



Usability and Challenges of pfSense Deployed for Management of Library Networks, Servers and Users in Kano State University of Science and Technology, Wudil

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Abstract

This paper examined the usability and challenges of the pfSense application in managing library networks, servers, and users in Kano State University of Science and Technology, Wudil. An exploratory survey research design was employed for the study. The population of the study was composed of 36 professional librarians. The sample size for the study was eight head of library units. A purposive sampling technique was employed in selecting the sample respondents. Data were collected through focus group discussion and thematic descriptive analysis was the technique used for analyzing the data. The findings revealed that learnability and efficiency were the best usability feature of the pfSense routing and firewall application. It was also revealed that asymmetrical training and epileptic electric power supply was the major usability problem, important to be fixed with higher priority while poor ICT knowledge and skills were the minor usability problem, whereby fixing it should be given low priority. It is recommended that alternative sources of electric energy supply should be given more priority and regular ICT training for librarians should not be undermined by the University management.

Keywords: Library and Internet Services, Network Firewall and Routing, pfSense and Library Management

Introduction

The rationale for establishing academic libraries is to acquire and disseminate information resources for teaching, learning, research, and leisure (Klain-Gabbay & Shoham, 2019). In addition, academic libraries equally implement offline and online information resources management tools for efficient and effective provision of library services and resources (Koltay, 2019). To actualise the networking and sharing functions of academic libraries,



network facilities need to be deployed in the library for efficient and effective provision of library and internet driven services. Several types of routers and/or applications could be deployed to create network environment in which networking services can be provided or provisioned. A Router or Network Application is capable of creating a Local Area Network through which services from Internet, library, intercom or email can be delivered.

Some notable routers are Cisco, MikroTik, Ubiquity, LinkSys, D-link, TP-link and host of others. Not all these facilities can provide the required quality of firewall and routing capability needed by enterprise or academic institution like academic libraries. In some cases, few network facilities like Cisco and MikroTik with stable, efficient and rugged firewall and routing features are expensive and difficult to install and manage. Nevertheless, many similar Free and Open Source Firewall and Routing applications are available to offer alternative services. The cost associated with some of the installable networking and firewall applications is the initial cost of equipment covering computer system and installation processes. Some of the Free and Open Source firewall and routing application are pfSense (<https://www.pfsense.org/>), OPNSense (<https://opnsense.org/>), Untangle – NG Firewall (<https://www.untangle.com/>), ClearOS (<https://www.clearos.com/>), IPFire (<https://www.ipfire.org/>), Smoothwall Express (<http://www.smoothwall.org/>), IPCop (<https://distrowatch.com/>), ufw (<https://help.ubuntu.com/community/UFW>), Shorewall (<http://www.shorewall.org/>), Endian Firewall Community (<https://www.endian.com/>), VyOS (<https://www.vyos.io/>), Sophos XG Home Edition and others (Aggarwal, 2018).

Network application is one of the evolving ICT facilities that assists and facilitates librarians' responsibility, because it enables unification of library functions and harmonisation of information resources required to boost information resources connectivity, transfer, storage, share and utilisation in a way that library services and resources delivery perform central roles in academic activities of learners, researchers and lecturers/teachers (nwuchekwa, 2015).

Network applications allow network operators to easily manage and monitor network traffic as well as manage the activities of network users.(Steele, 2019) Network applications are full-flexed routing software that are available in routers such as D-Link, LinkSys, Ubiquity, Cisco, MikroTik, etc or could be installed and configured on workstations such as Lenovo, Dell, HP, etc. desktops or on cloud computing systems like Microsoft Azure, IBN Cloud,



Amazon Web Services, Google Cloud, Oracle, Salesforce, SAP, Rackspace Cloud, VMWare, Alibaba Cloud, etc.(Aggarwal, 2018).

The pfSense application, when installed, produces characteristics of a typical router and has the provision for add-ons software and services to extend functionalities, services, capabilities, securities, speed, robustness, and flexibility. According to Aggarwal (2018), “the first benefit is that pfSense is feature-rich, robust, and very flexible software. Besides the essential firewall features, it has tons of additional features **for network routing, remote connectivity, diagnostics, and reporting**, along with many more. What's more, it is an extensible platform”. Like MikroTik router board application, pfSense® software was designed to be a customizable platform that could be hardware agnostic, giving engineers the ability to meet the needs of the project with a device with the right I/O and specifications, and then customize the pfSense firewall software settings to their needs.

The concept of a “Firewall” refers to the classic network hardware firewall such as the Cisco ASA, Checkpoint, Fortigate etc. However, a firewall can be a software application that can be installed on any off-the-shelf physical server to transform it into a hardware firewall appliance or to protect the server itself as a local security programme. The pfSense has, among others, the following features: Routing and Firewalling, Load Balancing, Proxy, OpenVPN, Site-to-Site VPNs, Blocking of IP addresses based on Threat intelligence feeds, IP Reputation Threat Sources and IDS/IPS (Aggarwal, 2018). With these features, librarians can safely provide library services without fear of attack and hacks.

Responsibilities of librarians, by default, spanning from information identification, selection, and acquisition to dissemination are manifolds, which may also include, but not limited to, organising, preserving, sharing, cooperating, integrating, and weeding information resources appropriately as requisite to satisfy the information needs of ever-growing library users. Over the years now, the emergence of Information and Communication Technologies (ICTs) has made the roles of librarians broader, easier, flexible, faster, and encouraging (Therault, 2012; Nwuchekwa, 2015).

Librarians need to possess essential computer skills, including networking and applications skills and knowledge to be able to implement or manage networking facilities in libraries, successfully (Itsekor & Ugwunna, 2014). The essential computer skills requisite of librarians consists of basic computer skills, internet basics, email skills, Windows or Macs skills whereas the networking skills cover ability to identify types of IP addresses such as public,



private, static and dynamic, and knowledge on how to identify and basically configure Class C network and subnet masks Ubogu, 2021). Librarian should be able to perform basic installation processes, including plugging and unplugging network cables or connecting network-enabled gadgets to wireless fidelity networks.

Statement of the Problem

Preliminary investigation through the visitation of some library libraries such as University of Maiduguri, Federal College of Education Kano, Kogi State University, Federal Polytechnic Kazaure and others revealed that several network-related library services were not maximally provided due to insufficient or poor implementation of networking and routing systems, which paved ways for cracking and hacking activities. A form of Library and Internet services sabotage staged by students to take advantage of available internet services while engaging in social media interactions and downloading of movies or direct watching of online video clips. In addition, librarians mostly believe that without internet, library services cannot be provided through intranet or extranet or worst still, that the implementation of integrated library management system based on network connectivity are impossible. These assumptions manifested in the stoppage of many network related library services in most of the university libraries visited in Nigeria. It is against this background that this study explored the firewall and routing application for the management of library servers, network, and users in Kano State University of Science and Technology Wudil library.

Objectives of the study

1. To examine the usability of pfSense Network Application in Kano State University of Science and Technology Library
2. To determine the usability challenges of pfSense routing and firewall application in Kano State University of Science and Technology Library

Literature Review

Academic libraries in higher institutions of learning have started exploiting the benefits of networking facilities to provide distributed information contents (Ubogu, 2021). This is possible by deploying network application that is capable of providing captive portal for managing Internet Protocol (IP), Dynamic Network Service, and harmonisation of services as well as control of authentication, authorisation and access (Onwuchekwa, 2015). The network librarians can use captive portal to create links embedded with Uniform Resource Locators



(URLs) to offer out the library servers with Online Public Access Catalogue as well as information contents. In other words, networked library environment is a reliable requisite for teamwork among librarians and user-centric approach to information and library services delivery.

Library is a custodian of information resources, and provide systems, environment and supporting services in facilitating accessibility to all manner of reliable, trustworthy and useful information resources for learning, teaching and research activities in academic institutions (Oyelude & Bamigbola, 2012). As a prerequisite for successful educational achievement, library is setup and equipped with all resources, tools and librarians to identify, classify, organise, protect, preserve and as well provide user education (Pareek & Gangrade, 2016). The information resources that library acquire, purchase, receive as gifts or donation could be printed or electronic. Libraries can compute into, preserved in and disseminate electronic information resources from offline databases through intranet or extranet services (Adebayo, Ahmed & Adeniran, 2018; Gavit, 2019). In the same way, the online category of digital information resources could be subscribed from online databases providers and be accessible via Internet services (Pareek & Gangrade, 2016). In some cases, library can build institutional repository or depository from the collection of published or unpublished information resources in the form of articles, conference proceedings, workshop papers, projects, theses, dissertations as well as students' guide and course curricula.

Information and Communication Technology tools are essential components of library resources (Steele, 2019). To provide network services such as internet or intranet efficiently and effectively, library need to purchase networking tools such as router, wireless access points, switches, and maybe, network cables. To receive internet services, library must be subscribe to Internet package, which must consists of Modem and Internet service. Such internet services could come from Global System for Mobile Communication (GSM), C-band, KU-Band, and KA-Band (Adebayo, Ahmed & Adeniran, 2018).

Network systems like intranet, extranet or internet depend on Transmission Control Protocol or Internet Protocol (TCP/IP), and Domain Name Service (DNS) to transmit data and signals. In all network connections, IP addresses are the channels through which the data and signals pass between and among systems and humans. In the Internet Protocol Version 4 space, there are five classes such as class A, B, C, D and E. In addition, there are four types of IP address



such as Public, Private, Static and Dynamic IP address. Mulikat, Raji, Funsho, & Tajudeen, 2018).

The Benefits of Network in Libraries

The benefits of implementing network application in the libraries are diverse. For instance, network in libraries facilitate information resources distribution, Internet service sharing, and increasing storage capacities (Chucks, Sani & Moses, 2020). Kalbande (2019) affirmed, “today the walls of the library are giving way to electronic environments to establish links with information and virtual libraries that are getting shaped on the resource sharing and network. Each individual library is acting as a place for storage and services to the users while the trend is to provide shared information to the users”. Network application expedite cooperation and collaboration among library institutions and librarians across different locations (Li & Yang, 2018). Remote access and instant messaging are part of network functionalities that could be benefited by libraries (Pritting, Jones, Jackson & Mulligan, 2017). Network application equally enhance digital archiving and responsive retrieval of electronic information contents (Holfeld, Jaeuthe & Wirth, 2015). More so, network application boosts information discovery and linked data, which are important for cloud computing and big data collaboration among information agencies, including library institutions (Froud, 2016).

