	0.84	Required
93	Install the downloaded software on your phone	0.86	Required
94	Complete the installation within 15-20 minutes	0.77	Required
K	*Skills in Unlocking cell phone*		
95	Identify materials for unlocking cell phones	0.85	Required
96	Contact service provider for unlocking code	0.90	Required
97	Browse and download correct software for unlocking	0.88	Required
98	Generate unlock codes correctly	0.86	Required
99	Find the serial number of the cell phone	0.87	Required
100	Generate *#06# into cell phone	0.89	Required
101	Use the downloaded software to enter into the Manufacturer website and slide the card out	0.88	Required
102	Enter only one code to unlock the phone	0.87	Required
103	Enter code 7 (Multi lock) if the phone is not unlocked by typing the first code (MCC+MNC)	0.88	Required
104	Use the computer to identify the secret code in case of any difficulties in unlocking	0.88	Required
L	*Skills in Unlocking phones using Password*		
105	Return the battery back again without SIM card	0.95	Required
106	Switch on the phone	0.35	Not required
M	*Skills in Jailbreaking*		
107	Select facilities for cell phone jailbreaking	0.86	Required
108	Determine what version of iOS to run	0.91	Required
109	Back up the cell phone	0.89	Required
110	Plug the cell phone into the computer	0.92	Required
111	Back up information using sidebar of the phone	0.91	Required
112	Turn off the passcode screen lock if enabled	0.90	Required
113	Visit the website from the cell phone	0.90	Required
114	Check for compatibility of cell phone	0.89	Required
115	Slide the bar to start the jailbreak process	0.86	Required
116	Reboot the cell phone	0.79	Required
117	Browse cydia for new apps	0.88	Required
118	Return home screen	0.87	Required

Table 2 (Continued)

S/N	Contents of Cell Phone Maintenance Training Modules	Factor Loading at 0.50	Remarks
N	*Skills in upgrading cell phones*		
119	Select right tools for cell phone upgrading	0.73	Required
120	Recognize various options in upgrading a cell phone	0.79	Required
121	Detect parts of the cell phone to be upgraded	0.78	Required
122	Download relevant application software for upgrading	0.69	Required
123	Install application software for upgrading	0.72	Required
124	Remove obsolete components from cell phone	0.86	Required
125	Install new component onto the cell phone	0.78	Required
126	Couple back the cell phone	0.71	Required
127	Confirm functionality of the upgraded cell phone	0.68	Required
O	*Skills in Servicing malfunctioned cell phones*		
128	Service cell phone with earpiece problem	0.65	Required
129	Check cell phone with mouthpiece not working	0.67	Required
130	Carry out minor repair on a cell phone with a ringing problem	0.65	Required
131	Heat the cell phones with a vibration problem	0.58	Required
132	Make a minor repair to a cell phone with a charging problem	0.66	Required
S/N	Contents of Cell Phone Maintenance Training Modules	Factor Loading at 0.50	Remarks
133	Heat service dead cell phone	0.61	Required
134	Dry clean a cell phone with a screen problem	0.64	Required
135	Clean a cell phone with keypad problem	0.66	Required
135	Clean the ports of a cell phone with SIM card and SIM card port problems	0.68	Required
137	Service cell phone with a network problem	0.54	Required
138	Adjust cell phone with hand free mode problem	0.68	Required
139	Set a cell phone hanging when snapping/video recording	0.56	Required
140	Adjust cell phone restarting when the memory card is inserted	0.59	Required
141	Service cell phone hanging due to overloading of application software	0.58	Required
142	Make a minor repair to a cell phone with a charging problem	0.54	Required
143	Dry clean wet cell phone with appropriate materials	0.51	Required

The researchers also explored the contents of cell phone maintenance training modules. Results of data analysis in Table 2 reveal that only three out of 143 content items had their factor loading less than 0.50. Only 140 content items satisfied the criteria for inclusion in the cell phone maintenance training modules while the three items with factor loading less than 0.50 at 10% overlapping variance were discarded. This means that 140 items were required for the development of cell phone maintenance training modules.

Table 3. Mean Responses of Lecturers, Instructors, Supervisors and Roadside Cell Phone Technicians on the Facilities required for Maintenance of Cell Phones (N=104)

S/N	Facilities for maintenance of cell phones	$\bar{X}$	P-values	Remarks	H0
1	Set of screw drivers for screwing	3.83	0.99	Required	NS
2	Infrared reword station for soldering and de-soldering of components in the cell phones	4.15	0.83	Required	NS
3	Soldering iron (small-tipped 30 to 50 watt irons)	3.84	0.91	Required	NS
4	Laptops of higher capacities	4.17	0.94	Required	NS
5	Flashing software	3.82	0.93	Required	NS
6	Compatible universal serial bus for cell phone	3.71	0.93	Required	NS
7	Internet facilities in case of downloading software for cell phone	4.03	0.97	Required	NS
8	A computer with Windows 200 or newer with a USB port. Phone	3.97	0.97	Required	NS
9	A code division multiple access cell phone (CSMA)	4.15	0.90	Required	NS
10	Eyelets and eye letting tools	3.93	0.95	Required	NS
11	Soldering lead	4.01	0.87	Required	NS
12	Soldering paste	3.94	0.84	Required	NS
13	Pickers for removing tiny and hidden objects form the phones	3.60	0.85	Required	NS
14	Torque screw driver precision tools	3.83	0.84	Required	NS
15	Long nose pliers for holding a tiny object in hidden place	4.07	0.93	Required	NS
16	Software (Assorted)	3.63	0.88	Required	NS
17	Cutting pliers for cutting flexible objects	3.84	0.97	Required	NS
18	Hot lead sucker/suction devices for removing melted solder	3.61	0.88	Required	NS
19	Digital power supply	4.15	0.90	Required	NS
20	Non-corrosive liquid flux) to prevent oxidation during	4.11	0.91	Required	NS
21	Standard universal headphone for testing signals/sound	3.80	0.92	Required	NS

Keys: X = Means of Respondents S=significant, NS=Not significant, H0 = hypotheses, N= Number of the respondents

Table 3. (Continued)

S/N	Facilities for maintenance of cell phones	$\bar{X}$	P-values	Remarks	H0
22	Magnify desk lamp	3.86	0.89	Required	NS
23	Multi-tester for testing and measurement of components electrical quintiles	4.10	0.98	Required	NS
24	Solder-resistant paint used in soldering	3.79	0.02	Required	NS
25	Ultrasonic cleaner	3.81	0.97	Required	NS
26	Booster for reactivating dead batteries of cell phones	3.92	0.95	Required	NS
27	Magnifying lens for enlarging tiny objects in a cell phone	3.88	0.02	Required	NS
28	Methylated spirit for washing panel or motherboard of cell phones	3.62	0.97	Required	NS
29	Heater for heating the motherboard during repair	3.53	0.99	Required	NS
30	Broad holder	3.74	1.07	Required	NS
31	Extension box for extending power source	3.76	0.91	Required	NS
32	Small brush for brushing away the solder residues	4.01	0.84	Required	NS
33	Regular power sources	3.74	0.77	Required	NS
34	Chargers (conventional and universal ones) for charging batteries	3.90	1.03	Required	NS
35	Signal chart books	3.92	0.70	Required	NS
36	Vacuum cleaner for cleaning of cell phones	3.61	1.06	Required	NS
37	Microscopes for seeing tiny components	4.03	0.86	Required	NS
38	Universal phone leaver to open complex cell phones	3.71	1.01	Required	NS
39	Intelligent printed circuit board cleaner for cleaning water	4.20	0.81	Required	NS
40	Universal extension cable for connecting directly to USB 2.0 ports on the personal computer	3.83	1.12	Required	NS
41	Anti-static wrist strap for ESD control	3.92	1.01	Required	NS
42	Antistatic tweezers for installing static sensitive components during mobile phone repair	3.98	0.73	Required	NS
43	User manual to give the direction of operation and servicing	4.06	0.85	Required	NS
44	Soft dry cloth for cleaning cell phone	4.14	0.98	Required	NS
45	Compressed air for blowing dust for the cell phones	3.71	0.98	Required	NS
46	Pickers for picking small objects in a cell phone	3.82	0.01	Required	S
47	Screw extractor for grabbing those screws and get them out without messing with the hardware	4.29	0.83	Required	NS

The researchers identified facilities for maintenance of cell phones. Results of data analysis in Table 3 reveal 47 facilities for maintenance of cell phones. The means of all the 47 facilities ranged from 3.60 to 4.29. Each Mean was above the cutoff of 3.50 indicating that these 46 facilities were required for maintenance of cell phones. The Table also shows that 46 facilities had their P-values greater than 0.05. This indicated that there was no significant difference in the mean responses of lecturers, instructors, cell phone technicians and supervisors in electrical/electronic industries on the 47 facilities for maintenance of cell phones and that there was a significant difference in the mean responses of the respondents on one facility. Therefore, the null hypothesis of no

significant difference was upheld for 47 facilities for maintenance of cell phones and rejected for one facility.

