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The Imperative of Technical Skilled Staff in Legacy Information System Management

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***Abstract*—Technical skilled personnel and information systems are important for the success of contemporary firms as they face intense rivalry, globalization, and time-to-market pressures. They are an essential element that plays a critical role in an organisation's ability to sense environmental change and respond efficiently and effectively to that change. Besides the technology components of an information system and the fast pace of technological innovation, the people involved in the design, operation and maintenance are essential elements of information systems. Most of the research work on deciding whether or not to continue with legacy information systems has been centred mainly on intrinsic agility factors. Extrinsic agility factors like technical skilled personnel have largely been overlooked. But, as information systems age or in the case of highly rigid processes, extrinsic agility factors like technical skilled personnel will start playing an important role in deciding whether to prolong the life cycle of the information system. However, human skills obsolescence is a growing problem for organizations that must support legacy systems. The technical skilled staff are either ageing out or upgrading their skills to a non-procedural programming paradigm due to market demand. It is, therefore, imperative to regularly assess the technical skilled personnel competency level of a legacy information system. This study evaluates and classifies the technical knowledge of skilled personnel using a developed online assessment system with test questions based on the legacy information system application program. The result obtained indicates that the technical skilled staff can still operate and maintain the case study information system.**

***Keywords*—Information System, Legacy Information System, Information Technology, procedural programming paradigm**

I. INTRODUCTION

Information systems can be defined as a set of interrelated components that collect or retrieve, process, store, and distribute information to aid decision-making and control in an organisation [3], [10]. The five major components are hardware, software, data, people, and processes. The first three components represent technology. The focus of information systems is the information aspects of information technology. According to Bourgeois *et al*. [3], it is easy to focus on the technology components when referring to information systems and forget to look beyond the information technology to fully understand their integration into an organization. The people involved in information systems are essential elements of information systems. According to Alexopoulou *et al*. [1], people, as represented by technical skilled staff constitute one of the major components of information systems. It is an essential element that plays a critical role in an organisation's ability to sense environmental change and respond efficiently and effectively to that change. Besides the fast pace of technological innovation, the people involved in the design, operation and maintenance are indispensable to information systems.

There is no standard definition of a legacy information system [6], [18]. "Aging information systems are often referred to as legacy" [5], [7], [21]. A legacy information system is "any information system that significantly resists modification and evolution" [2], [4]. Lioyd *et al.* [11] extend the definition of a legacy system to include business processes. According to Verbaan [18], "a procedural programming paradigm can also be referred to as legacy". Flowing from the definition of [5], [7], and [18], we define a legacy information system as an information system that has been in operation for some years and runs on a procedural programming language paradigm. Based on the literature review, we discovered that most of the research work on deciding whether to continue with legacy information systems or not has been centred mainly on intrinsic

agility factors. Extrinsic agility factors like technical skilled personnel have largely been overlooked**.** For ageing or highly rigid information systems processes, extrinsic agility factors like technical skilled personnel will start playing an important role in deciding whether to prolong the life of the information system or move on to a newer one [18]. Unfortunately, "human skills obsolescence is a growing problem for organizations that must support legacy systems" [23]. This is because technical staff are either ageing out or upgrading their skills to a non-procedural programming paradigm due to market demand. According to Hughes [20], as technical skilled staff reach retirement age, newly employed staff are unwilling to pick up old skills. To Zekaria *et al*. [24], "Skills shortage is a genuine lack of adequately skilled individuals available in the accessible labour market". Furthermore, Abu *et al*. [22] opined that due to the lack of experts that understand the legacy information system, the maintenance process is difficult.

This study is about investigating the organisational skill gap of technically skilled personnel and their classification into four categories: Novice, Apprentice, Associate and Expert with a developed online assessment system using a student information system as a case study. The higher the classification of the technical skilled staff, the more efficient and effective the staff are in maintaining the legacy information system. Therefore, it is likely that the Associate and Expert technical staff could be better equipped to maintain the legacy information system compared to the Novice and Apprentice.

