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Proposal for the implementation of IPTV services at the Polytechnic Higher Institute of Bié, Angola

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Abstract

This research work aims to improve the teaching-learning process using the implementation of IPTV services at the Polytechnic Higher Institute of Bié, based on the requirements of QoS (Quality of Service) and QoE (Quality of Experience) parameters. The implementation of IPTV services provides enormous potential in higher education, its conditions provide an active and collaborative education in the academic environment. The conducted research was a type of applied nature. From the point of view of its objectives, it is exploratory, descriptive and explanatory. To collect the data, the questionnaire survey and the interview were used. It has a qualitative approach and the technical procedure used was bibliographic and case study. The obtained results in the implementation of the proposed solution, it proved to be innovative and effective for the teaching-learning process at the Polytechnic Higher Institute of Bié, allowing the incorporation of VLE (Virtual Learning Environments) such as; the platforms MOOC (Massive Open Online Course), edX, Coursera, OCW MIT, MIRÍADA X, VEDUCA, OPENUPED and education support tools with contents for the use of IPTV, from the configuration of plugins on the plex media server, it allows communication between students and teachers reducing distance.

Keywords: IPTV; IPTV services; QoS; QoE; Virtual Learning Environment.

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1. Introduction

With the evolution of information and communication technologies, different ways of communicating data have emerged. One of the ways that has been evolving is sending instant messages, videoconferencing and sending audio and video, which together with the advancement of social networks, online radios and the emergence of the internet, it gave rise to video streaming. Streaming is the distribution of multimedia content over a network. In higher education, the main services that streaming can offer are; videoconferencing, interactive chats, virtual classrooms and even online classes. In the telecommunications market, companies are required to innovate, keeping up with new technologies, so that there is a major competitive advantage over the competition, it is capable of significantly improving the needs and aspirations of the Customer [1]. Advances in technologies of telecommunications have enabled the creation and development of new mechanisms for disseminating content to users [2]. Technologies such as IPTV (Internet Protocol Television) is defined as the distribution of television signals to users through a broadband connection over IP (Internet Protocol) enabling personalized and interactive user experiences, they are examples of these [3]. IPTV is an important tool for changing business structures and goes beyond subscription-based business models for telecommunications operators [4]. IPTV has revolutionized the media and telecommunications industries by providing a platform for broadcasting digitized television services over the Internet Protocol infrastructure [5]. IPTV offers complete interactivity and unlimited content. The multimedia services provided by IPTV ensure reliability, security, interactivity, personalization, QoS and QoE [6]. The proposed solution consists of a multimedia server, the plex media server, a client, a plex data center, a network storage device, and the NAS. In the implementation of the proposed solution, plugins were integrated that will enable the integration of VLE (Virtual Learning Environments), platforms such as; MOOC - Massive Open Online Course or as known Massive Online Courses, such as edX, Coursera, OCW MIT, MIRÍADA X, VEDUCA, OPENUPED and educational support tools with content for the use of IPTV like; IPTV USP, e-Aulas USP, E-UNICAMP, and KHAN ACADEMY. To integrate plugins in the proposed solution, it is sufficient to have a valid URL (Uniform Resource Locator). The general objective is to improve the teaching-learning process using the proposed implementation of IPTV services at the Polytechnic Higher Institute of Bié, Angola. It is based on the requirements of QoS and QoE parameters. The specific objectives are; to diagnose the existing network infrastructure that supports the implementation of IPTV services at the Polytechnic Higher Institute of Bié, Angola; to present the integration of virtual learning environments in the solution developed for the teaching-learning process at the Polytechnic Higher Institute of Bié, Angola; to develop a proposal for the implementation of IPTV services at the Polytechnic Higher Institute of Bié, Angola; to test the validation of the proposed solution; to propose the implementation of IPTV services at the Polytechnic Higher Institute of Bié, Angola. These objectives will be achieved through extensive research and literature review.

2. Literature review

2.1. General concepts

IPTV can be defined as multimedia services such as; television, video, audio, text, graphics and data delivered over IP-based networks that can provide the required level of QoS, QoE, security, interactivity and reliability. [6]. IPTV is a multimedia application that uses User Datagram Protocol (UDP) at the transport layer. Delay and

packet loss can affect the QoS of IPTV [7]. IPTV is similar to OTT because its structure is based on the Internet infrastructure. IPTV differs from OTT because it is built on the system operator's intranet and OTT is built on public networks [8]. IPTV is based on multicast IP address, with packet aggregation capability [9]. The Quality of Service (QoS) has the function of allowing the IPTV packet to have guaranteed delivery to the subscriber, using the appropriate QoS mechanisms (Diffserv) and the Quality of Experience (QoE) refers to the quality of service experienced by the final user. QoE in IPTV means a degree of image quality experienced by a viewer who is watching IPTV [10].

2.2. IPTV Services

IPTV providers mainly provide two streaming services; live channels and VoD. [6]. In summary, the contents offered by IPTV are presented like; scheduled or linear TV services, Content on Demand (CoD) or Video on Demand (VoD) services, Personal Video Recorder (PVR), notification service, communication service, information service and advertising service [6].

