Computer Laboratory Network Centralization Files Management System

Asia Pacific Journal of Management and Sustainable Development
Vol. 9 No. 1, 64-72
March 2021 Part III
ISSN 2782-8557 (Print)

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Date Received: June 15, 2020; Date Revised: January 30, 2021

Abstract- *This study aimed to design a system that can perform scheduled automatic backup of laboratory files, organize laboratory files accordingly and serves as the central repository of files for easy checking and retrieval of user files from the file server into the local computer. The system's automatic backup is ran by a file backup daemon. The daemon determines the newly created files stored by the user in each computer in the network and automatically save and organize this file to the file server when a predetermined backup schedule has been reached. The client-side system initiates the scheduled automatic backup, and relieving the file server of heavy workload. The system was designed and developed using the Prototyping methodology. The system was pilot tested at Iloilo Science and Technology University, Burgos St. La Paz Iloilo City. The system was further evaluated based on ISO 25010 by 20 respondents, 10 of whom are IT Professionals in ICT Industry and 10 of whom are IT Professionals in the Academe. The evaluation of the respondents to the system's software quality characteristics was based on ISO 25010 resulted to a value described as "Excellent". The result implies that the overall software characteristics of the system passed the ISO 25010 standards.*

Keywords: *automatic backup, file server, file backup daemon.*

INTRODUCTION

Computer network according to Lively [1] handles user access control, file security, distribution of user and network materials and monitoring of the overall performance of the entire network system. On the other hand, Computer laboratory network according to Ajanovski [2] has several purposes within the University which include its use during the practical demonstrations and individual work of students, storing and retrieval of files and data backup. Hence, computer laboratory is used by hundreds of users at the same time different access permissions, network set up, and back up procedure are required to maintain the efficient performance of the entire network.

However, despite the computing power offered by modern computers in terms of network set up and user access control, these computer systems are still prone to hardware and software failure which leads to unavoidable loss of user data.

As stated in Recovery Explorer [3] webpage, it is denoted that 42% of data loss in a computer system is due to hardware failure. These include problems on Hard Disk Drive (HDD) / Solid State Drive (SSD), Computer memory, Motherboard, Processor (CPU) and Power supply. Moreover, data loss in the computer laboratory may also happen due to mistakes made by the user itself. Statistics shows that 30% of data loss cases are caused by human errors. These include accidental deletion of important files, poor implementation of backup copy, and overwriting of file contents. On the other hand, software malfunctions take the third place in the list of reasons for data loss with 13% of data loss cases. These include improper use and implementation of backup software, antivirus software and converters.

These scenarios are still experienced in the traditional set up of computer laboratories hence, storing and retrieval of computer laboratory files are still done manually from client computer to a file server. Thus, in the event of network connectivity failure file server functionality is lost. Moreover, one of the most common problems with school laboratory file system is the inadvertent or accidental deletion of files by another computer user since every user shares the same computer in a network. These issues raised several problems to the instructors and students since laboratory activities are important assessment method of students programming and computing skills. This file is essential since it will aid the subject instructors to measure the student's level of understanding and performance in their respective computer subject. Thus, students' files should be preserved, managed, and are made available to authorized user.

The department is handling all the ICT related subjects of all courses within the University and thus, the computer laboratories are used by thousands of students. However, the file server used by the department is not yet automated and students who are using the computer network are forced to back up their files to the file server manually. In case of connectivity issue between the local computers inside the laboratory and file server, students opt to save their files instead to the local computer and this is when data loss is experienced or even overwriting of student's files.

To solve the problem on data loss in computer laboratories or within the network, several researches were conducted to address the issues in storing, retrieval and file back up. Data backup according to Xu and Luo [4] refers to the capability of the computer system to build a copy of important computer files, save this copy in a different storage location and allow its user to retrieve a copy when the original data is loss or damage. There are several known backup and restore systems that are currently available in the market offered by companies such as TSM, Veritas and IBM [5].

The client computer and the server usually have both systems communicating and mutually agreeing on the backup process. Numerous developed researches focus on the algorithm on how to optimize the backup process between client and server. One of the modern approaches to file server implements automatic and incremental file backup. Incremental file backup, according to Adshead [6], is a backup method that will only back up newly created files from the last backup. Newly created file from client machines is tracked and automatically saved to the file server. However, the apparent drawback of this scheme is that it will create huge network traffic, affecting other network-dependent services like internet.

This study is also anchored to the research conducted by Deepika, Pranay and Supriya [7]. The researchers developed a backup system which is consist of two nodes which handles the actual back up of files and the restoration procedure needed for recovering loss data. The backup sequence receives the data to be backed-up and the system will then encrypt the file and divides it into fragments. The Data Center encrypts the fragments again at the second stage and distributes them to the client nodes in random order. On the other hand, the Recovery Sequence of the system will trigger the Supervisory Server to start the recovery sequence. It will collect the encrypted fragmentations from various appropriate clients and decrypt these data Though these processes, the Supervisory Server can recover the original data that should be backed-up.

Moreover, this concept was also anchored to the study conducted by Badhel and Chole [8], called the Seed Block Algorithm Architecture (SBA) which is designed as a remote backup server. The remote Backup server is a replica of the original cloud server which is physically situated at a remote location. The whole back up process is composed of three main parts namely the Main Cloud Server, Clients of the Cloud and the Remote Server. The Seed Block Algorithm Architecture works by creating back up data of the newly created file in the client computer. The system will then save these data in the Main Cloud Server and resultant Data' is stored in the remote server as well. However, this study is unable to achieve all the issues of remote data back-up server which will allow the system to use less storage space.

Due to some constraints of previous approach in data backup, the researcher conducted this study to offer another solution in doing data backup within a network. The focus of this study is to optimize network traffic so that other network-related services, like internet, can flow seamlessly through the network. The system is focused on balancing functionality and speed of the network service, hence the system will only perform scheduled and incremental backup in the event of network failure.

The study Computer Laboratory Network Centralization Files Management System can accept multiple user login and storage space inside local computer; perform scheduled incremental back-up of files from client computer to server; secure stored file in local computer from an unauthorized user, organized file stored in local computer and file server according to some predefined attributes, authenticate new user in local computer and allow user to transfer to other client computer and still have the access to files in the file server.

METHODS

The researcher used the prototyping approach in planning, design and implementing the system development process as shown in Figure 1. According to Budde, et. al [9] prototyping is a model which view the software development process as an evolutionary approach. The process involves working on the early working version of the entire system and conduct experiments on them to achieved the overall system requirements and design. Also, according to Thakur

[10] early increments of a prototype will help draw out requirements from the end user for later increments. This therefore results in a lower risk of overall project failure.

During planning stage, the researcher identifies the nature and scope of the study. A feasibility study was conducted to determine the operational, technical, schedule and economic requirements of the study during this phase. Currently, the Computer Department of Iloilo Science and Technology University (ISATU) is experiencing difficulty and problem regarding the management of student laboratory files. The file server used by the department is not yet automated and students who are using the computer network are forced to back up their files to the file server manually. When the file server is unavailable, this becomes a problem to both students and faculty hence, data stored in the local computers will be prone for data loss. This scenario compelled the researcher to handle and solve the problem. To address the issue, the researcher conducted research and review related literatures and studies that will help the researcher identify the strengths and the weaknesses of existing network design. Also, during this phase, the researcher interviewed several experts in the field that could provide further suggestions on how to implement the new data backup scheme.

During the analysis phase, the researcher designed the logical model of the system by establishing the functional and non-functional requirements of the. Functional Requirement (FR) according to Alsaleh and Haron [12] include user needs from the system and the Non-Functional Requirement (NFR) on the other hand, represents the system architecture. The researcher after analyzing the user requirements come up with the following system features that will be integrated in the design of the newly created system. These include automatic gathering of files trigger, organization of file structure, securing local files, centralization of user accounts, access to files when client computer is damaged and checking of student files.

During the design phase, the researcher used several Unified Modeling Language (UML) diagrams such as Use Case and State Transition Diagram to represent the system flow. UML Diagram is a specification language that is used to create the abstract model of how the system will function [13]. Out of the UML diagram, the researcher also designed the user interfaces of the system and determines the necessary input, process and output of the system. The system was also coded and tested to meet specified user requirements.

During implementation phase, the researcher tested and deployed the system to the organization. This is the final phase of the development process where the final developed system is put in operation.

The functionality of the system and how the different user utilized the developed system is described using the Use Case Diagram as shown in Figure 1. A use case diagram shows the set of functionalities a system should provide since it represents the general view of the system. This will help the developer to not be overwhelmed by the system implementation details [14].

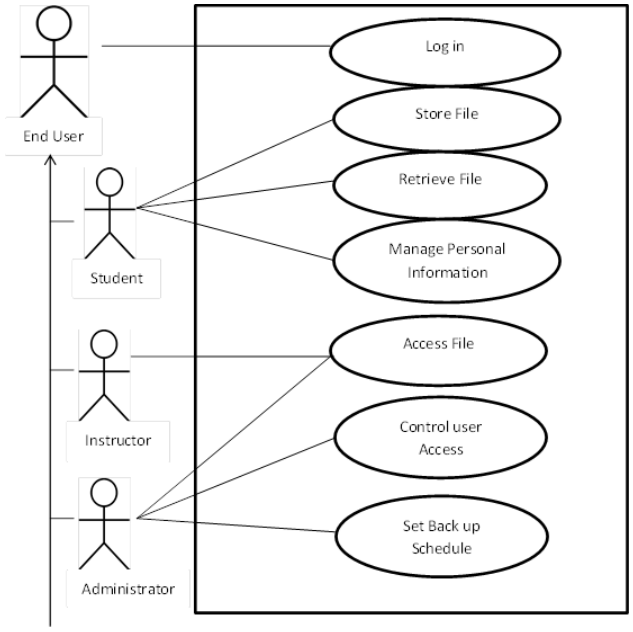

Figure 1. *Use Case Diagram of the System*

The system has three actors namely the student user, instructor, and administrator. All end users can log in into the system using their own user accounts. The Administrator will manage the addition, modification, and deletion of course and subjects, and backup schedule. It is also the role of the administrator to control and monitor student user for the administrator can activate and deactivate user account. Moreover, the administrator sets backup time schedule. This schedule is copied by the client computer and it will govern client-side system to monitor when the system will send or back up the newly created files to the file server. The administrator can also view student files deposited in the file server. File organization in the file server is arranged per student course and year level

as per student ID number. All the files are then listed under each student. The student has the option to create subfolders inside his local storage space. During backup, this folder organization is also copied to the file server.

The Teacher account simply views student files saved in the file server. File organization in the file server is arranged as per course and year level and student files are arranged per student with ID number.

The Student user account enables student to save, retrieve, and manage file/folder inside the local computer. Upon server validation, each student will have a storage space inside the file server and a storage space in local computer. The Student user information is synchronized to the file server. The file server will gather and organize the student files from local computers when the designated backup time was reached. The newly created files present in local computer will be gathered and is back up in the file server automatically. The system compares the file name and the file size of each file in the local computer to the files already stored in the file server. Once a new file name is found and a change in file time stamp is also found, the system will automatically collect these new and updated files and back up these files in the file server. The student accounts are also monitored in the server-side of the system to monitor and deactivate delinquent and inactive student accounts.

The system process was also designed using the State Transition Diagram. The State Transition Diagram of the system is shown in Figure 3. State transition diagram according to Copeland [15] is a diagram used to describe all the states that an object can have, the changes state, the conditions that must be fulfilled before the transition will occur and the activities undertaken during the life of an object.

The diagram illustrated on Figure 2 shows the mechanism for automatic copying of files to file server. Client-side system performs the automatic copying of files on the background as a daemon which does not need human interventions. Daemon is a software process that runs in the background without human intervention [16]. When the client computer is turned ON, the client-side system is automatically loaded into the computer memory and it instantly operates. As soon as the file server is available, the client-side system communicates with the file server to initiate the copying of files.

The core feature of the system is the ability of the system to detect newly created files deposited in all computers in the laboratory and allow the administrator to set back up schedule. The Client-side system copies the backup schedule being set from the file server to each local computer. If the predefined schedule is reaching the client-side system checks for the newly created files stored on local computer taking into consideration each file's time stamps. The system does this by utilizing databases in the client side and in server side which stores the latest time stamp of each file in every local computer inside each laboratory. These databases compare and determine if there are any file bearing a time stamp that is more recent than the previously time stamped stored on the databases. If the time stamp is new than what is currently stored in the file server, the client-side system copies the file to the file server. If there is no new file present in the local computer, then the client-side system will just continue to monitor for new files until it reaches another backup schedule.