II. METHODOLOGY

A standalone web-based online assessment system relevant to the Technical Skilled Personnel information system component was adopted in conducting the research. The online assessment system based on test questions was used to assess the technical skilled staff. The benchmark requirement for Technically skilled personnel as adapted from [8] ranges between 0 and 30% score for Novice, between 30% and 60% score for Apprentice, between 60% and 80% score for Associate and between 80% and 100% score for Expert. We adopted this definition for our study. The developed online assessment system is flexible, secure and convenient to use

A Student Information System built on MySQL database and mainly using a procedural PHP programming language application for a tertiary institution in Edo State, Nigeria, where the technical skilled staff are responsible for its operation and maintenance, is used as a case study. The information system which has been in operation for the past fourteen years was developed and maintained by Gheli Technology Solutions Limited, a privately owned registered company with headquarters in Edo state, Nigeria. A team of five technical staff is currently responsible for the maintenance of the information system. The five technical staff are graduates with at least a B.Sc or Higher National Diploma (HND) in Computer Science and related discipline.

III. ANALYSIS OF RESULTS AND DISCUSSION

The validated test questions were used to measure the skill level of the five Technical personnel. Literature reviews and expert judges or panels were used to measure content validity [17]. The test questions selected from the literature were mainly adapted from [9], [14] and [15]. Since the information system adopted as our case study runs a procedural PHP application program built on MySQL, the test questions were mainly centred on the procedural PHP programming language. The test questions were validated by five domain experts in the field of Computer Science, Information Systems and Software Engineering to determine their appropriateness. Three of the experts were from the academic and the other two were from the industry. The Questions were given to them to rate in Likert format from 1 to 5 based on the relevance of the test Questions to the subject matter. We took 3.5 and above scores as the pass mark for selection. The test questions that scored below 3.5 were rejected. To develop or validate good and understandable questions, tests are conducted using external test respondents [12]. Here, Strongly Disagree (SD) score is 1, Disagree (D) = 2, Undecided (UD) =3, Agree (A) = 4 and Strongly Agree (SA) =5, for each question or statement. All answers to the questions received scores. These scores were not interdependent; thus it provides us with an objective assessment allowing for comparison. Scoring 3.5 points or higher indicates that the statement was successfully validated. The respondents' characteristics and areas of specialization are stated in Table 1.

TABLE 1 CHARACTERISTICS OF THE RESPONDENTS USED IN THE SURVEY VALIDATION

Respondent	**Years of Experience**	**Occupation/ Rank**	**Area of Specialisation**
A	30	Academic / Senior Lecturer	Theoretical Computing, Design and Analysis of Algorithms and Program Design.
B	25	Academic / Professor	Knowledge Engineering and Biomedical Computing.
C	15	Academic / Senior Faculty	Software Engineering
D	17	Information Technology (Industry) / Senior Personnel	Information Systems
E	20	Information Technology(Industry)	Software Development & Network Administrator

*Source***:** Survey, 2019

The experts' responses were analysed quantitatively using descriptive statistics with average scores. The results of the analysis of the validated 247 test questions for technical skilled staff indicate that 237 test questions have an average score of 3.5 and above. We, therefore, adopted the 237 test questions relevant to the case study information system application program to determine the skill level of the technical staff.

Design Tools

The design tools used include: Algorithm, Flow Graph, Entity-Relationship Diagram, MySQL, WAMP Server and Macromedia Dreamweaver 8.0. The table design and algorithm are described in Table 2 and Fig. 1 respectively.

TABLE 2 TABLE DESIGN FOR TECHNICAL STAFF (tbl_user), QUESTIONS (tbl_ques), ADMINISTRATOR (tbl_admin), ANSWERS (tbl_ans) AND GRADE (tbl_grade)

I. tbl_user

Field	Type	Null	Default	Extra
Userid	int(10)	No	*None*	auto_increment
Name	varchar(40)	No	*None*	
Username	varchar(25)	No	*None*	
Password	varchar(32)	No	*None*	
Email	varchar(150)	No	*None*	
Status	int(11)	No	0	

II. tbl_ques

Field	Type	Null	Default	Extra
Id	int(10)	No	*None*	auto_increment
QuesNo	int(10)	No	*None*	
Ques	Text	No	*None*	

III. tbl_admin

Field	Type	Null	Default	Extra
AdminId	int(10)	No	*None*	auto_increment
adminUser	varchar(40)	No	*None*	
adminPass	varchar(32)	No	*None*	

IV. tbl_grade

Field	Type	Null	Default	Extra
No	int(10)	No	*None*	auto_increment
Userid	int(10)	No	*None*	
Name	varchar(40)	No	*None*	
Result	int(10)	No	*None*	
professional_status	varchar(40)	No	*None*	

V. tbl_ans

Field	Type	Null	Default	Extra
Id	int(10)	No	*None*	auto_increment
quesNo	int(10)	No	*None*	
rightAns	int(10)	No	0	
Ans	Text	No	*None*	

Design Techniques

Structured systems analysis and design method (SSADM) was adopted. It is suitable for the system under study as Flow Graph and Entity-Relationship diagram were used for implementation.

Programming Language and Tools used

PHP programming language, JavaScript, HTML, CSS, Macromedia Dreamweaver 8.0 and WampServer 2.0 was adopted for the implementation of the online assessment system using test questions.

Homepage (Access Controller/Control Centre)

The developed online assessment system is a web-based standalone application that is used for assessing the skill level of technical staff. The assessment system is based on Client/Server Architecture and structured as a 3-tier application, where the web browser constitutes the first tier, the middleware the second tier and the database the third tier. The homepage of the online assessment system also referred to as the access controller or control centre is the point of entry into the online assessment system. The subsystems are the Technical staff subsystem and the Administrator subsystem. The input parameters are derived from test questions. The Technical staff subsystem handles login, registration, access rights activation and logout. It is an interactive page. To prevent a security breach, the Username and Password must be valid to gain access to the welcome page. Users' email addresses can only be used once for registration. To reuse it, the administrator must first delete it from the database. The user's password is encrypted in the database; it cannot be decrypted by the administrator who is assigned a default username and password.

Technical Skilled Staff Assessment Subsystem

This subsystem enables the Technical Skilled Staff to sit for the test questions, submit them and get immediate feedback on performance from the report stored in the database.

STEPS:
1. Start
2. Call from **Staff Homepage**
3. Declare Option as Integer
4. Display Icon options: "1. Skilled Staff Record (Profile)", "2. Test Questions, Submission and Feedback Performance (Assessment)", "3. Logout"
5. **Select Case** Option
6. **Case** Option= 1. Skilled Staff Record (Profile)
7. **Case** Option=2. Test Questions, Submission and Feedback Performance (Assessment)
8. **Case** option= 3. Close Skilled Staff Record (Logout)
10. Return to **Staff Homepage**
11. Stop

Fig. 1. Technical Staff Assessment Subsystem Algorithm

Program Development

Programming tools, languages and integrated programming environment (IDE) are required in program development. The choice of programming languages and environment is dependent on the researcher's knowledge and their suitability for the system being developed.

Choice of Programming Language Environment

PHP and JavaScript programming languages were chosen for this study as well as HTML, CSS and MySQL. The Integrated Development Environment (IDE) adopted are: WampServer 2.0, and Macromedia Dreamweaver 8.0. IDE normally consists of a text editor, image editor, program testing, function descriptions and a debugger. They are fast and robust.

Language Justification

PHP was chosen because of its simplicity, advanced features, ability to create dynamic web pages, built-in links to the MySQL database and open source [13]. JavaScript, HTML and CSS are equally simple to use, open source and used in the creation of dynamic web pages.

User Interface

According to Whitten *et al*. [19] user interface defines "how the system users directly interact with the information system to provide inputs and queries and receive outputs and help". The user interface is often the standard by which systems are assessed rather than the functionality. Several user interfaces are used by business systems, examples of which are command line interface, menu-driven interface, form-based interface, natural language interface and graphical user interface. When designing user interfaces, Sommerville [16] suggested five design principles to which users must adhere and include the principle of Familiarity, Consistency, Minimal surprise, Recoverability and User guidance. This study adopted the graphical user interface and adhered to the five design principles because most users of business systems are familiar with the graphical user interface. The different operational subsystems interfaces were integrated into one functional homepage called "Online Assessment System Homepage" (see Fig. 2). The subsystem's interfaces are the Technical Skilled Personnel Subsystem Interfaces and Administrator Subsystem Interfaces (see Figs. 3 to 8).