2.3. Advantages and disadvantages of IPTV

IPTV typically has the advantage of providing more television channels than traditional television services [11]. IPTV offers the following main advantages; variety of vast available content, flexibility of access, image and sound quality, interactive resource [4]. The development of IPTV technology faces serious problems and difficulties of different nature, both technical and economic [12]. In short, the main disadvantages are; dependence on internet connection, legality issues, cost, dependence on IPTV provider.

2.4. IPTV Architecture

The general architecture of IPTV explains the different stakeholders of IPTV and the relationships between them such as; content provider domain, service provider domain, network provider domain and final user domain [6]. The basic architecture of IPTV consists on the following elements: acquisition servers, distribution servers, video-on-demand (VoD) creators and servers, IP routers and STBs [6]. The IPTV system includes a television, a set-top box (STB) for accessing video-on-demand (VoD) channels and services, e.g. Netflix, together with an Internet connection [13]. IPTV over wireless technology has emerged as the first-line system solution for classic cable structures and broadcast systems [14].

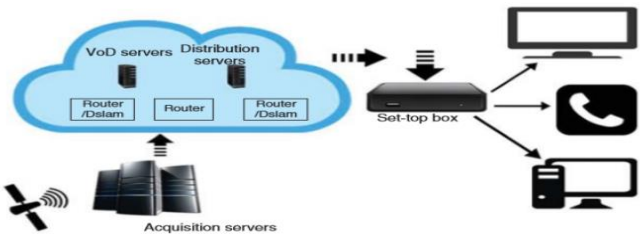

Figure 1: Basic architecture of the IPTV system [6]

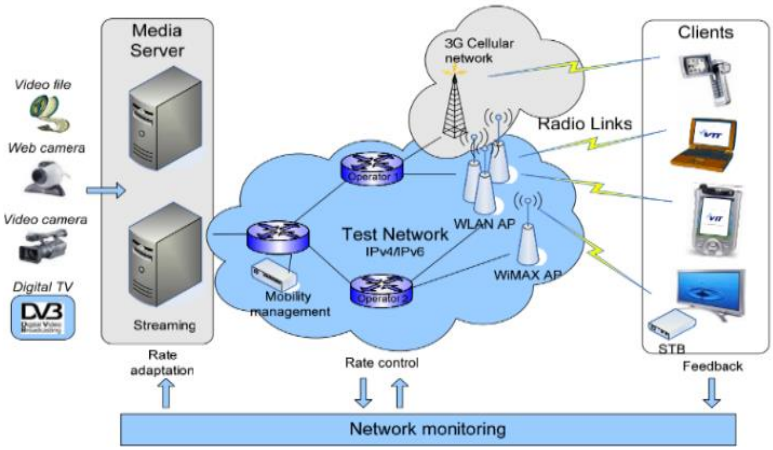

Figure 2: Architecture of the wireless IPTV development platform [15]

2.5. IPTV versus Internet Television

IPTV is sometimes confused with Internet TV delivery. Although both environments rely on the same core technology, their approaches to deliver IP-based on video differ in the following ways; Unlike other platforms, Internet TV leverages the public Internet to deliver video content to the final users. IPTV, on the other hand, uses secure, dedicated private networks to deliver video content to consumers [16].

2.6. IPTV versus Cable TV

With cable TV, customers receive all channels at the same time and the selection is made on the set-top box or on TV, while IPTV customers receive one channel at a time. When the channel changes, the equipment notifies a server, which sends the programming that the viewer wants to watch at that moment. This creates an almost infinite capacity of channels since the TV is connected to an interactive medium, it allows video on demand, doing away with the concept of a programming grid. IPTV allows the TV to be integrated with other devices at home, such as; telephone, computer and mobile phone. And one of the possibilities is to program the recording of a channel on the mobile phone, as if it were a remote control that works remotely. The customer can identify who is calling on the TV screen or transfer music, videos and photos from the computer to the TV. Instead of delivering all channels simultaneously to each subscriber, IPTV technology allows service providers to make available on the network only the channel stream that the final user has requested.

2.7. IPTV Security

In the IPTV market, there are three main types of technology used to protect the intellectual property (IP) rights of video applications: content protection systems (CPSs), conditional access systems (CAS), Digital Rights Management (DRM) [17]. The main security mechanisms in IPTV are using encryption such as; SSL/TLS, AES or DRM, to protect communication between servers, streaming devices and user applications. Implementing authentication is the process of verifying the identity and legitimacy of the parties involved in an IPTV transaction, monitoring and updating, they are the processes of tracking and improving the performance and security of the IPTV system, Education and information, they are the processes of raising awareness and

knowledge about IPTV security problems and solutions [18].

2.8. Existing threats to IPTV implementations

IPTV, before delivering the content to a set-top box (STB), the content travels through one or more networks. Consequently, it inherits all the security vulnerabilities existing in the network. The main threats to IPTV networks are; IPTV asset abuse, service theft, IPTV (related data) theft, service disruption, privacy breach and platform integrity compromise [17].

3. Methodology

The methodological approach adopted for this study was qualitative in nature, based on technical bibliographic research procedures and a case study applied to the Polytechnic Higher Institute of Bié. The research followed an applied logic, with exploratory, descriptive and explanatory objectives, aiming not only to identify, but also to understand and propose solutions for the implementation of IPTV services in the educational context.

Data collection was carried out using two main instruments; questionnaire surveys administered via Google Forms, and semi-structured interviews conducted via the Google Meet platform. These techniques allowed us to capture in-depth insights from potential users of the proposed solution, ensuring an analysis contextualized to the Angolan reality.

The development of the research was structured in six fundamental stages: (1) definition of a robust conceptual and theoretical framework; (2) detailed planning of the case study; (3) conducting a pilot test, aiming to improve the data collection instrument; (4) data collection itself; (5) rigorous analysis of the data obtained; and (6) preparation of the final report.

In order to ensure the validity of the results and their suitability to the local reality, a content validation was carried out with the help of experts in the field, using Kendall's concordance coefficient (W). The result obtained (W = 0.243, Sig = 0.557) indicated a positive correlation, reinforcing the clarity, relevance and objectivity of the study.

Additionally, technological tools such as; inSSIDer, NetSpot, WiFi Analyzer and Wireshark were used to diagnose the Polytechnic Higher Institute of Bié-network infrastructure, contributing to an accurate analysis of the existing conditions. For the implementation of the IPTV solution, Plex Media Server was used, which played a central role in the management of multimedia content. The network architecture model was developed using the Drawing tool, which facilitated the visualization and organization of the technical components of the proposed system.

4. Discussion and Results

4.1. Estimation of the required transmission speed on local network links

The estimated transmission speed required on local network links is calculated using the following expression:

$$V = 50\ Mbps\ x\ 10\ user = 500\ Mbps \qquad (1)$$

The estimate calculation was made at Polytechnic Higher Institute of Bié, with 50 Mbps of bandwidth, for the number of 10 users according to the proposed solution, with 50 Mbps the maximum transmission speed between the computer (server) and the central device of the network is 500 Mbps, it is a totally viable transmission speed if you have to use a wired connection between the router and the server.

4.2. Description of the proposed solution

The proposed solution is called Polytechnic Higher Institute of Bié-IPTV, and its purpose is to offer great opportunities and benefits in the teaching-learning process at Polytechnic Higher Institute of Bié, Angola. These parties include; content creators, broadband network owners and service brokers. The connection between these parties is represented in the general architecture of the proposed solution. The implemented architecture consists essentially of four domains, namely; content provider, service provider, network provider and finally, the final user, i.e., multimedia server, VoD server, Plex Media Center or application center and the client as illustrated in Figure 3.

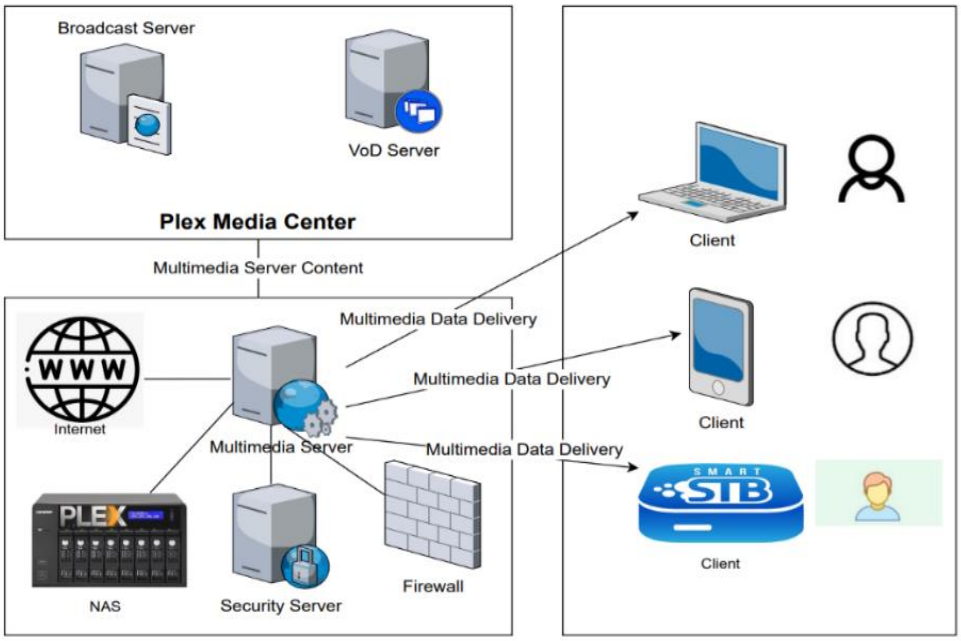

Figure 3: General architecture of the solution

The multimedia server receives the multimedia data and transmits it to the network in an encoded form, i.e., it streams the IPTV content to the clients. It is responsible for encoding video and audio using the most appropriate technology to facilitate transmission. The server has access to the multimedia data that is stored in two specific locations; broadcast content, where the data transmitted in this mode is located, and video content, where the data sent when a request for content made is stored. In the case of television content, this can be received from another location, such as; the Internet, where a data stream is received and, through transcoding, forwarded to the client. Data delivery is done in two ways, depending on the service being performed. In the

case of video on demand, when a client requests a certain content, it is delivered in full, from the initial moment. The protocol used for data delivery is RTP (Real-Time Transport Protocol), as together with RTCP (Real Time Transport Control Protocol) and RTSP (Real Time Streaming Protocol) it allows synchronization and configuration (for example, choice of codecs) necessary for IPTV transmission.

NAS (Network Attached Storage) works as a storage device connected to one or more local networks to store, manage and back up data. NAS is also a file-based storage server equipped with features against data loss.

The plex media center or application center is the coordination point that allows the distribution of IPTV services. It consists of two servers that receive requests from clients and respond with information regarding the available content. The broadcast server has the addresses that allow the client to receive data related to a channel, while the video-on-demand server stores the information regarding the reception of videos transmitted exclusively to the client.

The role of the client software in this architecture is to serve as an interface between the user and the plex media center in a first phase, where information regarding the available content reaches the client software from one of the service servers.

4.3. Implementation and evaluation of proposed IPTV services

In the implementation and evaluation of proposed IPTV services, it is important to describe the implementation of the proposed solution. An analysis of the software solutions that will be used is addressed, followed by a description of various aspects related to the implementation of the solution. Finally, the results obtained from the tests applied to the developed project are presented.

The main feature of a multimedia server is its ability to distribute data streams across the network to be received by clients. The multimedia server must have streaming server functionality.

Table 1: Types of multimedia servers

Name	Organization	Operating Systems	Free	Features
Darwin Stream Server	Apple	Linux, Windows, MacOS and others	Yes	Server and proxy.
Live 555 Media Server	Live 555	Linux, Windows, MacOS and others	Yes	Server (RTSP/RTP), trick play (pause, seeking, fast forward, reverse play).
VLC	VideoLan	Linux, Windows, MacOS and others	Yes	Player, server, other features.
WMS	Microsoft	Windows	No	Server, other features.
PLEX	Plex	Linux, Windows, MacOS and others	Yes	Server, other features.
KODI	XBMC Foundation,	Linux, Windows, MacOS, FreeBSD and others	Yes	Server, other features.
Emby	Emby	Linux, Windows, MacOS, FreeBSD and others	Yes	Server, other features.

From the studied applications, the ones that stood out the most were those belonging to the free software community, due to their capacity for integration into the developed project, which was also based on this type of software. From these tested applications, the one that allowed the greatest room for maneuver and integration into the project was Plex Media Server. Its features and supported protocols, as well as its streaming quality and robustness made this software the best choice for this project. One of these features is the ability to configure the server in real time remotely, specifically configuring broadcasting streams, VoD through configuration files, simple to navigate, with a pleasant interface, its use on a NAS (Network Attached Storage) and it has a lot to offer.

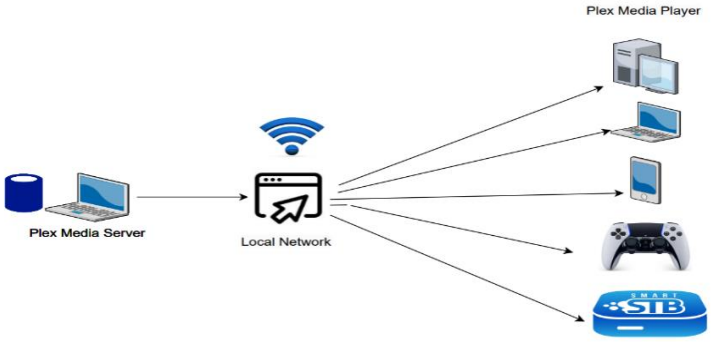

Figure 4: Schematic diagram of the proposed solution

4.4. Construction of the proposed solution on the plex media server

To install the plex media server, you must first download the plex media server, you must access the plex website [19].

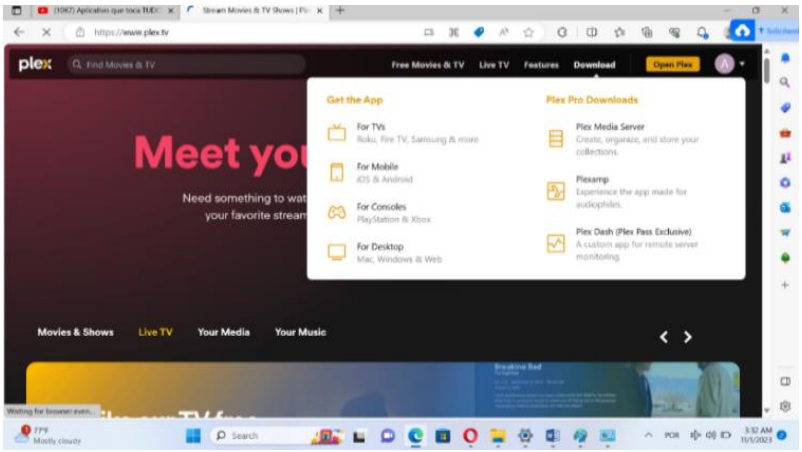

Figure 5: Plex main download panel [19]

After the window above, click on plex media server and then select the operating system, click on Choose Distribution and then install the plex media server.

To verify that the installation has been completed successfully, proceed to add a “Library”: click on “Add

Library"; select, assign a name to the library and the language is selected; as can be seen in Figure 6.

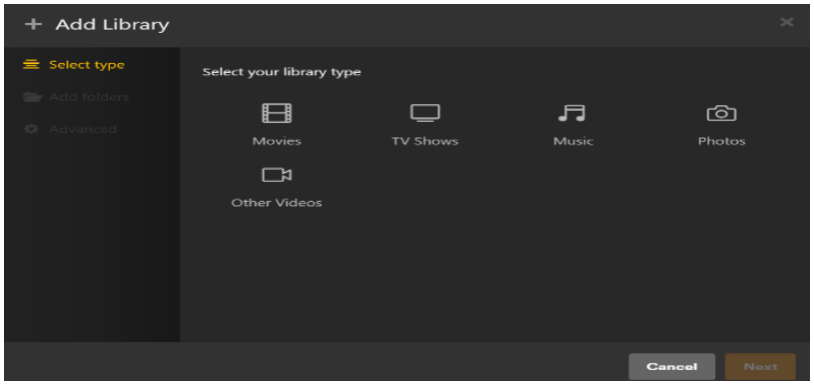

Figure 6: Library Creation after completing the installation

To configure languages, click on settings or configurations, click on language, then choose the language.

To enable remote access, you must first access the plex media server, click on settings or definitions, click on account, click on remote access.

Account Tab Configuration, it should be noted that so far there is only one user account. To add more user accounts, you must access a Premium version, for which you can make a one-time payment that is not very high, considering that you will be able to enjoy content according to the demands of the moment and without depending on third parties that upload the content. Home User Configuration, in this tab you can add the necessary users, you need to have a Premium account called Plex Pass, which is then configured as a single account. Clicking on the padlock symbol in the username allows you to add a PIN (Personal Identification Number) to limit access to the account, which will be displayed on the side of a user, when trying to access audiovisual content. Manage Library Access, one of the most interesting options is to access the library, to carry out the process follow the procedures, click on Settings or Definitions, click on the option Manage Library Access, this means that you can invite people to have access to your library, to do this you must click on Manage Library Access, click on Allow Library Access, in the window that opens enter the user name or email of the user:

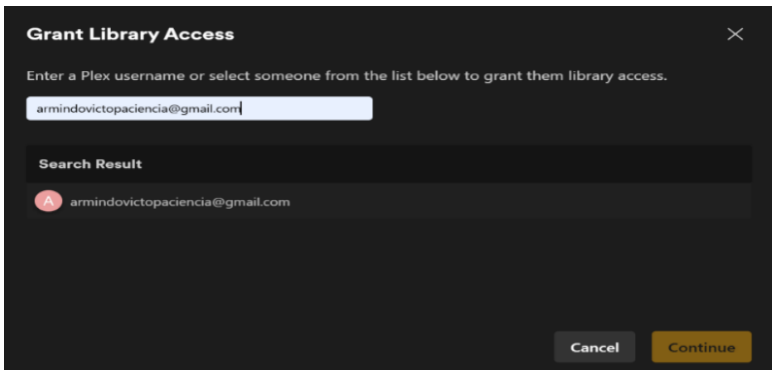

Figure 7: Manage Library Access Panel inserting user email

Then click Continue:

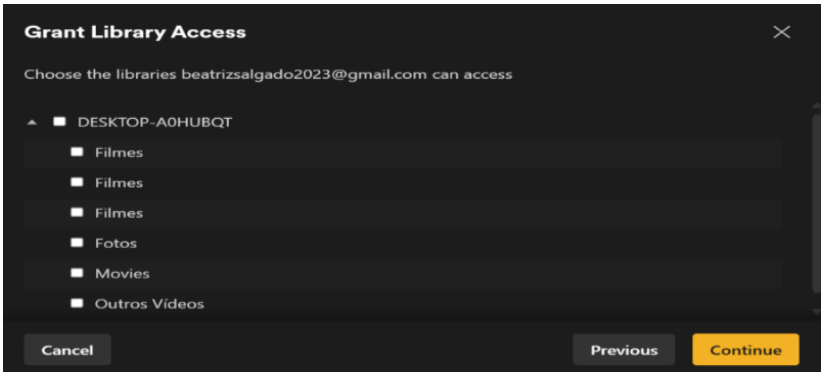

Figure 8: Panel for selecting content to share

The window below shows the user, the option to download or not:

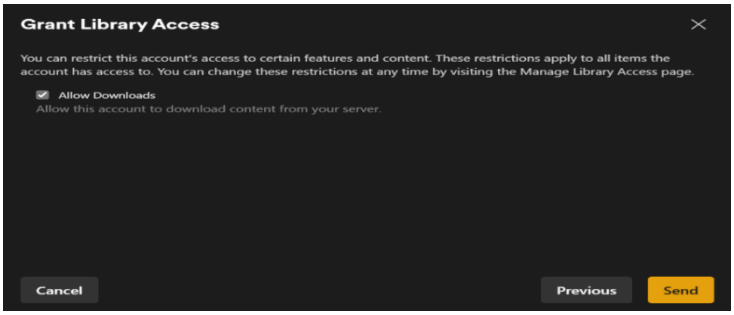

Figure 9: Panel option to download or not

After clicking Send, you can copy the link or complete it, it is sent to the user to access:

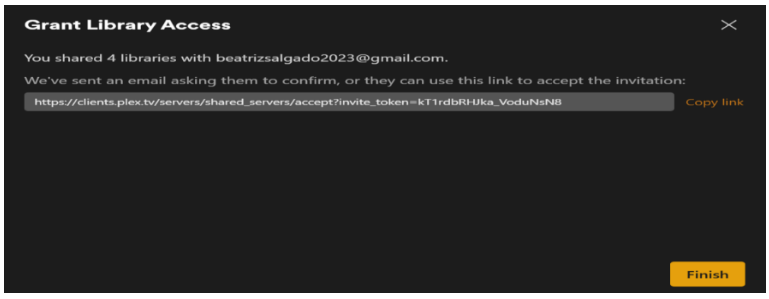

Figure 10: Final panel to send the link to the user

Creating user accounts, each device or user needs to have its own account, so that the server can manage which content will be available to each one. Each user account is protected by a PIN. To do this, it is necessary to purchase a Plex Pass, as this unlocks some functions, including the creation of multiple users, 15 users for each Plex Pass purchased, which is more than enough for the implementation of the proposed system, which only requires serving 10 users.

Installing server administration plugins, you must first have Plex Media Server installed. To install Plugins [20].

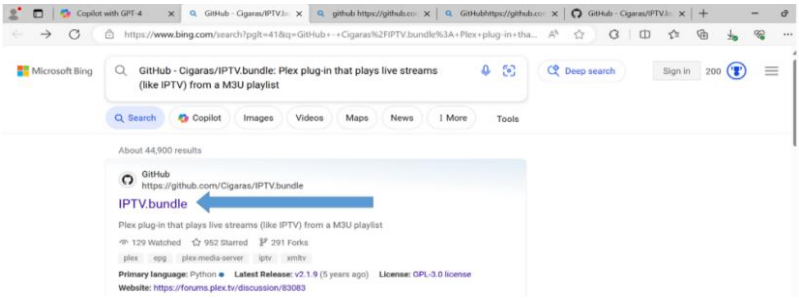

Figure 11: Window to Download IPTV.bundle [20]

Once you have downloaded the files necessary for the plugin to work correctly, to add it to the server you must follow these steps; the file must be unzipped and the obtained folder must have the full name and end in ".bundle"; then, we copy this folder to the plugins folder of the server software, which can be easily found in the installation path (click on start, right-click on Plex Media Server, click on Open File location, open the resource folder, open the Plugins folder and paste the unzipped file). With that, the file is now installed, close the browser where you have it. Open Plex Media Server to restart.

4.5. Questionnaire survey

The case study was conducted at the Polytechnic Higher Institute of Bié, between January and February 2024, involving 48 participants, 40 students and 8 members of the board of directors. In response to the question about the importance of technological innovation, 100% of participants unanimously stated that technological innovation is fundamental, which underlines the relevance of this topic in the context of Polytechnic Higher Institute of Bié. This consensus demonstrates that the academic community is widely aware of the need to integrate emerging technologies to improve the quality of teaching and learning process. The adoption of innovative technologies, like IPTV, is aligned with this vision of modernizing the educational environment.

Regarding the need to study the network communications infrastructure for the use of IPTV, 95.8% of participants agreed with the importance of this study, while 4.2% expressed an opposing opinion. Almost of all participants understand that the network infrastructure plays a crucial role in the effective implementation of IPTV services, since the quality of the connection and the capacity of the network directly influence the teaching-learning process mediated by this technology. This data reinforces the urgency of evaluating and improving the conditions of the existing network before proceeding with implementation.

Regarding prior knowledge of IPTV services, 64.6% of participants said they had heard of these services, while 35.4% were unfamiliar with the concept. This result suggests that although most participants have some level of knowledge about IPTV, there is still a significant portion that is unfamiliar with the technology. This indicates the need for training and awareness-raising actions so that all stakeholders fully understand the features and benefits of IPTV, which will be essential to ensure a successful implementation.

