



TVET Learning Innovation on Automotive Virtual Laboratory Based on Cloud Openstack

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Abstract: Changes and industrial transformation globally in the era of the industrial revolution 4.0 resulted in technological gaps between the industrial and academic environment, especially in the field of vocational education in automotive engineering. The purpose of this research is to design a virtual laboratory network model that contains the latest material sources from the industry called Virtual Cloud Automotive Laboratory (VCAL). The cloud network model in virtual laboratories is designed such as the Infrastructure as a Services (IaaS) platform, the Platform as a Services (PaaS), Software as a Services (SaaS). The design process is carried out by the PPDI method, namely Prepare, Plan, Design, Implement, Operate, and Optimize. VCAL is built using open stack software consisting of a database and user interface. The SaaS platform enables industries to share competency and occupational materials for maintenance and repair of light vehicle or automotive engines in the form of 3D view web, video, audio-visual that can be accessed by students, lecturers in enriching aspects of repair and maintenance skills. The test results are limited to Automotive Cloud Virtual Laboratory access done by 10 users simultaneously with different devices, namely PC computers, notebooks, Android smartphones, the results show that the server used can run very well.

Keywords: TVET Learning innovation, VCAL, open stack, PPDI, Automotive Virtual Lab.

1. Introduction

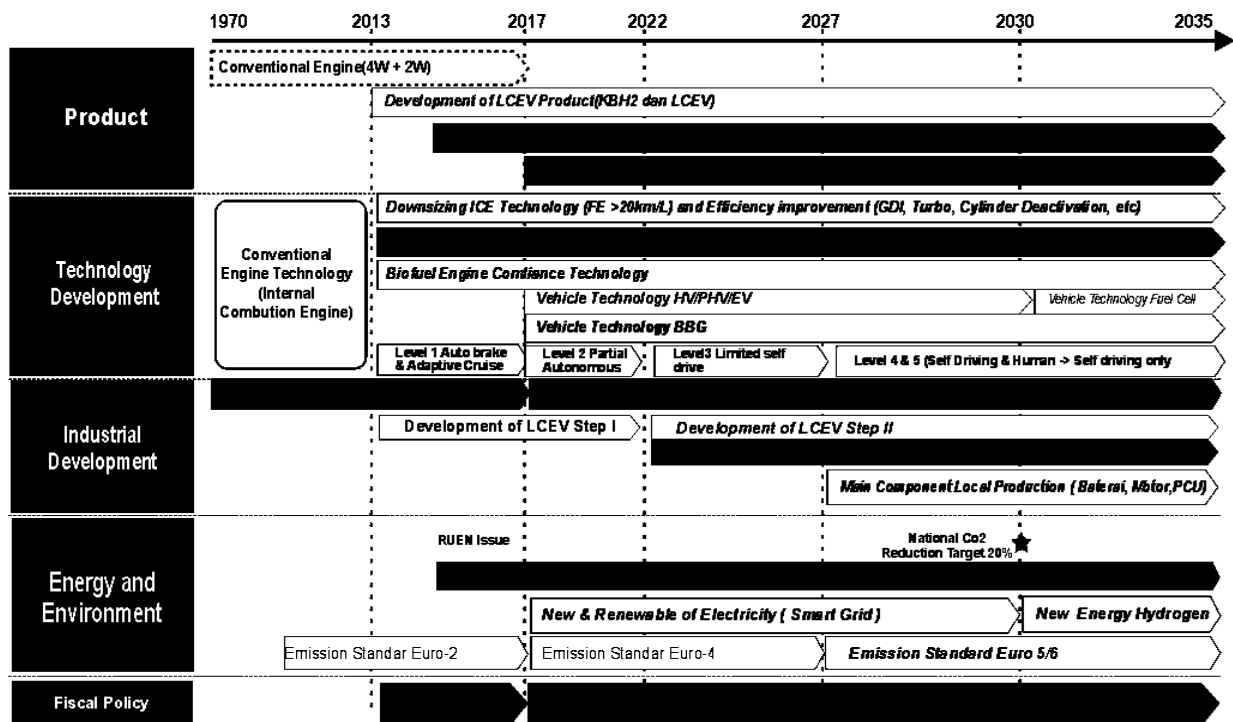
With the advent of the Fourth Industrial Revolution, vocational higher education institutions must adapt to emerging technologies through a combination of artificial intelligence, big data, simulations, internet of things (George & Langenhoven, 2019). Technology adaptation in Vocational education and training must be in line with the needs of future workers who have the ability to learn quickly and attitudes in understanding new technological features such as sophisticated manufacturing, intelligent robots, augmented reality, big data and analytics, cloud computing, and cybersecurity that are integrated vertical and horizontal in all fields is no exception to the automotive industry (Mohammad, Low, & Rahman, 2019). Some efforts have been developed in applying digital-based vocational learning technologies before, such as e-observation applications (Kuntadi, Widiaty, Yulia, & Mubaroq, 2019), web-based batik learning (Widiaty et al., 2019), Augmented Reality application principles of gasoline engine (Abdullah, Mulyanti, & Rohendi, 2018).

The need for workers must be in accordance with the requirements of the industry that has what is expected to have capabilities based on current employment is not only measured by academic achievement, but work competency is a major factor for getting a job (Lee, Sohod, & Ab Rahman, 2019). The work competency requested by the industry can

be identified through competency-based assessment and is an important factor for dealing with the problem of quality assurance gaps, limited access and industrial collaboration (Ana, Meirawan, Dwiyanti, & Saripudin, 2018).