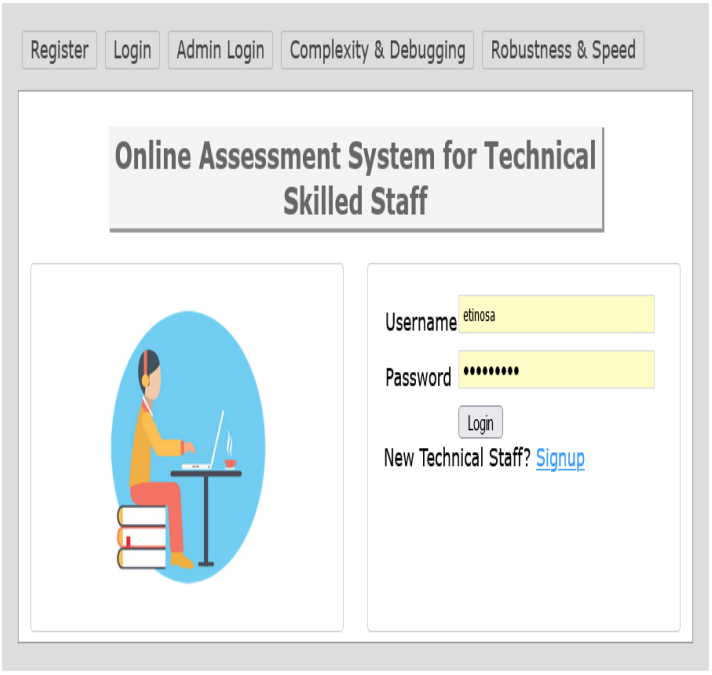

Fig. 2. Online Assessment System Homepage

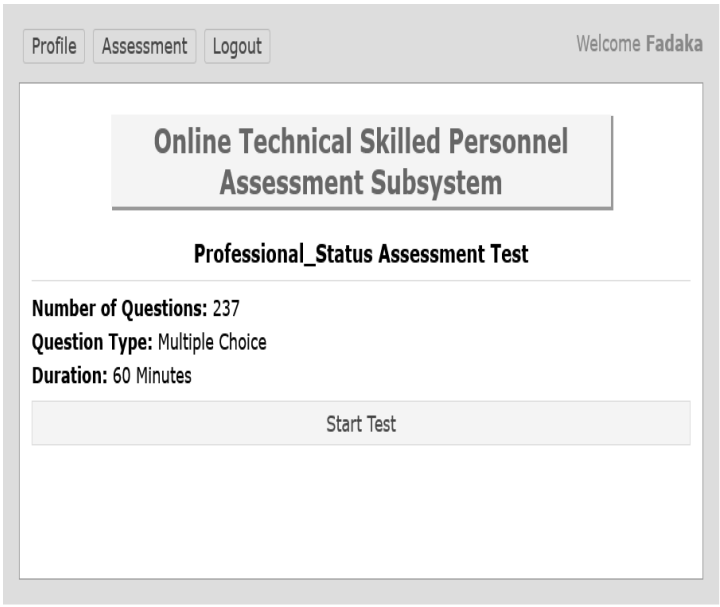

Fig. 3. Technical Skilled Personnel Assessment Subsystem

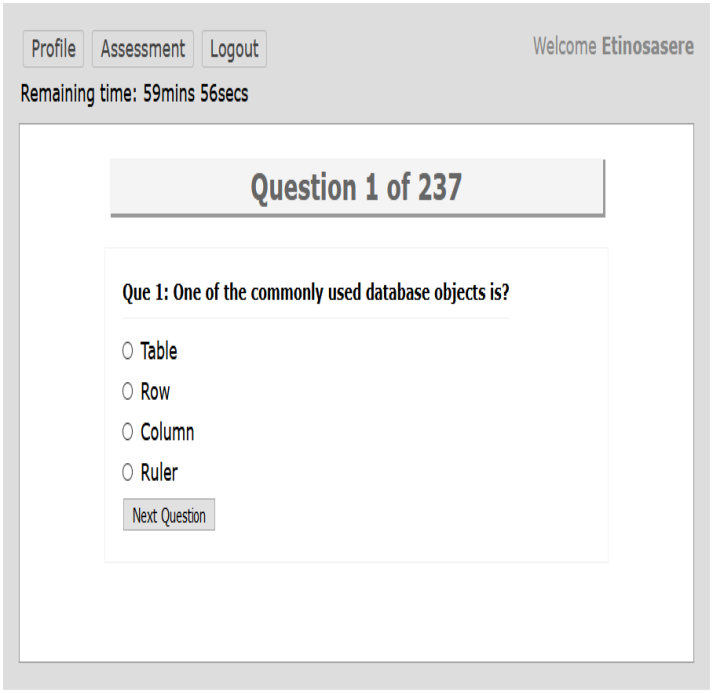

Fig. 4. Technical Skilled Personnel Assessment Interface

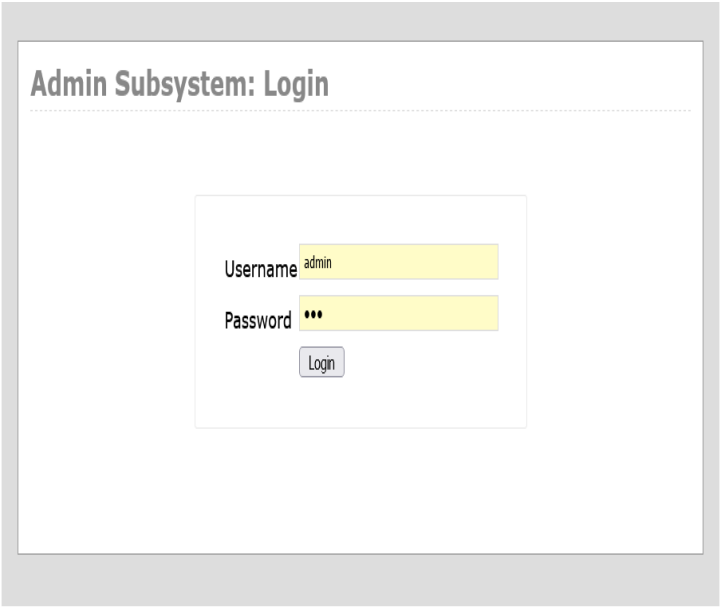

Fig. 5. Administrator Subsystem Login Interface

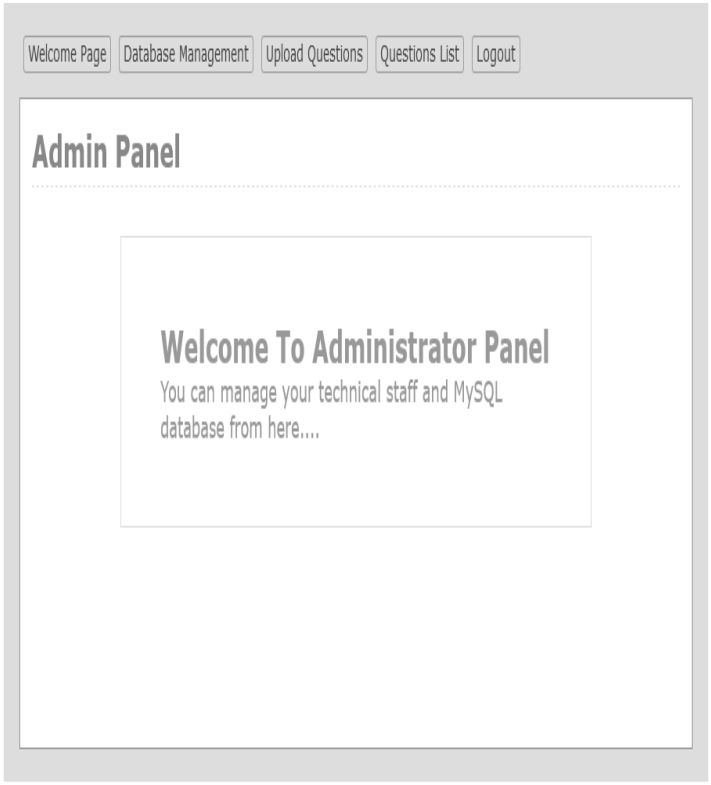

Fig. 6. Administrator Welcome Page Interface

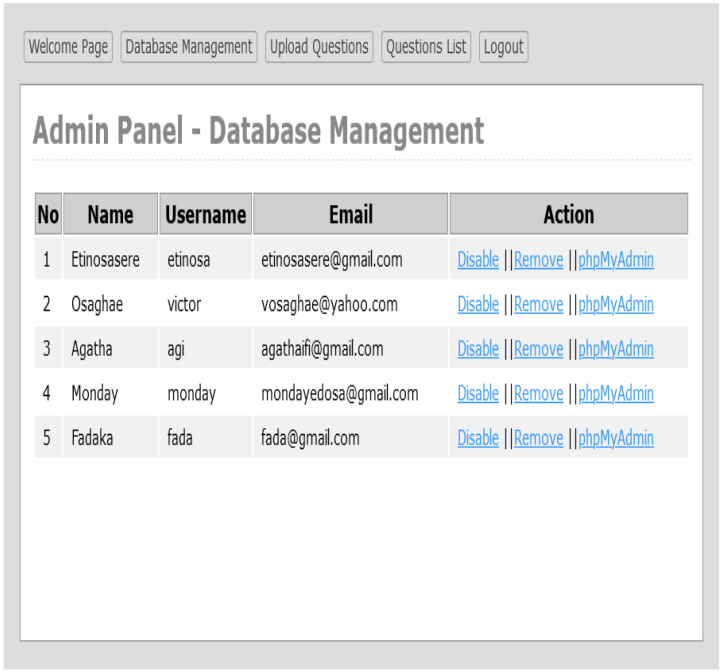

Fig. 7 Administrator Database Management Interface

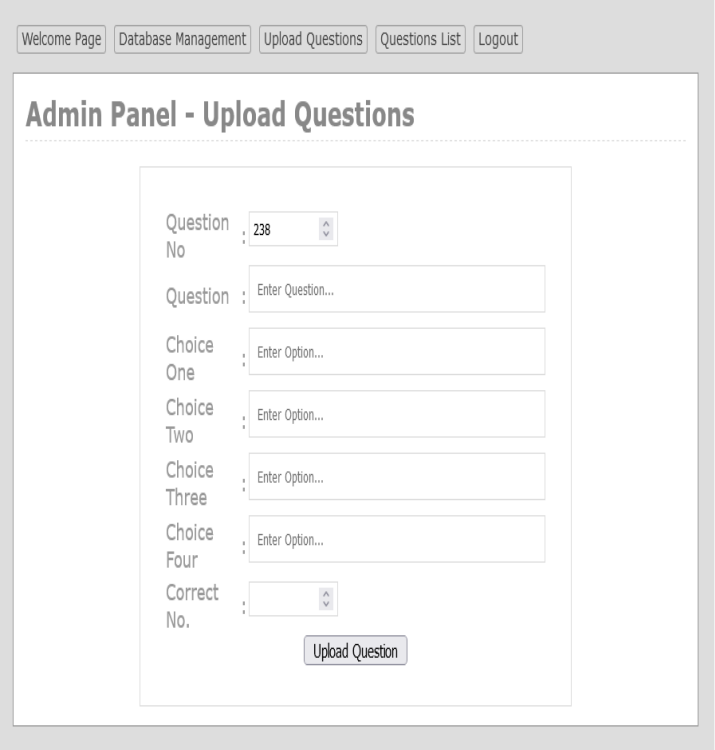

Fig. 8. Administrator Upload Test Questions Interface

For the technical skilled staff assessment and evaluation, the developed online assessment system with the validated 237 test questions was used. The test questions are mainly made up of PHP programs relevant to the case study student information system running a procedural PHP programming language application. The validated 237 test questions