The vast majority of participants (95.8%) also agreed that the implementation of IPTV services at Polytechnic Higher Institute of Bié would be relevant, including the need to develop a method for technical analysis of the network, against only 4.2% who disagreed. This almost unanimous approval highlights that both students and management members see IPTV as a valuable solution to improve the educational process. However, it also underlines the importance of a rigorous technical approach in implementation, in order to ensure that the infrastructure is capable of supporting the service without compromising quality.

Regarding knowledge about other streaming platforms, such as; YouTube, IPTV, OTT, Android TV, Fire TV Stick, WebTV, Google TV and others, YouTube was mentioned by the majority of participants, with 91.7% recognition. This reflects the dominance of this platform in the digital daily lives of participants, suggesting that familiarity with YouTube may facilitate the acceptance and use of other streaming platforms, like IPTV, in the educational environment. However, limited knowledge about specific education platforms, as IPTV, indicates that gradual adaptation and continuous training efforts will be necessary, as illustrated in the figure below.

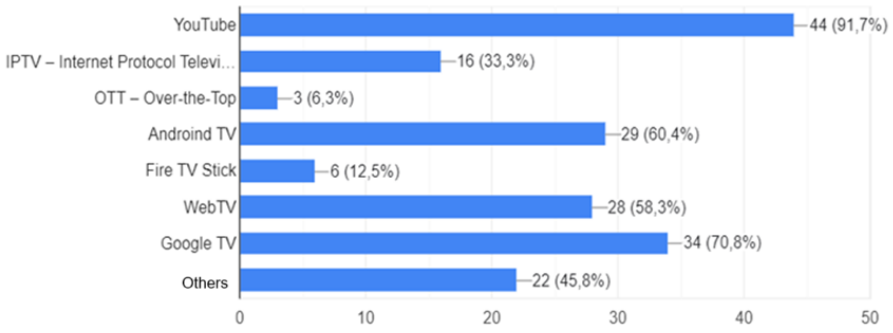

Figure 12: Service results

Regarding the question about knowledge of IPTV architecture, 72.9% of participants stated that they had no knowledge, while 27.1% indicated that they were already familiar with the topic. This shows that most participants are unaware of the technical aspects involved in IPTV architecture, which may reflect the need for greater dissemination and training on these technologies in the context of the Polytechnic Higher Institute of Bié. This lack of knowledge may represent an initial obstacle to the implementation of the system, since understanding the architecture is essential for its correct adoption and maintenance.

Regarding the tools used in Virtual Learning Environments (VLE), 66.7% of participants indicated that they were not aware of them, while 33.3% stated that they were familiar with these tools. The fact that the majority were not familiar with VLE tools highlights a gap that must be filled, since these tools are essential to promote interactivity and engagement in the teaching-learning process, especially in the context of integration with IPTV.

Regarding media and learning, 75% of participants had heard of these concepts, while 25% were unfamiliar. This data shows that, although the majority already recognize the importance of media in the educational process, there is still a significant portion of people who are unaware of the role of these technologies, which may limit the full use of the benefits of IPTV when integrated into teaching-learning process.

When asked about MOOCs (Massive Open Online Courses), 66.7% of participants said they were unfamiliar with this technology, while 33.3% had already heard of open online courses. This suggests that there is great potential for the introduction of MOOCs as a complement to IPTV in Polytechnic Higher Institute of Bié, but it also indicates that efforts will be needed to educate users about the advantages and possibilities of these courses. Platforms such as Coursera, which was mentioned by 40% of participants, and EDX (26.7%) are already recognized by some participants, which could facilitate the gradual introduction of similar technologies.

Regarding the MOOCs with the greatest potential to offer IPTV services in education, the results show a diversity of responses: 26.7% of participants mentioned the edX platform, 40% chose Coursera, 13.3% indicated OCW MIT, 26.7% mentioned Miríada X, 13.3% chose Veduca, 13.3% indicated Openuped and 46.7% indicated other platforms. These data suggest that there is fragmented knowledge among participants, reflecting a diversity of preferences and indicating that it will be necessary to present users with a wide range of educational options based on each one's specific needs.

Regarding the question of the advantages and disadvantages of implementing IPTV services at Polytechnic Higher Institute of Bié, 64.6% of participants stated that they did not know, 33.3% acknowledged that there were advantages and disadvantages, and 0% disagreed with the existence of such issues. The uncertainty expressed by most participants indicates that there is still little understanding about how IPTV can influence the educational environment. This lack of clarity may be a reflection of the lack of prior experience with the technology and it suggests that further study and effective communication about the benefits and challenges of implementing IPTV at Polytechnic Higher Institute of Bié are necessary. According to the question of which tools are used in VLE, as displayed in the figure below:

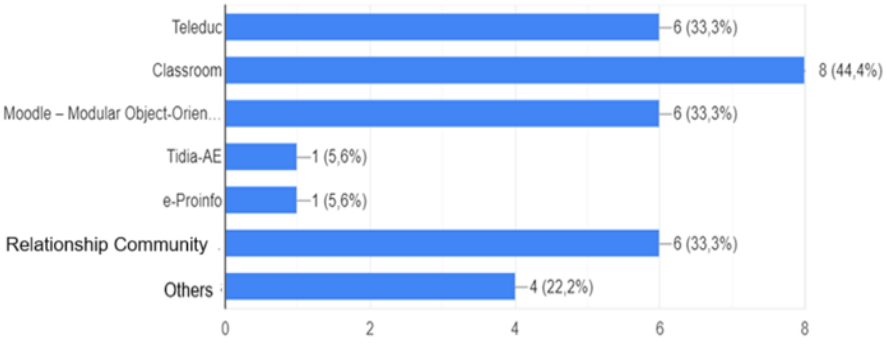

Figure 13: Results on tools used in VLE

Regarding the question about knowledge of Quality of Service (QoS) and Quality of Experience (QoE), 58.1% of participants stated that they were not familiar with these concepts, while 41.9% indicated that they were already aware of them. This result reveals that most participants are unaware of these technical parameters that are crucial for the implementation of IPTV, which suggests the need for specific training on the importance of QoS and QoE to ensure a satisfactory experience when using multimedia and educational services as IPTV. Lack of knowledge about these concepts can be an obstacle to the effective adoption of

the technology, since QoS and QoE are essential to ensure the quality of transmission and interactivity.

Regarding educational support tools with content for the use of IPTV, the results show a strong preference for IPTV USP, mentioned by 56% of participants. Other platforms, such as; e-Aulas USP (24%), E-Unicamp (4%), Unesp Aberta (16%), Portal de Vídeo Aulas UFF (40%), Khan-Academy-Fundação Leman (8%) and "Others" (32%) were also mentioned, but less frequently. This suggests that IPTV USP has greater visibility or familiarity among participants, possibly because it offers relevant content or because it is already widely used. This predominance indicates that the implementation of IPTV at Polytechnic Higher Institute of Bié can benefit from already consolidated models, as IPTV USP, which may facilitate the acceptance and use of the platform.

Regarding the perceived benefits of the integration of IPTV and education at Polytechnic Higher Institute of Bié, respondents highlighted mainly the ability to broadcast lectures, seminars and classes live (78.9%), which demonstrates the importance attributed to interactivity and remote access to educational content. Other benefits mentioned include the provision of online monitoring for students (50%), the creation of restricted access accounts via the web for students and teachers, with virtual disk space for collaboration (34.2%), and permission for the integrated use of other VLE tools (42.1%). These data reveal that most participants see IPTV as a tool capable of enriching the teaching-learning process, mainly by facilitating interactivity and collaboration between students and teachers.

On the other hand, 23.7% of participants mentioned the proposal for collective production of knowledge, using text editing programs, such as Google Docs, and 18.4% pointed out other benefits. This shows that, in addition to the most common uses, such as live broadcasting of classes, there is also recognition of IPTV as a tool that can facilitate collaboration and the creation of educational content simultaneously and dynamically, expanding pedagogical possibilities.

These responses indicate that IPTV, when integrated into the educational environment, offers a wide range of advantages ranging from improving content transmission to facilitating virtual collaboration and monitoring, promoting more dynamic and accessible teaching.

5. Conclusion

The Internet, with its vast global reach, continues to be an essential means of communication, especially due to its ability to disseminate information even in remote regions.

The advancement of Information and Communication Technologies (ICT) has profoundly changed the educational landscape, providing better quality content and a more interactive experience between teachers and students.

The implementation of IPTV services, integrating Quality of Service (QoS) and Quality of Experience (QoE) parameters, emerges as an innovative solution for higher education, promoting a more active and collaborative education.

The results of this research demonstrated that the implementation of IPTV at the Polytechnic Higher Institute of Bié has the potential to transform the teaching-learning process, integrating Virtual Learning Environment (VLE) platforms and educational tools such as MOOCs.

The analysis of the network infrastructure revealed the importance of improving communication capacity and quality, ensuring a better user experience and maximizing the impact of the proposed solution.

The assessment of technical feasibility and validation of data using tools such as inSSIDer, NetSpot, WiFi Analyzer and Wireshark. They allowed us to identify areas for improvement in the existing network and ensure that the proposed IPTV implementation is technically sustainable.

In addition, the integration with Plex Media Server and the modeling of the architecture with Drawing confirmed the robustness and capacity of the solution to meet the needs of Polytechnic Higher Institute of Bié.

Based on the data collected, it is clear that there is a great interest on the part of the academic community in adopting technological innovations, as demonstrated by the positive response to the importance of IPTV.

The need for technical training was evidenced by the limited knowledge of respondents regarding concepts such as QoS and QoE, which indicates that continuous training will be essential for successful implementation.

It is expected that this study will not only answer the hypotheses raised, but also pave the way for future, more sophisticated projects in the field of digital education in Angola.

IPTV can become a central tool for the modernization of the educational process, offering interactive and collaborative solutions that reduce geographical and temporal barriers, promoting a more accessible and inclusive higher education.

The proposal developed here has the potential to serve as a model for other institutions seeking to integrate advanced technology into their teaching-learning processes.

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