PFsense Router Board Application

PfSense was first created in 2004 as part of the project “m0n0wall” that aimed to create full-feature, embedded firewall software (Anina, 2021). It is a firewall/router computer software distribution based on FreeBSD with its Community Edition (CE) being partially open source while the pfSense-Plus is based on a closed source model. It is installed on a physical computer or a virtual machine to make a dedicated firewall or router for a network. It can be configured and upgraded through a web-based interface, and requires no knowledge of the underlying FreeBSD system to manage. The pfSense® has the firewall features such as: Stateful Packet Inspection (SPI), GeoIP blocking, anti-spoofing, time based rules, connection limits, dynamic DNS. Reverse proxy, and captive portal guest network. Its reliability and robustness are due to its strength of firewall, flexibility is use, open-source, user-friendliness, WireGuard support, fault tolerance and speed management (Baydan, 2017; Anina, 2021).

Minimum Hardware Requirement

- 64-bit amd64 (x86-84) compatible CPU
- 1GB or more RAM
- 9 GB or larger disk drive (SSD, HDD, etc.)
- One or more compatible network interface cards
- Bootable USB drive or higher capacity optical drive (DVD or BD) for initial installation

pfSense Firewall Use Case Diagram

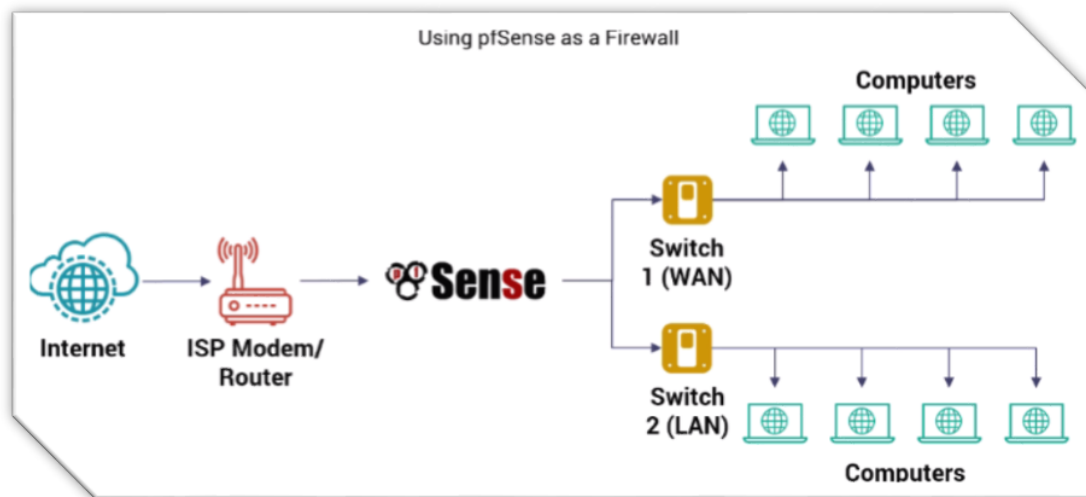


Fig. 1.1: pfSense® Firewall Use Case

PfSense takes Internet services from Internet Service Provider and simulates it to give out IP and DNS with internet services firewalled and provisioned based on the request of users. By doing this, the pfSense monitors and manages the requests or queries of the internet service users. While all management tools and functionalities are stationed in the backend of the pfSense, the captive portal is routed through web browsers of clients or workstations for interactivities with library or internet services. With the captive portal guest network, library users need to provide credentials for login, consisting of username and password, or Voucher for authentication, authorisation and access before using Internet services. However, URL are provided on the Graphic User Interface (GUI) as links, enabling the library users to click and access the library servers that provide OPAC or digital information resources.



PfSense Setup

The installation of pfSense can be done on a Personal Computer with minimum requirement of 120 Gigabytes of Hard disk, 4 Gigabytes Random Access Memory, 2.00 GHz processor and two Network Interface Controllers, Compact Disk or Digital Versatile Disk, and University Serial Bus. The installation of pfSense is not limited by these recommendations. Aggarwal (2018) enumerated that the installation of pfSense can be achieved through the following means:

1. **Optical disk image:** That could be an ISO image, a CD, or a DVD disc. This is an easy and familiar choice. Use this option if the target hardware has an optical drive. This is especially useful if the BIOS will not boot from USB.
2. **Memstick:** This option is similar to the CD or DVD, but runs the installation from a USB thumb drive. It is often faster than a CD or DVD. This is very useful with new devices, as many of them do not have integrated optical drives, making this the current best recommendation.
3. **Serial memstick:** This option is similar to the memstick image, but runs using the serial console rather than VGA for newer embedded systems.

It is mandatory to first download the PfSense software from the official website at <https://www.pfsense.org/download/>, considering the latest version. The pfSense application is of different architectures, such as AMD64 (64 bit) and Netgate ADI. The host of the application is also mirrored from different country such as New York City USA, Austin, TX, USA, Frankfurt Germany and Singapore. The pfSense® produces an installation and management environment. The installation environment is a Console. In this environment, about 17 command-based menus are available for executing important functions. The figure 1.2 displays the Console environment that gives access to several commands.


```

Enter an option: restart
VirtualBox Virtual Machine - Netgate Device ID: 9e6eeb2755c53e6da6b9
*** Welcome to pfSense 2.4.3-RELEASE (amd64) on pfSense ***

WAN (wan)      -> em0      -> v4/DHCP4: 10.0.2.15/24
LAN1 (lan)     -> em1      -> v4: 192.168.1.1/24
WAN2 (opt1)    -> em2      -> v4/DHCP4: 192.168.1.103/24

0) Logout (SSH only)          9) pfTop
1) Assign Interfaces          10) Filter Logs
2) Set interface(s) IP address 11) Restart webConfigurator
3) Reset webConfigurator password 12) PHP shell + pfSense tools
4) Reset to factory defaults   13) Update from console
5) Reboot system              14) Enable Secure Shell (sshd)
6) Halt system                 15) Restore recent configuration
7) Ping host                   16) Restart PHP-FPM
8) Shell

Enter an option:
  
```

Fig. 1.2: PfSense Console Administration

Depending on the goal that should be accomplished, each menu is meant to provide configuration processes that will ensure efficient and effective working of the application after the installation. However, the Console environment and the command-based functions therein cannot and is not expected to provide complete installation.

Dashboard for Graphic User Interface (GUI) of installed pfSense

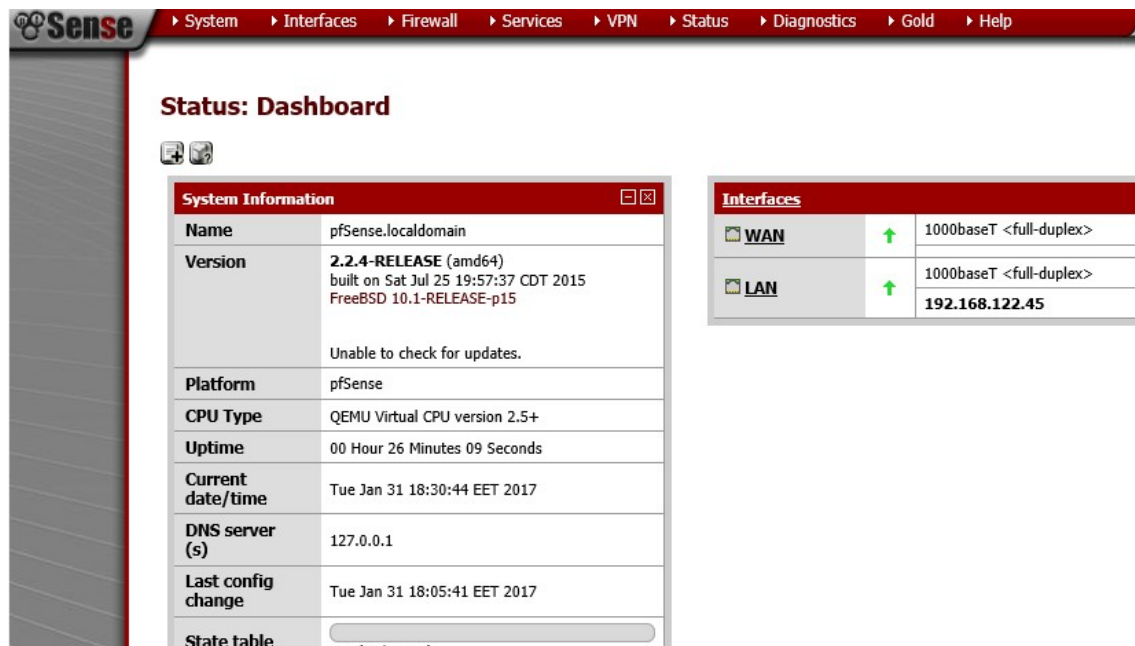


Fig. 1.3 PfSense Dashboard



The graphic user interface produces an environment where installation of ad-ons, components, services and running configurations are carried out. Each menu such as System, Interface, Firewall, VPN and status provides additional functionalities for effective and efficient management of the pfSense application. Figure 1.3 showcases the GUI of the pfSense.

Benefits of pfSense in the Library

PfSense provides Internet Protocol (IP) and Dynamic Network Service (DNS), which enable cataloguers, circulation librarians, serial librarians and e-librarians to connect their workstations to NewGenLib (NGL) server, Basic Electronic Information Library (BEIL) server, The Essential Electronic Agricultural Library (TEEAL) server without necessarily logging in. In addition, with the captive portal interface, and upon login, the library users are directed to an interface where they are permitted to click on the links of the offline and online databases such as the ScienceDirect (Elsevier), EBSCOhost, Google and Google scholar search engines.

To access the Online Public Access Catalogue (OPAC) being provisioned by the New Generation of Library Automation and Networking (NewGenLib or NGL), the workstations are identified by pfSense and supplied with Fully Qualified Domain Name (FQDN) or dedicated IP address, on demand. Much the same way, links are made available for accessing online databases or public search engines, the OPAC is the immediate GUI that both library users and librarians can access to search, find, locate and evaluate the full bibliographic information of printed information resources in the library. More so, the discovery functionality of the NGL allows the OPAC users to find alternative answers to the search request if Internet service is provided by the pfSense on the workstation used by the library users.

The digital or e-librarians use the pfSense to design and develop captive portal in which links to library servers are embedded. The login credentials, in form of user names and passwords, or vouchers, are created to manage and monitor library users' login and usage activities. Circulation librarian can remotely access the NGL and provide charging and discharging services to library users. The cataloguers can use the IP address provisioned by the pfSense to access the NGL, create bibliographic metadata, and upload electronic information resources.



Circulation services such as charging and discharging of information resources, users' registration, electronic information resources upload, information contents organisation, centralised administration of information contents, unification of users profiles, information retrieval and transfer, authentication, authorisation and access control can be provisioned and supported by the pfSense functionalities.

Usability of pfSense

Innovations in Information and Communication Technologies (IICT-2020). (2021) has described pfSense as highly scalable, flexible, effective, accommodative, secured, stable and easy to deploy. Bevan, Carter., Earthy, Geis, Harker (2016) described as the system usability, which comprises the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use, where:

- (a) Effectiveness measures the accuracy and completeness with which users achieve specified goals;
- (b) Efficiency measures the resources expended in relation to the accuracy and completeness with which users achieve goals;
- (c) Satisfaction measures the freedom from discomfort, and positive attitudes towards the use of the product.

It is pointed out by Innovations in Information and Communication Technologies (IICT-2020) (2021) that the factors that help in defining the usability of application include learnability, efficiency, memorability, error-and-error frequency, and satisfaction. For instance, Bevan, Carter., Earthy, Geis, Harker (2016) emphasized that learnability has to do with how quickly an individual user that is new to an application learns the user-interface to accomplish basic tasks by looking at its intuitiveness. They further explained that efficiency of application explains how quickly an individual user can perform tasks. Furthermore, memorability, according to the authors, refers to how quickly an individual user can remember how to use an application effectively or how the user can quickly relearn everything from the beginning. Errors-and-error frequency too is explained as the errors that an individual user makes while using an application. It also measures the serious level of the errors as well as how such individual can easily recover from these mistakes. Finally, satisfaction explains the feeling of success for completing a task with the application by a



user, which motivates the individual to return to the application when the need arises (Bevan, Carter, Earthy, Geis, Harker, 2016).

Brief history of Kano University of Science and Technology, Wudil Library

Kano State University of Science and Technology (KUST) library was established in April 2001 with the mission to support, strengthen and enhance the instructional and research programmes of the University providing adequate and relevant information through the acquisition, organisation, preservation and dissemination of processed information resources, working tools, and services to the university community users. For effective service provision and the desire to improve the operation efficiency, the main library is organised into department and units such as (a) Technical Services department, (b) Readers Services Department consisting of Circulation, Reserve and Reference services, (c) Serials Department, (d) e-Library/Automation Department, and (e) administrative department.

As part of its efforts for effective and efficient information resources and service provision, subscription to EBSCOhost, ScienceDirect (Elsevier) were made and offline databases such as, New Generation of Library Automation and Network (NewGenLib), eGranary, The Essential Electronic Agricultural Library (TEEAL), Basic Electronic Information Library (BEIL) were implemented and supported with PfSense Router Board Network application for connectivity, teamwork and provision of library' information resources and services.

pfSense Captive Portal Client Network GUI

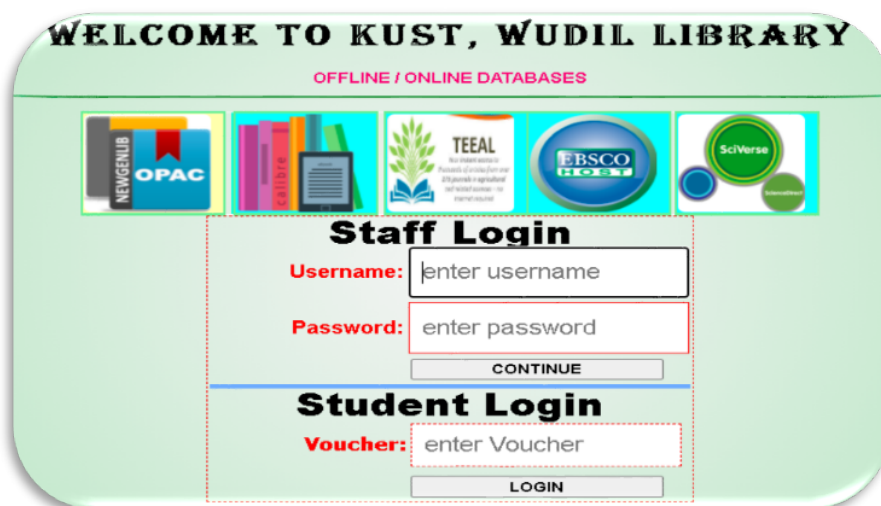


Figure 1.2: pfSense® Captive Portal Graphic User Interface



The figure 1.2 presents the pfSense Captive Portal Graphic User Interface, displaying various icon/logo with embedded links of library servers such as New Generation of Library Automation and Network (NewGenLib), Basic Electronic Information Library (BEIL)—an in-house offline-accessible database for dissemination of both e-books and e-journals, The Essential Electronic Agricultural Library (TEEAL), EBSCOhost and ScienceDirect (Elsevier) databases. Due to the flexibility of pfSense, unlimited number of URL links can be created to access offline or online databases. In addition, the pfSense networking application also provides powerful tool for Authentication, Authorisation and Access (AAA) as a means to manage library users' activities like login, timing and bandwidth for accessing Internet services, Internet-based information resources and Intranet-based offline databases. The pfSense provide login credentials like username and password or vouchers.

Material and Method

An exploratory survey research design was employed for the study. The population of the study composed of 36 professional librarians. The sample size for the study were eight heads of library units. Purposive sampling technique was deployed in selecting the sample respondents. Data were collected through focus group discussion. The discussion was held for one hour and twenty minutes. Thematic descriptive analysis was the technique used for analysing the data.

Data Presentation and Analysis

Total 2: Usability of the pfSense Network Application for Library operation in Kano State University of Science and Technology

pfSense Features	Learnability	Efficiency	Memorability	Error Frequency	Satisfactory
Connectivity/ Accessibility	8	6	5	7	5
Cooperation/ Collaboration	5	5	7	4	4
Sharing/ Transfer	7	4	3	4	5
Services delivery	8	7	8	6	5
Performance/ Productivity	6	6	4	6	5
Total Responses in Freq. (%)	34 (70.8%)	28 (58.3%)	27 (56.3%)	27 (56.3%)	24 (50.0%)

Usability Rating: Total rating = 48 (100%); 0 - 50 = Not usable; 50 - 100 = usable;



Connectivity and Accessibility

The group discussion between the research and eight librarians on the capability of pfSense to support connection to Internet and library and access to information resources produced the following results. All the 8 respondents agreed that *they learnt to use the user-interface of the pfSense quickly and was easy for them to accomplish basic tasks by merely looking at its intuitiveness*. 6 out of 8 respondents during the group discussion stated that *they were able to perform their library services as quickly as possible with the pfSense application in a way that they always achieve higher productivity*. 5 out of 8 respondents emphasized that they found it easy and quick to remember the processes and steps in effectively carrying out functions that involved the connection and accessibility to information resources via the pfSense routing and firewall application. 7 respondents affirmed that they frequently encounter error and quickly respond to the errors while using the routing and firewall applications, while 5 of the respondents professed that they attained feeling of success for completing tasks with the application and were motivated with the flexibility and ease of connectivity and accessibility functionality provisioned by the pfSense routing and firewall application.

Cooperation/ Collaboration

In the course of the group discussion, 5 respondents declared that *learning to cooperate or collaborate and efficiency in using the pfSense routing and firewall application were quick and acceptable*. In term of memorability, 7 out of 8 respondents admitted that *they were able to remember quickly on how to cooperate and collaborate with the pfSense application*. Meanwhile, 4 of the respondents posited that *they found errors when cooperating among the librarians*, whereas 4 respondents also acknowledged that they were satisfied with the possibility to cooperate or collaborate with the help of the pfSense routing and firewall application.

Sharing/ Transfer

The views of the respondents on the functionality of the pfSense to support and facilitate data or information sharing and transfer was captured. According to the information gathered, 7 respondents responded that it was *easy and flexible for them to learn to share and transfer information with the aid of pfSense routing and firewall application*. In addition, 4 respondents reported that *it was efficient for them to share and transfer data and information*,



while frequently making encountering errors which they were able to overcome. In the same vein, 3 respondent asserted that they could remember easily to share and transfer data or information contents across themselves with the application. Furthermore, 5 respondents advanced that they were satisfied with the ease at which they were able to share and transfer data and information over the network provided by pfSense routing and firewall application.

Services delivery

Question about library and internet services delivery were presented for discussion among the respondents. 8 respondents were affirmative that learning to use pfSense routing and firewall application for library and internet services delivery was very easy them whereas 8 of the respondents equally specified that they found it easy to remember how to use the application. 7 respondents stipulated that they were able to carry out library and internet services delivery efficiently with the application. While 6 respondents said that they encountered errors in the course of delivering library and internet services to the library users, 5 of the respondents stressed that they were satisfied with the library and internet services delivering capabilities of the pfSense routing and firewall application.

Performance/ Productivity

Discussion was staged to look at the degree of performance or service productivity that were experienced by the respondents and the following summaries were deduced. 6 of the respondents agreed that the ease of learning to use the pfSense routing and firewall application boosted their performance in their library services delivery. 6 of the respondents also acknowledged that the application efficiently made them gained higher productivity. Equally, 6 of the respondents responded that they also experienced errors with the application. While 4 of the respondents emphasized that it was easy for them to remember on how to use the application, which bolster their performance or productivity, 5 of the respondents declared that they were satisfied with the application because it facilitated their degree of performance or productivity.

Summarily, from the data presented and analysed, it could be deduced that the pfSense routing and firewall application did not provide the same level of experience in terms of



learnability, efficiency, memorability, error frequency and satisfaction to the respondents engaged in the group discussion. The cumulative responses on the learnability to use the pfSense routing and firewall application for connectivity, cooperation, sharing, and performance was 70.8%, 58.3% for efficiency, 56.3% for memorability and error frequency respectively, and 50.0% for satisfaction.

Table 3: Usability challenges to the use of pfSense Network Application in Kano State University of Science and Technology, Wudil

Thematic Code	Poor ICT knowledge and skills	Epileptic electric power supply	Poor/insufficient/disrupted Internet service	Rampant Viruses/malwares	Asymmetrical training
A01	1	3	2	0	3
A02	2	3	0	1	3
A03	2	3	1	0	3
A04	3	3	1	0	3
A05	2	3	0	1	3
A06	2	2	1	4	3
A07	2	4	2	3	3
A08	3	3	1	0	3

Severity Rating:

0 = I don't agree that this is a usability problem at all

1 = Cosmetic problem only: need not be fixed unless extra time is available on project

2 = Minor usability problem: fixing this should be given low priority

3 = Major usability problem: important to fix, so should be given high priority

4 = Usability catastrophe: imperative to fix this before product can be released

Usability challenges can be a serious disruption to the benefits that applications can offer to the users. In the group discussion held with the librarians at Kano State University of Science and Technology, Wudil, Library, some challenges that affected the usability of pfSense routing and firewall application were revealed. It was found that 5 of the discussants stated that poor ICT knowledge and skills constituted minor usability problem: fixing this should be given low priority whereas 2 of the discussants believed that poor ICT knowledge and skills was a major usability problem, important to fix, so should be given high priority.

Similarly, 6 out of the 8 discussants emphasized that **epileptic electric power supply was a major usability problem: important to fix, so should be given high priority**, while one of the respondents asserted that epileptic electronic power supply was a usability catastrophe: imperative to fix this before the pfSense routing and firewall application could reveal its benefits.



The challenge regarding **poor/ insufficient/ disrupted Internet service** was considered by 4 of the respondents as cosmetic problem only: need not be fixed unless extra time is available on project. While 2 of the discussants said that they did not think it was a usability problem, other 2 respondents confirmed that poor/insufficient/ disrupted internet services was a minor usability problem: fixing this should be given low priority, when implementing pfSense routing and firewall application in the library.

The challenge of rampant Viruses or malwares was considered by 4 of the respondents as not a usability problem while only 2 discussants agreed that rampant viruses / malwares was a cosmetic problem that only need not be fixed unless extra time was available on project. In the same vein, all the 8 respondents unanimously agreed that asymmetrical training was a major usability problem: important to fix, so should be given high priority.

Major Findings

The usability of pfSense network application was discussed among the researcher and the respondents, heading the units in Kano State University of Science and Technology, Wudil. The themes of discussion were the learnability, efficiency, memorability, error frequency and satisfaction in terms of connectivity and accessibility, cooperation and collaboration, sharing and transfer, service delivery, and performance and productivity. It was revealed that learnability and efficiency were the highest quality of feature of the pfSense application. The findings also revealed that the usability challenges faced by the respondents regarding the usability of the pfSense were major usability problem such as asymmetrical training and epileptic electric power supply considered important to be fixed, and therefore should be given high priority. In addition, poor ICT knowledge and skills was affirmed as a minor usability problem, whereby fixing it should be given low priority.

Conclusion

The pfSense application is a firewall and routing application. pfSense can be installed on most commodity hardware, including old computers and embedded systems. pfSense is typically configured and operated through a user-friendly web interface, making administration easy even for users with limited networking knowledge. Normally, one never needs to use terminal or edit config files to configure the router. Even software updates can be run from the web UI. pfSense is mostly used as a router and firewall software, and typically configured as DHCP server, DNS server, WiFi access point, VPN server, all



running on the same hardware device. pfSense also allows for installation of third party open source packages such as Snort or Squid through a built in Package Manager, making it the default choice of many network administrators.

Recommendations

Academic libraries should deploy pfSense® to take advantage of its firewall and routing capabilities for the management of library services—offline and online, networks—Internet, Intranet or Extranet, users—librarians and clientele. Information resources—printed or digital contents.

To derive the best benefits from pfSense for the management of library networks, servers and users, the librarians in academic libraries should be competent in Information and Communication Technology, covering basic computer systems, Internet services and Local Area Network facilities management; installation of applications, offline or online database servers, as well as integrated library management systems or software.

References

- Adebayo, O. A. Ahmed, Y. O.; & Adeniran, R. T. (2018). The role of ICT in provision of library services: a panacea for sustainable development in Nigeria. *Library Philosophy and Practice (e-journal)*. 1951. <http://digitalcommons.unl.edu/libphilprac/1951>
- Bevan N., Carter J., Earthy J., Geis T., Harker S. (2016) New ISO Standards for Usability, Usability Reports and Usability Measures. In: Kurosu M. (eds) Human-Computer Interaction. Theory, Design, Development and Practice. HCI 2016. Lecture Notes in Computer Science, 9731. Springer, Cham. https://doi.org/10.1007/978-3-319-39510-4_25
- Chucks, E. & Sani, Y. & Moses, T. (2020). A review of information and communication technology (ICT) facilities for the implementation of virtual library management system. *International Journal of Scientific and Engineering Research*. 11. 448-460.
- Froud, R. (2016). Resource sharing in the UK public library system: An update. *Interlending & Document Supply*, 44(4): 169–171. DOI: <https://doi.org/10.1108/ILDS-07-2016-0026>
- Gavit, B. K., (2019). Web Based Library Services. *Library Philosophy and Practice (e-journal)*. 2931. <https://digitalcommons.unl.edu/libphilprac/2931>
- Holfeld, B, Jaeuthe, T & Wirth, T. (2015). Resource Sharing with Minimum QoS Requirements for D2D Links Underlying Cellular Networks. In: Vehicular



Technology Conference, 1–7. Glasgow, UK. 11–14. DOI:
<https://doi.org/10.1109/VTCSpring.2015.7146058>

Innovations in Information and Communication Technologies (IICT-2020). (2021). In P. K. Singh, Z. Polkowski, S. Tanwar, S. K. Pandey, G. Matei, & D. Pirvu (Eds.), *Advances in Science, Technology & Innovation. Springer International Publishing*.
<https://doi.org/10.1007/978-3-030-66218-9>

Itsekor V.O. & Ugwunna I.S. (2014). ICT competencies in the 21st century library profession: a departure from the past. *Inter. J. Acad. Lib. Info. Sci.* 2(5): 51-57.
<http://www.academicresearchjournals.org/IJALIS/Index.htm>

Klain-Gabbay, L. & Shoham, S. (2019). The role of academic libraries in research and teaching. *Journal of Librarianship and Information Science* 1 –16
<https://doi.org/10.1177/0961000617742462>

Ducas, A., Michaud-Oustryk, N., & Speare, M. (2020). Reinventing ourselves: new and emerging roles of academic librarians in Canadian Research-Intensive Universities. *College & Research Libraries*, 81(1), 43.
doi:<https://doi.org/10.5860/crl.81.1.43>

Koltay, T. (2019). Accepted and emerging roles of academic libraries in supporting research 2.0. *Journal of Academic Librarianship*. 45(2), 75-80. DOI:
10.1016/j.acalib.2019.01.001.

Li, J. and Yang, S., (2018). Design and Implementation of Information Resource Co-Construction and Sharing System in Electronic Library. *Data Science Journal*, 17, p.32. DOI: <http://doi.org/10.5334/dsj-2018-032>

Mulikat, A., Raji, K., Funsho, B. & Tajudeen, Y. (2018). Planning, Designing, and Implementing a Local Area Digital Library Network. *Scientific Inquiry and Review*. 2. 28-41. 10.29145/sir/22/020204.

Onwuchekwa, E. O. (2015). Resource sharing and networking in library and information centres in Africa. (Third Edition), *Encyclopaedia of Information Science and Technology*. 3870-3881 pages, IGI Global. <https://doi.org/10.4018/978-1-4666-5888-2>.

Oyelude, A.A. and Bamigbola, A.A. (2012). Libraries as the gate: “ways” and “keepers” in the knowledge environment. *Library Hi Tech News*, 29(8) 7-10.
<https://doi.org/10.1108/07419051211287615>

Pareek, N. & Gangrade, A. (2016). Role of the Libraries as Information Resources in Globalization. *International Journal of Librarianship and Administration*; 7(1), 13-23. https://www.ripublication.com/ijla16/ijlav7n1_03.pdf



- Pritting, S, Jones, W, III, Jackson, T & Mulligan, M. (2017). Enhancing Resource Sharing Access through System Integration. *Journal of Interlibrary Loan Document Delivery & Electronic Reserve*, 26(1): 1–14. DOI: <https://doi.org/10.1080/1072303X.2017.1305034>
- Steele, C. (January 29, 2019). Why is computer networking important? Digital Divide Council. <http://www.digitaldividecouncil.com/why-is-computer-networking-important/#:~:text=%20Importance%20of%20computer%20networking%20%201%20Cut,flexible%20operations.%20The%20data%20is%20not...%20More%20>
- Therault, M. (November 27, 2012). The importance of networking: It's not just about socializing. Condobusiness; Part of the [reminetwork.com](http://www.reminetwork.com) <https://www.reminetwork.com/articles/the-importance-of-networking/>
- Ubogu, J.O. (2021). The Role of Librarian in the Twenty-first Century. Chigwada, J.P. and Nwaohiri, N.M. (Ed.) Examining the impact of industry 4.0 on academic libraries. *Emerald Publishing Limited, Bingley*, 91-102. <https://doi.org/10.1108/978-1-80043-656-520201017>