The process of gaining knowledge and project-based training in vocational education in mechanical engineering must be done by learning and training all the time by solving various problems, creativity, and developing appropriate competencies so that their competence increases. However, many students complain because it is difficult to follow and the lack of facilities in the field of engineering makes student creativity be decreased (Mustapha, Sadrina, Nashir, Azman, & Hasnan, 2020). By utilizing technology which is a key technology component that is widely used in the training of the assembly industry and automotive repair environments such as the application of assembly guidance, engine repair of light vehicles (Gattullo et al., 2019), diagnosis of engine fault search (Suresh & Sakthi, 2019).

Paryono said the importance of the transfer of industry knowledge and skills based on occupation or occupation was the focus of the Indonesian vocational education system, in fact graduates did not meet the expected criteria because the process of transfer of new technology to the vocational higher education environment did not occur (Paryono, 2015); Ana et al., 2018). The current process of transferring vocational technology to students must be supported by computer information technology facilities that are widely accessible so that online teaching has a lot of meaning in the training process contributing to increasing the learning capacity of students (Phan, Ngo, & Phan, 2020). Considering the importance of preparing future workforce graduates in accordance with national automotive production development plan policies (Directorate General of Metal Machinery Transportation Equipment and Electronics Industry, 2018) that have digital competency (Tretinjak & Andelic, 2016; capabilities in accordance with the criteria in the automotive or light vehicle field, it is necessary to innovate learning and training with cloud technology in vocational higher education as shown in Figure 1.



Keterangan : BGG : Bahan Bakar Gas HV : Hybrid Vehicle PHV : Plug-In Hybrid EV : Electric Vehicle PCV : Fuel Cell Vehicle LCEV : Loss Carbon Emission Vehicle PCU : Power Control Unit

Fig. 1 - National automotive development and production plan.
Source: (Hirve, Kunjir, Shaikh, & Shah, 2017)

Wei Nie et al (2018) propose an educational cloud application system with the SaaS platform implemented to support the relevance of material and security of access on the network, and ensure the source of training materials can be accessed by students, teachers, and industry parties via PC computers, tablets and Android smartphones. Research conducted by Sie Xiong et al, on a platform analyzing the needs of e-learning using the proposed education cloud will provide new and innovative solutions to solve traditional educational constraints of time and place, provide high-quality educational services, and promote the development of joint training programs at colleges and universities (Xiong, 2015).

In this study we propose a design of a virtual machine cloud laboratory using the PPDIIO life cycle approach, namely Preparation, Design Planning, Implementation, Operations, Optimization and using open stack software. Cloud laboratory is proposed to integrate the automotive industry environment with the campus environment as shown in Figure 2 Smart Lab Concep Diagram.

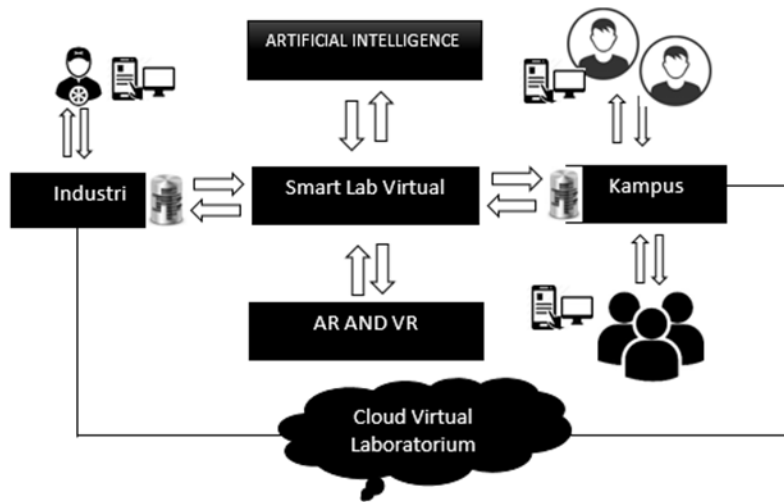


Fig. 2 - Smart lab concept diagram.

2. Method

Cloud virtual automotive engine engineering laboratory or CVL is a server built to accommodate and distribute a database of learning materials, Virtual Augmented Reality training applications, AR kit experiments (Tayeb, Latifi, & Kim, 2017), videos, animations, simulations. CVL was designed using the PPDIIO life cycle approach method as shown in figure 2 (Erfy Ismail et al., 2019).

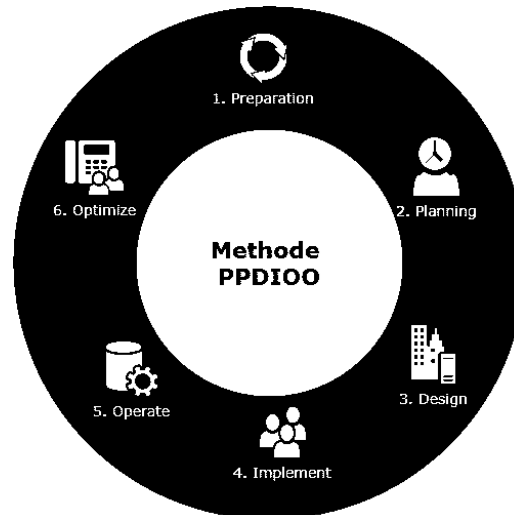


Fig. 3 - PPDIIO approach method.

In Figure 3, it describes a network life cycle model with the PPDIIO concept, namely, Prepare, Plan, Design, Implement, Operate and Optimize. The life cycle model of the network development method with this PPDIIO concept, the key steps in designing a virtual laboratory cloud network architecture begins with the preparation step by analyzing software hardware requirements, analyzing user requirements (Tantatsanawong, Kawtrakul, & