AFRICAN JOURNAL OF COMPUTING & ICT

Volume 11, Number 2, June 2018
https://afrjcict.net

ISSN 2006-1781

AFRICAN JOURNAL OF COMPUTING & ICT

Volume 11, Number 2, June 2018
https://afrjcict.net

CONTENTS

Editorial Board iv

From the Editor-in-Chief v

Comparative Evaluation of Linear Support Vector Machine and K-Nearest Neighbour Algorithm using Microarray Data on Leukemia Cancer Dataset 1-10
A. K. Oladejo[1], T. O. Oladele[2] and Y. K. Saheed[3]
[1, 2]Department of Computer Science,
University of Ilorin, Ilorin, Kwara State, Nigeria.
[3]Department of Physical Sciences,
Al-Hikmah University, Ilorin, Kwara State, Nigeria.

Experimental Evaluation of a Safety Data Model to Determine the Time Taken to Build, Merge and Publish XML File onto a Data Server 11-23
Ilyasu Anda[1], Isah Omeiza Rabiu[2], Enesi Femi Aminu[3] and Hussaini Abubakar Zubairu[4]
[1]Department of Library and Information Technology,
School of Information and Communication Technology,
[2]Department of Computer Engineering,
School of Engineering and Engineering Technology,
[3]Department of Computer Science,
School of Information and Communication Technology,
[4]Department of Information and Media Technology,
School of Information and Communication Technology,
Federal University of Technology, Minna, Niger State, Nigeria.

Digital Watermarking Algorithms for Visible Watermarks 24-36
A.R. Zubair
Electrical/Electronic Engineering Department,
University of Ibadan, Ibadan, Nigeria.

sVeriTool: A Verification Tool for Preventing Impersonation of Students in Examination Halls using Fingerprints 37-52
U.S. Haruna
Department of Computer Science,
Yusuf Maitama Sule University,
Kano, Nigeria.

Assessment of the Readiness of Academic Staff of a Tertiary Institution for Performance Evaluation using a Dynamic Human Resource Information System 53-75
Stephen G. Fashoto[1], Priscilla Ajiboye[2], Olumide Owolabi[3], Andile Metfula[1] and Olubunmi Y. Fashoto[4]
[1]Department of Computer Science, University of Swaziland,
Kwaluseni, Swaziland.
[2]Department of Information Technology, Kampala International University,
Kampala, Uganda.
[3]Department of Computer Science, University of Abuja,
Nigeria.
[4]Department of Psychology, University of Pretoria,
Pretoria, South Africa.

Call for Papers & Subscription Details 76

Editorial Board

From the Editor-in-Chief

It is a pleasure welcoming readers of *African Journal of Computing & ICT* to Vol. 11, No. 2, June 2018 edition. Five (5) papers appear in this edition.

In their paper, A. K. Oladejo, T. O. Oladele and Y. K. Saheed presented a performance evaluation of linear support machine (Linear SVM) and K-Nearest Neighbour algorithm (KNN) with the aid of microarray data on Leukemia cancer data set. The metrics used are classifier accuracy, sensitivity, specificity and precision. It is shown that Linear SVM performs better than KNN using all these metrics. For instance, the classifier accuracy of the former is given as 90% while that of the latter is 81.67%. Also, while the specificity of the former is 85.71%, that of the latter is 66.67%. The specificity, otherwise called True Negative, describes a classifier's ability to identify negative results.

The paper by I. Anda, I. O. Rabiu, E. F. Amin and H. A. Zubairu presents the result of an experiment to measure the time taken to build, merge and publish typical XML documents onto a data server. The author showed, among others, that it takes less than less than 13 seconds to publish XML file onto a data server.

The focus of the paper by A. R. Zubair is on digital watermarking algorithms. Digital watermarking refers to the act of hiding visible or secret message (called watermark) within a host message. In the paper, the author presented modality for deployment of visible watermarks as e-signature, e-stamp, e-label and e-copyright.

The phenomenon of examination malpractice is very rampant in educational institutions in recent times. This prompted the study by U. S. Haruna. In his paper, the author presented a software tool, called sVeriTool, for preventing impersonation of students in examination halls via taking their fingerprints.

The fifth paper appearing in this edition examines human productivity in higher institutions with the aid of a dynamic human resource information system. This system was used to assess the readiness of academic staff of tertiary institutions for performance evaluation, using an Ugandan University as a case study. By analysing the response received via questionnaire, it was shown, among others, that inadequate availability of ICT services is the single most important factor which can affect performance evaluation.

Once again, I wish to welcome all to the June 2018 edition of *African Journal of Computing & ICT*. Please enjoy reading it!

Bamidele ('Dele) Oluwade,
Editor-in-Chief,
Afr. J. Comp. & ICT,
ISSN 2006-1781

https://afrjcict.net

Comparative Evaluation of Linear Support Vector Machine and K-Nearest Neighbour Algorithm Using Microarray Data on Leukemia Cancer Dataset

Ayomikun Kubrat Oladejo [1], Tinuke Omolewa Oladele [2], and Yakub Kayode Saheed [3]
[1,2]Department of Computer Science, University of Ilorin, Ilorin, Kwara State, Nigeria.
Email: [1]*oladejoayomikun@gmail.com*
[2]*tinuoladele@gmail.com*
&
[3]Department of Physical Sciences, Al-Hikmah University, Ilorin. Kwara State, Nigeria.
Email: yksaheed@alhikmah.edu.ng

ABSTRACT
High dimensionality affects the performance of classifiers, especially for microarray gene expression datasets. A lot of efficient dimensionality reduction techniques that transform these high dimensional data into a reduced form have been proposed for microarray data analysis and they perform well. However, these techniques need to be improved in systematic ways as regards to their performance metrics. This research work makes use of two dimensionality reduction strategies, feature selection and feature extraction, to address the problems of highly correlated data. In this study, analysis of micro array data was carried out on Leukemia cancer dataset, with the end goal of finding the smallest quality subsets for precise tumor arrangement. One-way ANOVA algorithm was used for selecting relevant variables and Principal component analysis (PCA) algorithm was used to remove the most relevant variables out of the ones that have been selected. The experimental analysis was carried out on matlabR2015a (8.5.0.197613) environment. The classification algorithms employed are support vector machine (SVM) and K Nearest Neighbour (KNN) as a classification method. Feature selection and feature extraction were combined into a generalized model to help to obtain a robust and efficient dimensional space. In this approach, redundant and irrelevant features are removed at each stage. The classification presents an efficient performance metrics in terms of accuracy, attaining 90% of SVM and 81.67% accuracy of KNN algorithm. The complexity of the proposed method is also significantly reduced.

Keywords: *Classifiers, K Nearest Neighbours (KNN), One-Way ANOVAs, Support Vector Machine (SVM), Microarray data.*

African Journal of Computing & ICT Reference Format:

Ayomikun Kubrat Oladejo, Tinuke Omolewa Oladele & Yakub Kayode Saheed (2018), Comparative Evaluation of Linear Support Vector Machine and K-Nearest Neighbour Algorithm using Microarray Data On Leukemia Cancer Dataset,
Afr. J. Comp. & ICT, Vol.11, No.2, pp. 1 - 10.

I. INTRODUCTION

Over the past two decades, the world has witnessed a true explosion of data, which has mainly been driven by innovative storage technology and the increasing popularity of the Internet. Today, an enormous measure of information is produced in the therapeutic area. A well-known source is microarray information. Microarray is a natural stage for get-together gene articulations [1].

Microarray experiment is a biological procedure to measure the activities of genes at a specific time frame applied to a subject, that is, pre-cancer screening, general health check and cancer remission check. It is designed for bioinformatics field to provide an insight for information on the gene interactions and cancer pathways with a potential for cancer diagnosis and prognosis, prediction of therapeutic responsiveness, discovery of new cancer groups and molecular marker identification [2-5]. Microarray experiment contains measurements for thousands of microscopic spot of DNA probes (that is DNA spots that have been complimentarily banded in the microarray experiment), however, only a small set of these probes are relevant to the subject of interest, for example, amongst 7129 probes in the leukaemia microarray data available from the Broad Institute, only about 1000 probes are relevant to the leukaemogenesis pathway [2]. Therefore, techniques for extracting the informative genes that underlies the pathogenesis of tumour cell proliferation, from high dimensional microarrays is necessary [4-7] and the need for computing algorithms to undertake such a complex task emerge naturally. This brings the theme of computational analysis in microarray studies to the forefront of research.

Microarray gene expression data is characterized by high feature dimensionality, sample scarcity and complex gene behavior (that is the interaction between genes within the data), which pose unique challenges in the development of computing algorithms in class prediction, cluster discovery and marker identification, with the aim of deriving a biological interpretation of the set of genes which underlies the cause of the disease. Additionally, microarray gene expression data may contain subgroup of cancer classes within a known class. This makes the analysis of microarray difficult. Thus, the first and foremost consideration for analysing microarray data is feature extraction. For class prediction, the extracted gene subset is used to avoid the over fitting problem on supervised classifiers and to achieve better predictive accuracy that generalizes well to unknown data [5]. Frequently, data preprocessing is required on microarray data to remove undesirable data characteristics with the idea of ensuring data integrity and improving classification performance. For instance, missing values in microarrays require some mathematical formulas to impute reasonable estimates to salvage the data. Feature reduction is the approach most commonly used to remove data redundancies.

In this study, analysis of micro array data was carried out on Leukemia cancer dataset, with the end goal of finding the smallest quality subsets for precise tumor arrangement. One-way ANOVA algorithm was used for selecting relevant variables and Principal component analysis (PCA) algorithm was used to eliminate the most relevant variables out of the ones that have been selected. This paper presents a comparative analysis of LSVM and KNN algorithms for micro array analysis on leukemia cancer. The rest of this paper is organized as follows. In section 1.2, literature review is presented, section 2 highlight the methodology, experimental analysis is showed in section 3. Section 4 is the results and discussion. In section 5, the paper is concluded.

II. LITERATURE REVIEW

A lot of research has addressed the topic of dimensionality reduction on classification of the microarray data by using different methods with different classifiers. A generic approach for classifying two types of acute leukemia was introduced by Golub et al. [2]. Several feature techniques have been proposed in the literature and survey of feature algorithms is included. Many researchers are involved in the study of goodness of a feature subset in determining an optimal one.

The work done by [8] assessed and thought about the effectiveness of various characterization techniques, including SVM, neural system, Bayesian grouping, decision tree (J48, ID3) and random forest strategies. Further, the productivity of the element choice techniques including bolster vector machine recursive element disposal (SVM-RFE), Chi-squared and relationship based component determination was looked at. Ten times cross approval was utilized to figure the exactness of the classifiers. To begin with, the characterization strategies were connected to all datasets without playing out any component choice. In many datasets, SVM and neural systems performed superior to other arrangement

techniques. In all cases SVM-RFE performed exceptionally well when it was connected with SVM arrangement techniques.

[9] displayed a gene selection scheme called ANOVA, which is utilized to locate the base number of qualities from microarray quality articulation that can be utilized as a part of arrangement of malignancy. The proposed positioning plan called two-way Analysis of Variance (ANOVA) was utilized for the determination of imperative qualities. The characterization can be found by the utilization of surely understood classifiers such as Support Vector Machines. The lymphoma dataset were utilized to show the viability of this approach. If the selected data contains missing values or exhaust cell sections, it must be preprocessed. This work incorporates three stages. Step 1 is an important gene selection stage using a scoring scheme called Analysis of Variance (ANOVA) method and afterward the best genes can be chosen with the most elevated scoring value from positioned data. The next step is the gene extraction using the principal component analysis (PCA) and the last step is classification capability of all gene combinations which can be performed with the utilization of the Support vector machine and K-Nearest Neighbor. The Selected genes are put into the classifier if exactness is not gotten to such an extent that classification is performed with a gene combination. The acquired outcomes utilizing ANOVA with SVM is then contrasted with the T - score strategy.

[10] offered a nonparallel plane proximal classifier (NPPC) troupe for malignancy order in light of microarray genes articulation profiles. A hybrid and computer supported analysis (computer aided design) structure is presented in light of channels and wrapper techniques. Least excess most extreme pertinence (MRMR) positioning technique is utilized for feature selection. The wrapper strategy is connected on those genes sets to diminish the computational weight and nonparallel plane proximal classifier (NPPC).

[11] featured the disclosure of differentially expressed genes (DEGs) in microarray data in their approach to construct an exact and savvy classifier. A T-Test highlight choice method and KNN classifier was connected on the Lymphoma data set to come to the DEGs and to breaking down the impact of these genes on the classifier accuracy, discretely.

The authors in [12] demonstrated how Support Vector Machine "SVM" has an excellent performance on classification and prediction; it is widely used on disease diagnosis or medical assistance. SVM only function well on two-group classification problems. Their study combined feature selection and SVM recursive feature elimination (SVM-RFE) to investigate the classification accuracy of multiclass problems for dermatology and zoo databases. The dermatology dataset contains 33 feature variables, 1 class variable and 366 testing instances; and the zoo dataset contains 16 feature variables, 1 class variable and 101 testing instances. The feature variable in the two datasets were sorted in descending order by explanatory power, and different feature sets were selected by the SVM-RFE to explore classification accuracy.

Taguchi method was also combined with SVM classifier in order to minimize parameters C and γ to increase classification accuracy for multiclass classification. Penalty parameter C represents the cost of the classification error of training data during the learning process, as determined by the user. When C is greater, the margin will be smaller, indicating that the fault tolerance rate will be smaller when a fault occurs. Otherwise, when C is smaller, the fault tolerance rate will be greater, where γ is the linear kernel function.

In [1] proposed different approaches to perform dimensionality reduction on high-dimensional microarray information. Distinctive component choice and highlight extraction strategies which plan to evacuate repetitive and unimportant highlights for new cases of classification can be precise were established. A well-known wellspring of its information is microarrays, a natural stage for social occasion quality articulations. Examining the microarrays can be troublesome because of the span of the information they create, and the entanglement connection among the diverse qualities makes investigation more troublesome and expelling overabundance highlights can enhance nature of the outcomes. A famous strategy for choosing huge highlights was introduced and a correlation between them was made.

III. METHODOLOGY

3.1 Feature Selection

A number of methods have been proposed for rule extraction from SVMs. Broadly speaking, these methods can be categorized into three main families which are: pedagogical, decomposition, and eclectic [13]. Some of these techniques till date still deliver moderately substantial administer sets, which constrains their clarification capacity [14]. Rule sets can just offer

clarification if the quantity of rules in the rule set is generally little and its order exactness is high. Simpler rules likewise offer better understanding and explanation [15]. To remove more understandable rules, irrelevant features which do not add to the grouping choice ought not to be in the rule predecessors. This highlights a requirement to consider feature selection as an integral part of rule extraction. In feature selection, one selects only those input dimensions that contain the relevant information for solving the particular problem. There are three categories of feature selection which are: filters, wrappers, and embedded techniques. This work focuses on filter-based approach.

3.2 Feature Selection Procedure

The feature selection procedure includes four important key steps; subset generation, subset evaluation, stopping criterion and result validation which are shown in Figure 1.

3.3 Proposed System

In this study, the researcher proposed to use feature selection method first, then feature extraction using Support Vector Machine algorithm in the first phase to reduce the dimensionality of the data by yielding the key attribute in the data. Thus, fewer numbers and smaller rules are obtained resulting in the improvement of the comprehensibility of the system. Lastly, classification Algorithm was employed using linear SVM Algorithm on Leukemia data set. The framework of the proposed system is shown in figure 2.

3.4 Experimental Analysis

3.4.1 Dataset Description

For implementing and testing the effectiveness of the algorithm, experiment will be performed on Leukemia dataset. The data set will be obtained from a genomic database. This dataset is going to be chosen because of its public accessibility and has previously been used for several Machine Learning studies [17]. The information required to be stored in the database is Leukemia cancer dataset [17]. It contains DNA microarray gene expression data. 7132 attributes and 35 instances are loaded from an excel spread sheet. The steps of the proposed study are as follows;

1. Load
2. Feature selection
3. Feature extraction
4. Classification

3.4.2 Feature Selection

In the feature selection mode, the feature is selected using the ANOVA t-test analysis at 95% confidence interval level which is at the 0.05 significance level. The obtained result is saved for future reference, so as to be passed into the feature extraction modules.

3.4.3 Principal Component Analysis (PCA) For Feature extraction

The result of the components extracted when PCA technique was used, a total of 20 components were extracted from the selected features. Analysis of Variance (ANOVA) is a hypothesis-testing technique used to test the equality of two or more population (or treatment) means by examining the variances of samples that are taken. ANOVA allows one to determine whether the differences between the samples are simply due to random error (sampling errors) or whether there are systematic treatment effects that cause the mean in one group to differ from the mean in another.

IV. RESULTS AND DISCUSSION

4.1 RESULTS

Figure 3 shows the confusion matrix result for the classified components which was extracted using SVM technique. The True Positive rate yields 85.7% and False Negative rate yields 92.3%. Confusion matrix gives the layout of the performance of a classification model (classifier) on a set of test data for which the true values are known.

Figure 3 shows the confusion matrix result for the classified components which was extracted using SVM technique.

TP=36 FP=3 FN=3 TN=18

Accuracy: This is the simplest scoring measure. It calculates the proportion of correctly classified instances.

Accuracy = (TP + TN) / (TP+TN+FP+FN)
(36 + 18) / (36 +18 +3 +3) = 54/60
Accuracy rate = 0.9
Percentage accuracy rate: 90.00%

Sensitivity: The sensitivity rate also known as the Recall or True Positive, tells us how likely the test will come back to positive on a sample that has the characteristic of Leukemia cancer:

Sensitivity = TP/ (TP+FN)
36/36+3 =36/39
Sensitivity Rate = 0.9231
Percentage Sensitivity Rate = 92.31%

Specificity*:* The specificity also known as the True Negative relates to the classifiers ability to identify negative results.

Specificity = TN/ (FP+TN)
18/ (3+18) = 18/21
Specificity Rate = 0.8571
Percentage Specificity Rate = 85.71%

Precision: This is a measure retrieved instances that are relevant.

Precision: TP/ (TP+FP)
36/ (36+3) = 36/39
Precision Rate = 0.9231
Percentage precision: 92.31%

4.2 Discussion

a. Comparative Evaluation of Linear SVM AND KNN

b.

Table 1: Comparative Evaluation of Linear SVM and KNN from the reduced dataset.

Performance Metrics	Classification using Linear-SVM	Classification Using KNN
Classifier Accuracy (%)	90	81.67
Sensitivity (%)	92.31	89.74
Specificity (%)	85.71	66.67
Precision (%)	92.31	83.33

Table 1, shows that the feature selection based on One-way-ANOVA method achieves necessary higher value in the datasets on the performance metrics such as the accuracy, specificity, and prediction when compared to the direct based method on the Leukemia cancer dataset.

Figure 5 shows the performance metrics of classification in terms of accuracy, sensitivity, specificity and precision using linear SVM and KNN.

V. CONCLUSION

In this study, analysis of micro array data was carried out on Leukemia cancer dataset, with the end goal of finding the littlest gene subsets for accurate cancer classification. The study employed SVM and KNN for classification and ANOVA for feature selection. ANOVA is an exceptionally powerful positioning plan while SVM is an adequately decent classifier contrasted with comparative mining approaches. As we have seen from the results in the Leukemia dataset, the gene combination that gives good separation may not be unique. In the Leukemia data set, 786 selected genes was classified using One-Way ANOVA feature selection. MATLAB R2015a (8.5.0.197613) was used to implement this procedure. The outcome demonstrates that the proposed decrease approach achieved promising results of the supplemented quantities of genes to the classifiers.

REFERENCES

[1] Zena, M. H., and Gillies, D. F. (2015). A review of feature selection and feature extraction methods applied on microarray data. London: Department of Computing, Imperial College.

[2] Golub, T. R., Slonim, D. K., Tamayo, P., Huard, C., Gaasenbeek, M., Mesirov, J. P., Coller, H. Loh, M. L., Downing, J. R., Caligiuri, M. A., Bloomfield, C. D. and Lander, E. S. (1999). Molecular classification of cancer: Class discovery and class prediction by gene expression monitoring. Science, 286(5439):531-536.

[3] Dupuy, A., and Simon R. M. (2007). Critical review of published microarray studies for cancer outcome and guidelines on statistical analysis and reporting. JNCI Journal of the National Cancer Institute, 99(2):147-157.

[4] Yu, J. J., Yu, A. A., Almal, S. M., Dhanasekaran, D., Ghosh, W. P., Worzel, and Chinnaiyan, A. M. (2007). Feature selection and molecular classification of cancer using genetic programming. Neoplasia, 9(4):292303, 2007.

[5] Wang, Y., Miller, D. J. and Clarke R. (2008). Approaches to working in high-dimensional data spaces: gene expression microarrays. British journal of cancer, 98(6):1023-1028.

[6] Osareh, A., and Shadgar, B. (2008). Classification and diagnostic prediction of cancers using gene microarray data analysis. Journal of Applied Sciences, 9(3):459-468.

[7] Zhang, J. T., Jiang, B., Liu, X., Jiang, and Zhao H. (2008).Systematic benchmarking of Microarray data feature extraction and classification. International Journal of Computer Mathematics, 85(5):803{811, 2008.

[8] **Pirooznia**, **M**., **Yang**, J. Y., **Yang**, M. Q. and **Deng**, Y. A. (**2008**). A Comparative Study of Different Machine Learning Methods on Microarray Gene Expression Data. BMC Genomics, 9.

[9] Bharathi, A. and Natarajan, A. M. (2010). Cancer Classification of Bioinformatics data

using ANOVA International Journal of Computer Theory and Engineering, Vol. 2, No. 3, June, 2010 1793-8201.

[10] **Ghorai** S., Mukherjee A., Sengupta S., and **Dutta** P. K. (2011). Cancer classification from gene expression data by NPPC ensemble. IEEE/ACM Trans. Computational Biology and Bioinformatics; 8:659-671.

[11] Abeer, M., Basma, A. (2014). A Hybrid Reduction Approach for Enhancing Cancer Classification of Microarray Data. (IJARAI), Vol. 3, No.10. pp.1- 10. 2014.

[12] Mei-Ling Huang, Yung-Hsiang Hung, W. M. Lee, R. K. Li, and Bo-Ru Jiang (2014). SVM-RFE Based Feature Selection and Taguchi Parameters Optimization for Multiclass SVM Classifier. Hindawi Publishing Corporation, The Scientific World Journal Volume 2014, Article ID 795624, pp.1-10. http://dx.doi.org/10.1155/2014/795624.

[13] Andrews, R., Diederich, J., and Tickle, A. B. (1995). A Survey and critique of techniques for extracting rules from trained Artificial Neural Networks. Knowledge Based Systems. Vol.8, Issue 6, December 1995, pp.373-389.

[14] Barakat, N. H., and Bradley, A. P. (2007). Rule extraction from Support Vector Machines: A Sequential Covering Approach IEEE transactions on knowledge and data engineering.Vol. 19, no. 6, pp. 729-741, **2007.**

[15] Duch, W., Setiono, R., and Zurada, J. (2004). Computational intelligence methods for rule-based data understanding. Proceedings of the IEEE, Vol. 92, No. 5, pp. 771-805. May 2004.

[16] Solberg T. R., Sonesson A. K., Woolliams J. A., Odegard J, Meuwissen T. H. (2009). Persistence of accuracy of genome-wide breeding values over generations when including a polygenic effect. 41:53. doi: 10.1186/1297-9686-41-53.

[17] Virtaneva, K. I., Wright, F. A., Tanner, S. M., Yuan, B., Lemon, W. J., Caligiuri, M. A., Bloomfield, C. D., Albert de la Chapelle and Krahe**,** R. (2001). Gene expression profiling reveals fundamental biological differences in AML with trisomy 8 and normal cytogenetics. Nature Genetics 27**, page** 65. ISSN 1546-1718 (online). doi:10.1038/87158.

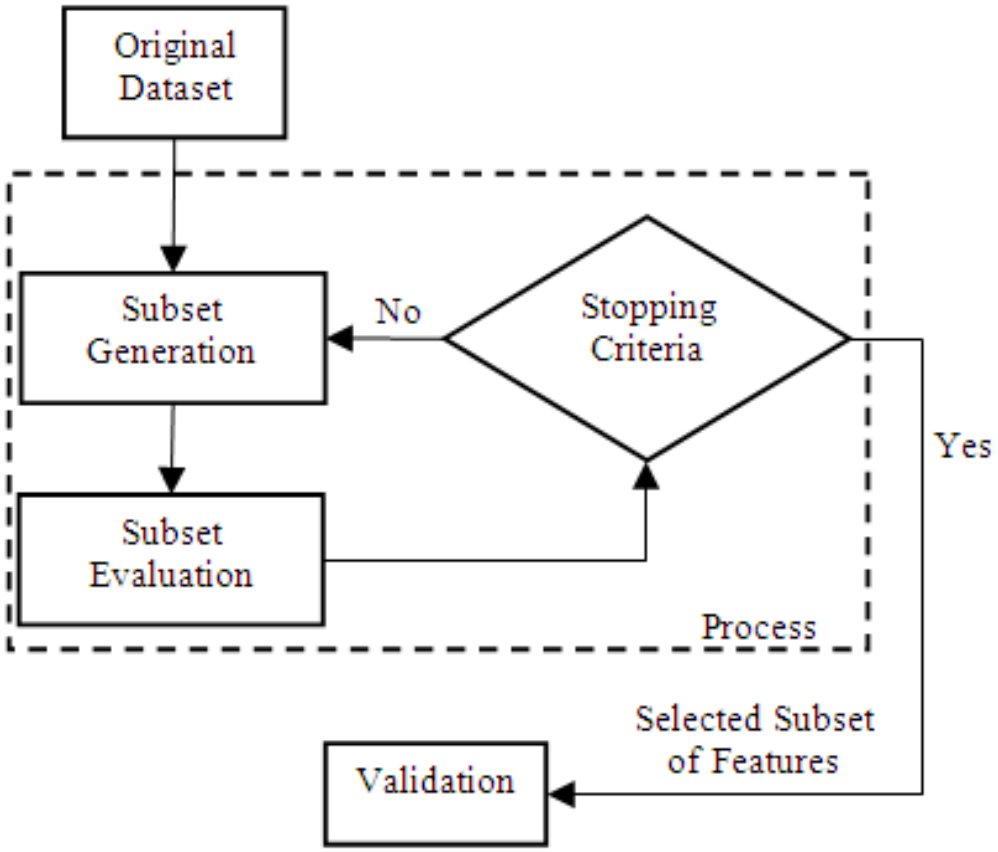


Figure 1: Feature Selection Method (adapted from [16])

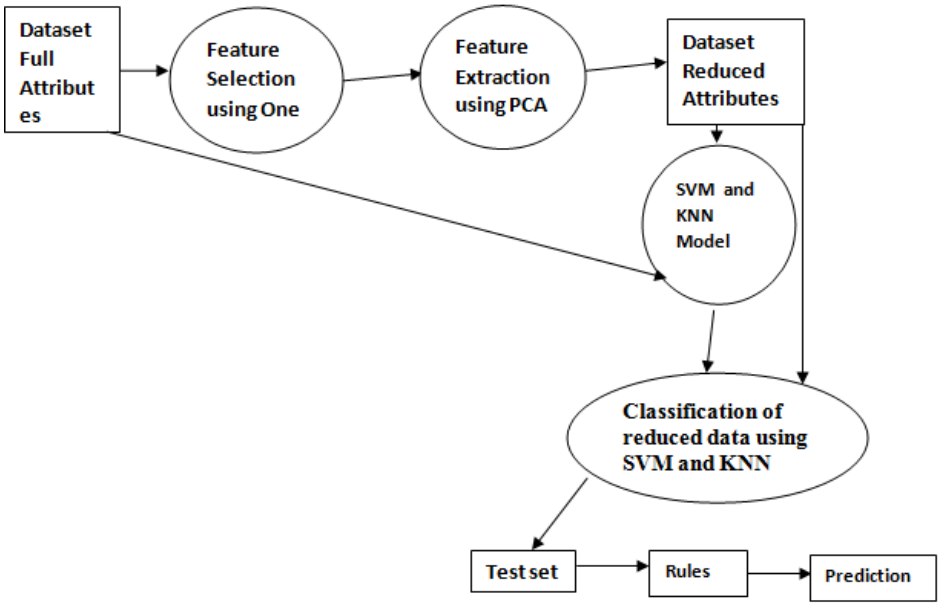


Figure 2: Framework of the Proposed System.

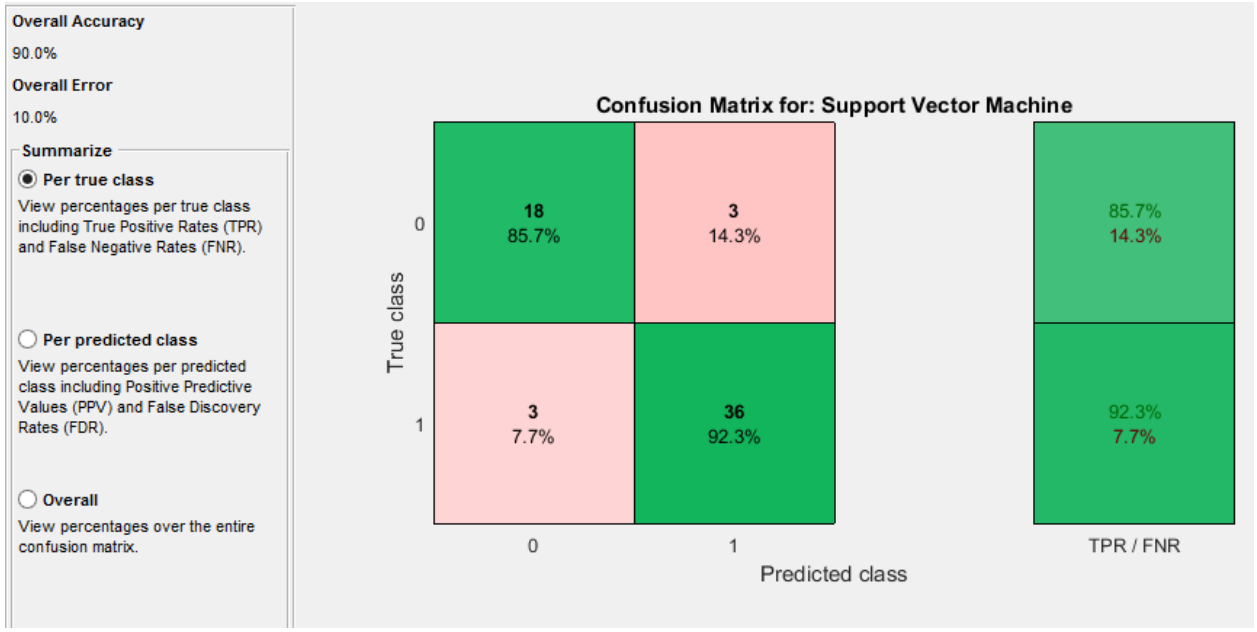


Figure 3: Confusion Matrix for the classification of selected features Using Linear-SVM.

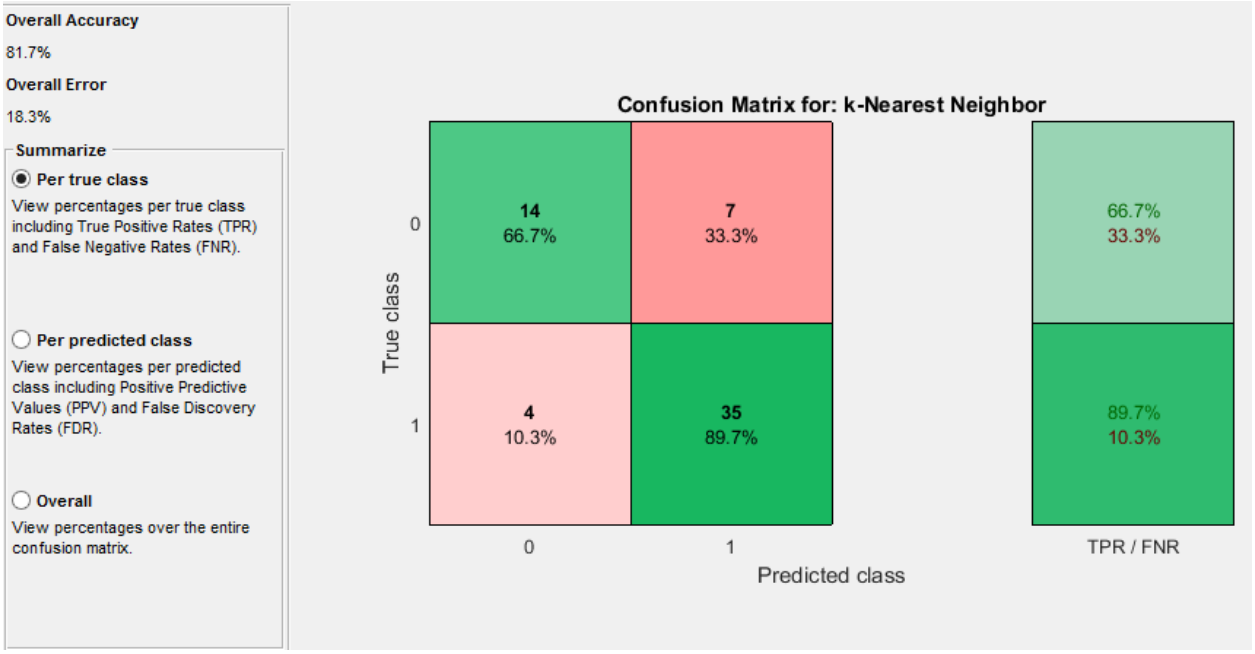


Figure 4: Confusion matrix for Leukemia dataset

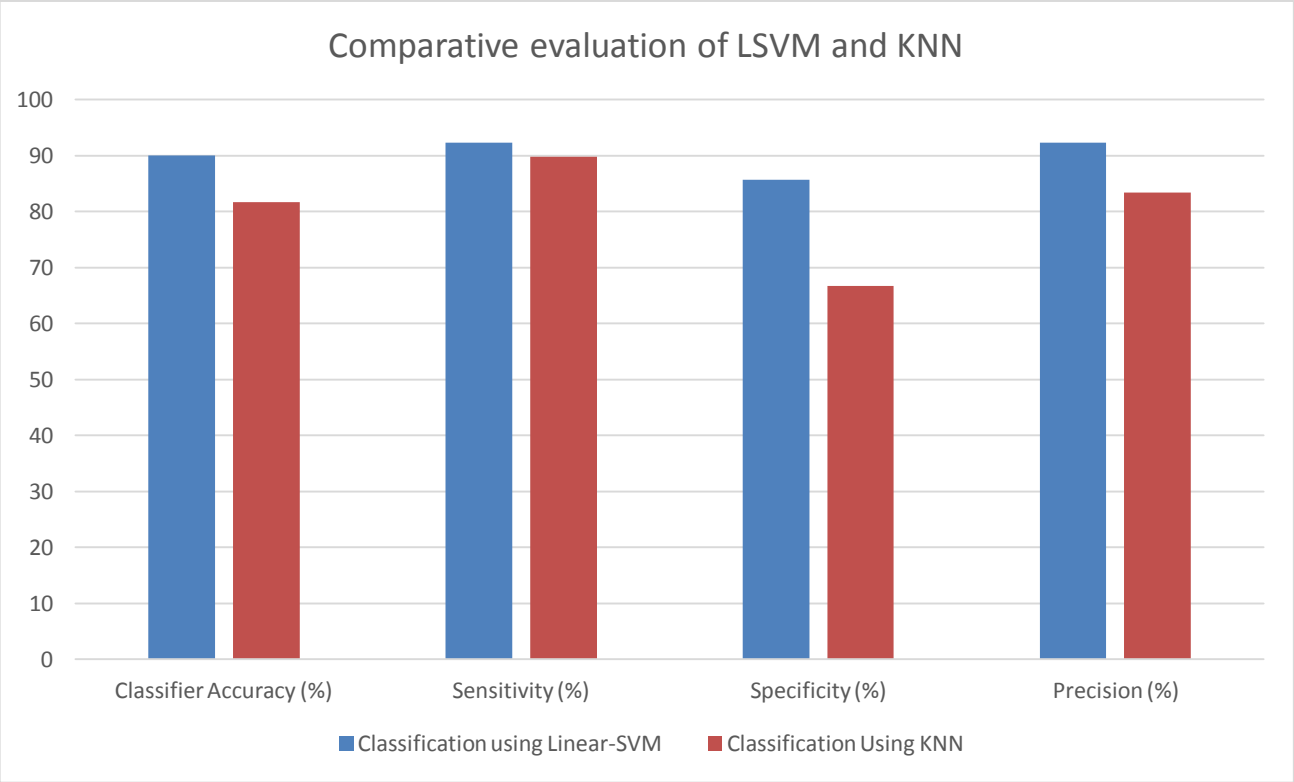


Figure 5: Performance metrics of L-SVM and KNN

https://afrjcict.net

Experimental Evaluation of a Safety Data Model to determine the Time Taken to Build, Merge and Publish XML File onto a Data Server

Ilyasu Anda[1], Isah Omeiza Rabiu[2], Enesi Femi Aminu[3] & Hussaini Abubakar Zubairu[4]
[1]Department of Library and Information Technology, School of Information & Communication Technology,
[2]Department of Computer Engineering, School of Engineering & Engineering Technology,
[3]Department of Computer Science, School of Information & Communication Technology,
[4]Department of Information and Media Technology,School of Information & Communication Technology,
Federal University of Technology, Minna, Niger State Nigeria.
[1]*Email: ilyasu.anda@futminna.edu.ng;*[2]*isah.rabiu@futminna.edu.ng;*
*3enesifa@futminna.edu.ng;*4*abu.zubairu@futminna.edu.ng*

ABSTRACT
Some datasets are prone to risk and hazards, inadvertently affecting the integrity of the data with attendant errors in result interpretation and usage which could sometime escalate to disastrous levels. Despite these potential errors in data leading to various mishaps, this part of the system has been ignored. This paper aims to experiment a model (Safety Data Model) to ensure safety of data used in the data analysis for decision making. It focuses on safety of data in a critical application, taking into consideration the integrity of the data, time taking to extract and publish the XML files to the data server. It, thus, represents the data in a more concise format that a consumer of such data can easily assess the sources and evaluate the integrity of the data before any decision-making. The research proposes an experimental evaluation of a safety data model that helps to prevent the possible mishaps. Twelve (12) Excel files of Safety Related Condition Reports (SRCR) data between 2002 and 2013 were used, which contain a total of 1039 rows of data. It took roughly 20.703 seconds to complete the Extract, Transform Load (ETL). Modern and sophisticated ETL software tools including Microsoft SQL Server 2012 Data Tools and Microsoft Structured Query Language (SQL) Server Management Studio were used in data manipulation. The prototype was able to filter data into safe, unsafe and hazardous data which were ready to be loaded into the Data Warehouse (DWs). The prototype was able to generate an XML document containing safe, unsafe and hazardous data. The prototype was proved to be effective because it was able to build XML Data within 0.484 seconds, merge and publish XML documents within 12.719 seconds. The purpose of this is to show the end users the actual data in order to justify whether the data is truly safe, truly unsafe or truly hazardous according to the quality summary in the metadata. The end user can also verify the whole data from the source if necessary and if the end user is satisfied with the quality of the data, then, the safe data can be extracted directly from the XML.

Keywords: *Safety; Big-Data; Data-Warehouse; Microsoft SQL Server; Metadata.*

African Journal of Computing & ICT Reference Format:

I.Anda, I. O. Rabiu, E. F. Aminu & H. A. Zubairu (2018), Experimental Evaluation of a Safety Data Model to Determine the Time Taken to Build, Merge and Publish XML File onto a Data Server, *Afr. J. Comp. & ICT*, Vol.11, No.2, pp. 11 - 23.

I. INTRODUCTION

In this era of globalization and the dynamic world of ICT, the importance of and crave for safe and error -free data cannot be overemphasized. This often posed a great challenge to the system analysts and to the end-users of these data who rely on it for serious decision making. One of the problems bedeviling data analyst in a safety critical environment is the unstructured and redundant nature of the data to be analyzed. More so, the time complexity in analyzing this type of data is always very high, consequently leading to data failure. Furthermore, some datasets are prone to risk and hazards, inadvertently affecting the integrity of the data with attendant errors in result interpretation and usage which can sometimes escalate into disasters and fatalities.

A safety-related system was developed with software and data often described as a real - world environment in which the system will function properly and play a dynamic role in ensuring accurate operations. Computer modelling with a very good engineering practice dictates that data is produced to the same integrity requirements as applicable in other similar system elements. Regrettably, existing knowledge suggests this is often not the case. This is because data processing has shifted from the role of operations support to becoming a major operation in itself, hence the need for quality management of data. However, many similarities exist between quality data model and quality data extraction.

Despite the potential errors in data processing as observed in most systems, leading to accidents or mishaps, the aspect of safety model has not been extensively explored; its application in any critical safety environment is very key in meeting end user objective in such a way that a consumer of the data can judge the integrity of the data and factor this into the decision-making aspect of their response with minimal error [1, 2, 10].

Data has always been of utmost importance in computer systems, but when it comes to safety related systems, data are used extensively in such applications in the form of constants and variables. The data in such systems can take a number of forms which are characteristics of the device, Constants for calibration, Data for plant configuration, Topological data etc.

Each of the above mentioned classes of data shares a characteristic that data is generated separately from the executable software. But the generation of such data happens to be a complicated procedure. For example, the data collected in describing a rail network or the surroundings of an airport always suffer from the scope of errors and faults, and such faulty data poses severe risks in the operations of the safety related systems [3].

In order to ensure the safety of information systems, development methods involving risk-based approaches are adopted, where data related to potential risks is collected for the proposed system and then analyzed to keep identified risks at an acceptable level. One mechanism to ensure this is to stipulate development and assessment practices via Safety Integrity Levels (SIL). The level of rigor in the processes is commensurate with the safety risks associated with the system. The data collected for risks that help in defining a SIL affect the overall architecture of the proposed system a great deal. The SIL also affects the overall functioning of the system providing better safety solutions [3].

All computer-based systems, including the safety related systems require data for their operations. Those who use these systems require data for making decisions which are sometimes critical. Since data assume a great level of importance in such data driven safety related systems, carefully produced data elements leave great impacts on the overall decision-making process of the management. Decision makers generally have to face a number of challenges while analyzing the data when there are problems in the way data has been collected or generated, especially when the data happens to be safety critical [4].
Metadata is a type of data, which carries information about the data itself. The term metadata is also referred as data about data. A metadata provides information about various aspects of the data being used in the system. Some of these aspects are Format of the data, Origin of the data, Time and date of creation of data.

Qualitative attributes of data, Author of the data, Purpose for which the data was created. The metadata like any other data can be stored in a data storage system. The storage of metadata is often called as Metadata Repository [5].

The structure of the metadata needs to comply with various rules pertaining to the fields and elements of information contained in the metadata as defined in the standards. The metadata structure can be defined in a number of programming language syntaxes which provide uniformity in designing the metadata [6]. Usually the metadata is schematized by making use of markup languages like HTML or XML. XML being the industry standard these days is the most favorable mark-up language to structure metadata. Another very good example of structuring metadata is by making use of

Taxonomies which involve creating certain keywords for a particular type of data element. These key words can be applied to the data upon its creation signifying the required information for metadata [7].

For this reason, a complete data model that will accurately describe all possible relationships between files and document is essential. Such a model should also provide the foundation upon which critical data administration task can be automated for operational and business application.

II. RELATED LITERATURE

This section investigates various literatures on safety related data extraction.

[8] This work developed two data verification approaches. The first presented an approach for automated verification of data models that extracts a formal data model from an object-relational mapping. The second approach was an unrestricted verification technique for data models which exploited the inherent modularity in Model-View-Controller (MVC) frameworks to automatically extract a formal data model from the data model specification. The two approaches were integrated and implemented in a tool called iDaVer written using the Ruby on Rails framework. The experimental results demonstrated that the developed approach is efficient in detecting and repairing errors in real-world web applications but the model did not considered safety related data.

[9] This work proposed full and generic data ware housing for complex data analysis. A generic UML model was proposed to model low-level and semantic information for complex data analysis. Then, a complex data as an XML document was integrated into Operational Data Storage (ODS). The multi-agent systems (MAS)-based ETL prototype was developed to facilitate this integration based on a flexible and progressive architecture. Furthermore, a comprehensive methodology was also proposed for future analysis of complex data. This approach was validated using a java application. This takes as input a reference multidimensional model and XML documents, and provides logical and physical models for an XML cube composed of homogeneous XML documents. The evaluation of this work showed a significant improvement in terms of response time, thus, the time complexity for the extracted files was ignored.

[10] It developed a method for building metadata through a data chain, mining this metadata and represents it for a consumer of the data to judge base on the integrity of the data and factor this into the decision-making aspect. It proposes a design and implement for safety data model that helps to ensure integrity of data use for data analysis and decision making. More so, modern and sophisticated ETL software tools including Microsoft SQL Server 2012 Data Tools and Microsoft SQL Server Management Studio were also used for the design. The data were extracted from Safety Related Condition Reports (SRCRs) dataset and used data mining techniques to transform and filter unsafe and hazardous data from the extracted data and stored the safe data into the Data Warehouses (DWs). The prototype was able to load data into designated DWs by extracted all datasets, transform and load the data into the DWs and moved extracted files to archive folder within some few seconds. However, the prototype was unable to Build XML Metadata, Build XML Data, Write Data to XML File, Write Metadata to XML File, Merge XML Document, and Publish XML File to the server.

[11] Employed an automated system extraction structure that includes a discrete extraction rule used for extraction of items from static by way of all-encompassing of dynamic system sheets. This extraction was conducted in three different stages together with a research conducted on a Web text for extraction, position of objects of interest in a Web sheet and lastly, extracting items of interest in a page. A system of over two thousand Web pages was evaluated and 100% accuracy was achieved. Though, the system was entirely automated, but then the evaluation procedure was not computerized.

[12] An innovative procedure called EXALG was presented for the extraction of organized data from a sequence of web pages originating from a common model. The model was revealed by implementing two designs such as, correspondence classes and differentiating parts. Investigation reveals that EXALG on the assembly of web pages disclosed that it is efficient for data extraction from web pages. This investigation has therefore shown that the whole web page was not considered and no special attention for the safety of the extracted data.

[13] This paper developed an automated method of extracting structured data from web pages. These pages comprise several groups of structured data records. Firstly, a tag free based on visual information was built. Furthermore, a tree edit distance method and a visual cue were used to carry out post-order traversal of the tree and subtrees were matched in the process. At the end of the process, data items found in data items were aligned and

extracted. The method was found to be able to effectively extract data from both flat and nested records. Experimental evaluation showed that data extraction could be carried out accurately.

[14] Examined a wrapper induction, a method that constructs wrappers repeatedly, to address traditional methods of data extraction, which is tedious and error-prone. In this work, the ability of this new technique to handle actual internet resources was considered and the time it required to learn wrappers in each class. These were achieved using six wrapper classes. The results obtained showed that most of the wrapper classes considered were very useful. However, a limited number of the classes were very slow and safety of data model was generally not used. This made the extracted data vulnerable to attack.

[15] Information Extraction Based on Pattern Discovery (IEPAD) was proposed. This system can automatically determine extraction rules from web pages. Firstly, repeated pattern mining and multiple sequence alignment automatically identified a record boundary. A data structure called PAT tree was used to realize identification of the repeated patterns. In addition, repeated patterns were further extended by pattern alignment to realize all record instances. This new method is fully automated and experimental results showed that the system outperformed fourteen popular search engines.
[16] A computer program was developed to assist in the assessment process. A field test of the Safety Management Assessment System (SMAS) was conducted at a marine terminal in California. Two teams, with members from the terminal and the regulatory agency, along with a facilitator, were selected and trained. These two independent teams conducted separate evaluations on the same marine terminal. A comparison of their assessments showed that the use of ranges and comments were very helpful. An analysis of field test data shows that SMAS can produce results more consistent than randomness. SMAS shows promise as an efficient and practical method to assess humans and organizations.

An analysis of field test data showed that SMAS can produce results more consistently than randomness with a conclusion that SMAS computer program is critical in conducting the assessment and SMAS also shows promise as an efficient and practical method to assess humans and organizations but in overall results, the safety analysis of the data used was not considered.

[17] Safety related tasks are modelled using the Structured Analysis and Design Technique (SADT). This shows the inputs, resources and criteria/constraints necessary to produce the required outputs; risks are modelled as deviations from normal or desired processes. The framework emphasizes the dynamics of safety management as a process. It aims to provide an abstract ordering of the field which can clarify and specify research and policy needs for the future but a dynamic pattern for safety data extraction was ignore.

[18] Data-driven systems use data from a number of sources including data extracted (and possibly processed) from existing external information systems and data produced specifically for the required system. This data is used to describe the system environment using configuration data (which is largely static or slowly moving) and status data (which is dynamic and will sometimes change rapidly). However, upon all the data extracted from numerous sources, attention was not given for data integrity, thus, safety data was not considered.

III. RESEARCH METHODOLOGY

This chapter describes the methodology that is followed in the development of the Safety Data Model design for Metadata and the use of navigational data. These developments are carried out in five steps and presented a conceptual Logical Design for Data Model layers that includes Data Source Layer, ETL Layer, Physical Layer, and Logical Layer to examine the necessary transformation in each layer. [10]

This method is reliable as it offered opportunity for navigational data, which is highly useful in shifting towards an acceptance of electronic data on a large scale through the use of several sources to affect data safety. The big data also needs to be verified and validated to ensure that the data is highly acceptable for further usage in a safety of critical applications.

Tools used for Data Analysis
SQL Server 2012 Management Studio.
According to Brian Larson, SQL Server Management Studio (SSMS) is a suite of user interface tools used to manage databases for SQL Server Integrated Services (SSIS) project. SSMS allows users to connect to Instance database servers, create databases and tables, and other database objects.

Furthermore, SSIS creates structures known as packages and the packages are used to move data from one system to the other [19].

Data Extraction process
The SQL Server Integrated Services (SSIS) package executes using the Debugger provided in Visual Studio 2012. The Debugger helps in carrying out unit testing, evaluation for each component in SSIS package and thus makes it easy to identify errors and fix bugs. The green ticks show that the control flow executed successfully without any error.

Figure 1 shows the control flow of the data extraction process. The entire process begins with the creation of SSIS project and to create an SSIS project, the following procedure is followed:

Click on File, then click on New Project, on the drop down provided by the New Project, choose Business Intelligence, then Template and choose Integration Services on the right-hand. The name of the project was entered as HealthAndSafetyETL. Then click OK to create an SSIS project.

After creating the SSIS project, a default package was created and made ready for use with ETL. Next, the variables were created and named as FileName, Archive, XML Data and XML Metadata for storing the filename of the current excel file, storing the path to the archive folder where extracted XML data and XML metadata were stored.

The next step is to create a Foreach Loop Container that loops through each excel file inside HealthAndSafetyDataset folder and extract, transform and load data into DWs. Then the Excel files were moved into an archive folder.

The Foreach Loop Container was dragged from the SSIS Toolbox on the left under the Containers section. Then the Data Flow Task and File System Task were dragged into the Foreach Loop Container. The purpose of the Data Flow Task is to design how data will be extracted from each excel file, transforming the extracted data and loading it into DWs. The main aim of the File System Task is to help in moving the extracted dataset file into the specified archive folder.

This paper is an improvement of an existing literature [10]. However, in comparing the existing model with this work, the following differences and similarity were observed:

Existing Literature was able to extract files from the datasets, transform the data and move the extracted files into archive folder. However, the current work was able to make the following improvement:

- Build XML Metadata
- Build XML Data
- Write Data to XML File,
- Write Metadata to XML File
- Merge XML Document
- And Publish XML File to the server

`

Furthermore, a modern sophisticated ETL software tools including Microsoft SQL Server 2012 Data Tools and Microsoft SQL Server Management Studio were also used for the design in both work. The data were extracted from SRCRs in both researches as well.

Main Data Source
Figure 7 shows the interface of the Main data source in Excel sheet, renamed as HealthAndSafetyDataset in a new created folder. A complete form of the datasets sources is available at:
http://catalog.data.gov/dataset?q=SRCRs.
Twelve (12) Excel files of SRCR data between 2002 and 2013 was used, which contain a total of 1039 rows of data. It took roughly 20.703 seconds to complete the ETL as at the time the experiment was conducted

Safety Data Model
The Safety Data Model was developed based on the requirements analysis as showing in Figure 2.

Data Source
Data source layer represents Big Data source datasets where many datasets are available for decision makers to analyze. The datasets can be in the structured or unstructured format. Structured data such as XML, which is made available via APIs call, is more preferable as a data source. However, unstructured data in a text, HTML or excel format can also be used as source data as the case may be.

ETL Layer
ETL Layer represents Extract, Transform, and Loading layer. This layer extracts data from the datasets, transforming the data into a format required by the DWs,

filtering the unsafe and hazardous data out into a separate database before loading the safe data into the DWs.

Physical Layer

The Physical Layer is the central data repository of a Safety Data Model where data will be stored in DWs.

Presentation Layer

The application layer is referred as the presentation layer of the Safety Data Model as shows in Figure 3 where the metadata will be published and rendered to end-users in XML format. We used visual studio 2012 to extract data and metadata from the DWs in XML format. The XML file was then made accessible to the end user via a remote server. Figure 3 bellow shows the Presentation Layer Design. [10]

Logical Layer

The logical layer of the Safety Data Model represents the logical view of the entire data that controls and manages errors that could have emanated from DWs for safety control and build the XML metadata and XML data before XML document are generated.

IV. IMPLEMENTATION AND RESULTS

This section presents an evaluation and the results of the prototype implementation. The prototype was evaluated using a self-evaluation approach with the Visual Studio Debugger and also discussed other possible evaluation methods relevant to our implementation.

Logical and Presentation Layer Implementation

We implemented a logical and presentation layer together using Visual Studio 2012 Data Tools. These tools make it easy to query DWs and generate XML documents on the fly, merging XML documents and sending XML documents to a remote server.

Metadata Implementation

We implement metadata to provide summary information about the quality of SRCR datasets and schema. Figure 4 bellow shows the metadata structure in XML format.

The XML metadata document contains as shown in Figure 4. Quality Summary, Data source and Schema Description tags. The end user will use Quality Summary in the metadata to understand if the data is safe for analysis and decision making. Data source provides information about the source of the data while Schema Description gives detailed information about column name, data type and description of the column.

The data contain Safe, Unsafe and Hazardous data in different tags for easy access as depicted in Figure 5. We used Execute SQL Task to run a query that generates XML, Metadata, XML Data and Script Task write the XML Metadata and XML Data to the file. We also used XML Task and FTP Task to merge the two XML documents and publish it to a remote server to allow easy accessibility for the end user.

The Safe Data schema

Figure 6 depicts Safe Data schema, which shows the Time Taken to Confirm and Report the status of the data. These two variables were added to get day differences between when a condition was discovered and when it was actually confirmed. The two added times help in the process of determining the quality of safe data and thereby allow us to filter out hazardous data. If the Time Taken to Confirm Existence or Time Taken to Report has a positive value. It indicates that the condition is truly discovered before confirming the existence and the data can be relied upon. However, if either time has a negative value, it indicates that the date value has been wrongly recorded and is not reliable. Therefore, decisions made from such data could lead to loss of life and properties; hence, we filter this as hazardous data. [10]

Figure 7 shows Safety Data Model Implementation execution result. It depicts the time taken for each task to be completed. The package with filename Package.dtsx represents an organized collection of connections, control and data flow elements, event, variables, parameters, etc., using either the graphical design tools that SSIS provides. The dts settings files are stored in the DTSX format and are appended with the dtsx extension. The green tick at the base of Figure 7 shows the overall success of the execution process

Table 1 represents an execution result summary. It shows automated self-evaluation results with indication of various tasks, the time taken and the success or failure of the evaluation as observed from the experiment. The overall results prove that the implementation was successfully carried out as follows: Loop Through Dataset, ETL & Move Extracted Files into Archive folder, Build XML Metadata and XML Data, Write Data and Metadata to XML File, Merge XML Document, and Published XML File to the server.

Possible Method of Evaluation

The plan for user evaluation includes evaluation documents, which consist of explanation of the user interface, user manual and tasks to be performed by the participants. The target participants are data analysts that make use of SRCRs data for decision-making. This document needs to be well prepared and explained to the participants. In addition, a questionnaire asking relevant questions would be presented to the participants immediately after the tasks to capture their observations, experiences and feedbacks. This questionnaire will be analysed for a greater understanding of the strengths and the weaknesses of the current Safety Data Model implementation.

V. CONCLUSIONS

This research presents an experimental evaluation of safety data model to ensure the integrity of the data used in the data analysis and decision-making. It however, takes into consideration the time taken to Build, Merge and Publish XML File to a Data Server so that a consumer of such data can verify and judge if the data is safe or free from errors. Software tools such as Microsoft SQL Server 2012 Data Tools and Microsoft SQL Server Management Studio were employed to implement the developed model. The overall results of the model appeared in 00:00:20.703 microseconds, which proved that the results are effective, seamless and the integrity of the data extracted, are largely free from error.

ACKNOWLEDGEMENT

All praises are due to Allah, Omnipotent, Omniscience who has in all time given us the strength and energy to carry out this research. The proffered gratitude goes to some of our colleagues whom in one way or the other offered useful suggestions for the success of the research.

REFERENCES

[1] Kumar, S and Patanka, S. (2012), Easy, Real-Time Big Data Analysis Using Storm, last retrieved from http://www.drdobbsom/open-source/easy-real-time-big-data-analysis-using-s/240143874 on 18th September 2013.

[2] Agile Alliance, Agile principles, 2001. Available: http://www.agilealliance.org/the-alliance/the-agile-manifesto /the-twelve-principles-of-agile-software/ 2001: [Accessed: 7 July 2013].

[3] Dahl. G, The use of Bayesian belief nets in safety assessment of software-based system, HWP-527, Halden Project, 1998, pp.98-104

[4] Caspi. P, Formal Design of Distributed Control Systems with Lustre, SAFECOMP99, LNCS 1698, Springer-Verlag, Berlin, 1999, pp. 396-409

[5] Pataricza, A, Checking General Safety Criteria on UML State charts", Computer Safety, Reliability and Security, Proc. 20th Int. Conf., SAFECOMP-2001, Springer, vol. 2187 of LNCS, 2001, pp. 46–55

[6] Egyed, A. Value-Based Requirements Traceability: Lessons Learned. In Proceedings of the 15th IEEE International Conference on Requirements Engineering, RE'07, 2007, pp. 115-118.

[7] Politi, M, Modelling Reactive Systems with State charts: The Stalemate approach, iLogix, 1999, pp.90

[8] Jaideep, Nijjar (2014) Analysis and Verification of Web Application Data Models, University of California, 1-159

[9] Boussa¨ıd, O., Darmont, J., Bentayeb, F. and Loudcher, S. (2017) 'Warehousing complex data from the Web', Int. J. Web Engineering and Technology, pp. 1–27.

[10] Anda, Ilyasu; Isah, Omeiza Rabiu; Enesi, Femi Amin, "A Safety Data Model for data analysis and decision making", International Journal of Information Engineering and Electronic Business(IJIEEB), Vol.9, No.4, pp.21-30, 2017. DOI: 10.5815/ijieeb.2017.04.04

[11] Buttler, D., Liu, L., Pu, C. A fully automated extraction system for the World Wide Web. IEEE ICDCS-21, 2001.

[12] Arasu, .A. and Garcia-Molina, H. Extracting Structured Data from Web Pages. SIGMOD-03, 2003.pp. 1-25. A-5

[13] Liu, Bing, and Yanhong, Zhai. "NET–a system for extracting web data from flat and nested data records." In International Conference on Web Information Systems Engineering, Springer Berlin Heidelberg, pp.487-495. 2005.

[14] Nicholas Kushmerick, Wrapper induction: efficiency and expressiveness. Artificial Intelligence, 118:15-68, 2000.

[15] Chang, C. and Lui, S-L. IEPAD: Information extraction based on patterndiscovery.https://www.semanticscholar.org/paper/IEPAD%3A-information-extraction-based-on-pattern 10, 2001 : [Accessed: 5 Feb 2014].

[16] D.D. Hee, B.D. Pickrel, R.G. Bea, K.H. Roberts, R.B. Williamson Reliability Engineering and System Safety, safety Management Assessment System (SMAS): 65 (1999) 125–140.

[17] A.R. Hale. B. H.J. Heming a, J. Catfhey b, B. Kirwan b "modelling of safety management systems", Safety Science, Elsevier Science Ltd. Holland 1997, V26, 121- 140

[18] A. Faulkner, N. Story. "Data: an often-ignored component of safety-related systems," International Conference on Computer Safety, Reliability, and Security 86-95, 2000. 6, 2000

[19] L. Brain, Delivering Business Intelligence. New York, MC, Graw-Hill: 2012.pp. 4-770

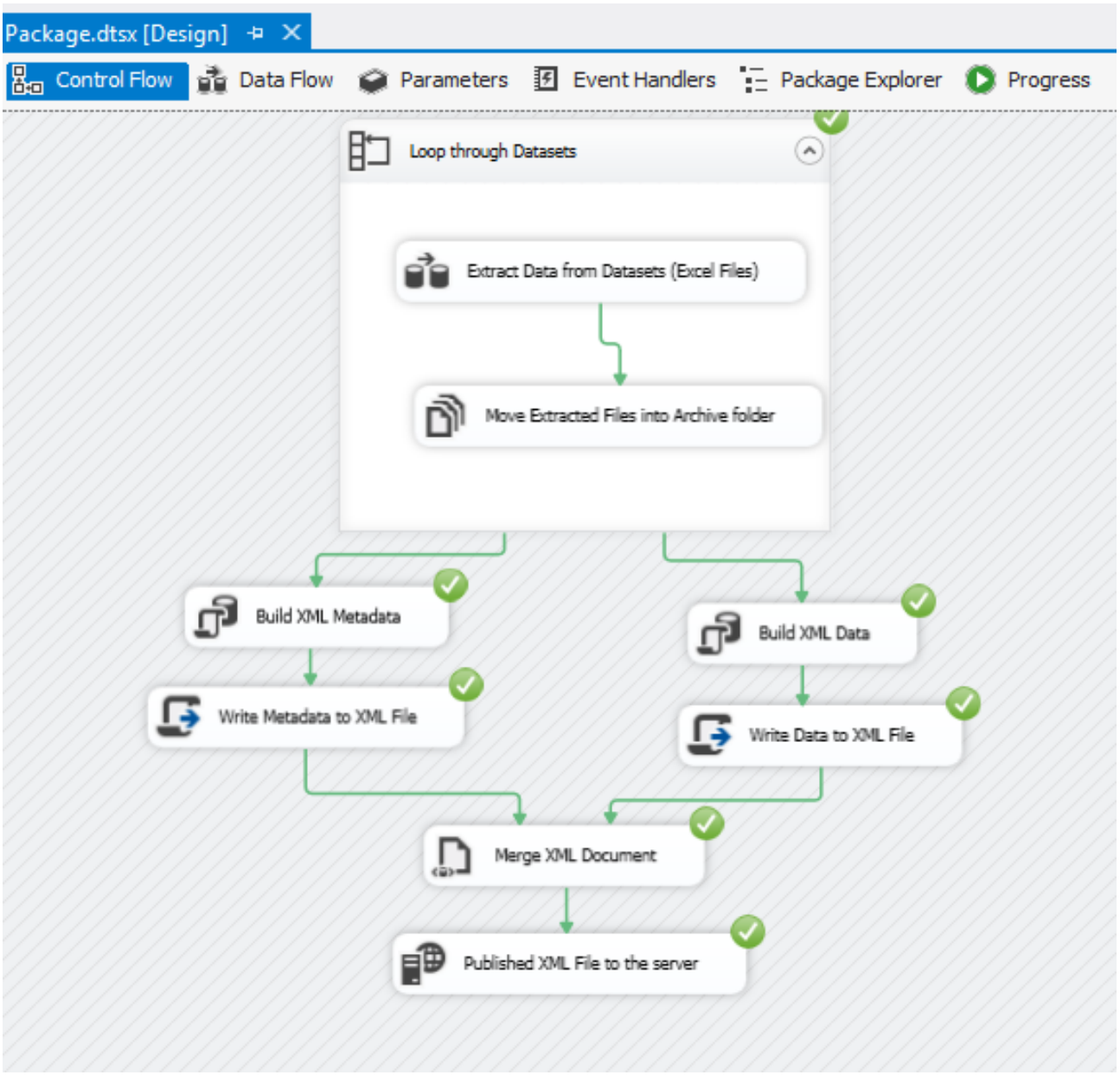


Figure 1: Control Flow for Data Extraction

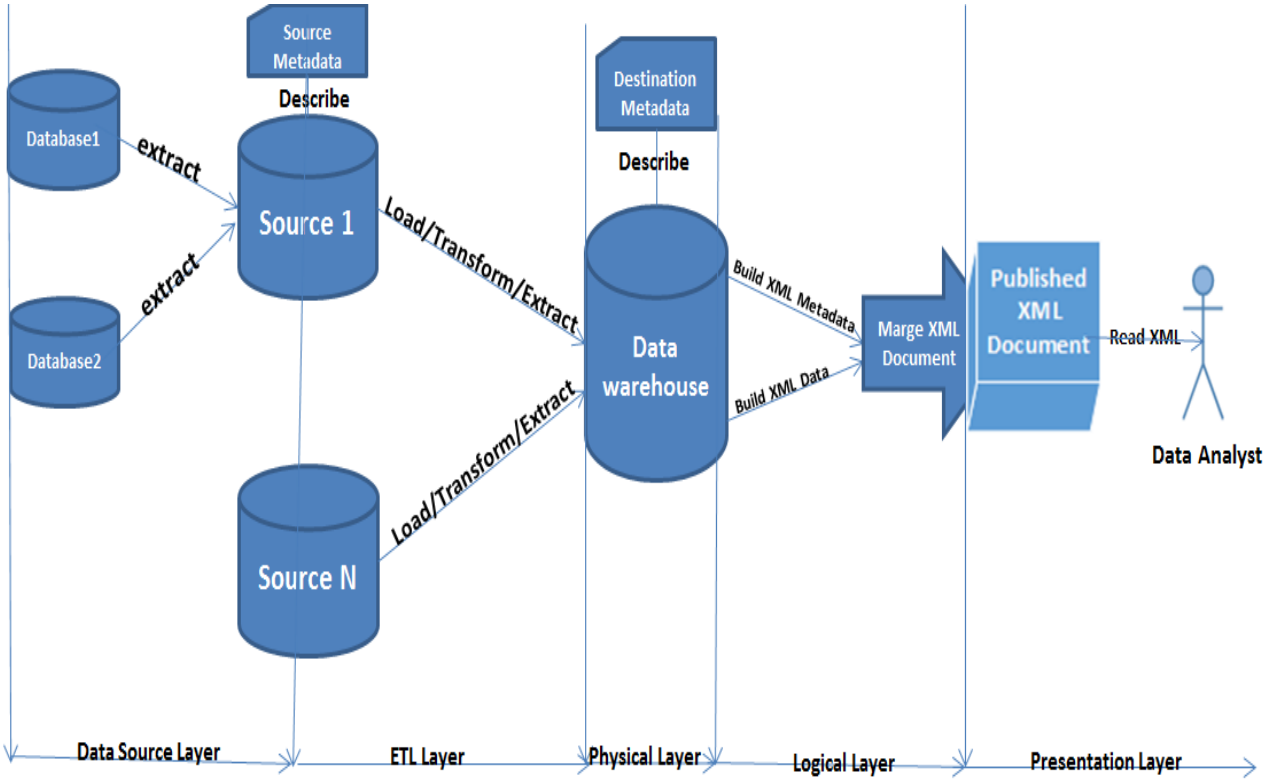


Figure 2: Safety Data Model [3]

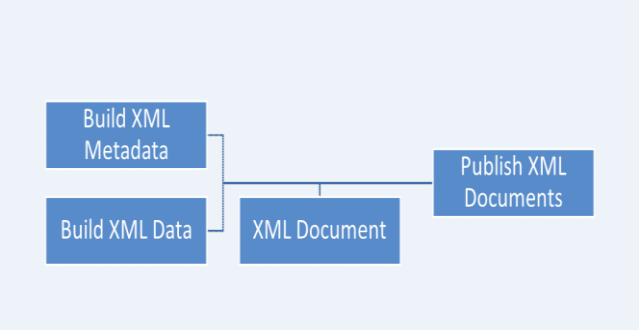


Figure 3: Presentation Layer Design

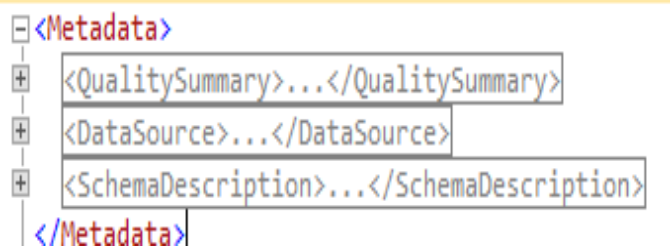


Figure:4 Metadata Structure

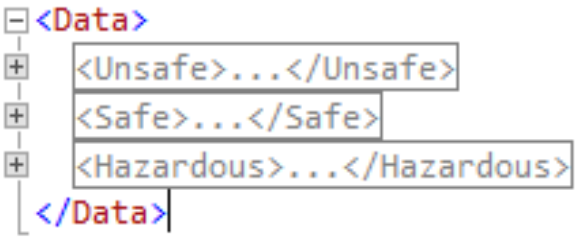


Figure 5: XML Data Structure

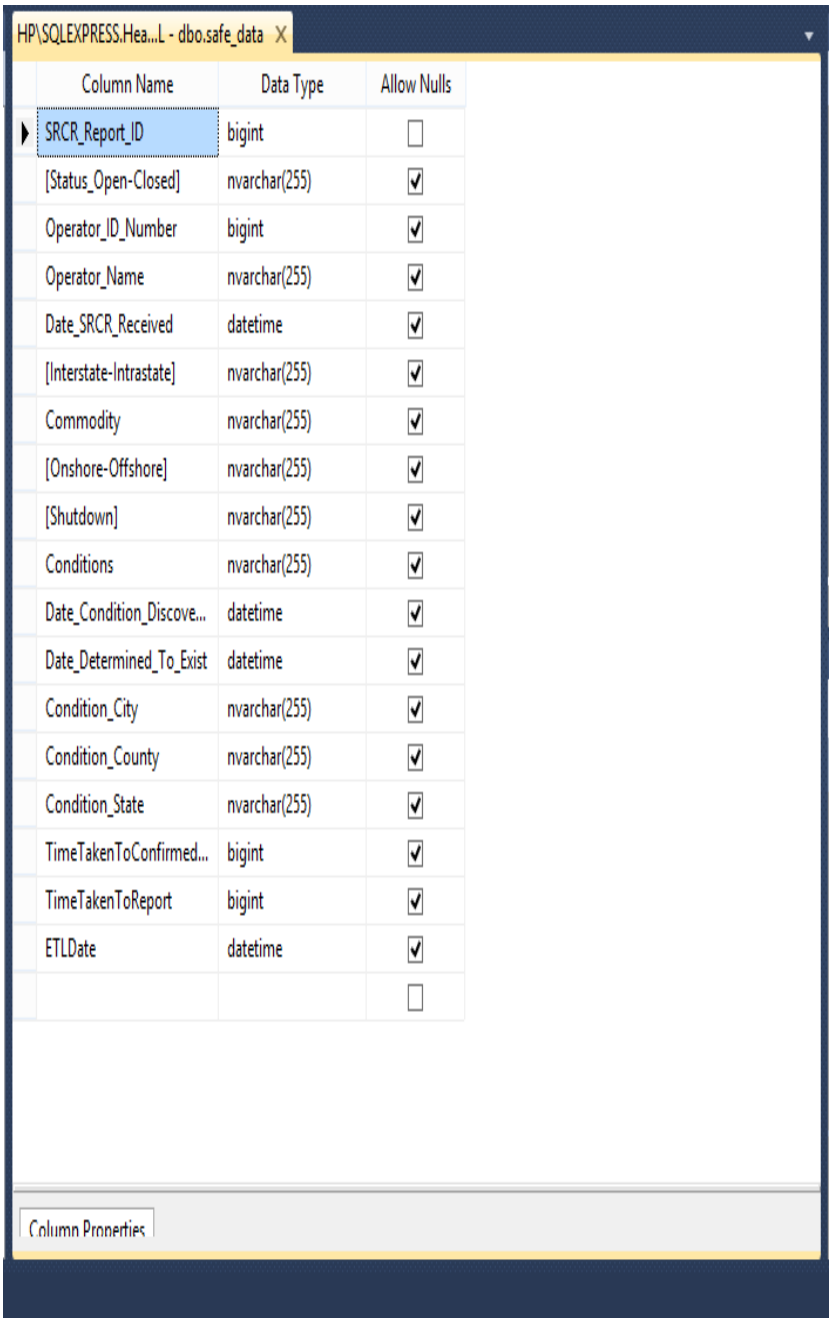


Figure 6: Safe Data Schema

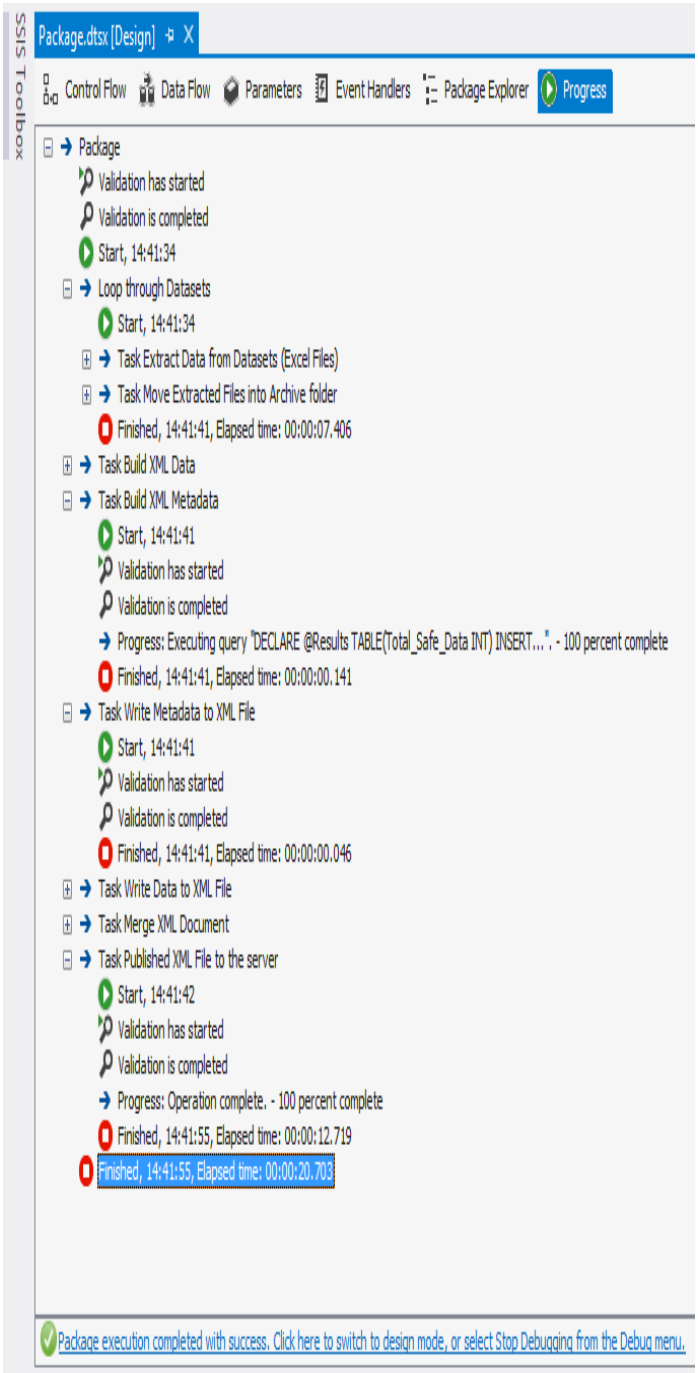


Figure 7: Safety Data Model Implementation Execution Result

Table 1: Execution Result Summary

S/N	Task	Time Taken	Success / Failure
1	Loop Through Dataset, ETL & Move Extracted Files into Archive folder	00:00:07.406	Success
2	Build XML Metadata	00:00:00.141	Success
3	Build XML Data	00:00:00.484	Success
4	Write Metadata to XML File	00:00:00.046	Success
5	Write Data to XML File	00:00:00.016	Success
6	Merge XML Document	00:00:00.078	Success
7	Published XML File to the server	00:00:12.719	Success
	Total	00:00:20.703	

Digital Watermarking Algorithms for Visible Watermarks

A.R. Zubair
Electrical/Electronic Engineering Department
University of Ibadan
Ibadan, Nigeria
Email: ar.zubair@ui.edu.ng, ar.zubair@yahoo.co.uk

ABSTRACT
Imposing one signal on another signal is termed modulation and is very common in electronic communication. Imposing one image on another image is termed watermarking. Digital watermarking is the hiding of a visible or secret message or information (watermark) within an ordinary message (host). Digital watermarking is applied for copyright protection, content authentication, detection of illegal duplication and alteration, feature tagging and secret communication. For reasons of environmental protection and energy conservation, people are adopting paperless records and documents. e-documents are replacing paper documents. Five digital watermarking algorithms were developed and applied for placement of visible watermarks as e-signature, e-stamp, e-logo, e-label, and e-copyright on e-document images, medical images, and other images. Necessary mathematical equations were formulated for the algorithms. Tuning parameters are used to regulate the location of watermark on host image and adjust the amplitude of the watermark relative to the amplitude of the host. The algorithms deployed e-signature, e-stamp, e-logo, e-label and e-copyright satisfactorily on host images.

Keywords: *Visible Watermarks, e-signature, e-stamp, e-logo, e-label, e-copyright.*

African Journal of Computing & ICT Reference Format:

A. R. Zubair (2018), Digital Watermarking Algorithms for Visible Watermarks, *Afr. J. Comp. & ICT*, Vol.11, No.2, pp. 24 - 36.

I. INTRODUCTION

Imposing one signal on another signal is termed modulation and is very common in electronic communication. Modulation is the systematic variation of a property of one signal called the carrier in accordance to the instantaneous amplitude of another signal called the baseband signal or the information bearing signal or the modulating signal [1]. Actually, the carrier is just being used to carry the other signal across the communication channel. The property of the carrier being varied may be the amplitude, frequency or phase which give rise to Amplitude Modulation technique (AM), Frequency Modulation technique (FM) or Phase Modulation technique (PM) respectively. There are digital modulation techniques like Pulse Amplitude Modulation (PAM), Delta Modulation (DM) and Pulse Code Modulation (PCM). Electronic communication is the transfer of information from one point to another by electronic means. Fig. 1 shows the block diagram of a typical electronic communication system [1]. The information is usually converted to an electronic signal.

Modulation is necessary in electronic communication to enable the information bearing signal travel long distance through the channel and to permit multiplexing. Multiplexing is the transfer of different information signals over a single channel. Some property of the carrier signal S2 is varied in accordance with S1 to give the modulated signal S3 which is transmitted over the channel. S1 is recovered at the receiving end.

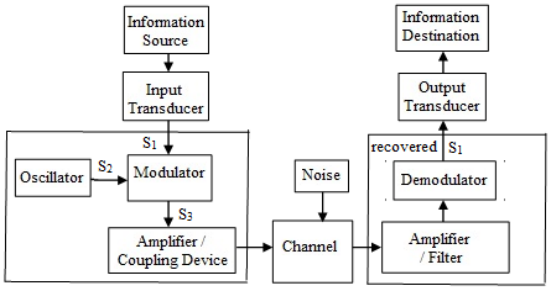


Fig. 1: Sampling of analog signal and loss of samples [1].

Modulation is deliberate interference of one signal with another. Two (or more) signals are mixed together at the sending end. One signal is interfering with another signal. But the concept of ''desired signal'' and ''unwanted signal (noise)'' is somehow complicated here. One man's food is another man's poison. Anyway, successful separation and recovery of all the signals or at least the desired signal at the receiving end is desirable.

The rapid expansion of the internet and the increased availability of digital data recording and duplicating devices have increased the availability of digital data (such as text, audio, images, and videos to the public [2,3,4,5]. Copyright owners are concerned about illegal duplication and distribution of their data and work. A solution for this is to use digital watermarking to protect the intellectual property of creators, distributors or owners of such data.

Digital watermarking is applied for copyright protection, content authentication, detection of illegal duplication and alteration, feature tagging and secret communication. Digital watermarking is the hiding of a visible or secret message or information (watermark) within an ordinary message (host) and its extraction at its destination. The use of watermarks is as old as paper manufacturing [6,7]. Watermarking is first used in paper mills as paper mark of the company [8]. Watermarking was later introduced in postage stamps and national currency notes to make forgery more difficult [6,8].

The digitization of our world expanded the concept of watermarking to include immaterial digital impressions for use in authenticating ownership claims and protecting proprietary interests [6]. Digital watermarks are like their ancestors (paper watermarks) [6]. Digital watermarking is an active area of research [9,10,11,12,13,14,15,16,17, 18,19,20,21,22]. Tao, Chongmin, Zain and Abdallah (2014) did a thorough review of Robust Image Watermarking Theories and Techniques [20].

A visible watermarking scheme has two conflicting requirements which are visibility and unobtrusiveness [21]. It's expected to be visible and it's expected not to cover vital image details. At times, it's good if it's translucence. A secret watermarking scheme has three requirements which are imperceptibility, robustness, and capacity [9,10,12,15].

A Model for Watermarking and Secret Communication is presented in Fig. 2 and is described by Eqn. (1) [9,10,12,14,15,20,21]. Like modulation, watermarking involves embedding one image signal known as the watermark (w) in another image signal known as the host (h) to form watermarked image (g). w constitutes noise in h. C_1 and C_2 are weighting factors [21]. Watermark extraction is required to detect the presence of w in g and recover both h and w from g. Intentional addition of one image to another image for the purpose of Watermarking (ownership identification) and Secret Communication may have adverse effects on both images.

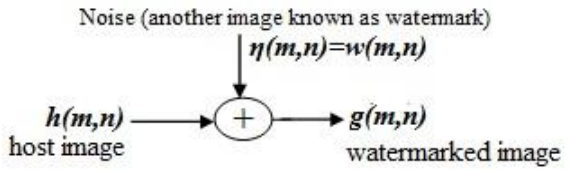


Fig. 2: Model for Watermarking and Secret Communication [9,12,15].

$$g(m,n) = C_1 h(m,n) + C_2 w(m,n) \quad (1)$$

For reasons of environmental protection, energy conservation, space conservation and running cost reduction, people and establishments are adopting paperless records and documents. e-documents are replacing paper documents. In this work, five algorithms were developed for application of digital watermarking of visible watermarks as e-signature, e-stamp, e-label, and e-copyright on e-document images, medical images and other images based on the model of Fig. 2 and Eqn. (1). Necessary mathematical equations were formulated for the algorithms. These arithmetic and logical equations represent the means of effecting or implementing the watermarking basic Eqn. (1) for the specific applications. Users can specify the location of watermark on the host image. Certain tuning parameters are introduced to guide the process and also to ensure that the watermark does not

cover vital information in host image. The watermarking procedures or steps are described in the following section with the aid of block diagrams and the formulated mathematical equations.

II. DIGITAL WATERMARKING ALGORITHMS

2.1 e-signature

The proposed e-signature watermarking process is shown in Fig. 3. t, x, y, and T are constants which can be regarded as tuning parameters. These tuning parameters are used to regulate the location of watermark on host image and adjust the amplitude of the watermark relative to the amplitude of the host.

The e-signature w is first pre-processed to ensure it's on a pure white background. w_p is the pre-processed watermark and is given by Eqn. (2). The objective of pre-processing is to improve the contrast of the signature compared with the background. w_p is set equal to w. Then, any pixel in the w_p such that its red (r), green (g) and blue (b) components are greater than the threshold t is considered to belong to the background and is made white by changing its r, g and b components to 255 as described in Eqn. (2).

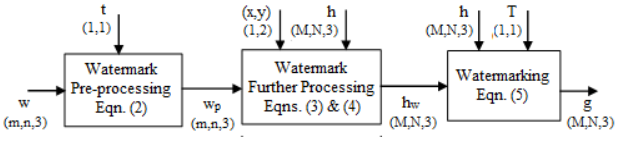


Fig. 3: e-signature watermarking process.

$$w_p(i,j,k) = \begin{cases} 255 & \text{if } w(i,j,1) > t \,\&\, \text{if } w(i,j,2) > t \\ & \&\, \text{if } w(i,j,3) > t \\ w(i,j,k) & \text{otherwise} \end{cases} \quad (2)$$

Fig. 4 which shows the r, g and b colour components for some grey levels. As r, g and b tend to 255, the colour tends to white. As r, g and b tend to 0, the colour tends to black. For example, w(i,j,1), w(i,j,2) and w(i,j,3) in Eqn. (2) are the r, g and b components of w. A threshold t was introduced to distinguish the signature from the background. If a pixel appears to be close to white ($180 \leq$ r, g and b ≤ 255), it's treated as background and all its colour components are set to 255 as in Eqn. (2). Otherwise, the pixel is treated as part of the signature and its r, g and b values are left intact as in Eqn. (2).

The dimensions of h and w are obtained as M by N by 3 and m by n by 3 respectively: M > m and N > n. A blank white image h_b of the same dimension as h is formed as given by Eqn. (3). The user supplies and can change a starting pixel coordinate (x,y) location for the placement of the e-signature on the host. The e-signature is placed on h_b to form h_w in accordance with Eqn. (4). The watermarked image g is obtained from h and h_w by Eqn. (5) such that any white pixel in h_w (with r, g and b components greater than threshold T) is replaced with corresponding host image pixel. h_w has some part containing watermark information and the remaining part is blank or white. Host information is to be added to the white part of h_w. Threshold T is used to identify the white part. If a pixel in h_w appears to be white ($240 \leq$ r, g and b ≤ 255), it's treated as white and is replaced by corresponding host pixel as in Eqn. (5). For multiple e-signatures, a watermarked image with e-signature is resent as host h and the process is repeated.

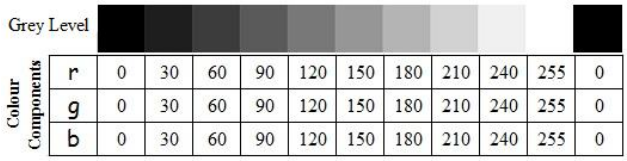


Fig. 4: Some grey levels obtainable with red-green-blue (rgb) colour model.

$$h_b(i,j,k) = 255 \quad (3)$$

$$h_w(i,j,k) = \begin{cases} w_p(\text{i - x + 1, j - y + 1, k}) & \text{if } x < i < (x+m-1) \\ & \&\, \text{if } y < j < (y+n-1) \\ h_b(\text{i, j, k}) & \text{otherwise} \end{cases} \quad (4)$$

$$g(i,j,k) = \begin{cases} h(i,j,k) & \text{if } h_w(i,j,1) > T \,\&\, \text{if } h_w(i,j,2) > T \\ & \&\, \text{if } h_w(i,j,3) > T \\ h_w(i,j,k) & \text{otherwise} \end{cases} \quad (5)$$

2.2 e-stamp or e-logo

The proposed e-stamp or e-logo watermarking process is presented in Fig. 5. x, y, and T are constants which can be regarded as tuning parameters. The e-stamp or e-logo w is first pre-processed. The pre-processing involves flipping the e-stamp or e-logo from right to left if required. In some cases, this may not be required. The dimensions of h and w are obtained as M by N by 3 and m by n by 3 respectively: M > m and N > n. A blank white image h_b of the same dimension as h is formed as given by Eqn. (3). The user supplies and can change a starting pixel

coordinate (x,y) location for the placement of the e-stamp or e-logo on the host.

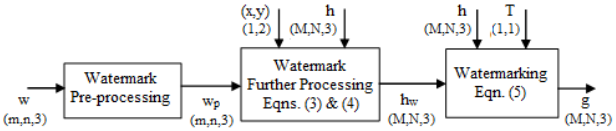


Fig. 5: e-stamp or e-logo watermarking process.

The e-stamp or e-logo is placed on h_b to form h_w in accordance with Eqn. (4). The watermarked image g is obtained from h and h_w by Eqn. (5). A typical value of threshold T is in the range [240-255] as discussed in section 2.1. For multiple e-stamp, a watermarked image with e-stamp is resent as host h and the process is repeated.

2.3 e-label on medical images

e-label on medical images may contain information like patient's surname, hospital number and the date the medical image was captured. The proposed e-label on medical image watermarking process is exactly like e-stamp watermarking process discussed in section 2.2 and illustrated in Fig. 5. The pre-processing involves flipping the transpose of the e-label from right to left if required. This may be necessary to ensure that critical medical information on the medical image is not covered by the e-label. This may not be required in some cases.

2.4 Background e-stamp or e-logo

In some cases, the host image which is an e-document is black write up on white background. Part of the white background can be replaced with a visible e-stamp or e-logo at the center by watermarking. Background e-stamp or e-logo watermarking process is illustrated in Fig. 6. c, T, and τ are constants which can be regarded as tuning parameters. The pre-processing involves flipping the e-stamp or e-logo from right to left if required. In some cases, this may not be required.

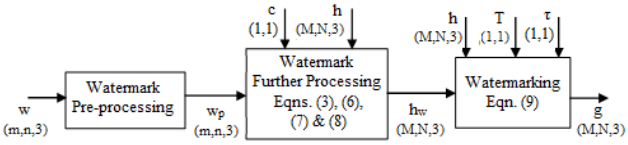


Fig. 6: Background e-stamp or e-logo watermarking process.

The dimensions of h and w are obtained as M by N by 3 and m by n by 3 respectively: M > m and N > n. A blank white image h_b of same dimension as h is formed as given by Eqn. (3). The starting pixel coordinate (x,y) location for the placement of the e-stamp or e-logo on the host is obtained by Eqns. (6) and (7). The e-stamp or e-logo w with a scaling constant c is placed at the center of h_b to form h_w in accordance with Eqn. (8). c is to ensure that the e-stamp or e-logo is just slightly visible in the background. c ranges from 1 to 1.5.

$$x = \frac{M}{2}\Big|_{\substack{\text{approximated to the}\\ \text{lowest whole number}}} - \frac{m}{2}\Big|_{\substack{\text{approximated to the}\\ \text{lowest whole number}}} - 1 \qquad (6)$$

$$y = \frac{N}{2}\Big|_{\substack{\text{approximated to the}\\ \text{lowest whole number}}} - \frac{n}{2}\Big|_{\substack{\text{approximated to the}\\ \text{lowest whole number}}} - 1 \qquad (7)$$

The watermarked image g is obtained from h and h_w by Eqn. (9). Threshold T first identify a pixel in h which is part of the write up on e-document if its r, g and b ≤ T; where 150 < T < 220. Such identified pixel must appear in the watermarked image and a value of τ is deducted from its r, g and b values to make it darker as in Eqn. (9). τ is in the range [0-30]. Subtracting a constant τ from the r, g and b values make the pixel closer to black as illustrated in Fig. 4. The user may override Eqns. (6) and (7) by supplying a starting pixel coordinate (x,y) location for the placement of the e-stamp on the host.

$$h_w(i,j,k) = \begin{cases} cw_p(\mathrm{i}-\mathrm{x}+1, \mathrm{j}-\mathrm{y}+1, \mathrm{k}) & \text{if } \mathrm{x} < \mathrm{i} < (x+m-1) \\ & \& \text{ if } \mathrm{y} < \mathrm{j} < (y+n-1) \\ h_b(\mathrm{i},\mathrm{j},\mathrm{k}) & \text{otherwise} \end{cases} \qquad (8)$$

$$g(i,j,k) = \begin{cases} h(i,j,k) - \tau & \text{if } \mathrm{h}(i,j,1) < T \,\&\, \text{if } \mathrm{h}(i,j,2) < T \\ & \& \text{ if } \mathrm{h}(i,j,3) < T \\ \mathrm{h}_w(i,j,k) & \text{otherwise} \end{cases} \qquad (9)$$

2.5 e-copyright

The proposed e-copyright watermarking process for adding visible watermark w as e-copyright to a host image h is shown in Fig. 7. x, y, and c are the tuning parameters. The dimensions of h and w are obtained as M by N by 3 and m by n by 3 respectively: M > m and N > n. A dark image h_d of the same dimension as h is formed as given by Eqn. (10). The user supplies and can change a starting

pixel coordinate (x,y) location for the placement of the watermark on the host. The watermark is placed on h_d to form h_w in accordance with Eqn. (11). The watermarked image g is obtained from h and h_w by Eqn. (12). c is to reduce the intensity of e-copyright relative to the host image. c ranges from 0.1 to 0.5.

$$h_d(i, j, k) = 0 \tag{10}$$

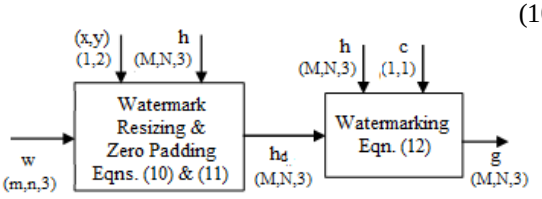


Fig. 7: e-copyright on image watermarking process.

$$h_w(i, j, k) = \begin{cases} w(\mathrm{i}-\mathrm{x}+1, \mathrm{j}-\mathrm{y}+1, \mathrm{k}) & \text{if } \mathrm{x} < \mathrm{i} < (x+m-1) \\ & \& \text{if } \mathrm{y} < \mathrm{j} < (y+n-1) \\ h_d(\mathrm{i}, \mathrm{j}, \mathrm{k}) & \text{otherwise} \end{cases} \tag{11}$$

$$g(i, j, k) = h(i, j, k) + ch_w(\mathrm{i}, \mathrm{j}, \mathrm{k}) \tag{12}$$

III. RESULTS AND DISCUSSIONS

The processes were developed into algorithms in Matlab working environment. The algorithms are tested with some watermarks and host images. Test results are presented and discussed in this section. Possible ranges of the tuning parameters have been stated in section 2 but the values of the tuning parameters actually used for each test are recorded and presented with the results.

3.1 e-signature

The algorithm for the e-signature watermarking process was tested with e-signatures. The results are presented in Figs. 8, 9 and 10. e-signatures were successfully placed at specified locations on e-documents. Multiple e-signatures on a single e-document were achieved by re-sending a watermarked image as host and repeating the watermarking process with a different e-signature at a different location on the e-document.

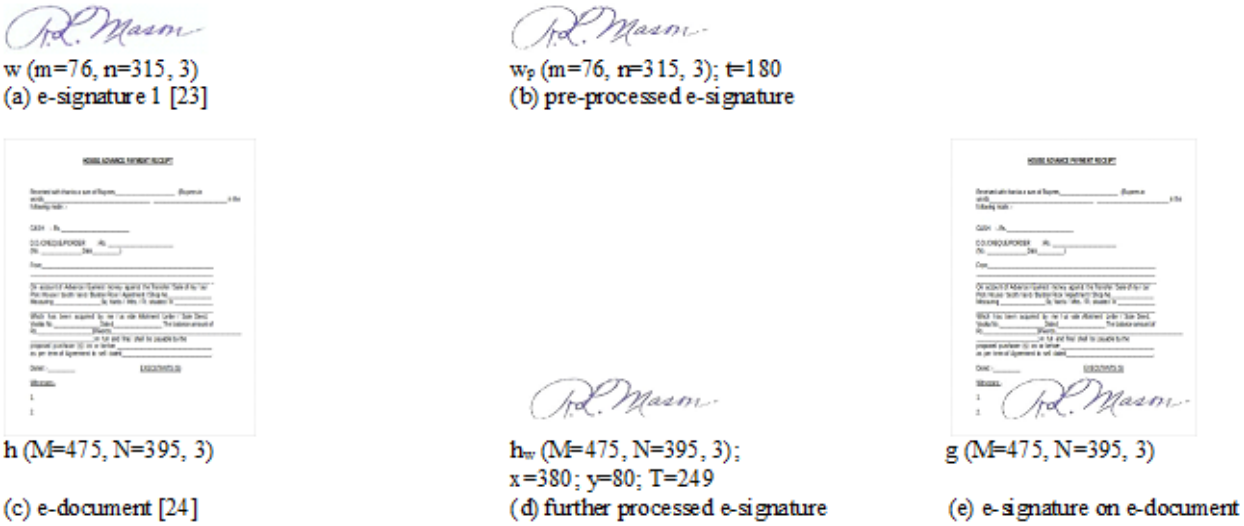
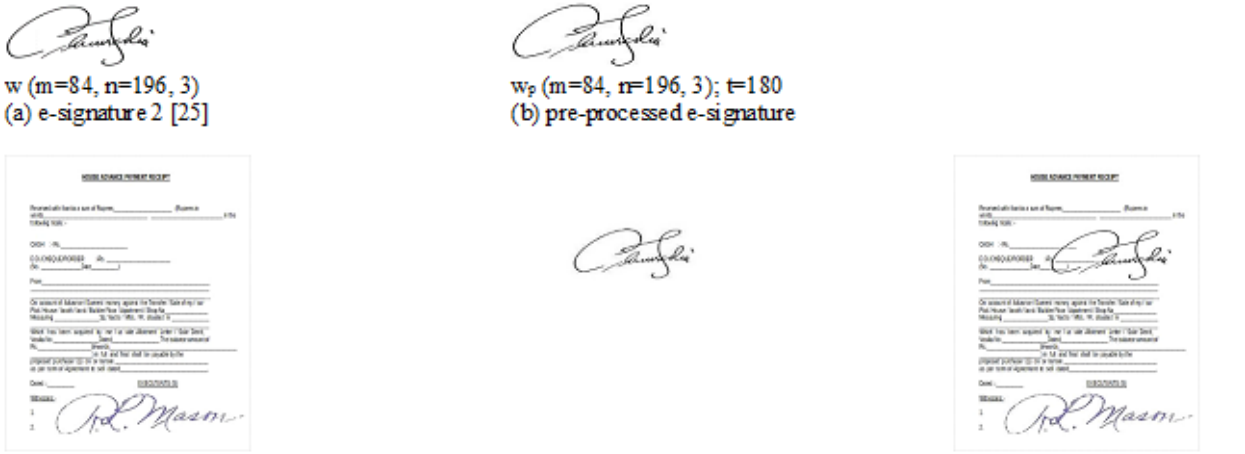


Fig. 8: e-signature on e-document first experimental results.



w (m=84, n=196, 3)
(a) e-signature 2 [25]

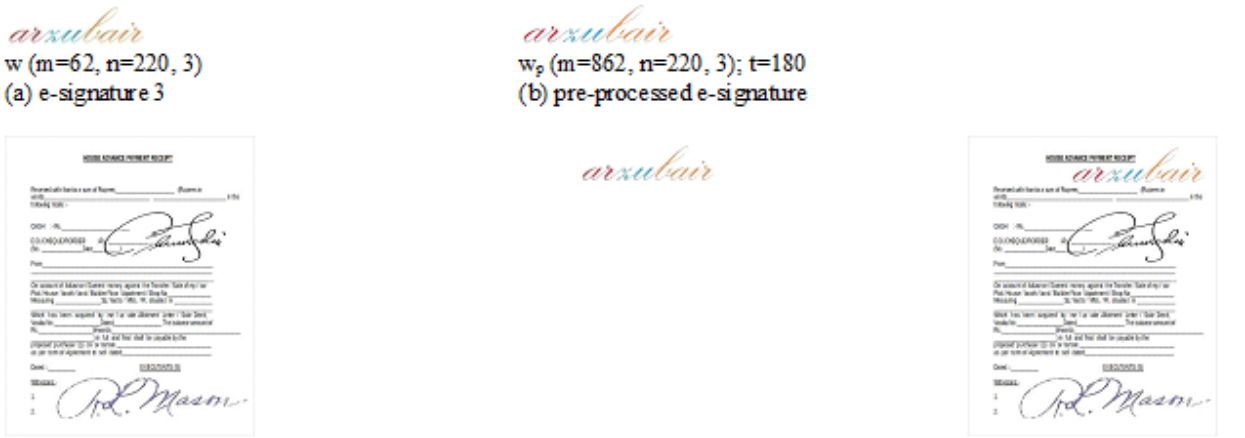
w_p (m=84, n=196, 3); t=180
(b) pre-processed e-signature

h (M=475, N=395, 3)
(c) e-document

h_w (M=475, N=395, 3);
x=120; y=155; T=249
(d) further processed e-signature

g (M=475, N=395, 3)
(e) e-signature on e-document

Fig. 9: e-signature on e-document second experimental results.



w (m=62, n=220, 3)
(a) e-signature 3

w_p (m=862, n=220, 3); t=180
(b) pre-processed e-signature

h (M=475, N=395, 3)
(c) e-document

h_w (M=475, N=395, 3);
x=20; y=160; T=249
(d) further processed e-signature

g (M=475, N=395, 3)
(e) e-signature on e-document

Fig. 10: e-signature on e-document third experimental results.

3.2 e-stamp or e-logo

The algorithm for the e-stamp or e-logo watermarking process was tested with e-stamps and e-logos. The results are presented in Figs. 11, 12, 13 and 14. e-stamps and e-logos were successfully placed at specified locations on e-documents. Multiple e-stamps and or e-logos on a single e-document were achieved by re-sending a watermarked image as host and repeating the watermarking process with a different e-stamp or e-logo at a different location on the e-document.

Fig. 11: e-stamp on e-document first experimental results.

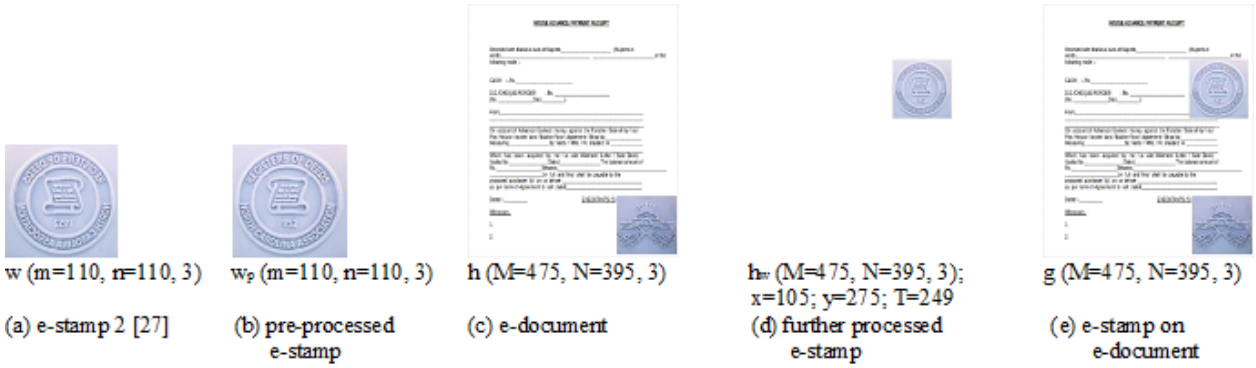


Fig. 12: e-stamp on e-document second experimental results.

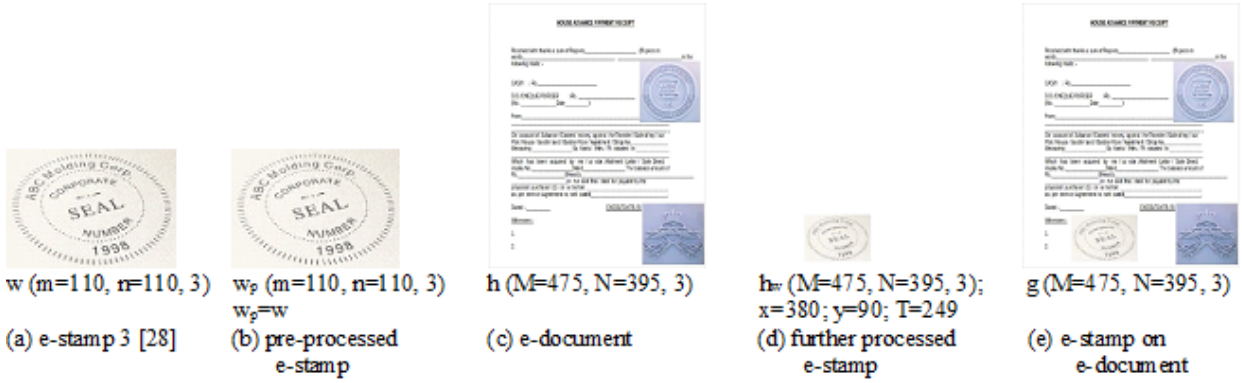


Fig. 13: e-stamp on e-document third experimental results.

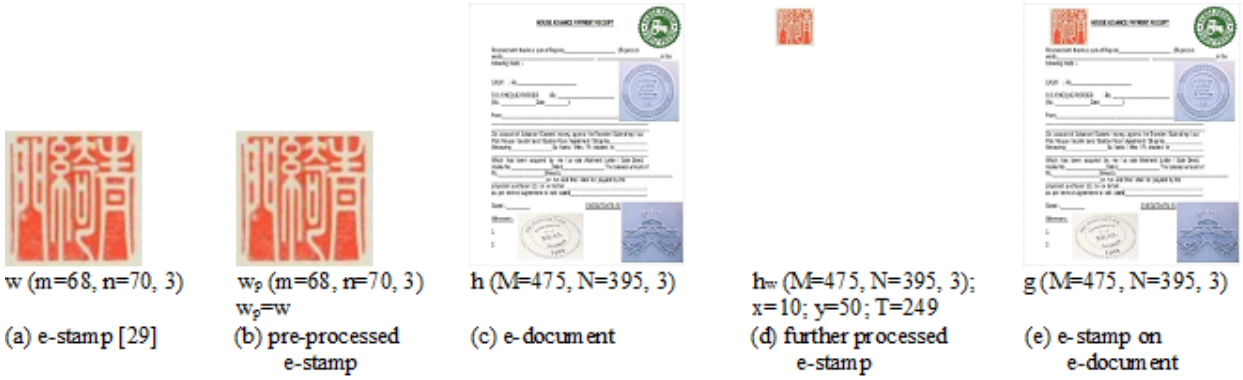


Fig. 14: e-stamp on e-document fourth experimental results.

3.3 e-label on medical image

The algorithm for the e-label watermarking process was tested with three e-labels and medical images. The results are presented in Figs. 15, 16 and 17. e-labels were successfully placed at specified locations on medical images.

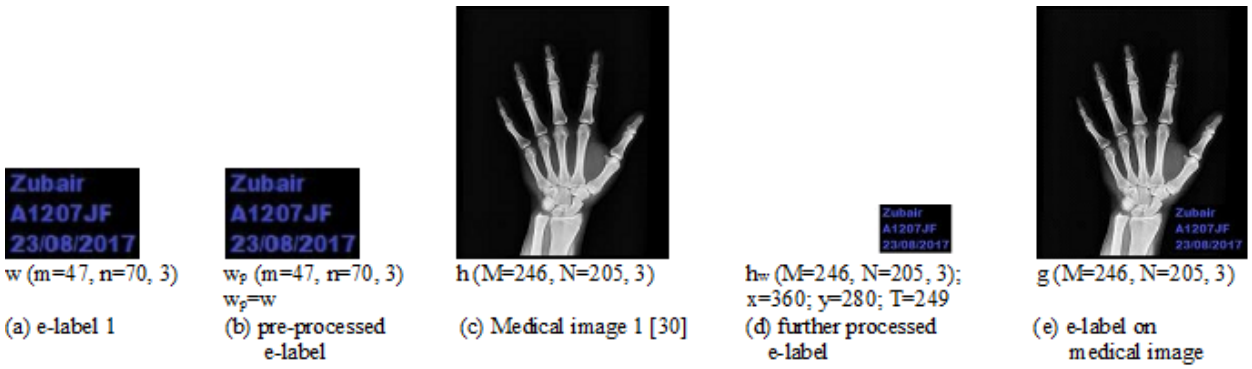


Fig. 15: e-label on medical image first experimental results.

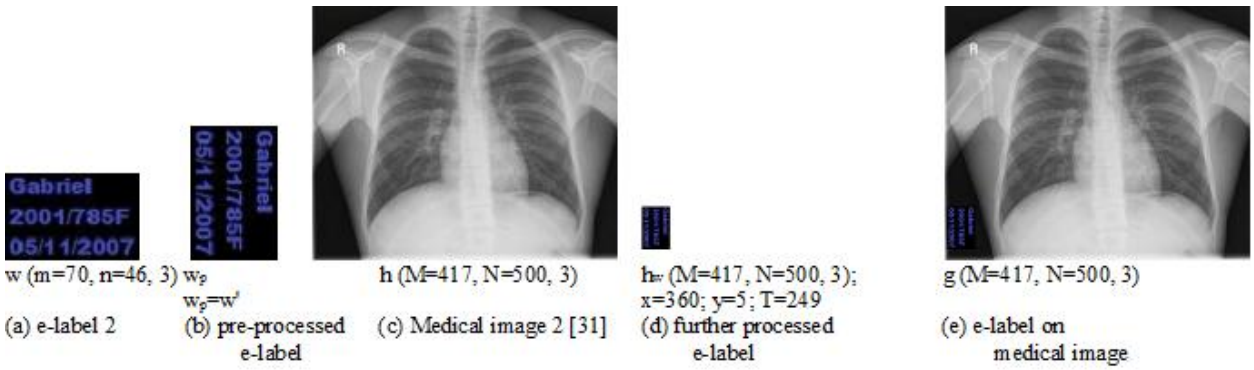


Fig. 16: e-label on medical image second experimental results.

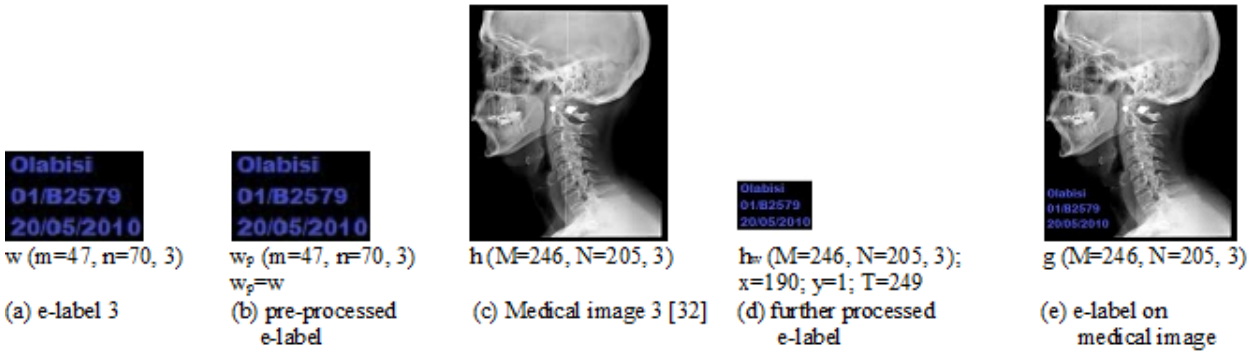


Fig. 17: e-label on medical image third experimental results.

3.4 Background e-stamp or e-logo

The algorithm for the background e-stamp watermarking process was tested with e-stamps or e-logos. The results are presented in Figs. 18, 19 and 20. e-stamps were successfully placed as the background images at specified locations on e-documents. It is observed from the displayed results that the higher the value of parameter c, the lighter is the background logo. Furthermore, the higher the parameter τ the clearer the e-document black write-up against the background e-logo.

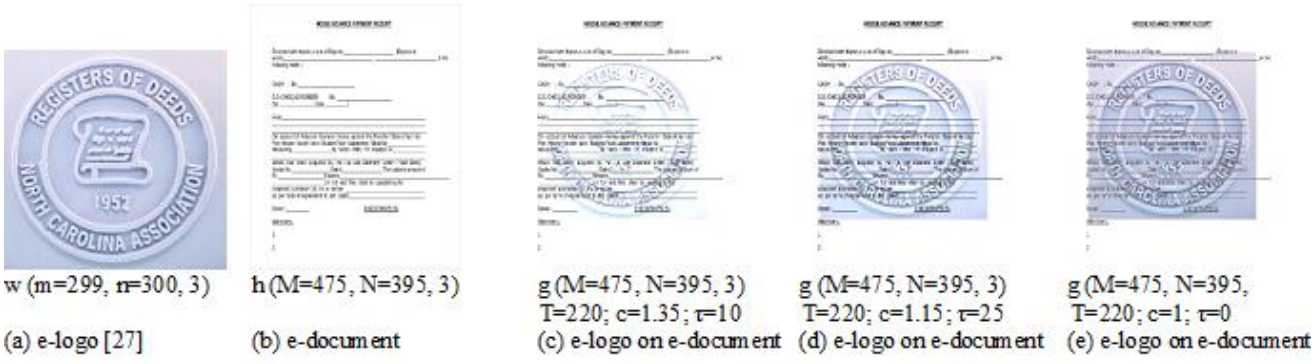


Fig. 18: Background e-logo on e-document first experimental results.

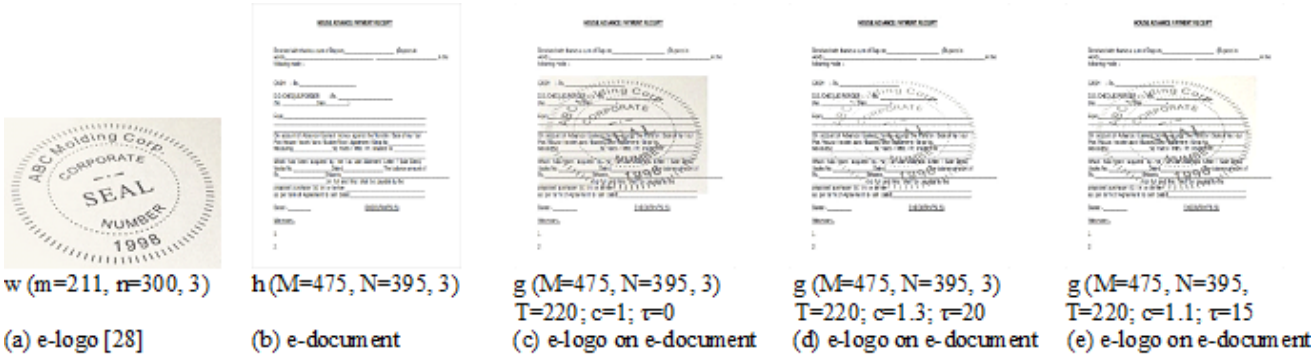


Fig. 19: Background e-logo on e-document second experimental results.

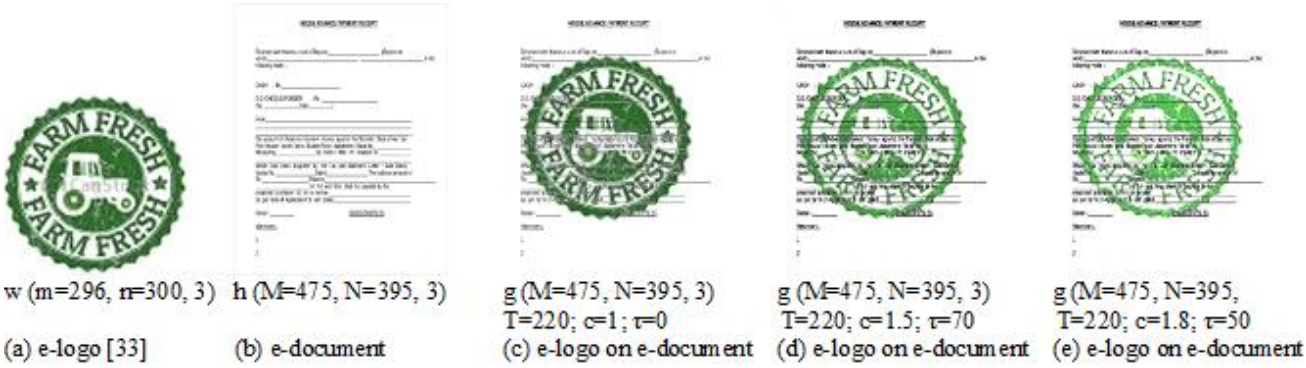


Fig. 20: Background e-logo on e-document third experimental results.

3.5 e-copyright on images

The algorithm for the embedding of visible watermark as e-copyright on a host image was tested. The results are

presented in Figs. 21, 22 and 23. Visible watermarks were successfully placed at specified locations as e-copyright on host images.

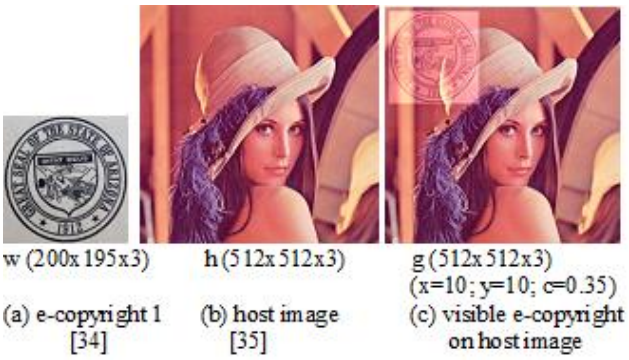


Fig. 21: Visible watermark as e-copyright on host image first experimental results.

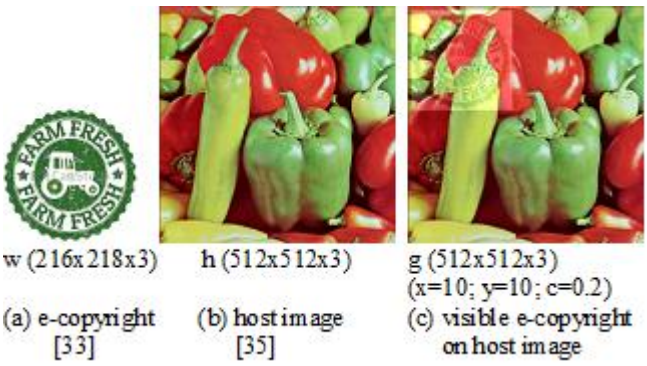


Fig. 22: Visible watermark as e-copyright on host image second experimental results.

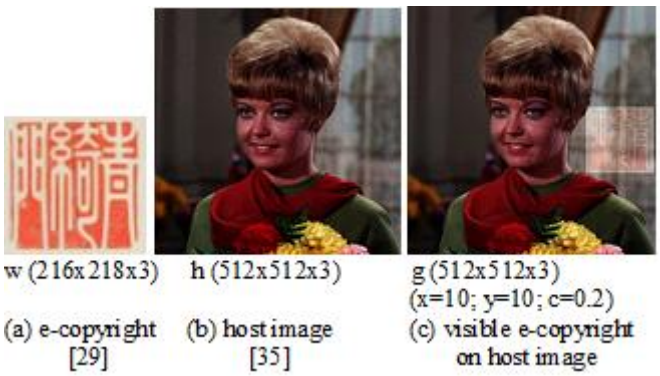


Fig. 23: Visible watermark as e-copyright on host image third experimental results.

IV. CONCLUSIONS

Algorithms for the deployment of watermarks as e-copyright, e-signature, e-stamp, e-logo and e-label on e-document images, medical images and general images have been developed. E-signature, e-stamp, e-logo, e-label, and e-copyright were successfully placed at specified locations on host images. Multiple watermarks on a single host image are also realized. Tuning parameters were introduced to regulate the location of watermark on host image and adjust the amplitude of the watermark relative to the amplitude of the host.

REFERENCES

[1] Brook, J. D. and Wynne, R. J. (1998). Signal Processing Principles and Applications. London: Edward Arnold.

[2] Canada, B. and Majumder, D. D. (2000). Digital Image Processing and Analysis. India: Prentice-Hall.

[3] Gonzalez, R. C. and Woods, R. E. (2002). Digital Image Processing. Massachusetts: Addison-Wesley.

[4] Jain, A. K. (2003). Fundamentals of Digital Image Processing. India: Prentice-Hall.

[5] Weeks, A. R. (1999). Fundamentals of Electronic Image Processing. India: Prentice-Hall.

[6] Mohanty, S. P. (1999). Digital Watermarking: A Tutorial Review, Technical Report, University of South Florida (1999) retrieved from http://www.cs.unt.edu/smoh-anty/research/Reports/MohantyWatermarking Survey1999.pdf on 9th April 2018.

[7] Berghel, H. (1997). Watermarking Cyberspace, Communications of the ACM, Volume-40, Issue-11, pp. 19-24.

[8] Saini, L. K. and Shrivastava, V. (2014) A Survey of Digital Watermarking Techniques and its Applications, International Journal of Computer Science Trends and Technology (IJCST), Volume-2, Issue-3, pp. 69-73.

[9] Fei, C., Kundur, D. and Kwong, R. H. (2006). Analysis and Design of secure watermark-based authentication systems, IEEE Trans. on Information Forensics and Security, Volume-1, Issue-1, pp. 43-55.

[10] Barni, M., Bartolini, F., Rosa, A. D. and Piva, A. (2000). Capacity of full frame DCT image watermarks, IEEE Trans. on Image Processing, Volume 9, Issue 8, pp. 1450-1455.

[11] Hernandez, J. R. and Gonzalez, F. P. (1999). Statistical analysis of watermarking schemes, Proceedings of the IEEE, Volume-87, Issue-7, pp. 1142-1166.

[12] Hsu, C. T. and Wu, J. L. (1999). Hidden digital watermarks in images, IEEE Trans. on Image Processing, Volume-8, Issue-1, pp. 58-68.

[13] Lu, C. S. and Liao, H. Y. M. (2001). Multipurpose Watermarking for image authentication and Protection, IEEE Trans. on Image Processing, Volume-10, Issue-10, pp. 1579-1592.

[14] Mohanty, S. P., Ramakrishnan, K. R. and Kankanhalli, M. S. (2000). A DCT Domain Visible Watermarking Technique for Images, IEEE International Conference on Multimedia and Expo, pp. 1029-1032.

[15] Niu, X. M., Lu, Z. M. and Ho, S. H. (2000). Digital watermarking of still images with gray-level watermark, IEEE Trans. on Consumer Electronics, Volume-46, Issue-1, pp. 137-144.

[16] Voyatzis, G. and Pitas, I. (1999). The use of watermarks in the protection of digital multimedia products, Proceedings of the IEEE, Volume-87, Issue-7, pp. 1197-1207.

[17] Fordjour, P. A. and Shuo-Zhong, W. (2003). Spatial domain technique for visible watermarking, Journal of Shanghai University, Volume-7, Issue-4, pp. 384-388.

[18] Zubair, A. R., Fakolujo, O. A. and Rajan, P. K. (2009). Digital watermarking of still images with colour digital watermarks, In IEEE EUROCON'09, pp. 1338-1345.

[19] Agarwal, H., Sen, D., Raman, B. and Kankanhalli, M. (2016). Visible watermarking based on importance and just noticeable distortion of image regions, Springer Journal on Multimedia Tools and Application, Volume-75, Issue-13, pp. 7605-7629.

[20] Tao, H., Chongmin, L., Zain, J. M. and Abdalla, A. N. (2014). Robust Image Watermarking Theories and Techniques: A Review, Journal of Applied Research and Technology, Volume-12, Issue-1, pp. 122-138.

[21] Santoyo-Garcia, H., Fragoso-Navarro, E., Reyes-Reyes, R., Cruz-Ramos, C. and Nakano-Miyatake, M. (2017). Visible Watermarking Technique Based on Human Visual System for Single Sensor Digital Cameras, Hindawi Journal on Security and Communication Networks, pp. 1-18.

[22] Chang, C. and Hwang, K. A. (2000). Digital Watermarking Scheme Using Human Visual Effects, Informatica 24, pp. 505-511.

[23] e-signature 1, retrieved from http://schoonermoon.com/wp-content/uploads/2010/04/signature.jpg on 4th September 2017.

[24] e-document, retrieved from https://images.sampleforms.com/wp-content/uploads/2016/12/House-Advance-Payment-Receipt-Format.jpg on 4th September 2017.

[25] e-signature 2, retrieved from http://schoonermoon.com/wp-content/uploads/2010/04/signature.jpg on 4th September 2017.

[26] e-stamp 1, retrieved from http://metalclays.yfbycxmxznt6.maxcdn-edge.com/content/images/thumbs/0004411_signature-stamp-51mm-2-inch_415.jpeg on 4th September 2017.

[27] e-stamp 2, retrieved from http://metalclays.yfbycxmxznt6.maxcdn-edge.com/content/images/thumbs/0003283_signature-stamp-76mm-3-inch_415.jpeg on 4th September 2017.

[28] e-stamp 3, retrieved from http://www.thestampmaker.com/Images/Categories/corporate-seal-stamps.jpg on 4th September 2017.

[29] e-stamp 4, retrieved from https://i.pinimg.com/736x/59/67/c0/5967c04de81417afb30a2fa32aaef226.jpg on 4th September 2017.

[30] Medical image 1, retrieved from https://pixabay.com/en/x-ray-health-arm-doctors-medicine-1704855/ on 4th September 2017.

[31] Medical image 2, retrieved from http://www.chestx-ray.com/index.php/education/normal-cxr-module-train-your-eye#!1 on 4th September 2017.

[32] Medical image 3, retrieved from http://unisci24.com/363266.html on 4th September 2017.

[33] e-logo, retrieved from https://comps.canstockphoto.com/farm-fresh-stamp-image_csp16448873.jpg on 4th September 2017.

[34] e-logo, retrieved from http://www.arizonaedventures.com/arizona/blog/reference-guide/state-symbols/ on 4th September 2017.

[35] USC-SIPI Image Database, retrieved from http://sipi.usc.edu/database/index.html on 4th September 2017.

https://afrjcict.net

sVeriTool: A Verification Tool for Preventing Impersonation of Students in Examination Halls Using Fingerprints

U.S Haruna
Department of Computer Science
Yusuf Maitama Sule University, Kano,
Nigeria
Email: shafsonharun@gmail.com

ABSTRACT
Development in Information and Communication Technology (ICT) has significantly changed the way we think and carry out our day-to-day activities. Students' verifications, especially for examinations and other related tasks, are obvious examples. Handling this kind of tasks manually, either through the use of students' examination or identification cards, could undoubtedly be onerous, hectic, erroneous and scandalous especially when there is a large number of students. This triggers the need of providing a suitable and computerized mechanism of students' verifications for such tasks. As globally agreed, one of the effective methods of humans verification is through the use of their fingerprints due to its uniqueness and naturalness. This paper presents the design and implementation of an intuitive, secured and efficient examination verification tool that is strictly based on students' fingerprints, with the aim of easing the associated activities and shelving the possible cases of impersonation form of examination malpractice. The tool has been developed using Visual Basic (VB), with Microsoft SQL server for database related services and GrFinger Software Development Kit (SDK) for finger recognition.

Keywords: *ICT, Fingerprint, Student, Examination, Verification, Tool*

African Journal of Computing & ICT Reference Format:

U. S. Haruna (2018), sVeriTool: A Verification Tool for Preventing Impersonation of Students in Examination Halls using Fingerprints, *Afr. J. Comp. & ICT*, Vol.11, No.2, pp. 37 - 52 .

I. INTRODUCTION

According to [1], examination is one of the potent mechanism of ensuring that, students indeed grasped the knowledge communicated to them by their respective educational institutions, for the overall aim of serving the basic and standard needs of their communities. Through examinations, educational institutions and concerned government agencies can be able to pinpoint and evaluate students' capacities, especially for the purpose of getting qualifications; teachers' capacities; and quality and impact of the knowledge being taught to the students to their societies [2] [3]. Based on this, it's worth noting that, the importance of examinations cannot be overemphasized, hence strict majors need to be taken in ensuring that they are conducted with minimal or zero cases of malpractice.

In the Nigerian system of education, at the end of each semester, students take examinations for each and every examinable course they have registered, for the purpose of assessing their academic quality and that of their institutions. As stated earlier, examinations are marred with so many unethical activities of examination

malpractices such as leakages, copying and impersonations. This is a global problem. Students are admitted into examination hall for a particular course after satisfying the 75% attendance requirement in addition to other requirements stipulated by their respective university Senates [3].

In the current system, students are manually verified and admitted into the examination hall through presentation of their examination cards, despite the global advancement and adoption of information technology in all aspects of human endeavors. The process is entirely onerous, time-consuming and fraudulent. Furthermore, in some institutions, students are partially verified while writing their examination, this might eventually pave a way to impersonation form of examination malpractice and subsequently leads to fallen standard of education [1]. The entire verification process and other processes associated with examination in Nigerian institutions have proven to be inefficient and "contemporary shame" as coined by [4]. Considering the aforementioned issues, despite all the efforts been made to make things right, the current system has proven to be a partial failure and a blow to the institutions.

Impersonation is one of the most disturbing forms of examination malpractice, this involved collaboration between students and perhaps lecturers (staff) to smuggle an unregistered (brilliant) student to write exam for a registered one, and this obviously has a catastrophic effect on the entire education system and the society at large [3]. This necessitates the need of devising a lasting solution to this problem, through the automation of the verification and identification processes involved by applying one or more of the concepts of biometrics.

Biometric identification can be through one of the many physical unique and immutable attributes of human beings such as DNA, retina, fingerprints and voice recognition, with fingerprints standing unique for being the most reliable, stable, and affordable of them all [5]. Fingerprint is "made of a series of ridges and furrows on the surface of the finger" [6]. [6] further pointed out that, biometrics as a rapidly evolving technology, has been successfully used in many aspects of human endeavors that require secured identification processes. In this paper, an automated way of verifying students during the course of their examinations with the aim of shelving the possible cases of impersonations is propose. A sample solution was developed using Visual Basic (VB), with Microsoft SQL server for database related services and GrFinger Software Development Kit (SDK) for finger recognition.

II. LITERATURE REVIEW

According to [7], Examination malpractice can be defined as any intentional form of wrongdoing displayed by a candidate writing an examination or any other individual before, during or after the examination with the sole aim of making the candidate (student) in question obtain undeserved marks or grades. There are several forms of examination malpractice, some of which are: collaboration between students and examination officials for scandals; inscription; impersonation; bribery; and intimidation [7].

[8] iterated that examination malpractice has catastrophic effects on both the educational system and the society at large, because it leads to the production of half-baked graduates that can grow and serve the society as teachers, doctors, engineers etc. He further stated that, the entire educational system of a country and the country itself lose international credibility consequent to examination malpractice and hence has to be stopped or at least be reduced to the minimal possible level. [9] is of the opinion that extensive usage of Information and Communication Technology (ICT) by academic institution could play vital roles in enhancing and modernizing teaching as well as curving or entirely shelving possible cases of examination malpractices through the application of biometrics interfaced by client applications and Closed-Circuit Television (CCTV).

Several verification and identification tools based on biometrics have been developed in different sectors of human endeavors. The uniqueness and naturalness of biometric features such as fingerprints, validate them to be among the most effective means of intuitively, uniquely and rapidly identifying or verifying any individual based on his physiological or behavioral characteristics [10]. Automated biometric systems can be used to replace manual attendance register for employees or students through recognizing one of the supported biometric features (face, iris, card or fingerprint) captured by a sensor that serves as an interface between the system and the real world [11]. On another vain, [11] further states that, the strength of biometric is in its ability to deal with behavioral and physiological attributes of human beings, hence can be used in developing tools that are more secured and capable of preventing unauthorized access to buildings and systems.

[9] proposed a design of a biometric system based on fingerprints called E-Invigilation that can be used for students' verification during examination, with the sole

aim of eliminating impersonation form of examination malpractice. [12] came up with the design and implementation of a verification tool than can be used in authenticating/verifying students for a Computer Based Test (CBT). The tool uses fingerprints in attempts to prevent malpractices through impersonations.

Furthermore, on realizing that even institution of higher learning are not immune to security breaches especially on issues regarding online examination malpractices, [13] proposes a design and a prototype fingerprint based system that can be used to that regard. The developed prototype dealt with only identification (who are you?) of students for online examinations with no authentication (prove it) support. [14] developed a general purpose fingerprint-based biometric tool for Evan Enwerem University, located at Okigwe Road, Owerri, Imo State, Nigeria. The tool is only meant for identification process within the University.

None of the investigated tools have clearly and effectively handled students' identification/verification for any form of examinations in attempts to reduce to bare born the impersonation form of examination malpractice using fingerprints. In this paper, I propose an automated way of verifying students during the course of their examinations with the aim of shelving the possible cases of impersonations. A sample solution was developed using Visual Basic (VB), with Microsoft SQL server for database related services and GrFinger Software Development Kit (SDK) for finger recognition.

III. METHODOLOGY

Research methodology can be quantitative or qualitative. The method employed in collecting the data is through interviewing both the students and the staff involved at Yusuf Maitama Sule University, Kano, in addition to keen analysis and understanding of the entire processes involved as well as studying previous researches on examination and other related activities in Nigerian institutions of higher learning. After careful examination of the current system of students' verification process, it was found to be manual and inefficient.

Summarily, based on the analysis and the interview conducted between May and June, 2017, the current system involved the following steps:

i. Student registers his/her sessional courses online and generate Course Registration Form (CRF)
ii. Student attends lectures for each of the courses he/she has registered for. For a student to be allowed into the
iii. Examination hall for a particular course, it's required that he satisfies a minimum of 75% attendance for it.
iv. After 12 weeks of lectures, lecturers prepare examinations questions and submit them for modification and subsequent approval.
v. A student that is eligible to sit for examinations prints his/her examination card from the same online registration portal he/she has registered his/her courses. This card serves as his pass into the examination hall. Note: students are allowed to change their profile pictures, this clearly paves way for impersonation.
vi. On the examination day, each student presents the examination card obtained in (iv) above before entering the examination hall or while taking his/her examination, for verification. This is undoubtedly hectic, onerous and distractive.

The interview was conducted on 35 selected persons from both the staff and the students of the Faculty of Science, Yusuf Maitama Sule University, Kano State, Nigeria. The group consists of 15 staff (9 males and 6 females) and 20 students (15 males and 5 females) from various departments of the faculty. Some of the questions asked in the course of the interview are:

i. Are you satisfied with the current way of students' verification during examinations in your institution?
ii. What are your views towards using ICT in easing our day-to-day activities, students' verification during examinations inclusive?
iii. Do you agree that impersonation form of examination malpractice has catastrophic effect on our society?
iv. Will shelving impersonation through the use of students' fingerprints helps in enhancing the quality of education in our society?
v.

The outcome of the interview clearly justifies that majority (85.71%) of the interviewed persons are dissatisfied with the current system that favors impersonation and inefficiency and also welcome the idea of using fingerprints for the verification exercise. In view of this, the author proposed an automated modern system with the aim of addressing the identified disturbing issues. Structured System Analysis and Design Methodology (SSADM) form of waterfall model was keenly used in

coming up with the design of this system. The interview further provide the author with the requirements that satisfy the expectations of the end-users (students and staff) of the system.

IV. DESIGN OF THE VERIFICATION SYSTEM

In coming up with graphical representation of the system, some Unified Modelling Language (UML) diagrams were used. UML is a "graphical language for ***visualizing***, ***specifying***, ***constructing***, and documenting the ***artifacts*** of a ***software***-intensive ***system"*** [15]**.** ***The UML diagrams used are use-case diagrams and activity diagrams.***

Use Case Diagram

Figure 1 below depicted the use case of the system. The system has three users, namely: Student, Examiner and Admin. The figure depicted the various activities that can be performed by each user of the system.

An admin is the super user of this system and responsible for the following major operations:

i. Registering/creating new users (students and examiners)
ii. Editing users
iii. Managing Examiner menu
iv. Generating attendance list for future consumption
v. Adding exam for a course and associating it with one of the registered examiners
vi. Assigning students to their various exams

An examiner can log in into the system and select an exam from the ones he has been associated with by the admin and start verifying the students. He can also be able to generate an attendance list for that particular examination after the verification process. On the other hand, students interact with the system biometrically. During the verification process, the system presents to the examiner the details (picture, level, etc.) of each verified student and notify him appropriately for unverified ones.

Activity Diagrams

In coming up with the design of the system, several activity diagrams have been created and used. Figure 2 and 3 below presented samples of these diagrams. Figure 2 is a figure depicting the activities involved whenever an admin attempts to login. Admin Dashboard is a page that provide interfaces to all the activities that can be performed by admin as listed in "Use Case Diagram" above.

Figure 3 below depicted fingerprint activity diagram expressing the activities involved while enrolling a new student or verifying already enrolled one. During enrolment process, student fingerprint is captured and stored, while during the verification process, the detected fingerprint is verified against the stored information. In the first stage, a fingerprint capturing device is use to capture student's fingerprint. These devices are equipped with mechanism that allow them pre-process read fingerprints and remove unnecessary noise and images and finally extract the actual fingerprint features that can be used for templates creation. For enrolment process, the generated template is safely stored within a database. For verification process, the captured fingerprint is compared with the stored templates by a Matcher (which is part of fingerprint capturing devices). The matcher achieve this through the use of matching algorithm incorporated as part of the device. If a match is found, the student will then be verified, else, the system respond appropriately.

Database Design

The main purpose of using database in the tool is to effectively organize and store information about users, students, courses etc., and it should also allow the application to interact with this data through the use of Structured Query Language (SQL) queries. A relational type of database is used in the system because it stores information in form of tables which are made up of rows (representing records) and columns (representing fields or attributes).

Based on the outcome of the system requirements, the primary entities that will make up some of the tables in the database are users (admin and examiner), students and Courses. Obvious attributes of these tables are: user – username and password; students – name, registration number, email, phone number etc.; Courses – course code, course title, academic session etc. A primary key is provided for each table which uniquely identifies each record of the records. Foreign keys are used to establish relationships between tables. These relationships can either be one-to-many, many-to-many and one-to-one.

Figure 4 below depicted a logical data model structure of the database independent of implementation technology. This model is the basis for designing the physical model that was implemented in the tool.

V. IMPLEMENTATION OF THE VERIFICATION SYSTEM

As stated earlier, the system has been developed using Visual Basic (VB), with Microsoft SQL server for database related services and GrFinger Software Development Kit (SDK) for finger recognition. This section depicted some of the various pages of the tool.
Note: All the figures provided in this section were captured at run time, refer to Appendix for snapshots of the implementation showing the project title.

User Login Page
This is the page that's first displayed when you run the system. Admin or examiner can provide his/her login credentials to have access to the system. On successful login, the system automatically redirect the user to his/her respective page. Figure 3 depicted the login page for the system.

Student Registration Page
As stated earlier, admin is the one responsible for registering students and associating them with examinations on need. As shown in Figure 4 below, the admin enters student's details (registration number, name, date of birth etc.); snap or select student's picture; capture his/her fingerprints; and finally save the records for subsequent uses.

Student Verification Page
A course is selected for which the student presented himself/herself for its examination. The student then places his fingertip on the fingerprint scanner for verification. On successful verification, student's details are presented to the examiner as depicted in Figure 5 below, and subsequently include his record to the list of attendees for the course.

For unverified students, the system will equally notify the examiner with an appropriate message as shown in Figure 6 below.

VI. TESTING

The units of this tool have been tested effectively using the black-box approach of testing. This is to ensure that the tool is functionally sound and correctly adhered to both its functional and non-functional requirements. In black-box testing, only methods interfaces are tested rather than their actual implementations. By so doing, several logical errors have been identified and resolved. Table 1 below depicted a sample test conducted on the tool.

VI. CONCLUSION AND FUTURE WORK

Examination is one of the potent mechanisms of evaluating students' performances and ensuring that they indeed grasped the knowledge communicated to them by their respective educational institutions, for the overall aim of serving the basic and standard needs of their respective communities. Manual verification of students into examination hall is generally considered to be inefficient, onerous and scandalous especially for large number of students. The tasks involved are laborious, monotonous and favors impersonation form of examination malpractice. This clearly justifies the need of designing and implementing an automated system that can be used in biometrically verifying students during examinations. Automated systems have proven to be more intuitive and efficient when compared to their manual counterparts. The naturalness and uniqueness of fingerprint makes it a reliable identification and verification mechanism. This paper has presented a reliable students' verification tool based on their fingerprints that will avert impersonation and ease the tasks involved. The tool will also apparently makes lecturers (staff) concentrate more on other important aspects related to examinations.

Due to the popularity and advantages offered by web-based applications, we envisage redeveloping the tool to go in tandem with this trending technology. Having it as a web-based application will surely pave way for us to incorporate attendance functionality and subsequently allows integration of the 75% attendance requirement before a student is allowed to take examination for each course.

REFERENCES

[1] H. Ndume, S. I. Dasuki and P. Ogedebe, "E-Assessment Systems For Universities In Developing Countries: A Nigerian Perspective," *African Journal of Computing & ICT,* vol. 7, no. 4, pp. 9-14, 2014.

[2] A. Rehmani, "Impact of Public Examination System on Teaching and Learning in Pakistan," 2003. [Online]. Available: http://www.aku.edu/AKUEB/pdfs/pubexam.pdf. [Accessed 21 September 2017].

[3] S. U. Oko and R. I. Adie, "Examination Malpractice: Causes, Effects and Possible Ways of Curbing the Menace. A Study of Cross River University," *International Journal of Managerial Studies and Research (IJMSR),* pp. 59-65,

2016.

[4] M. Nwadiani, "Curbing Examination Malpractice in the Nigerian Education System," in *First Annual Conference of the Faculty of Education, Ambrose Ali University*, Ekpoma, 2005.

[5] S. Rdchua , G. Yiadom-Boakye and R. Woolsey, "Student Verification System for Online Assessments: Bolstering Quality and Integrity of Distance Learning," *Journal of Industrial Technology*, vol. 27, no. 3, pp. 1-8, 2011.

[6] M. N. Uddin, S. Sharmin, A. H. S. Ahmed, E. Hasan, S. Hossain and Muniruzzaman, "A Survey of Biometrics Security System," *International Journal of Computer Science and Network Security*, vol. 11, no. 10, pp. 16-23, 2011.

[7] O. C. Onyibe, U. U. Uma and E. Ibina, "Examination Malpractice in Nigeria: Causes and Effects on National Development," *Journal of Education and Practice*, vol. 6, no. 26, pp. 12-17, 2015.

[8] S. U. Oko and R. I. Adie, "Examination Malpractice: Causes, Effects and Possible Ways of Curbing the Menace. A Study of Cross River University of Technology," *International Journal of Managerial Studies and Research (IJMSR)*, vol. 4, no. 1, pp. 59-65, 2016.

[9] O. O. Fayomi, L. Amodu, C. K. Ayo, O. R. Idowu and F. O. Iyoha, "E-Invigilation: Panacea to Examination Malpractice in Nigeria," in *ICERI2015 Conference*, Spain, 2015.

[10] S. Phadke, "The Importance of a Biometric Authentication System," *The SIJ Transactions on Computer Science Engineering & its Applications (CSEA)*, vol. 1, no. 4, pp. 128-132, 2013.

[11] T. Hub, "Importance of Using a Biometric Attendance for Tracking Employee/Student Attendance," Technology Hub, 8 November 2017. [Online]. Available: technologyhub.ng/2017/11/08/importance-of-using-a-biometric-attendance-for-tracking-employeestudent-attendance/. [Accessed 13 April 2018].

[12] O. Omorogiuwa and F. N. Nwukor, "Design and Implementation of a Computer Based Test Centre Using Biometric for Authentication," *American Journal of Advanced Research*, vol. 1, no. 1, pp. 13-18, 2017.

[13] B. Auernheimer and M. J. Tsai, "Biometric Authentication for Web-Based Course Examinations," in *38th Hawaii International Conference on System Sciences*, Hawaii, 2005.

[14] A. V. Chinedum, "Design and Implementation of a Biometric Information System," *International Journal of Scientific Research and Innovative Technology*, vol. 4, no. 2, pp. 125-137, 2017.

[15] A. Wesley, "UML (Unified Modeling Language," Harding, 1999. [Online]. Available: https://www.harding.edu/dsteil/301/notes/uml/uml.htm. [Accessed 31 January 2018].

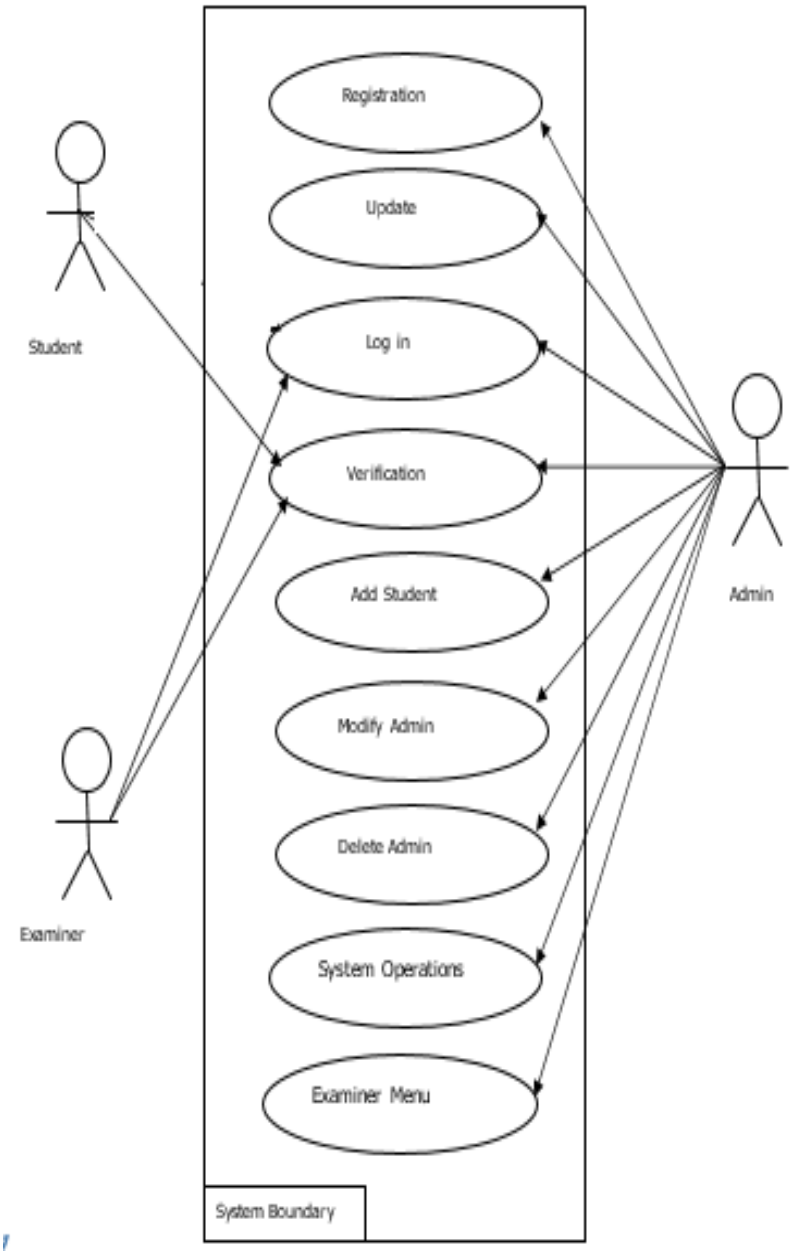


Figure 1: Use-Case Diagram

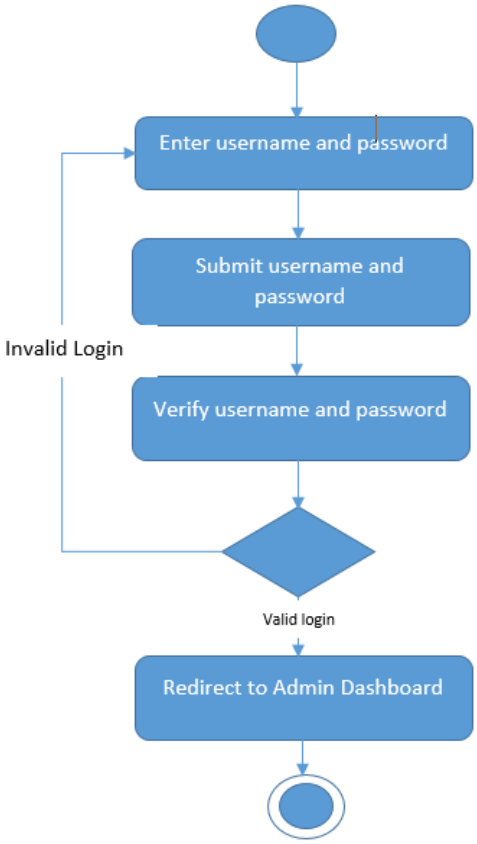


Figure 2: Admin Login Activity Diagram

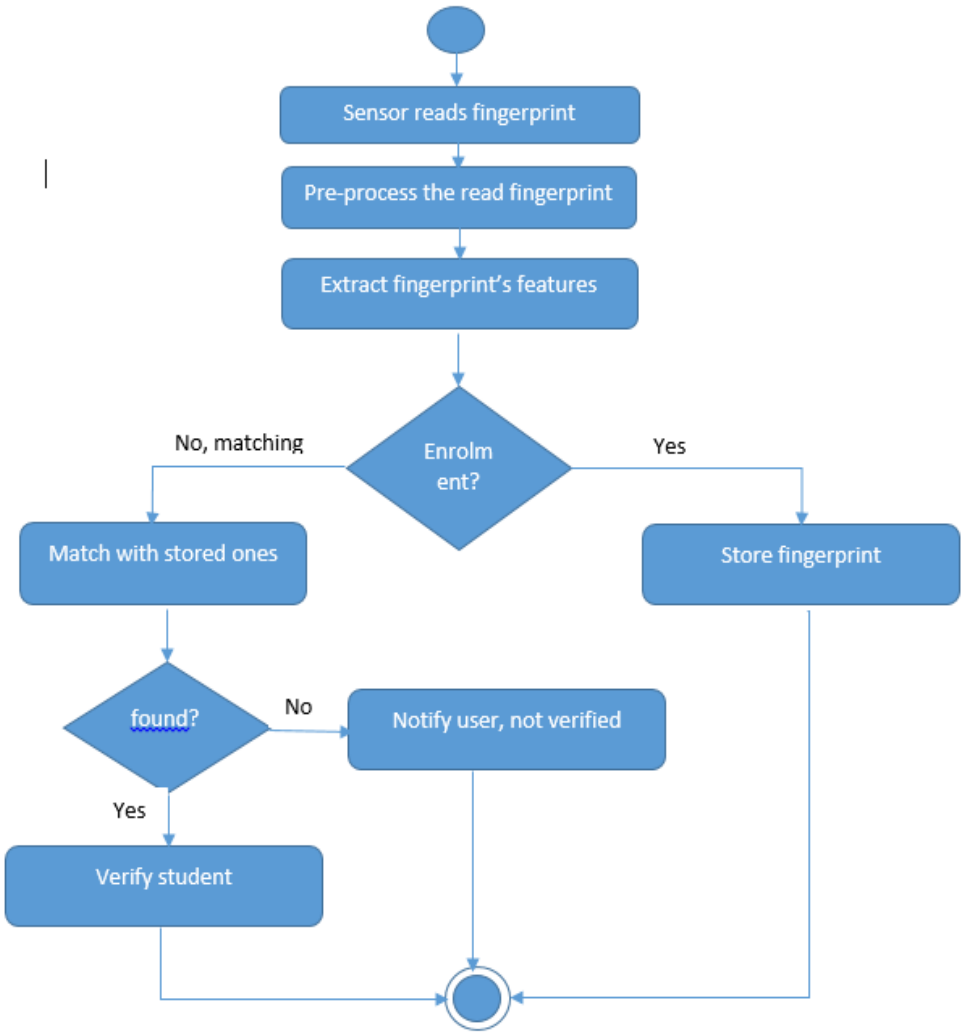


Figure 3: Fingerprint Activity Diagram

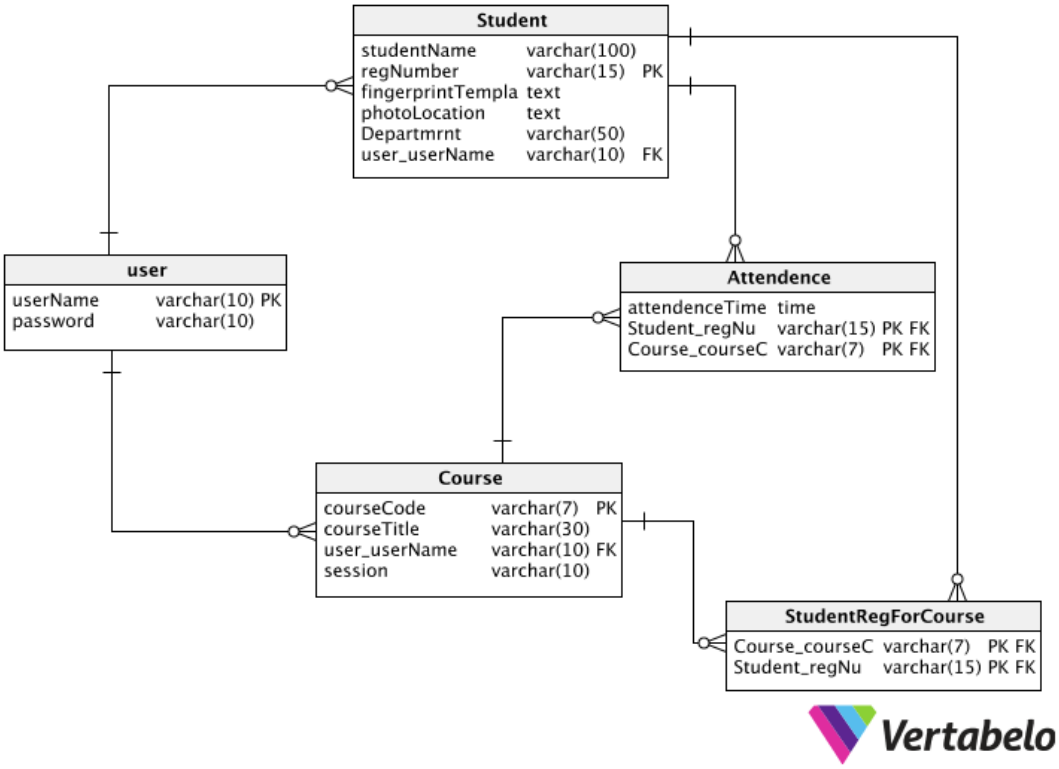


Figure 4: Database Design Structure designed using https://www.vertabelo.com/

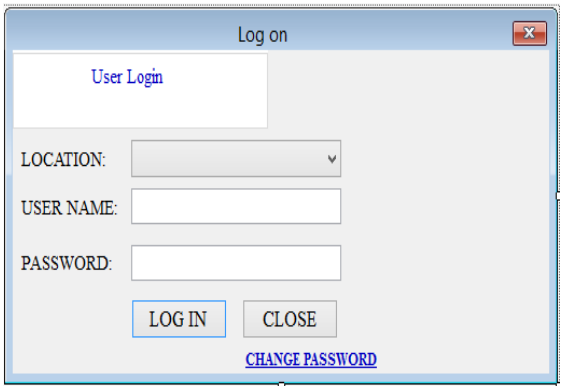


Figure 5: User Login Page

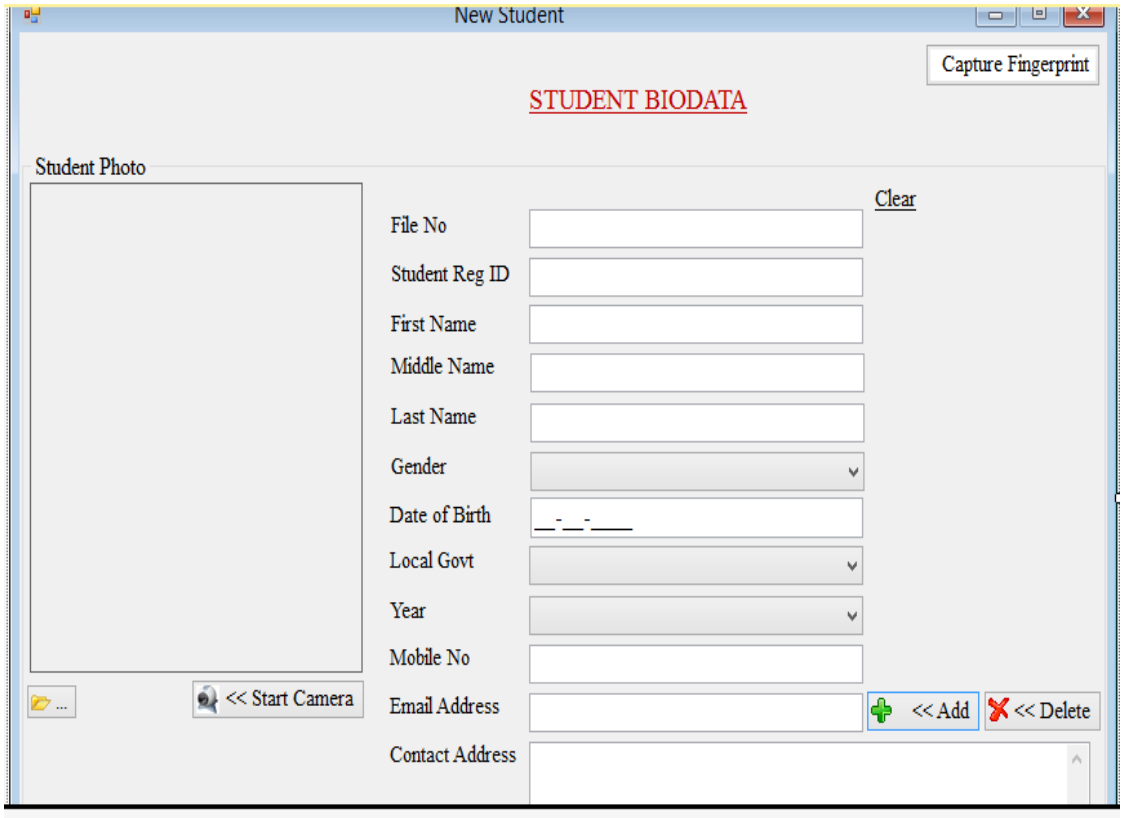


Figure 6: Student Registration Page

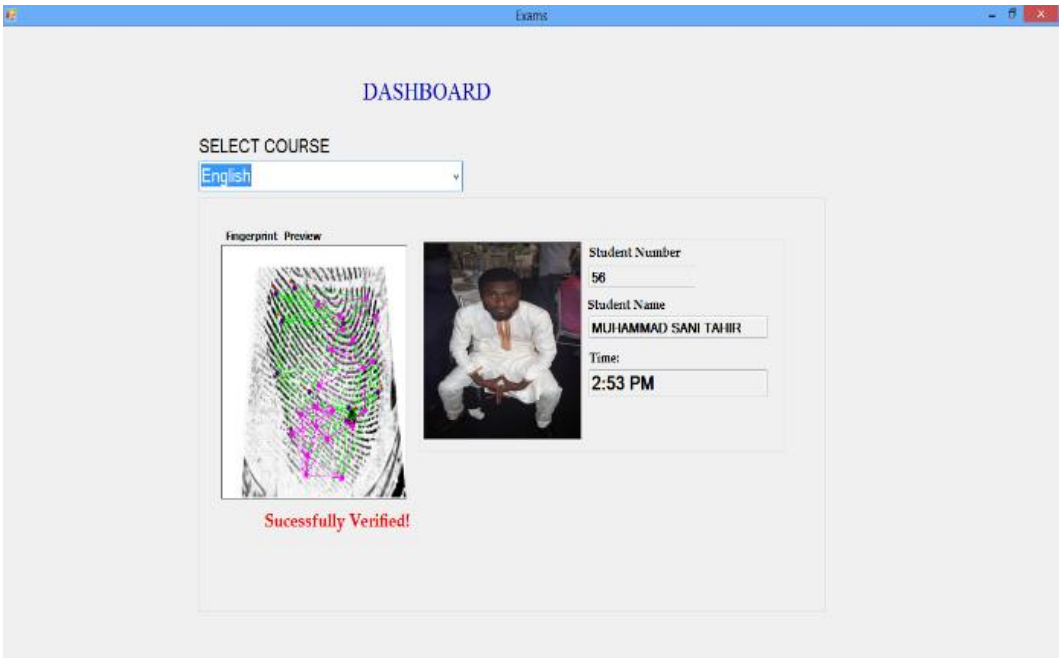


Figure 7: Student Verification (Successful)

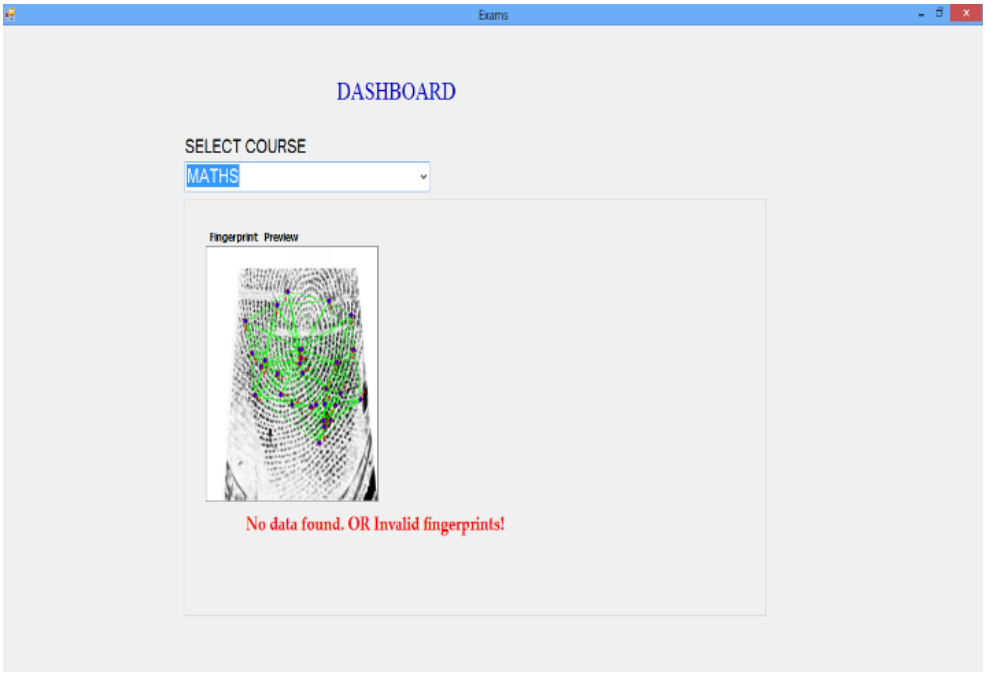


Figure 8: Student Verification (Failed)

Id	**Test Explanation**	**Test Input**	**Expected Result**	**Status**
01	Enter an invalid username or password	Username: ukah Password:123	Show "Invalid username or password"	Pass
02	Verifying student for a particular exam that he was associated with.	Student's fingerprint	Recognizes the student and display his/her details, with a message "successfully verified"	Pass
03	Student registration	Student's details, picture and fingerprint	Display "Student has been successfully registered	Pass

Table 1: Test Table

https://afrjcict.net

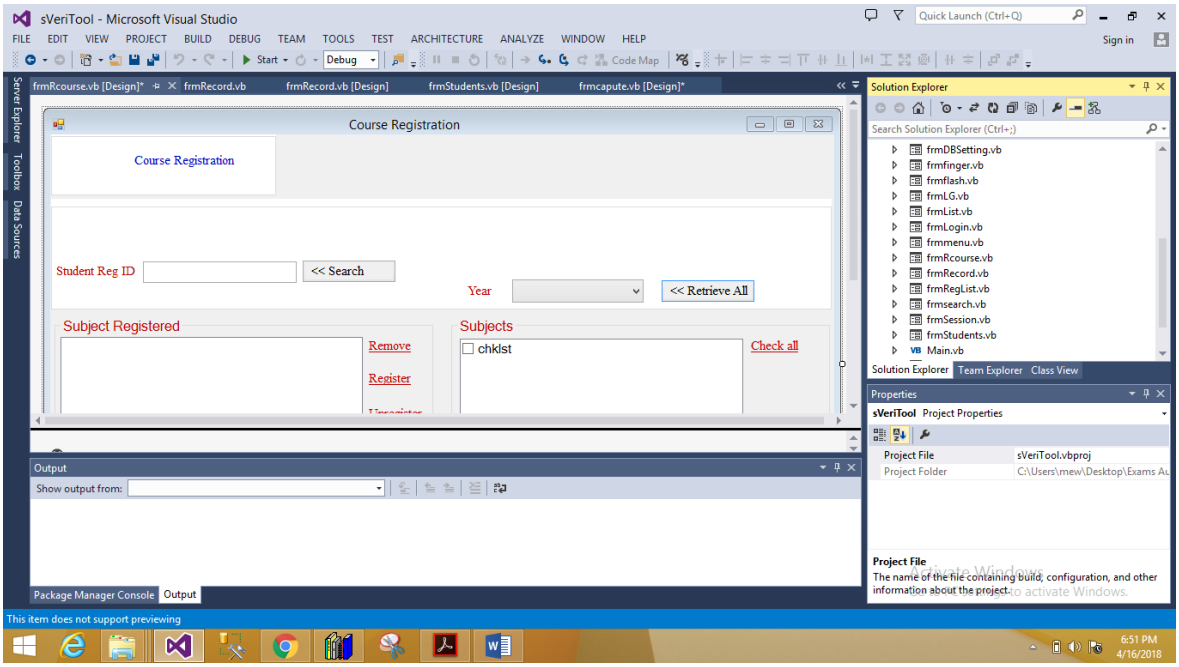


Figure 9: Student's Course Registration Interface

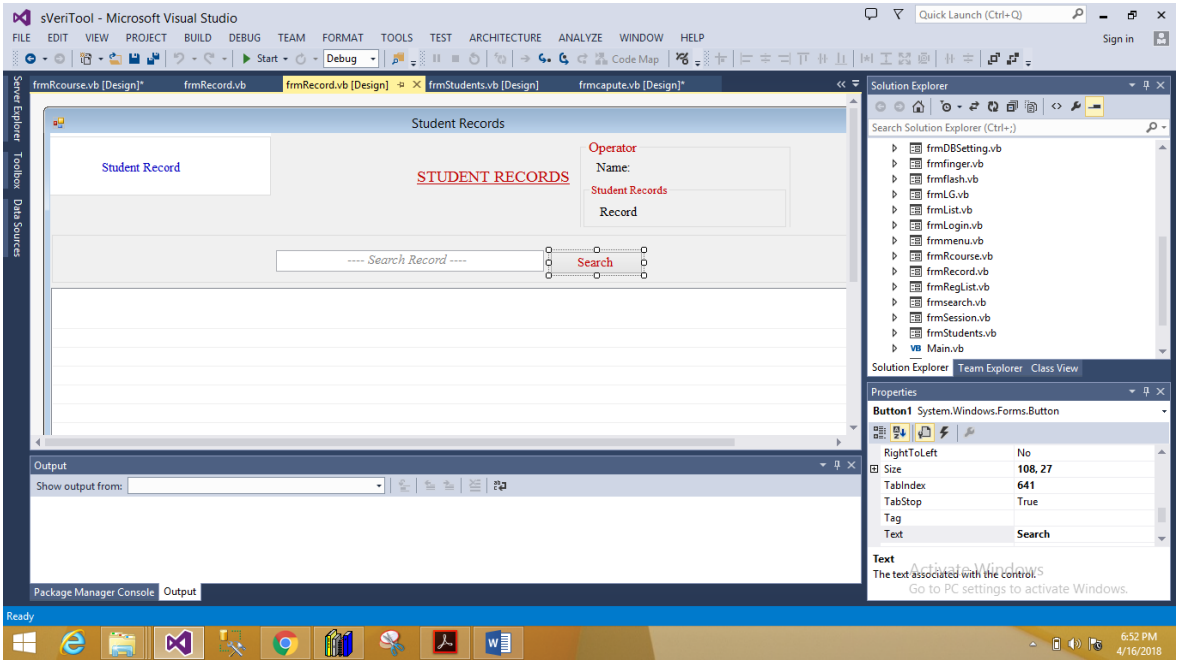


Figure 10: Search Student's Record Interface

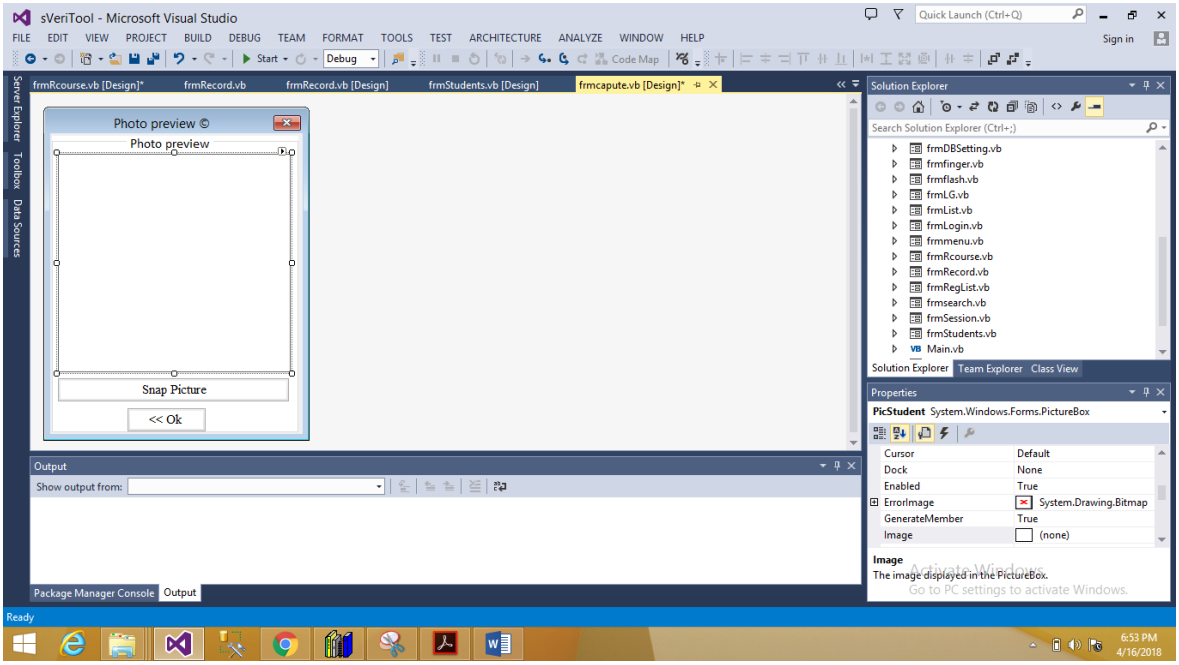


Figure 11: Snap Picture Interface

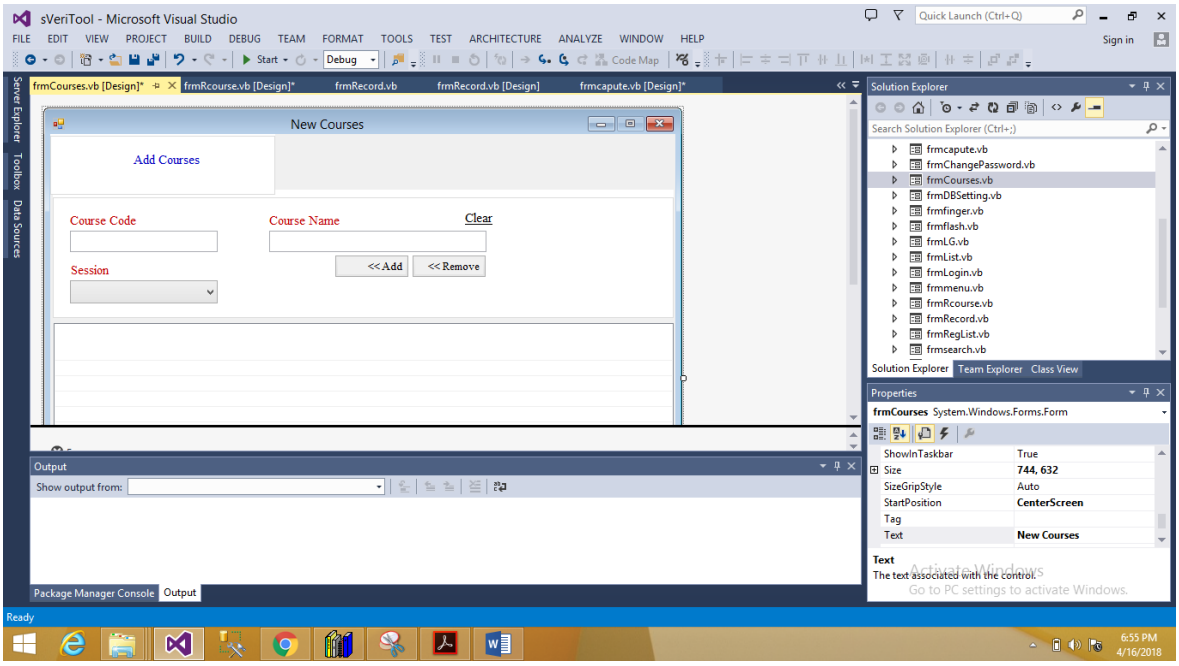


Figure 12: New Course Registration Interface

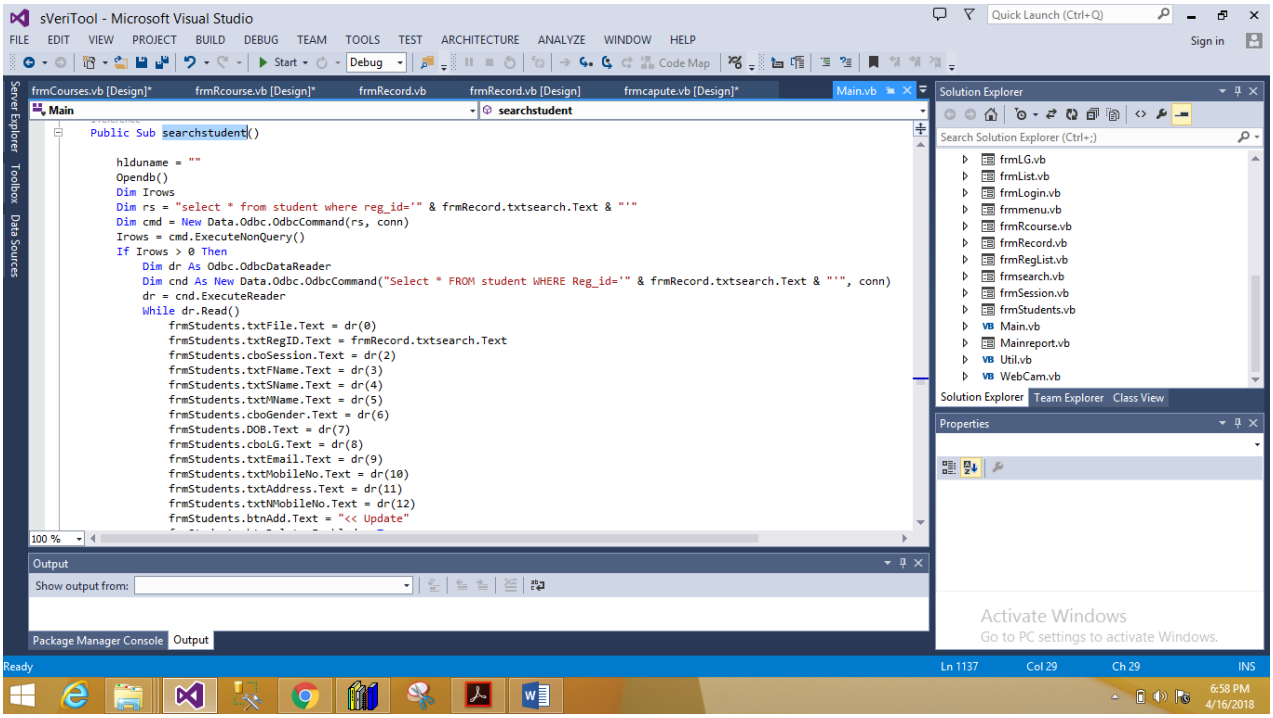


Figure 13: Code Snippet for Searching Student

https://afrjcict.net

Assessment of the Readiness of Academic Staff of a Tertiary Institution for Performance Evaluation using a Dynamic Human Resource Information System

Stephen G. Fashoto[1], Priscilla Ajiboye[2], Olumide Owolabi[3], Andile Metfula[1] & Olubunmi Y. Fashoto[4]
[1]Department of Computer Science, University of Swaziland, Kwaluseni, Swaziland.
[2]Department of Information Technology, Kampala International University, Kampala, Uganda.
[3]Department of Computer Science, University of Abuja, Nigeria.
[4]Department of Psychology, University of Pretoria, Pretoria, South Africa.
Email: [1]*sgfashoto@uniswa.sz*; [1]*asmetfula@uniswa.sz*
[2]*oyeladpri@yahoo.com*
[3]*doowo@yahoo.com*
[4]*buniolabodu@yahoo.com*

ABSTRACT
In this study, we assessed the readiness of academic staff of Kampala International University (KIU), Uganda for the application of a dynamic Human Resource Information System (HRIS) framework in the performance evaluation of staff members. This dynamic framework is being proposed to address the challenges faced by the Human Resources Department of the University in using the current static system. Problems of the current system include delays and frequent misplacement and loss of documents, often resulting in career stagnation on the part of staff members. The Technology Organization Environment (TOE) theory was used to investigate the factors for evaluating the performance of KIU academic staff and examining the role of a dynamic HRIS in performance evaluation. The focus of this paper is to determine the readiness of academic staff to adopt HRIS and the most important factors for its successful implementation. The use of questionnaires was employed in this study in order to gather first hand data and findings right from the respondents on the field. Data was analysed using SPSS 16.0 for windows. The findings show that unavailability of Information and Communication Technology (ICT) services, poor ICT skills, irregularities of the system and absence of organizational competition are the most significant TOE factors that could militate against the effective application and usage of the HRIS if adopted. It was also found that, if properly implemented with attention paid to the probable adverse factors, the dynamic HRIS is capable of a faster, fairer and more accurate operation than the paper-based assessment system.

Keywords: *HRIS, performance evaluation, technological factors, organizational factors, environmental factors.*

African Journal of Computing & ICT Reference Format:

Stephen G. Fashoto, Priscilla Ajiboye, Olumide Owolabi, Andile Metfula & Olubunmi Y. Fashoto (2018), Assessment of the Readiness of Academic Staff for the Application of a Human Resource Information System Framework in Performance Evaluation, *Afr. J. Comp. & ICT*, Vol.11, No.2, pp. 53 - 75.

© Afr. J. Comp. ICT, June 2018; ISSN 2006-1781

I. INTRODUCTION

With the advent of Information Technology (IT), digital possibilities have been replacing the old ways of carrying out activities, one of which is the Human Resource Management (HRM) service delivery [1]. The very high cost of acquiring, implementing, and maintaining a robust and reliable Information Technology infrastructure has made many universities in the developing world to lag behind in the development of ICT infrastructure, compared to those in developed countries [2]. In addition, the performance evaluation carried out by Human Resources in organizations these days is becoming strongly dependent on a dynamic system for immediate data collection, analysis and evaluation for better productivity [3]. Few studies on human resource information system (HRIS) have been conducted in developing countries such as Uganda, Swaziland, Kenya and Nigeria while a lot of studies have been carried out in developed countries [4]. Studies carried out in developing countries indicate that there is the need to adopt a dynamic human resources information system. This HRIS will improve on the current paper-based systems being used in most universities across the African continent, seeing that performance evaluation of staff constitute a major challenge to the Human Resources departments of many tertiary institutions. Usage of the paper-based static system has the disadvantages of time wastage, loss of valuable information as papers sometimes get misplaced, and the danger of career stagnation. For example, [5] states that "Career stagnation among the academic staff of Ugandan universities can be linked to the universities appraisal/evaluation systems". More so, these disadvantages of time wastage, loss of valuable information and the danger of career stagnation have been affecting the general performance of the institution in general.

Human resource simply refers to the resource that resides in the knowledge, skills and motivation of people [6]. Performance evaluation is very important to the growth and development of any organization because it greatly affects the disposition of the staff in contributing to the attainment of the organizations goals and objectives [7].
Performance evaluation (which is also known as performance measurement) is described as the formal determination of an individual's job-related actions and their outcomes within a particular position or setting. The focus of this paper is to determine the readiness of academic staff to adopt HRIS and the most important factors for its successful implementation. It is also aimed at checking whether his or her achievement was above or below the organization's norms. It is an evaluation carried out on an employee's job performance over a particular period of time, an equivalent of a report card of an employee and how the employee's manager rated the performance over the prior year [8].

There are different opinions on why performance evaluations are done. Some organizations do it because they feel compelled to do it; at times, because other organizations do it [9]. On the other hand, some organizations evaluate performance in order to ensure that they have pieces of paper in the employee's file, should there be need to carry out corrective action. Nevertheless, successful organizations understand the necessity of incorporating several performance evaluation methods into their performance management process and strategy [8]. In most tertiary institutions in developing countries, the staff performance evaluation is done in order to identify and make recommendations on which performance category the staff member may be placed. This is done annually by the use of documents manually compiled by individual staff members. Considering the long hours it usually takes to carry out this activity annually, this study was borne out of the desire to improve the performance evaluation method and practices of KIU.

The Human Resources Information System (HRIS), also called the Human Resources Management System (HRMS), simply refers to a systematic procedure for collecting, storing, maintaining, retrieving, and validating data that is required by an organization about its human resources, personnel activities, and organizational unit characteristics [10]. Sadhu [11] also corroborates the above definition by explaining that human resources information systems help human resources professionals achieve human resources objectives adequately and at the stipulated time. For example, Human Resources Information Systems provide businesses with rapid data access, information exchange, and strategic advantage. HRIS was also able to enhance organizational effectiveness and contains swift information processing, boost communication among staffs, decreases HR expenses and increase efficiency and output [12, 13, 14].
Today's HRMS applications have solutions tailored for companies of any size and also support all types of HR staffing models. This is unlike the earlier HR systems that are a paper-centric function, which have been in use in most universities in developing countries. In these universities, partially automated Human Resources

Systems would only be found in payroll departments, with green-screen technology and mainframe computing. These systems are known mainly to generate basic printed reports such as the employee lists [15].

The human resource management in an organization cannot work smoothly if HRIS is not properly considered [6]. Businesses, governments, and non-profit organizations all around the world mostly depend on Human Resource Information Systems (HRIS) to aid information sharing as well as facilitate downsizing and reengineering efforts [16]. The benefits of HRIS, mostly seen in organizations and institutions where the system is in use, can also be enjoyed at KIU, if properly adopted.
Also, in the present economy, organizational success largely depends on the efficiency of human resources (HR) of the organization and it is also believed that information technology plays a major role in Human Resource Management (HRM) domain [1][17]. Similarly, it has been found that organizations gain competitive advantages not merely with IT, but with its usage along with its components, to complement resources [18]. It has also been stated that one of the most successful ways to run businesses in the world today is by using appropriate IT applications in all HRM processes [19]. All these indicate the major essence of HRIS as examined by different researchers.

1.1 Statement of the Problem

Recently in Uganda it has been realized that, to some extent, performance evaluation and management systems are mostly implemented in the health sector; even so, there exist some loopholes in their implementations [20]. There are inadequacies in setting performance targets and performance management planning is hardly done. Although many health care workers had job descriptions, the performance indicators and standards were not clearly defined and known to all workers and managers. Additionally, the schedules for performance assessments were not always followed. There were limited prospects for career progression, inadequate performance feedback and poor rewarding mechanisms [20]. However, all these challenges are traceable to the manual performance evaluation being carried out in the health sector. Apart from the health sector, it was found that there exists a significant relationship between the method of evaluating the performance of staff and the career development of the staff members in the Uganda academic institutions [5]. Therefore, the career stagnation among academic staff in Ugandan universities has been linked to the universities' evaluation systems which have similar loopholes as that of the health sector [5].

1.2 Aim and Objectives of the Study

In view of the problems associated with the current static and manual system of assessing the performances of the academic staff of Ugandan universities, the implementation of an IT-driven dynamic system to overcome these problems should be given serious consideration. Successful implementation of such a system, however, depends to a large extent on the preparedness of the staff being assessed.

It is, thus, the aim of this study to assess the readiness of academic staff for the application of a dynamic framework of Human Resource Information System (HRIS) by the Human Resource Directorate of the Kampala International University.
The objectives are to:

i. identify the core factors that needed to be considered in order to have an effective HRIS for the performance evaluation of academic staff of Ugandan universities;
ii. analyze and document the requirements for a dynamic system's framework; and
iii. investigate the possible impacts of using a dynamic framework in performance evaluation.

The rest of the paper is organized as follows: Review of related literature, theoretical frameworks for HRIS and comparison of models are presented in Section 2. The methodology of assessing the readiness of staff, data collection method and the analysis of the collected data is presented in Section 3. Results and reliability of the variables and validity testing of the data and the impacts of using the framework are presented in Section 4. Discussion is presented in Section 5 and concluding remarks are made in Section 6.

II. REVIEW OF RELATED LITERATURE

With current developments in technology, it is possible to create a real-time information-based, self-service, and interactive work environment [21]. Employee Information Systems have developed from the automated employee record keeping in the 1960s into more complex reporting and decision systems [22]. The last decade, specifically from 2006 up to date, registered a distinct increase in the number of organizations acquiring, storing, analyzing and using human resources data with the help of Human Resource Information Systems (HRIS) [21]. Given the relevance of accessing relevant information for decision making, Human Resources (HR) respond more quickly to changes than at any time before. This recent emergence of HRIS automates and works out regular administrative and

compliance functions that were formerly carried out manually by the HR departments [21].

Several authors have studied the application of HRIS, the challenges of implementing it, its benefits and other key features. These authors have individual opinions about the system and its application but most of their opinions have similarities. For example, [23] put forward that HRIS is a system that is used to acquire, store, manipulate, analyze, retrieve and distribute pertinent information about an organization's human resource while [24] sees HRIS as a socio–technical (integrated) system whose purpose is to gather, store and analyze information regarding an organization's human resources department, comprising of computer hardware and applications as well as people, policies, procedures and data required to manage the Human Resources function. Table 1 gives a brief summary of several authors' reviews of HRIS.

2.1 Theoretical Frameworks for Human Resource Information Systems

The existing literatures on HRIS suggest that different models have different impacts on HR across various organizations but provide little explanation for this variation. Early surveys also suggested that HRIS was used mainly to automate routine tasks and "to replace filing cabinets" [33]. Some of the theories known to support the organizational use of Human Resource Information system (HRIS) are further explained; the most suitable among them is chosen.

The Theory of Reasoned Action (TRA), which was originally introduced by Fishbein in 1967, was reviewed and tested in 1975 by Fishbein and Ajzen. The reviewed theory defined relationships among intentions, norms, attitudes and behavior. This theory postulated that an individual's use of a particular information resource in preference to others is mostly governed by such individual's method of performing the said behavior. This model is a generalized one that explains the reasons why people perform or do not perform a particular behavior, what governs individual's choice making and how external factors affect decision making [34].

The TOE (Technological, Organization and Environmental) framework was developed in 1990 [35]. It identifies three aspects of an enterprise's context that influence the process by which it adopts and implements a technological innovation: technological context, organizational context, and environmental context. Its technological context describes both the internal and external technologies relevant to the organization. This includes current practices and equipment internal to the firm, as well as the set of available technologies external to the firm [36, 37]. The organizational context refers to descriptive measures about the organization such as scope, size, and managerial structure, while environmental context is the arena in which an organization conducts its business - its industry, competitors, and dealings with the government [35].

Another known model related to technology acceptance and its use is the Technology Acceptance Model (TAM), which was originally proposed by Davis in 1986. TAM, a theoretical model helps to explain and predict users' behavior towards Information Technology [38]. TAM is considered an influential extension of the Theory of Reasoned Action (TRA). [39] proposed TAM to explain why a user accepts or rejects Information Technology by adapting TRA. TAM gives a basis with which one traces how external variables influence attitude, belief and intentions of use. Two significant beliefs as postulated by TAM are: perceived usefulness and perceived ease of use. According to TAM, one's actual use of a technology system is influenced directly or indirectly by the user's behavioral intentions, attitude, perceived usefulness of the system, and perceived ease of the system.

Another theory whose factors affect decision making in Information Technology is the Unified Theory of Acceptance and Use of Technology (UTAUT) model. This model was formulated by Venkatesh and others to explain user intentions to use an information system and subsequent usage behavior. In this theory, several independent variables are a restatement of the original Theory of Reasoned Action (TRA) and (TAM) in predicting technology acceptance [40].

However, [41] have asserted that several extensions and integrations of the entire model or part of the model have been developed to reclaim its generalizability, which include the extensions that analyzed UTAUT in new technological settings, new user populations and new cultural environments. These extensions and replications of the model have worthwhile relevance in expanding the understanding of technology acceptance and the theoretical boundaries of the UTAUT model. Nevertheless, despite the fact that this model gives a better understanding for technology acceptance and application, the initial UTAUT model only focused on large organizations. Additionally, these experts also show that the scales used in this model are still new, and the relevancy of these scales needs to be further tested and verified.

The strengths and weaknesses of the theories reviewed above were compared in order to be able to consider and choose the theory that best supports the application of HRIS.

Table 2 is a tabular listing of the strengths and weaknesses of the theories considered.

2.1.1 Comparison of the Models

The models discussed above are compared on the basis of the following factors for HRIS application, namely: perceived usefulness, patronage factor, compatibility, relative advantage of the system in use, complexity, management support and communication processes.

No - Indicates that the stated variable is not present in a given Technology Model while, Yes -Indicates that the stated variable is present in the given HRIS Model.

Based on the comparisons in Table 3, we adopted the TOE model of [35] for this study of HRIS application in performance evaluation of KIU staff, since it features all the essential organizational, environmental and technology factors, and also considers HR professionalism and structure, management support and other factors that facilitate better performance of the human resource with HRIS.

2.1.2 The TOE Model

i) Technological factors

[35] and [4] found out that an organization with an effective and efficient human resources i.e. good education will have better capability in technological innovation.

Technological factors focus on the manner in which technology characteristics can influence adoption [46]. These technological factors involve the use of IT infrastructures that entail a set of physical devices and software applications which are necessary to drive the whole enterprise. In HRIS development, Information system plays an important function in planning and computerization of human resource information. Even though HRIS established independence from corporate management information system (MIS), yet HRIS is not well established to be an autonomous entity within the personnel area in a large number of firms. To attain optimum HRIS efficiency, computer-skills training are crucial for relevant personnel. [47] found that inadequate personnel technical training and skills in information management is a possible drawback in HRIS management. [48] and [26] mentioned that for an effective HRIS, suitable training must be given to every human resource personnel, line managers and also other staff members. The availability of personnel with prior understanding and skills necessary for HRIS is a major factor in effective HRIS adoption.

ii) Organizational factors

Organizational factors are factors that represent organizational characteristics which influence adoption of HRIS [46]. A number of studies have found that the demographic characteristics of organizations (organization size, a firm's experience with technology, the type of business, and organizational ownership) are important factors in organizational IT adoption [49].

Employee Structure and Education Levels which positively influence HRIS adoption, particularly in human resource management (HRM) are also core organizational factors.

Experience in IT and understanding of electronic tools enable the adoption of e-HRM since both are associated with readiness and competence of end users to operate the system [50][30]. Current research has established that education structure does not facilitate or hamper the adoption of e-HRM, due to constant propagation of essential IT knowledge in many demographic segments [31].

Lack of commitment on the part of HR management is considered to be important enough to impede HRIS implementation. Human Resources units are of paramount importance in maintaining organizations committed to HRIS. Therefore, Human Resources units should emphasize the importance of HRIS to management [51]. In some organisations, top-ranking HR executives tend to be pessimistic about HRIS probably because of power-shift caused by the system [52]. This attitude is capable of impeding successful HRIS implementation.

iii) Environmental factors

Environmental factors describe the area where organizations conduct their business; they include industry characteristics, government regulations, and supporting infrastructure [3, 53]. External environmental factors have been extensively studied in previous research and have been found to have substantial influence in IT adoption. Diffusion theorist state that of all the external factors influencing IT adoption, Internet adoption, challenges from contenders, users or providers, government position, associate partnerships, technological

structure, technology specialist and expectancies of consumers are usually common. External factors are usually regarded as less significant compared to internal factors. However, few studies have been carried out on the relative importance of internal and external factors [54]. Organizations make use of HRIS to assist in making up-to-date decisions, utilize their staffs effectively, rationalize HR activities and adequately distribute HR resources. Therefore, the urge to be competitive in every enterprise will in turn lead to HRIS adoption and implementation.

III. METHODOLOGY

3.1 Data Collection Method

The primary collection of data was through the use of questionnaires. Questionnaires were used for the selected respondents from each school/college in the university. The aim of distributing these questionnaires to these respondents was to gather data directly from respondents on the field.

The questionnaire had two sections, the first containing demographic information like the respondent's age, gender, highest qualification, and school/college. The second section sought to measure the independent and dependent variables of the study, which are the technological, organizational and environmental factors with their respective performance evaluations.

The technological factors comprise the following elements:

i. Power shortage, available ICT facilities, and unstable internet.
ii. Poor ICT skills and lack of trust in the functionality of the system
iii. Compatibility

The organizational factors include the following:

i. Management support
ii. HR professionalism and structure
iii. Communication processes
iv. Trainings
v. Financial support

The environmental factors include the following elements:

i. Publicity
ii. Competition
iii. Policies

3.2 Conceptual Framework of HRIS for Performance Evaluation in KIU

Figure 1 shows the conceptual framework that was adapted in this work for the detailed proposed dynamic HRIS framework.

As shown in figure 1, the independent variables are the Technological, Organizational and Environmental Characteristics. These independent variables are the factors investigated (as stated in the specific objective) and considered in evaluating the academic staff performance. The Dependent Variable (DV) is the performance evaluation of KIU academic staff which can be improved upon by the use of the dynamic HRIS. When compared to the existing gap in the Human Resources Directorate of KIU, based on the direct effects of the independent variables, application of dynamic HRIS by the directorate should result in a faster and more efficient performance evaluation.

The detailed framework in figure 2 is the proposed model obtained from the findings of this study. It is preceded by the preparation of the evaluation instruments to be used in carrying out the performance evaluation. These include the factors against which the performance will be evaluated, like the number of publications, the frequency of the relevant certifications obtained, years of relevant work experience and attendance at meetings. This study revealed that majority of the respondents agrees that the frequency of the relevant certifications obtained should be of primary importance among the evaluation instruments to be used. These evaluation instruments are, however, subject to periodic reviews for better evaluation.

Once the evaluation instruments are uploaded into the system, they get administered to the academic staff members either through the use of a digital or mobile application (which is easily accessible to all).

The dynamic nature of the proposed framework is seen in the real-time evaluation of the input data uploaded by the academic staff members, such that the data gets analyzed against the evaluation factors (technological, environmental and organizational factors) immediately it is uploaded into the system. The output is collected at the web-based system of the college or university. One of the advantages of this real time system is that the individual staff performance can be viewed as frequently as desired like weekly or fortnightly for necessary amendments to be made as soon as there is need for it.

3.3 Data Analysis

After the data collection process, the data was processed and prepared for analysis. The data processing stages involved data editing, data categorization/coding, data entry into the computer and summarizing the entered data. This was followed by the analysis of the processed data using correlation and regression analysis which was achieved using Statistical Packages for Social Scientists (SPSS version 16). Analysis was further done to compare the technological, organizational and environmental factors with the performance evaluation factors in the KIU Main Campus using descriptive statistical tools, which include mean and standard deviation.

IV. RESULTS

4.1 Reliability Testing

Reliability is a measure of the degree to which research instruments yield consistent results after repeated trials. It involves checking if the instrument consistently measures what it is intended to measure. In this work, the internal consistency was measured using Cronbach's Alpha and results are presented in tables 4a, 4b and 4c.

Cronbach's alpha is the most common measure of internal consistency ("reliability"). It is normally used when multiple Likert questions are used in a questionnaire and such questions form a scale whose reliability is to be determined. However, if the focus of this study was more concerned with inter-rater reliability, a Cohen's (k) kappa might be used; but since the focus is more on reliability testing, the Cronbach's alpha for reliability was used.
One problem with the split-half method is that the reliability estimate obtained using any random split of the items is likely to differ from that obtained using another. One solution to this problem is to compute the Spearman-Brown corrected split-half reliability coefficient for every one of the possible split-halves and then find the mean of those coefficients. This is the motivation for Cronbach's alpha. It is, thus, superior to the Kuder and Richardson Formula 20 since it can be used with continuous and non-dichotomous data. In particular, it can be used for testing with partial credit and for questionnaires using a Likert scale as in this study.

Cronbach's alpha formula can be defined as shown below:

Given variables $\mathbf{x}_1, \ldots, \mathbf{x}_k$ and $\mathbf{x}_0 = \sum_{j=1}^{k} x_k$, the Cronbach's **alpha** is defined to be

$$\frac{k}{k-1}\left(\frac{\sum_{i\neq j}^{k} cov(x_i, x_j)}{var(x_0)}\right) = \frac{k}{k-1}\left(1 - \frac{\sum_{j=1}^{k} var(x_j)}{var(x_0)}\right)$$

Property 1: Let $\mathbf{x}_j = \mathbf{t}_j + \mathbf{e}_j$ where each $\mathbf{e}_j$ is independent of $\mathbf{t}_j$ and all the $\mathbf{e}_j$ are independent of each other. Also let $\mathbf{x}_0 = \sum_{j=1}^{k} x_j$ and $\mathbf{t}_0 = \sum_{j=1}^{k} t_j$.
Then the reliability of $\mathbf{x}_0 \geq \boldsymbol{\alpha}$, where $\boldsymbol{\alpha}$ is Cronbach's alpha.

Here, $\mathbf{x}_j$ is viewed as the measured values, the $\mathbf{t}_j$ as the true values and the $\mathbf{e}_j$ as the measurement error values.
Cronbach's alpha provides a useful lower bound on reliability (as seen in Property 1). Cronbach's alpha will generally increase when the correlations between the items increase. For this reason, the coefficient measures the internal consistency of the test. Its maximum value is 1, and usually its minimum is 0, although it can also be negative. A commonly-accepted rule of thumb is that an alpha of 0.7 (some say 0.6) indicates acceptable reliability and 0.8 or higher indicates good reliability. Very high reliability (0.95 or higher) is not necessarily desirable, as this indicates that the items may be entirely redundant. These are only guidelines and the actual value of Cronbach's alpha will depend on many things, e.g., as the number of items increases, Cronbach's alpha also tends to increase even without any increase in internal consistency.

From table 4a, the Cronbach's alpha value in respect of the technological factors (power shortages, unavailable ICT services, poor ICT skills, Lack of trust in the functionality of the system, Irregularities of the system and unstable internet) was found to be 0.710. This indicates a high level of internal consistency for the scale in this study since the alpha value is expected to be at least 0.70 before it can be accepted to be reliable (Cronbach, 1971). Therefore, the result shows that the technological factors are reliable.

From table 4b, it can be seen that the Cronbach's alpha value in respect of the impacts (Improves staff motivation to work, Increases the number of students applying to the institution, Increases the productivity of the school, Gives the institution a competitive advantage, Encourages better innovative to work, Allows easy and faster evaluation of individual staff, Gives room for consistently monitored evaluation, Makes the staff members to be on their toes for the best performances and Serves as an effective and lasting documentation means) of using a dynamic framework in performance evaluation was found to be

0.774, which indicates a high level of internal consistency for the scale in this study since the alpha value is expected to be at least 0.70 before it can be accepted to be reliable (Cronbach, 1971). Therefore, the result shows that the Impacts of using a dynamic framework in performance evaluation are reliable.

From table 4c, the Cronbach's alpha value in respect of the requirements (Frequency of article publications in journals, Frequency of books written and published, Attained academic qualifications with certificates, Years of relevant work experience, Number of academic awards received, Relevant certifications obtained, Past academic posts/offices held with date, Number of attended lecturers per week with evidence, Response from taught students with evidence, Prompt submission of student's scores and results, Departmental meetings attendance and Application of other relevant skills possessed) for using a dynamic framework in performance evaluation was found to be 0.710. This indicates a high level of internal consistency for the scale in this study since the alpha value is expected to be at least 0.70 before it can be accepted to be reliable [55]. Therefore, the result shows that the Impacts of using a dynamic framework in performance evaluation are reliable.

4.2 Validity Testing

Validity is the extent to which an instrument measures what it is supposed to measure and performs as it is designed to perform [56]. It is rare, if nearly impossible, that an instrument be 100% valid; so validity is generally measured in degrees. As a process, validation involves collecting and analyzing data to assess the accuracy of an instrument, [57] recommends values greater than 0.5 as acceptable. He gave the acceptable ranges as values between 0.5 and 0.7 to be mediocre, values between 0.7 and 0.8 to be good and values between 0.8 and 0.9 to be great values. The values of Kaiser-Meyer-Olkin (KMO) test were determined for this study and shown in tables 5a and 5b.

Data type validation is customarily carried out on one or more simple data fields.

In this study, the KMO test using the required variables of requirements for the HRIS and its impacts were carried out and the result was found to be above the expected value as, the researchers, thus, proceeded with the work.

4.2.1 TOE Factors that Affect the Application of A Dynamic System Framework for Performance Evaluation

The technological, organizational and environmental factors that affect the application of a dynamic system framework for performance evaluation were considered individually in order to see the individual effects of each of them in the application of the dynamic system. All the interpretations in this section were based on the mean ranges as indicated in table 6a, while table 6b shows only the technological factors that affect this application.

To calculate the mean range of the data, with reference to the Likert scale we used:

Very true=4, True=3, Rarely true=2, Not true=1

$$\text{Mean range} = \frac{n+1}{n}$$

where n is the number of the Likert scale used, which is 4.
Therefore, mean range = $\frac{4+1}{4} = \frac{5}{4} = 1.25$

The values in table 6b show that a majority (mean=3.88, Std =0.75) of the respondents were in agreement that unavailability of ICT services is the single most important factor that can affect the application of a dynamic system framework for performance evaluation. This implies that for the dynamic system to be effectively applied, ICT services must be made available for the users of the system. Otherwise, the efficiency and effectiveness of the system will not be realized. Nevertheless, other factors also reflected truly high and very truly high interpretations. This implies that all the six (6) factors under the technological factors can affect the application of the dynamic system's framework.

Table 6c shows that majority (mean=2.88, std =0.58) of the respondents were in agreement that lack of organizational competition was the highest factor that affected the application of a dynamic system for performance evaluation. This implies that for the dynamic system to be effectively applied from the environmental perspective, organizational competition should be considered. However, other factors measured in table 6c also reveal at least 'a true interpretation' which implies that they should also be put into consideration.

4.2.2 Performance Evaluation Factors among Academic Staff Members in Using the Dynamic Human Resource Information System

The application of the dynamic HRIS in carrying out performance evaluation has been found to have impacts on the output of the performance evaluation. The general perceptions of the supposed users of this dynamic system, the academic staff members of KIU Main Campus, were measured and the results are given in table 7a. Table 7b also shows the measured requirements to be considered for the performance evaluation. These will serve as the inputs to the dynamic HRIS.

According to table 7a, it was found that majority (mean = 3.88, Std = 0.95) of the respondents were in agreement that the dynamic human resource information system improves the standard of the institution. This implies that the major importance of the system as viewed by the respondents is that it will improve the standard of the institution. Nevertheless, other variables too showed the perceptions of the respondents since their interpretations were not low.

Furthermore, table 7b shows that majority (mean = 3.88, Std = 0.95) of the respondents were in agreement that the frequency of the academic awards received should be a high consideration for evaluation of the academic staff members. At the same time, all other variables too should be considered since none falls below the true level.

4.3 Demographic characteristics of respondents

The demographic characteristics of the respondents in this study include gender, age, highest level of qualification and the college or school respondent belongs.

The demographic characteristics are presented in Table 8a-1. Table 8a-1 shows mainly male respondents (62.1%), though a reasonable number of females (37.9%) participated in the study. Majority of the respondents were Master's degree holders (55.2%), followed by bachelors (24.1%), other qualifications (13.8%) and PGDE (6.9%). The college/school with the highest respondents was SEAS (31%), followed by CHSS (24.1%), SCIT and COEDL had the same number of respondents (13.8%), followed by SOL (10.3%) and the college with the least number of respondents was CEM with a percentage of 6.9. It was also shown in table 8a that majority of the respondents' ages are between 35-44years (41.4%), followed by the age group 25 – 34years (31%), 45 – 54years (17.2%), then below 25years of age (6.9%) and finally, the least number of respondents were those who belong to the age group of 55years and above with 3.4%.

Table 8a-2 shows the full meaning of the acronym used in table 8a-1 concerning the college/school within KIU.

Table 8b shows that an irregularity of the system and poor ICT Skills has 0.000 significant values. This implies that these two factors are the strongest technological factors that affect performance evaluation. This is because any value less than 0.05 as the significant value will result in significant effects, while any value greater than 0.05 will result in non-significant effects. Since the sigma value is 0.000, the effects would be significant.

The "Sig." column whose value is given as 0.004 in Table 8c indicates the exact significance level of the ANOVA. Since this value is less than the critical value of alpha which is 0.05, then the effect is said to be significant. Any value less than 0.05 will result in significant effects, while any value greater than 0.05 will not result in any significant effect. Since the value is 0.004, the effects would be statistically significant.

This implies that the organizational factors listed in Table 8d have great influence on performance evaluation

4.4 Discussion

For our first finding, the study revealed that majority of the respondents agreed that unavailability of ICT services is a technological factor that affects the application of a dynamic system for performance evaluation as presented in table 6b. Table 8b shows that irregularities of the system and poor ICT Skills have 0.000 significant values which imply that these two factors are the strongest technological factors that affect performance evaluation. The reason is that any value less than 0.05 as the sigma value will result in significant effects, while any value greater than 0.05 will result in non-significant effects. Since the sigma value is 0.000, the effects would be significant. All these support and explain the postulation in [58] that ICT skills is one of the main factors that affect teachers' use of information and communication technology.

Our second finding revealed that majority (mean = 2.88, Std = 0.58) of the respondents agreed that lack of organizational competition among the staff members is the main environmental factor that affects the application of a dynamic system for performance evaluation; this is shown on table 6c. This is in line with the statement that organizational performance is measured through different indicators, one of which is healthy competition among employees and this guarantees the continuity of the

organization to be competitive in a global marketplace [59].

Our third finding as shown on Table 7a is that a majority (mean = 3.88, Std = 0.95) of the respondents agreed that improving the standard of the institution was the main perception of the academic staff on the use of the dynamic management information system. This is also supported by [60] who say that technology plays a pivotal role in the daily operations of most business entities, organizations and institutions. Also, the advancement in technology and the use of automated equipment has also resulted in the faster, improved and more efficient accomplishment of tasks.

The "Sig." column whose values are given as 0.001 and 0.002 in Table 8d indicate the exact significance level of the ANOVA. Since this value is less than the critical value of alpha which is 0.05, then the effect is said to be significant. Thus, with the values of 0.001 and 0.002, the effects are statistically significant. This means the listed organizational factors on table 8d have a great influence on performance evaluation.

Table 7b shows that a majority (mean = 3.88, Std = 0.95) of the respondents agreed that the frequency of academic awards received was the main general requirement to consider in evaluating academic staff members in using the dynamic human resource information system. According to [1], limited research, which affects the frequency of academic awards received, is seen as one of the challenges associated with successful HRIS implementation. This is why the response from taught students was the least perception of the academic staff on the use of academic management information system (mean = 4.13, Std = 0.03).

On the basis of this research carried out among the academic staff of KIU, it can be concluded that unavailability of ICT services, poor ICT skills and lack of organizational competition are the most significant challenges that can affect the implementation of HRIS in KIU, main campus.

V. CONCLUSION

From the research carried out, the human resource information system framework, which is a form of dynamic management information system framework, is worth adopting in KIU. This is because an organization that takes time to invest in a HRIS is investing in its future and in its success. It will be necessary to customize any HRIS to the unique needs of an organization so that the system can remain flexible and relevant throughout the life of the organization. However, for this to be effectively and efficiently achieved, it was realized from respondents' feedback through the questionnaires that there is need for ICT trainings. The provisions of ICT services, adequate training for the ease of use of the system, motivation of staff members encourages healthy organizational competition. These mentioned factors have been found to be the highest contributing technological and environmental factors affecting the application of the dynamic management information system framework in KIU.

Therefore, we can conclude that this study has made a contribution to existing knowledge in the area of HRIS framework application, which has been found to depend largely on ICT skills, trainings and organizational competition. Moreover, based on the specific objectives of this study, the following can be concluded from the study:

i The current system for evaluating academic staff performance in KIU was found to be a paper-based system, which largely focuses on paper evidences for performance evaluation;
ii The dynamic human resource information system has been shown to be capable of evaluating staff performances in a faster and more accurate manner than the paper-based system, if properly adopted.
iii For a faster, more satisfying and more efficient mode of performance evaluation, the dynamic framework is proposed for application by the human resource directorate of KIU, main campus.

It should be pointed out, however, that, if the information system is not properly utilized its impact on staff performance evaluation will be negative. Hence, for the effect of the third specific objective to be realized, the HR Directorate should ensure that this dynamic human resource information system framework is properly utilized.

ACKNOWLEDGEMENT

The authors will like to acknowledge the anonymous reviewers for their critical review which has helped to substantially improve the quality of this paper.

REFERENCES

[1] Lippert, S.K. and Michael, S.P. (2005) Human resource information systems (HRIS) and technology trust. *Journal of information science*, 31(5), 340-353.

[2] Sabi, H.M, Uzoka, F.M.E, Langmia, K and Njeh, FN (2016) Conceptualizing a model for adoption of cloud computing in education. International Journal of Information Management volume 36, Vol.36, no.2, 183-191

[3] Troshani, I., Jerram, C. and Hill, S.R. (2011) Exploring the public sector adoption of HRIS. *Industrial Management & Data Systems*, 111(3), 470-488.

[4] Alam, M.R.G., Masum, M.A.K., Beh, L. and Hong, S.C. (2016) Critical factors influencing decision to adopt human resource information system (HRIS) in Hospitals. PloS ONE 11(8), 1 – 22.

[5] Mpoza, J.B., Ssempebwa, J., Nakaiza, J., Lukyamuzi, A. and Hawa, H. (2014) Appraisal and Career Development of Academic Staffs in Uganda's Public Universities. *The Ugandan Journal of Management and Public Policy Studies, Vol. 5, No 1. Pg. 130 - 146.*

[6] Ananya, R. C and Mansor, N. N (2013) Adoption of Human Resource Information System: A Theoretical Analysis. *The Second International Conference on Leadership, Technology and Innovation Management* Volume 75, 473-478

[7] Uzoka F.M.E. and Akinyokun O.C. (2005) Knowledge Base System for Human Resource Evaluation in a University Environment. *Journal of Testing and* Evaluation, Volume 33, Issue 1, 1-8

[8] Lotich, P. (2014) Advantages and Disadvantages of Performance Appraisals. (Retrieved February 19, 2017) Available from: http://thethrivingsmallbusiness.com/advantages-and-disadvantages-of-performance-appraisals/

[9] Clark, G., Smith, J. and White, S. (2010). The American recovery and reinvestment act of 2009 – Human Resources, Accounting and Information Systems Issues, Vol. XI, No. 2, 1-2

[10] Heather, B. (2017) A Brief history of HRMS software. (Retrieved 8th March 2017)Available from https://www.hrmsworld.com/history-of-hrms-software-351.html

[11] Sadhu, K.A. (2016) Human Resource Information System (HRIS). Accessed in April, 2016 http://managementversity.com/tag/hris/

[12] Beadles, N., Lowery, C.M. and Johns, K. (2005). The impact of human resource information systems: an exploratory study in the public sector", Communications of the IIMA, Vol. 5 No. 4, 39-46.

[13] Dery, K., Grant, D. and Wiblen, S. (2009). Human resource information systems: replacing or enhancing HRM, Proceedings of the 15th World Congress of the International Industrial Relations Association IIRA 2009, Sydney, Australia, August 27.

[14] Wiblen, S., Dery, K. and Grant, D. (2010) Transitioning from a proprietary to Vanilla HRIS: the resulting implications for talent. Proceedings of the 3rd European Academic Workshop on Electronic Human Resource Management, Bamberg, Germany, May 20-21, pp.326 -341.

[15] Chugh, R. (2014). Role of Human Resource Information Systems in an Educational Organization. Journal of Advanced Management Science, Vol. 2, No. 2, 149-153

[16] Maier, C., Laumer, S., Eckhardt, A. and Weitzel, T. (2013) Analyzing the impact of HRIS implementations on HR personnel's job satisfaction and turnover intention. *The Journal of Strategic Information Systems*, Vol 22, 193–207.

[17] Straus, S. G., Weisband, S. P. and Wilson, J. M. (1998) Human resource management practices in the networked organization: Impacts of electronic communication systems. In C. Cooper and D. Rousseau (Eds.), *Trends in Organizational Behavior*, 5, 127-154.

[18] Powell, T. C., and Dent-Micallef, A. (1997) Information technology as competitive advantage: The role of human, business, and technology resources. *Strategic management journal*, 18(5), 375-405.

[19] Zhang, L. & Wang, H. (2006). Intelligent information processing in human resource management: an implementation case in China. Expert Systems, 23, 356-369.

[20] George, W. L and Janetta, H. R. (2013) Performance management. *BMC Health Services Research Lutwama; licensee BioMed Central Ltd*, Vol. 13, 355, pp. 1-12

[21] Bhuiyan, F., Chowdhury, M. M. C and Ferdous, F (2014) Historical Evolution of Human Resource Information System (HRIS): An Interface between HR and Computer Technology, Human Resource Management Research. *Human Resource Management Research*; 75-80

[22] Geradine, D. (1986) Human Resource Information Systems- A current assessment. MIS Quarterly, 10(1), 15-27

[23] Broderick, R. and Boudreau, J. (1992) Human resource management information technology and the competitive edge. *Academy of Management Executive*, 6(2), 7-17.

[24] Hendrickson, A. (2004) Human resource information systems: backbone technology of contemporary human resources. *Journal of Labour Research*, 24(3), 381-394.

[25] Haines V.Y and Petit A. (1997) Conditions for successful human resource information systems. *HRM Journal*, Volume 36, Issue 2, 261–275

[26] Tannenbaum, I.S. (1990). Human Resource in Information Systems: User Group Implications. Journal of System Management, 40(1), 27 -36

[27] Leepak. D.P. and Snell, S.A., (1998) Virtual HR: Strategic Human Resource Management in the 21st Century, *Human Resource Management Review*. 8(3), 215-234

[28] Kovach, K. A. and Cathcart, C. (1999) Human resource information systems (HRIS): Providing business with rapid data access, information exchange, and strategic advantage. *Public Personnel Management*, 28(2), 275-282.

[29] Rue, H.J., Bondarouk, T., and Looise, J.C. (2004) e-HRM: Innovation or Irritation, An Explorative Empirical Study in Five Large Companies on Web- based HRM,' *Management Review*. 15,3, 364-381.

[30] Voermans, M. and Van Veldhoven, m. (2007). Attitude towards E-HRM: an empirical study at Philips Per Rev, 36 (6), 887-902

[31] Strohmeier, S. and Kabst, R. (2009) Organizational adoption of e-HRM in Europe: An empirical exploration of major adoption factors. *Journal of Managerial Psychology*, 24(6), 482-501.

[32] Kashive, N. (2011). Managing today's workforce: Human Resource Information System (HRIS), its challenge and opportunities. International Journal of Research in Finance & Marketing, 1(6), 38-66.

[33] Martinsons, M. G. (1994) Benchmarking human resource information systems in Canada and Hong Kong. *Information & Management*, 26(6), 305-316.

[34] Donghua, T. (May, 2008) Using Theory of reasoned action (TRA) in understanding selection and use of information resources: An information resource selection and use model. *A dissertation presented to the faculty of the graduate School, University of Missouri-Columbia.*

[35] Tornatzky, L. and Fleischer, M. (1990) *The process of technology innovation*. Lexington.

[36] Thompson, J.D. (1967) Organizations in action, *New York, McGraw-Hill.*

[37] Hage, J. (1980) Theories of organizations: Forms, process and transformation, New York, John Wiley & Sons

[38] Legris, P., Ingham, J. and Collerette, P. (2003) Why do people use information technology? A critical review of the technology acceptance model. *Information & Management*, 40, 191–204.

[39] Davis, F. D. (1989) Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly*, 13(3), 319–339.

[40] Venkatesh, V., Morris, M. G., Davis, G. B. and Davis, F. D. (2003) User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 27(3), 425-478.

[41] Venkatesh, V. Thong, J. Y. L. and Xu, X. (2012) Consumer acceptance and use of information technology: Extending the Unified Theory of Acceptance and Use of Technology. MIS Quarterly, 36 (1), 157-178.

[42] Ajzen, I., and Fishbein, M. (1980) Understanding attitudes and predicting social behavior. *Englewood Cliffs, NJ: Prentice-Hall*.

[43] Davis, F. D., Bagozzi, R. P. and Warshaw, P. R. (1989) User acceptance of computer technology: A comparison of two theoretical models. *Management Science*, 35(8), 982–1003.

[44] Lee, Y.-H., Hsieh, Y.-C. and Hsu, C.-N. (2011) Adding Innovation Diffusion Theory to the Technology Acceptance Model: Supporting Employees' Intentions to use E-Learning Systems. *Educational Technology & Society*, 14 (4), 124–137.

[45] Lin, C. and Anol, B. (2008) Learning Online Social Support: An investigation of Network Information Technology Based on UTAUT. Cyberpsy, Behaviour and Soc. Networking

[46] Yang, K. H., Lee, S. M., and Lee, S. G. (2007). Adoption of information and communication technology:impact of technology types, organization resources and management style. *Industrial Management & Data Systems*, 107(9), 1257-1275.

[47] Denton, K. D. (1987) Getting the technology up and running: An experience at Litton: *Advanced circuitry division*, IE, 20-12.

[48] Kavanagh M. J., Gueutal, and Tannenbaum S. I. (1990). Human Resource Information Systems.Boston: *PWS-Kent*

[49] Iacovou, C. L., Benbasat, I. and Dexter A. S. (1995) Electronic data interchange and small organizations: Adoption and impact of technology. MIS Quarterly, 465-485.

[50] Shrivastava, S. and Shaw, J. B. (2003) Liberating HR through technology. *Human Resource Management*, 42(3), 201-222.

[51] Lederer, A. L. (1984) Planning and developing a human resource information system. The logic of a step-by-step approach. *The Personnel Administrator*, 29(8), 27-39.

[52] Kossek, E. E., Young, W., Gash, D. C. and Nichol, V. (1994) Waiting for innovation in the human resources department: Godot implements a human resource information system, Human Resource Management, Vol. 33, No. 1, 135 - 159.

[53] Oliveira, T. and Martins, M. F. (2010) Understanding e-business adoption across industries in European countries. *Industrial Management & Data Systems*, 110(9), 1337-1354.

[54] Tan, M. and Teo, T. S. (1998) Factors influencing the adoption of the internet. *International Journal of Electronic Commerce*. 5-18.

[55] Cronbach, L. J. (1971) Test validation. In R. L. Thorndike. *Educational Measurement* (2nd ed.). Washington, D. C.: American Council on Education, pp. 443-507

[56] Phelan C. and Wren. J, (2006) Exploring reliability in academic assessment. (Retrieved 01 January 2015) Available from https://www.uni.edu/chfasoa/reliabilityandvalidity.htm

[57] Kaiser, H. F. (1974) An index of factorial simplicity. Psychometrika, 39, 31–36.

[58] Afshari, M, Abu-Bakar, K. and Luan, W (2009). Factors affecting teachers' use of information and communication technology. *International Journal of Instruction* , Vol.2, No.1, pp. 78-98

[59] Abdullah, M. (2016) The impact of strategic human resource management on performance. *Economia. Seria Management.* Volume 17, Issue 2, pp. 273-283

[60] Oni A.O, Gonese G.M and Matiza, T. (2014) The Impact of Management Information Systems on a South African University's Organisational Processes. *Mediterranean Journal of Social Sciences* MCSER Publishing, Rome-Italy Vol 5, No 9, 199-207

Table 1: Review of related works on HRIS

REFERENCE	DEFINITION OF HRIS
[26]	HRIS is a system that is used to acquire, store, manipulate, analyze, retrieve and distribute information about an organization's human resources
[25]	HRIS is a composite of databases, computer applications, hardware and software necessary to collect, record, store, manage, deliver, present and manipulate data for human resources.
[24]	It is a system used to acquire, store, manipulate, analyze, retrieve and distribute pertinent information about an organization's human resource.
[27]	Used the term virtual HR to describe a network based structure built on partnership and mediated by information technologies to help the organization to acquire, develop and deploy intellectual capital.
[28]	HRIS is any System that is used for "collecting, storing maintaining, retrieving and validating data needed by an organization about its human resources".
[24]	HRIS is a socio–technical (integrated) system whose purpose is to gather, store and analyze information regarding an organization's human resources department; it comprises of computer hardware and applications as well as people, policies, procedures and data required to manage the human resources function
[29]	HRIS is a way of implementing HRM strategies, policies, and practices in organizations through the conscious and direct support of and/or with the full use of channels based on web technologies.
[30]	HRIS is defined as the administrative support of the HR function in organizations by using Internet technology.
[31]	HRIS describes the activity of planning, implementing and applying Information Technology for both networking and supporting at least two individual or collective actors in their shared performance of HR activities.

Source: [32]

Table 2: Strengths and Weaknesses of the Technology Acceptance Models

Model	**Author and Year**	**Strength**	**Weakness**
TRA	[42]	It has performed extremely well in the prediction of situations of both voluntary and mandatory use.	It focuses on individual level behavior and ignores environmental, technological, organizational and social factors that might influence that behavior
TAM	[43]	Several studies have found out that perceived usefulness has high influence on behavioral intention to use a specific system and these studies provided a strong evidence to support TAM as a model for predicting systems usage behavior.	It does not reveal determinants of the perceived usefulness and perceived ease-of-use variables. This model also ignores patronage factor (training technical support and management support) which may be determinants of perceived usefulness
TOE	[35]	Existing literature has it that TOE framework demonstrates usefulness of understanding the diffusion of Information Systems (IS) innovation and, more importantly, it provides a much better explanation which addresses a firm's decision-making behaviors.	TOE concentrates more on organizational, environmental and technology factors which include compatibility, complexity, relative advantage of the system in use, HR professionalism and structure, management support, communication processes, degree of centralization, competitors, and government regulations.
Revised TAM	[44]	This model accounts for the numerous factors that influence HRIS system acceptance. It integrates two models, IDT and TAM. The findings by application of this model supported existing research that there is strong relationship between PEU and PU, as originally proposed by Davis et al. (1989). Therefore, it is suitable to be applied in different types of studies.	This model has a tendency of being redundant in the sense that some constructs carry same meaning, for instance the relative advantage construct in IDT is similar to the notion of the PU in TAM. This model also ignores patronage factor (training technical support and management support) which may be a determinant of perceived usefulness.
UTAUT	[40]	This model consolidates previous TAM related studies, defines and relates the following four constructs: performance expectancy, effort expectancy, social influence and facilitating conditions for the variables.	The scales used in UTAUT model are new, as they are a combination of a number of prior scales, and, therefore, the suitability of these scales needs to be further tested.
Extended UTAUT	[45]	It defines five constructs which include performance expectancy, effort expectancy, social influence, and a new construct of disturbance concerns.	It has been found to be less parsimonious than the previous Technology Acceptance Model and TAM2 because its high resistance is only achieved when moderating key relationships have up to four variables.

Table 3: The Models Compared against Identified factors of HRIS application

Models						
Factors	**UTAUT [40]**	**EXTENDED UTAUT** [45]	**TRA [42]**	**TAM D [39]**	**REVISED TAM [44]**	**TOE [35]**
Perceived usefulness	Yes	Yes	No	Yes	Yes	Yes
Patronage factor	No	No	No	No	No	Yes
Compatibility	No	No	No	No	Yes	Yes
Relative advantage	Yes	Yes	No	No	Yes	Yes
Complexity	No	No	No	No	No	Yes
Management support	Yes	Yes	No	No	No	Yes
Communication processes	Yes	Yes	No	No	Yes	Yes

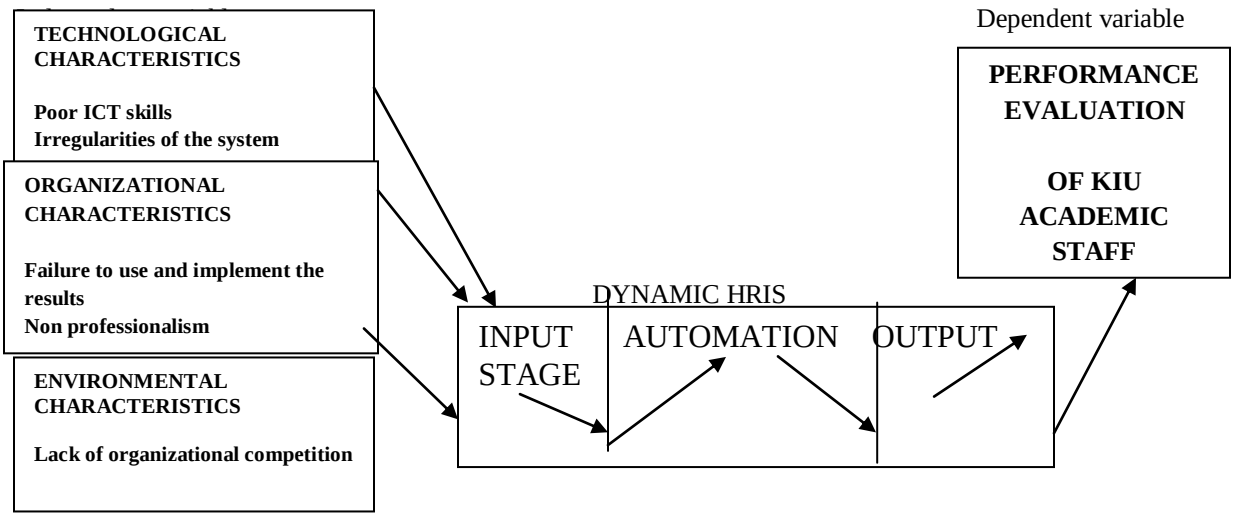


Figure 1: Proposed Conceptual Framework (Adapted from [3])

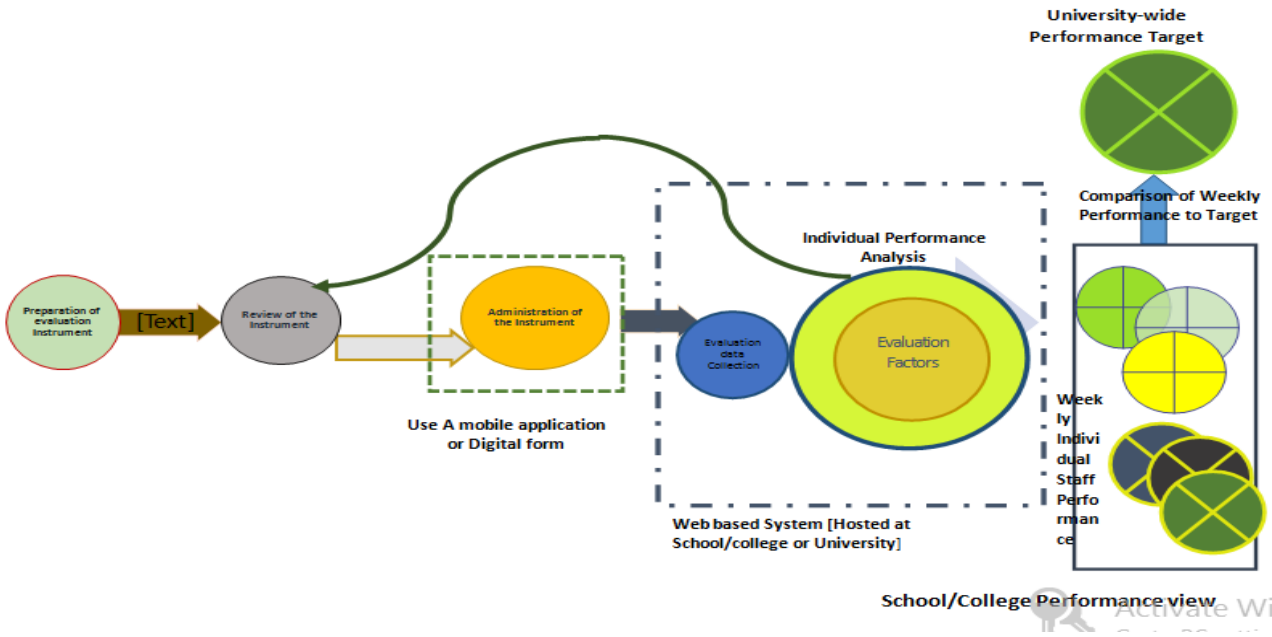


Figure 2: Dynamic Management Information System model for Performance Evaluation at KIU

Table 4a: Cronbach's analysis for Technological factors

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	Number of Items
0.577	0.710	6

Table 4b: Impacts of using a dynamic framework in performance evaluation

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	Number of Items
0.531	0.774	9

Table 4c: Requirements for the dynamic system's framework

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	Number of Items
0.520	0.710	12

Table 5a: Testing the validity of the data for the dynamic system's framework

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.610
Barletts Test of Approximation Chi-Square sphericity	15.101
Degree of Freedom(DF)	12
Significance	0.600

Kaiser-Meyer-Olkin (KMO) measure of technological factors = 0.611, which is acceptable

Table 5b: Test of impacts of using a dynamic framework in performance evaluation

Kaiser-Meyer-Olkin Measure of Sampling Adequacy	0.530
Barletts Test of Approximation Chi-Square sphericity	15.778
Degree of Freedom(DF)	10
Significance	0.602

Kaiser-Meyer-Olkin (KMO) measure of Impacts of using a dynamic framework in performance evaluation = 0.602 which is acceptable

Table 6a: Mean range and interpretation

Mean Range	**INTERPRETATION**
0 – 1.25	Not true
1.26-2.51	Rarely True
2.52-3.77	True
3.78-5.03	Very True

*Table 6b: Statistical measured response of the **technological** factors that affect the application of a dynamic system framework for performance evaluation*

S/N	Variables studied	Mean	Standard deviation	Coefficient of variation	Interpretation
1.	Power shortages	3.88	0.66	0.0170	Very true
2.	Unavailable ICT services	3.88	0.75	0.0194	Very true
3.	Poor ICT skills	3.93	0.35	0.0089	Very true
4.	Unstable internet	3.20	0.35	0.0109	True
5.	Irregularities of the system	3.50	0.12	0.0034	True
6.	Lack of trust in the functionality of the system	3.88	0.65	0.0168	Very True

*Table 6c: Statistical measured responses of the **environmental** factors that affect the application of a dynamic system for performance evaluation*

S/N	Variables studied	Mean	Standard deviation	Coefficient of variation	Interpretation
1.	Limited publicity for the dynamic system	3.88	0.12	0.0031	Very true
2.	Lack of organizational competition	2.88	0.58	0.0202	True
3.	Lack of encouraging policies supporting the use of the internet	3.88	0.50	0.0129	Very true
4.	Absence of performance evaluation policies from the university's' management	3.88	0.70	0.0181	Very true

Table 7a: Statistical measured response on the perception among the academic staff members on using the dynamic human resource information system framework

S/N	Variables studied	Mean	Std. Deviation	Coefficient of variation	Interpretation
1.	It is easy to use	3.38	0.81	0.0240	True
2.	It makes the necessary requirements for promotion easily available and accessible to all staff	3.88	0.17	0.0044	Very True
3.	It is a better way of evaluating staff members	3.88	0.84	0.0216	Very True
4.	It improves the standard of the institution	3.88	0.95	0.0245	Very True

Table 7b: Statistical measured response on the requirements the dynamic human resource information system framework should consider for evaluating the academic staff members

S/N	Variables studied	Mean	Std. Deviation	Coefficient of variation	Interpretation
1.	Frequency of article publications in journals	3.88	0.48	0.0124	Very True
2.	Frequency of books written and published	3.88	0.76	0.0196	Very True
3.	Attained academic qualifications with certificates	3.88	0.37	0.0095	Very True
4.	Years of relevant work experience	3.88	0.47	0.0121	Very True
5.	Number of academic awards received	3.88	0.95	0.0245	Very True
6.	Relevant certifications obtained	3.88	0.90	0.0232	Very True
7.	Past academic posts/offices held with date	3.88	0.65	0.0168	Very True
8.	Number of attended lecturers per week with evidence	3.88	0.85	0.0219	Very True
9.	Response from taught students with evidence	4.13	0.03	0.0007	Very True
10.	Prompt submission of student's scores and results	3.88	0.85	0.0219	Very True
11.	Departmental meetings attendance	3.88	0.65	0.0167	Very True
12.	Application of other relevant skills possessed	3.88	0.25	0.0064	Very True

Table 8a-1: Demographic Characteristics of the respondents

Variable	**Option**	**Percentage (%)**
Gender	Male	62.1
	Female	37.9
Age	Below 25years	6.9
	25 – 34years	31
	35 – 44years	41.4
	45 – 54years	17.2
	55years and above	3.4
Highest level of Qualification	Masters	55.2
	Bachelors	24.1
	PhD	6.9
	Others	13.8
College/School	SEAS	31
	CHSS	24.1
	SCIT	13.8
	COEDL	13.8
	SOL	10.3
	CEM	6.9

Table 8a-2

COLLEGE/SCHOOL	MEANING
SEAS	School of Engineering and Applied Sciences
CHSS	College of Humanities and Social Sciences
SCIT	School of Computing and Information Technology
COEDL	College of Education and Distant Learning
SOL	School of Law
CEM	College of Economics Management

Table 8b: Coefficients of technological factors and the dependent variable (performance evaluation)

Model	Unstandardized Coefficients	Unstandardized Coefficients	Unstandardized Coefficients	Unstandardized Coefficients	
	B	Std. Error	Beta	T	Sig.
constant	7.912	2.576		3.072	0.003
Power shortage	-0.270	0.391	-0.067	-0.691	0.491
Unavailable facilities	0.500	0.663	0.088	0.753	0.453
Poor ICT skills	3.769	0.603	-0.593	-5.873	0.00
Irregularities of the system	-3.929	0.702	-.565	-5.595	0.00
Lack of trust in the functionality of the system	0.393	0.541	0.065	0.727	0.469

Table 8c: Regression between independent variables of organizational factor and dependent variable(performance evaluation)

Model	Sum of Squares	DF	Mean Square	F	Sig.
Regression	462.445	6	77.074	3.399	0.004
Residual	2222.194	98	22.675		
Total	2684.638	104			

Table 8d: Coefficients of organizational factors and the dependent variable (performance evaluation)

Model	Unstandardized Coefficients	Unstandardized Coefficients	Unstandardized Coefficients	Unstandardized Coefficients	
	B	Std. Error	Beta	T	Sig.
constant	5.324	3.825		3.222	0.002
Lack of training on how to use the system	1.419	0.748	0210	1.896	0.061
Management support	0.495	0.817	0.057	0.606	0.546
Financial support	-0.515	0.756	-0.069	-0.682	0.497
Failure to use and implement the result	-3.636	1.132	-0.431	-3.211	0.002
Poor communication link within the organization	0.794	0.812	0.135	0.978	0.331
Non-professionalism	-1.616	0.492	-0.344	-3.286	0.001

Call for Papers & Subscription Details

Papers for consideration for publication in ***African Journal of Computing & ICT***, ISSN 2006 – 1781, are invited which contain substantial ideas that have the potential of aiding inventions or a technological breakthrough for general and specialized use .The Journal mainly publishes online editions; print editions are published in restricted quantities based on request. Four editions are normally published every year. Special editions are published as the need arises.

Scope
The journal especially welcomes papers focussing on novel application of computing and ICT to the solution of challenges and peculiarities of the African continent, nay, under-developed world. Examples of such themes are application of computing principles to African Traditional Religion practices (such as Ifa divination), application of ICT to solve epileptic electric power supply, harnessing of solar and alternative power, and effective biometric solution to identity card management. Others include ICT applications to areas like cyber-theft, insecurity (terrorism, kidnapping etc), electoral process, cheap and affordable houses/roads/rails, oil and mineral exploration etc. In general, papers are solicited from all areas of computer science and information and communication technology, including but not limited to, the following themes:

*Electronic Systems (viz. E-Commerce, E-Government, E-Learning, E-Agriculture, E-Health & Tele-Health Systems) *Computer Graphics & Games *Multimedia Systems *E-Library and Virtual Library Systems *Wireless Networks & Applications *Economic Intelligence *Computer Forensics * Cyber Security *Development Informatics *Mobile Applications & Technologies *General Computing *Computer Science *Information Technology *Information Management *Bioinformatics *Information System *Information Science *Information Security *Business Computing *Computer Networks *Artificial Intelligence *Computation *Software Engineering *Knowledge-based Systems *Database Management *Data Mining & Data Warehousing *Knowledge Management *Computer Architecture *Web Services *Cloud Computing *Internet of Things *Information Technology in Construction Management *Intelligent Building * DNA Computing * Modelling & Simulation * Space & Satellite Communication System

Prospective Authors
Papers are solicited, not only from seasoned scholars, but also from young researchers with research results, such as (post)graduate students in related fields. All papers are fully refereed. Highlights of current journal policy may be obtained from https://afrjcict.net/faq

Journal Format
Kindly download any recent article (2018) on the journal website (https://afrjcict.net) as a writing guide. All articles are free and downloadable at no cost. Authors of accepted papers are required to include their biodata (containing passport-sized photographs) at the end of the papers, immediately after the References. This will be published along with the papers.

Pagination Fees
Due to the fact that the journal is open-access, authors pay a modest processing/pagination fee of US$100 (₦25, 000 or equivalent currency) to support the production process.

Subscription Fees
The subscription fee for a single edition of the journal is US$50 (₦5, 000 or equivalent currency), excluding postage. Request for subscription should be directed to the addresses below.

Paper Submission Addresses
Please send your submission as electronic mail attachment in MSWord to submissions@afrjcict.net; submissions.afrjcict@gmail.com
(cc: bamidele@aims.ac.za; oluwade@sigmaxi.net).

ISSN 2006-1781

URL- https://afrjcict.net
Email: submissions@afrjcict.net; submissions.afrjcict@gmail.com