Table 4. Mean Responses of Lecturers, Instructors and Supervisors on the Evaluation Techniques and Activities required for assessing Cell Phone Maintenance Modules (N = 60)

S/N	Evaluation Techniques and Activities	$\bar{X}$	P-values	Remarks	H0
A	**Evaluation Techniques**				
1	Observing trainees while carrying out repair on a faulty cell phone	3.81	0.74	Required	NS
2	Written questions and answers	4.14	0.75	Required	NS
3	Oral techniques for assessing trainees	413	0.78	Required	NS
4	Students cell phone practical technique	3.76	1.00	Required	NS
5	Carry out the project on a cell phone	4..37	0.84	Required	NS
6	Procedure testing	4.24	0.77	Required	NS
7	Checklist	3.53	0.76	Required	NS
8	Use rating scale to asses trainees while maintaining cell phones	4.40	0.74	Required	NS
9	use evaluation questionnaire in the process of assessing trainees	4.38	0.84	Required	NS
10	Set matching tests for evaluating trainees under cell phone maintenance training	3.93	0.98	Required	NS
11	Multiple choice test	4.09	0.99	Required	NS
12	Cell phone short answer tests	3.72	0.84	Required	NS
13	Cell phone maintenance performance tests	4.34	0.93	Required	NS
14	Psycho productive tests	4.31	0.89	Required	NS

Keys: X=Mean of Respondents, S =significant, NS=Not significant, H0=Hypotheses, N= Number of the Respondents

Table 4: (Continued)

S/N	Evaluation Techniques and Activities	$\bar{X}$	P-values	Remarks	H0
B	**Evaluation Activities**				
15	Identify causes of a particular fault in a cell phone	3.85	0.93		
16	Dismantle a faulty cell phone without causing any further damages	4.27	0.71	Required	NS
17	Identify types of components in a cell phone with their functions	3.73	0.73	Required	NS
18	Dismantle different types of cell phone	4.16	0.84	Required	NS
19	Clear faults in a cell phone without causing further damage	3.72	0.88	Required	NS
20	Remove faulty or malfunctioned components such as integrated circuits, charging points, mouthpiece, SIM sit without causing damage to the motherboard	4.08	0.84	Required	NS
21	Clean faulty cell phones with brush and methylated spirit	4.19	0.84	Required	NS
22	Diagnose faults in different types of charger	3.64	0.85	Required	NS
23	Flash different types of cell phones using laptops	4.20	0.91	Required	NS
24	Service all kinds of cell phones (smartphones included)	3.64	0.84	Required	NS
B	**Evaluation Techniques**				
25	Package the repaired or serviced cell phone	4.20	0.86	Required	NS
26	Test the repaired/serviced cell phones for functionally	4.05	0.78	Required	NS
27	Configure the smartphones to browse the internet	4.26	0.78	Required	NS
28	Apply digital or analogue multitester to test electrical components correctly	4.21	0.86	Required	NS
29	State the procedure for opening a cell phone	3.57	0.83	Required	NS
30	Relate symptoms to a fault (s) developed in a cell phone	3.72	0.92	Required	NS
31	Draw circuit diagrams of a cell phones	4.35	0.85	Required	NS
32	Identify different types of components that make up a cell phone	4.18	0.79	Required	NS
33	Solder a particular component correctly	3.71	0.72	Required	NS

The researchers explored the evaluation methods and activities for assessing the objectives of the training modules. Results of data analysis in Table 4 reveal 14 evaluation techniques and 19 activities for assessing cell phone maintenance training modules. The Means for the evaluation techniques and activities ranged from 3.57 to 4.38. Each mean was above the cutoff of 3.50 indicating that all the techniques and activities could be used to assess cell phone maintenance training modules. The results also show that 33 evaluation techniques and activities had their P-values greater than 0.05. This indicated that there was no significant difference in the mean responses of lecturers, instructors and supervisors in electrical electronic industries on the 33 evaluation techniques and activities for assessing cell phone maintenance training modules. Therefore, the null hypothesis of no significant difference was upheld for 33 evaluation techniques and activities.