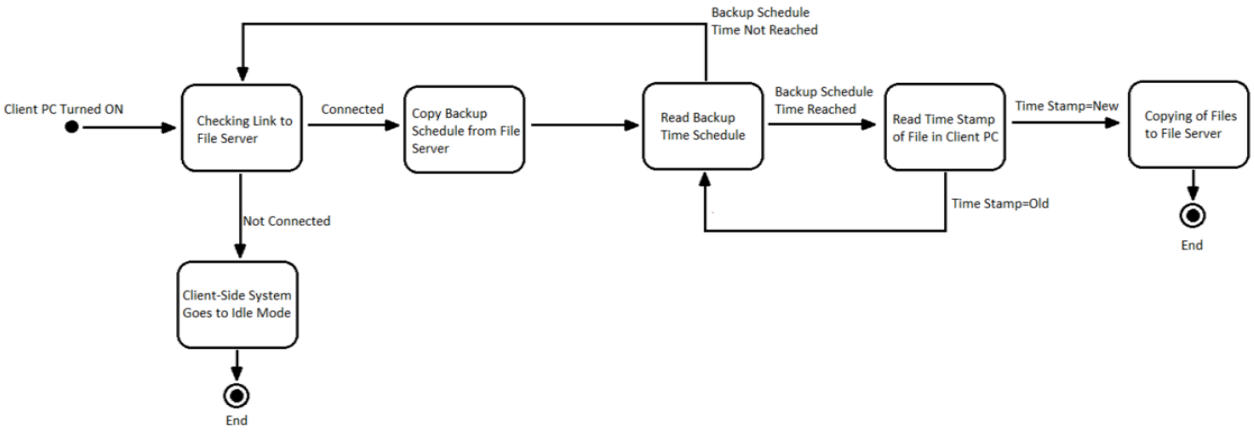

Figure 2. *State Transition Diagram*

Turning ON the client computer and the file server will also initiate the start of the system. The client-side system checks the connectivity and availability of the file server upon start up. Once the file server and the client side is not connected, the computer user can still continue saving their file on the secure local space provided to the user in the local computer and the client-side system becomes in idle mode. When the client-side system verifies that the file server is connected to the local computers, the client-side system monitors the backup schedule. The backup schedule is configured by the administrator in the file server; it could be either set by interval time or as an absolute time. Another core feature of this system is the organization and segregation of files. This feature guarantees the proper placement of file in the folder hierarchy and it will be easier for the teacher to check student's work.

The mechanism is designed to make sure that the client computer and file server is having the same folder structure so that the backup copy of files is always organized and easier to locate. This client-side function is also automated. Upon logging ON the client-side system, checks the existence of storage folder based on the course and subject the student user has selected. The storage space folder of client computer must match with storage space folder in the file server so that the overall system can efficiently store and locate files for every student user.

The functionality of system was tested to determine if it meets the standards and requirements of the potential user. The system underwent several tests run to determine whether the system's objectives have been reached satisfactorily. Testing was done using Whitebox and Blackbox testing. Black box testing includes test cases for functional testing which is based on the requirement or design specification of the software entity under test while white box testing is based on the implementation of the software entity which includes specific statements, program branches or paths [17].

The test and evaluation of the system through white box and black box testing was conducted at a State University in the Philippines. The evaluation was performed by 20 Information and Communication Technology (ICT) professionals in the industry and in the academe. These people are programmers, network administrators, database administrator, web designers, system analyst, and potential users of the system in ISAT. The goal is to evaluate whether the system has met the specified requirements of the potential users and to check whether the system meets the IS0 25010 software quality standards.

The researcher used the expert sampling in the selection of the respondents of the study. Expert sampling is a type of purposive sampling which was used as a basis of determining the number and qualification of respondents. According to statisticshowto.com [18], expert sampling is used when the researcher needs an opinion or the assessment of people with high degree of knowledge about the study area.

The software was evaluated based on the ISO 25010 standard for evaluating software quality characteristics which include eight quality characteristics including Functional Suitability, Performance Efficiency, Compatibility, Usability, Reliability, Security, Maintainability and Portability [19] through a questionnaire.

The respondents can rate the acceptability and functionality of the system's output based on ISO/IEC 205010:2011 using a five-point rating scale described as follows: Excellent, is at range 4.5 - 5, Very Satisfactory is at range 3.5 – 4.49, Satisfactory is at range 2.5 – 3.49, Good is at range 1.5 – 2.49 and Poor is at range 1 – 1.49. Respondent's identities are being maintained to be strictly confidential.

The accuracy of the system was evaluated using F-measure and is derived from 50 backup processes focusing on the ability of the system to copy new files saved on local computer into the file server wherein the backup file belonged to the corresponding user's folder. If the whole process is correct, then the backup process of the present invention is functioning correctly, otherwise incorrect.

RESULT AND DISCUSSION

This research was evaluated based on ISO/IEC 25010:2011 System and Software Engineering – Systems and Software Quality Requirements and Evaluation (SQuaRE)- Systems and Software Quality Models. All eight (8) quality standards were used to evaluate the conformance of the application to the software standards set by ISO and to determine where all the specifications were met successfully. The result of the evaluation is as shown in Table 1.

Table 1. Summary of ISO Evaluation of Computer Laboratory Network Centralization Files Management System

Characteristics	IT Industry		Potential User		Entire Group	
	M	Description	M	Description	M	Description
Functional Suitability	4.70	Excellent	4.57	Excellent	4.63	Excellent
Performance Efficiency	4.53	Excellent	4.60	Excellent	4.57	Excellent
Compatibility	4.65	Excellent	4.55	Excellent	4.60	Excellent
Usability	4.38	Excellent	4.75	Excellent	4.57	Excellent
Reliability	4.23	Excellent	4.60	Excellent	4.41	Excellent
Security	4.38	Excellent	4.72	Excellent	4.55	Excellent
Maintainability	4.56	Excellent	4.82	Excellent	4.69	Excellent
Portability	4.50	Excellent	4.50	Excellent	4.50	Excellent
Grand Mean:	4.49	Excellent	4.64	Excellent	4.56	Excellent

The result of the ISO 25010 evaluation is shown in Table 1. The Computer Laboratory Network Centralization Files Management System was evaluated in terms of functional suitability, performance efficiency, compatibility, usability, reliability, security, maintainability and portability. The grand mean as to the evaluation of IT Professionals in the Industry is 4.49 which is denoted as Excellent and the grand mean for the Potential Users is 4.64 which is also denoted as Excellent. The evaluation of the system as a whole has a mean rating of 4.56 which is denoted as Excellent. The result of the evaluation means that the Computer Laboratory Network Centralization Files Management System has conformed to the software quality standards set by ISO/IEC 25010. The result further implies that the result implies that Computer Laboratory Network Centralization Files Management System meets the standards for specification and evaluation in terms of acquisition, requirements, development, use, evaluation, support, maintenance, quality assurance and control, and audit.

The functional suitability characteristic of the system was evaluated and was given a mean rating of 4.70 which is denoted as excellent by IT Professionals and a mean rating of 4.57 which is also denoted as excellent by potential users. As a whole, the functional suitability characteristic of the system has a mean rating of 4.63 and is also denoted as excellent. This means that the system was able to meet the set of functions that covers the entire specified task and user objective, the system provides the correct results with the needed degree of precision and the system facilitate the accomplishment of specified task and objectives.

The performance efficiency of the system was rated by the IT Professionals with a mean of 4.53 denoted as Excellent and potential users with the mean of 4.60 denoted as excellent. The grand mean for the system's performance efficiency has a mean rating of 4.57 which is denoted as excellent. As stated by Curtis [20], it is important to measure performance efficiency since it will affect customer satisfaction, productivity, scalability, and response time and resources allocation. The result of the system evaluation implies that the system response time and processing time is acceptable. The result also shows that the system uses the computer resources efficiently.

The Compatibility of the system is rated by the IT professionals with a mean of 4.65 denoted as Excellent and the potential users with the mean of 4.55 denoted as excellent. The grand mean for the system's Compatibility has a mean rating of 4.60 which is also denoted as excellent. This means that the system is proficient enough to run in different environments and networks and could also adapt to different version upgrades, monitor resolution, internet speed, and other configurations in the computer system. The operation of the proposed system is so simple that any external factors could do minimal impact on it. The result of the evaluation implies that the system can work effectively with other windows-based platform. Moreover, the system was able to work with the different modules and pass and receive data from the data repository.

The evaluation of usability characteristic of the system shows that the system is easy to learn and use. The present invention has simple client-side user interface. Most of the responsibility of the client-side system is automatic and running in the background. The IT professionals rated the system's usability with the mean of 4.38 which is denoted as excellent. On the

other hand, potential users rated the system's usability with the mean rating of 4.75 which is denoted as excellent. The overall evaluation shows that the respondents rated the usability of the system with the mean of 4.57 which is denoted as excellent. This means that the system is recognize by the user as appropriate for their needs, the system enables the user to learn how to use the system efficiently, the software is easy to operate, control and appropriate for use, the system protects the user against errors in data entry, and the system provides the user with pleasing and satisfying interaction. This is because the system requires little interaction from users. Majority of the work is done by the file-gathering daemon.

The Reliability characteristic of the system was evaluated by IT professionals with the mean of 4.23 which is denoted as excellent. Potential users rated the system with a mean of 4.6 which is denoted as excellent. The overall mean of the system's reliability is 4.41 which is denoted as excellent. This means that the system's component meets needs for reliability under normal operation, the system is operational and is accessible when required for use, the system operates as intended despite the hardware and software faults and the system can easily recover after a system fault. This result conforms to Pan [21] that the system's reliability is the probability of failure-free software operation for a specified period of time in a specified environment.

This result denotes that the system as perceived by the respondents is capable of gathering and organizing files discreetly and reliably. System ensures that there is always a duplicate or backup copy of laboratory files, offering higher reliability when file server or client computer is unavailable. Moreover, respondents saw that files stored on local computer are secured and most of the times are accessible when needed. Potential users appreciated the system's efficiency in utilizing network traffic and the ease of checking the laboratory files of students.

The Security characteristic of the system was evaluated by IT professionals in industry with the mean of 4.38 which is denoted as excellent and by the potential users with a mean of 4.72 which is denoted as excellent. The overall mean of the system's reliability is 4.55 which is denoted as excellent. This means that the system ensures that data are accessible only to those authorized to access, the system prevents unauthorized access to and modification of the program, the system can prove that actions has taken place so that it cannot be repudiated later. The result of the evaluation implies that the system was able to provide security measures to its client and data. The system was designed to have a user log in to ensure that only authorized user can view and modify data within the system enforcing confidentiality. Files are secured and have always a duplicate copy supporting data integrity. Moreover, files are always available to authorized user. Files are centralized in the file server, enforcing data availability. Furthermore, the proposed system does not allow other users from accessing file/folder of other user sharing the same local computer. Only the owner can access his/her own file/folder.

The Maintainability characteristic of the system was evaluated by IT professionals in with the mean of 4.56 which is denoted as excellent. The potential users rated the system with a mean of 4.82 which is denoted as excellent. The overall mean of the system's reliability is 4.69 which is denoted as excellent. This means that the system is easy to fix in case a bug occur, add new features, improve usability, increase performance, and make changes to support new environments. The result taken from the respondents implies that the system has a well-designed hierarchy of interfaces which is easier to follow, understand and maintain.

The Portability characteristic of the system was evaluated by IT professionals with the mean of 4.5 which is denoted as excellent. Potential users rated the system with a mean of 4.5 which is denoted as excellent. The overall mean of the system's reliability is 4.5 which is denoted as excellent. This means that the system can effectively and efficiently be adapted for different or evolving hardware, software or other operational or usage environments, the system can be successfully installed and/or uninstalled in a specified environment, and the system can replace another specified software product for the same purpose in the same environment. The system adheres to the idea that the system should be portable and can be deployed easily. The proposed system is packaged in executable files and can be installed easily on client computers.

The precision of the system is 100% which is denoted as Excellent using the threshold published by Hussain and Saraswathi [22]. According to Dandekar [23] precision is a measure of how precise the recall is. The result implies that the system is good in recognizing positive value that are actually positive. This means that the system can recognize 100% of the respondents correctly.

The recall of the system is 96% which is denoted as excellent using the threshold published by Hussain and Saraswathi [22].

The F measure value using the software's precision and recall is 97.96% which implies that the accuracy of the system to recognize a person is Good using the threshold as published by Hussain and Saraswathi [22].

CONCLUSIONS AND RECOMMENDATION

Based on the results as earlier presented, the system was able to meet all its specified requirements and objectives. This means that the client computer can accept multiple users to login and multiple secure storage spaces are created, client computer can perform scheduled incremental backup of files to file server, and the system can organize files inside the file server according to course-subject folder hierarchy, the system allow user to transfer to other client computers and still can access his/her files and preserve his/her file organization. Moreover, based on the perception of respondents from the industry and potential users from the University the system is excellent in all the eight software quality characteristics as outlined by ISO 25010. This implied that the system conforms to the standard as set by ISO 25010.

Considering the findings of the study and the conclusions drawn, the researcher recommends that further study to enhance the algorithm that manages the network traffic created by surge of file in the network during backup should be enhance so that the system can extend its functional capability to gather files from peer client computer in the event that the file server is unavailable.

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