with an average score of 3.5 and above were uploaded into the assessment system by the head of the technical unit who equally doubles as the system administrator. The objective is to measure the skill level of the technical staff. The online-based test was administered simultaneously to the five technical staff with a time duration of 60 minutes. The test allocated time was activated when the technical staff logged into the welcome page and clicked the start-test button. The inbuilt countdown timer was designed to log out staff and auto-submit answers upon the expiration of 60 minutes. Besides auto-submission, the system was designed in such a way that answers are equally submitted to the database after answering the 237th question. This was to enable the technical staff to have a feel of all questions and not to submit them prematurely. The unit head can equally auto-submit answers remotely by clicking on the timer stop button or by amending the “countdown date" command. Skipping of questions was nevertheless permitted. The result of the test assessment was immediately displayed to the individual staff. Upon closing the page or logout, the session will terminate and the result can no longer be retrieved except in the MySQL database by the system administrator who has the access right.

The technical staff were trained on how to use the technical staff assessment subsystem. The web browser's "back" and "forward" buttons were disabled and not permitted to be used, nor were the technical staff permitted to go back to previous questions. The system uniform resource locator (URL) was http://localhost/exam/. To access localhost from other computers using the same Wi-Fi network, the URL adopted was http://edegbe/exam/. To access the Administrator panel, the Admin login button is clicked and the username and password are then entered into the interface. The local host and the five client computers were connected to the same Wi-Fi network in conducting the assessment test.

To run the online assessment application, the first step was connecting the five systems to the same Wi-Fi network alongside the local host server. The next step was to double-click the WampServer icon shortcut in the localhost desktop and click yes to the resulting dialogue box for the WampServer to be online. The system goes online when the WampServer icon on the taskbar of the localhost server turned white. Javascript was enabled in the browser's settings for countdown timer activation, users' login; the back and forward button disablement. The last step was setting the countdown timer to 60 minutes.

To take the assessment test, the five technical staff registered their details before they could log in with their username and password. This process was done by double-clicking the web browser icon shortcut on their desktop and then entering the web address http://edegbe/exam/ into the web browser. To gain access to the staff welcome page from the homepage, the username and password must be entered correctly. The password entered is encrypted with MD5 so that it cannot be decrypted. The existing email address stored in the database cannot be used for new registration, except if it is first removed from the database by the Administrator. The Administrator accessed the admin interface by clicking the Admin login on the homepage. To login into the admin welcome page and database, the username and password must equally be entered correctly into the admin interface. The results of the technical staff assessment conducted are in Fig. 9.

SQL result
Host: localhost
Database: db_exam
Generation Time: Jul 22, 2020, at 11:38 AM
Generated by: phpMyAdmin 3.2.0.1 / MySQL 5.1.36-community-log
SQL query: SELECT * FROM `tbl_grade` LIMIT 0, 30 ;
Rows: 5

No	userid	name	result	professional_status
1	15	Fadaka	119	APPRENTICE
2	16	Etinosasere	138	APPRENTICE
3	17	Osaghae	176	ASSOCIATE
4	18	Agatha	180	ASSOCIATE
5	19	Monday	154	ASSOCIATE

Fig. 9. Program Output of Technical Staff

The results of the administered test questions for the five technical staff indicate that two of the staff scored 119 and 138 out of 237 test questions respectively. This shows that they are apprentices. The risk factor of leaving them to operate and

monitor the system is very high. They should not be left alone with the students' information system without supervision. The other three staff scored 176, 180 and 154 out of 237 test questions respectively. This shows that their professional status is Associate. They can handle the information system. The risk factor of their taking charge of the system is low. From the result obtained, there is no Novice to understudy the Associate. Equally, there is no Expert to take overall responsibility in case of critical issues. This calls for some concern. However, the three Associate staff can manage and maintain the students' information system while the Apprentice does basic system monitoring and reporting. The two Apprentices should be under the tutelage of the Associates. Nevertheless, there is a need for the organisation to employ the service of an expert to guide and coordinate the activities of the information system for optimal performance. Training and re-training of staff to bridge their skill gap discovered will be beneficial in the long run. It will be necessary to have novices and apprentices in the department to understudy the Associates and Experts practically in an industry reputed to have high staff turnover.

IV. CONCLUSION

The developed online assessment system was used to evaluate and classify the technical knowledge of the technical staff to determine their capacity to operate and maintain the student information system. Our major findings indicate that the student information system can still be managed and maintained by the technical skilled staff. In light of our findings, the following actions should be considered to bring about improvement in the system:

1. The Technical staff should undergo continuous training to have sufficient knowledge and skills to manage the student information system, troubleshoot any problem that occurs and transfers that knowledge to other members of the IT department.
2. An expert staff should be employed from outside the organisation when the skill gap cannot be filled in the short run.
3. The top management should continue to provide strategic management and support to the IT unit.
4. Staff placed under the professional status of Apprentice should not be relieved of their job, but be made to do the basic work of monitoring the information system and giving feedback to the Associates and Experts whom they are made to understudy.
5. The organisation should endeavour to have at least an expert technical staff to coordinate all activities concerning information system maintenance to drastically reduce the risk of relying on less qualified technical skilled personnel.

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REFERENCES

[1] Alexopoulou, N., Kanellis, P., & Martakos, D. (2006). *Agile Information Technology Infrastructures*. Greece: Idea Group Inc.

[2] Bisbal, J., Lawless, D., Wu, B., & Grimson, J. (1999). Legacy Information Systems: Issues and Directions. *IEEE Software*, 16(5), 103-111.