4. Discussion of Findings

The findings of this study revealed 11 objectives, 141 contents of cell phone maintenance modules, 46 facilities for maintenance of cell phones, 33 evaluation techniques and activities for assessing cell phone maintenance modules. The findings were in agreement with the finding of Bakare (2014) who found that ability to identify various parts of cell phones and their functions, troubleshooting faulty cell phones, configuring different types of cell phones, upgrading various smart or high ends phones, flashing various types of smart cell phones, jailbreaking high-end cell phones and using all kinds of facilities required for maintaining cell phones are suitable as objectives for cell phone maintenance training modules.

One hundred and forty-one contents were suitable because they have factor loading of 0.50 and above. This finding agreed with Giachino and Gallington (1977) that if the content has no components of non-loading items, it is assumed that the factorial validity of the content is high. The finding also agreed with the opinion of Jain (2010) that the higher the absence of low loading items the more important and suitable the contents. The finding was in agreement with the opinion of Kapoma and Namusokwe (2011) that content is a list of subjects, skills, topics, themes, concepts or works to be covered in a programme. This finding is in agreement with the finding of Bakare, Zakka and Fittoka (2010) who conducted a study on the integration of mechatronics in electrical/electronic technology programme of colleges of education in order to ensure occupational quality assurance of graduates in the 21st century Nigeria. The authors found out 10 contents and 22 competencies of mechatronics to be included into electrical electronic technology programme of colleges of education to ensure occupational quality assurance of graduates in the 21st century.

Forty-six facilities were found relevant for maintenance of cell phones of different kinds. Among the facilities are set of screwdrivers for screwing, infrared rework station for soldering and de-soldering of components, soldering iron (small-tipped 30-to-50 watt irons), laptops for flashing phones, compatible universal serial bus for cell phone, flashing software, internet facilities in case of downloading software for cell phones and computer with Windows 2000 or newer with a USB Port.800Mhz+, 256MB RAM. These findings were in agreement with the finding of Bakare (2014) that set of screwdrivers for screwing, infrared rework station for soldering and de-soldering of components, soldering iron (small-tipped 30-to-50 watt irons), laptops are highly essential for carrying out repair and servicing operations on cell phones. The findings were also in consonance with the report of Alfa Institute of Cell Phone Repair and Training Centre (2012) that infrared rework station for soldering and de-soldering of components, eyelets and eye letting tools among others are essential for electronic repair and maintenance.

It was found out in the study that 33 evaluation techniques and activities were required for assessing cell phone maintenance modules. The techniques include observation, written questions and answers, students practical technique, oral techniques, project given technique, and procedure testing. Evaluation activities also include identifying causes of a particular fault in a cell phone, dismantling a faulty cell phone without causing any further damages, identifying types of components in a cell phone with their functions, dismantling different types of cell phones, clearing of faults in a cell phone without causing further damage, removing faulty or malfunctioned components such as integrated circuits, charging points, mouthpiece and cleaning of faulty cell phones with brush and methylated spirit. The finding was in agreement with the opinion of Osinem (2008) that oral questions and procedure testing could be used to evaluate training outcome. The author stated that each of the techniques possesses distinct characteristics that make it useful for measurement of a particular kind of performance. The findings of the above researchers in their various research activities helped to support the justification of the

results of this study on the development and factorial validation of cell phone maintenance modules.

5. Conclusion

A cell phone is one of the mobile communication technologies found in every aspect of human endeavour. There is hardly any human activity where cell phones have not made an impact. It has been observed that most of the users could not easily locate efficient technicians who can repair and service faulty cell phones thereby making users whose cell phones are bad to abandon them for the purchase of new ones. Few technicians found repairing cell phones are not formally trained and therefore use trial by error approach and cause more problems to cell phones contracted to them. It is in this direction that this study was carried out to develop and validate cell phone maintenance modules for training in order to have skilled and efficient cell phone technicians. This will solve the problem of shortage of technicians for maintenance of cell phones. It is therefore recommended that developed and validated cell phone maintenance modules should be used to train interested individuals on repair and servicing of cell phones.

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