[3] Bourgeois, D. T., Smith, J. L., Wang, S., & Mortati, J. M. (2019). *Information Systems for Business and Beyond*. Retrieved from https://opentextbook.site/exports/ISBB-2019.pdf.

[4] Brodie, M. L., & Stonebraker, M. (1995). *Migrating Legacy Systems: Gateways, Interfaces and the Incremental Approach*. San Francisco, CA: Morgan Kaufmann.

[5] Chen, K., & Rajlich, V. (2001). RIPPLES: Tool for Change in Legacy Software. *Proceedings of ICSM '01: IEEE Computer Society Press*, Los Alamitos: CA, 230-239.

[6] Crotty, J., & Horrocks, I. (2017). Managing Legacy System Cost: A Case Study of a Meta-assessment Model to Identify Solutions in a Large Financial Services Company. *Applied Computing and Informatics*, 13, 175-183.

[7] Furnweger, A., Auer, M., & Biffi, S. (2016). Software Evolution of Legacy Systems: A Case Study of Soft-migration. *Proceedings of the 18th International Conference on Enterprise Information Systems (ICEIS 2016)*, 1, 413-424.

[8] Insource. (2017). *Technical Skills Assessment*. Retrieved from https://insource.solutions/wp-content/uploads/2017/10/InSource_Document_Technical-Skills_102017.pdf.

[9] Iqbal, A. (2020). *Basic Computer Knowledge MCQs: Multiple Choice Questions and Answers (Quiz & Tests with Answer Keys)*. Bushra Arshad Publisher.

[10] Laudon, K. C., & Laudon, J. P. (2014). *Management Information Systems*. England: Pearson Education Limited.

[11] Lloyd, A. D., Dewar, R., & Pooley, R. (1999). Legacy Information Systems and Business Process Change: A Patterns Perspective. *Communications of the Association for Information Systems*, 2(24).

[12] Mortensen, R., Jasemian, T., & Nielsen, T. B. (2007). Measuring Agility: A Quantitative Survey among IT Professionals (Unpublished Master's Thesis), Aalborg University, Denmark.

[13] Nixon, R. (2012). *Learning PHP, MySQL, JavaScript and CSS*. 1005 Gravenstein Highway North, Sebastopol, CA 95472: O'Reilly Media Inc.

[14] Sanfounding. (2019a). PHP Questions and Answers. Retrieved from https://www.sanfoundry.com/php-questions-answers-functions/.

[15] Sanfounding. (2019b). MySQL Questions and Answers. Retrieved from https://www.sanfoundry.com/sql-mcqs-mysql-datatypes-1/.

[16] Sommerville, L. (1998). *Software Engineering*. Addison Wesley Longman Limited, England.

[17] Straub, D., Boudreau, M., & Geden, D. (2004). Validation of Guidelines for IS Positivist Research. *Communications of the Association for Information Systems*, 13(1), 380-427.

[18] Verbaan, M. (2010). Legacy Information Systems, Can They be Agile? A Framework for Assessing Agility. *Communications of the IIMA*, 10 (4), 1-14.

[19] Whitten, J. L., Bentley, L. D., & Dittman, K. C. (2001). *Systems Analysis and Design Methods*. San Francisco: McGraw-Hill Higher Education, A Division of the McGraw- Hill Companies.

[20] Hughes, O. (2021). These Old Programming Languages are Still Critical to Big Companies. But Nobody Wants to Learn Them. TechRepublic. Retrieved from https://www.techrepublic.com/article/these-old-programming-

languages-are-still-critical-to-big-companies-but-nobody-wants-to-learn-them/.

[21] Tsai, J. C., A, Jiang, J. J., & Hung, S. (2022). Legacy Information System Replacement: Pursuing Quality Design of Operational Informational Systems. *Information & Management*, 59(2).

[22] Abu, B., H., Razali, R., Jambari, D. I. (2021). Legacy Systems Modernisation for Citizen-Centric Digital Government: A Conceptual Model. *Sustainabilit*, 13, 13112. https://doi.org/10.3390/su132313112.

[23] Sandborn, P. (2015). The Forecasting and Impact of the Loss of Critical Human Skills Necessary for Supporting Legacy Systems. *IEEE transactions on Engineering Management*, 62(3), 361-371.

[24] Zekaria, Y. & Chitchyan, R. (2019). Literature Review of Skill Shortage Assessment Models. https://doi.org/10.13140/RG.2.2.28731.13605.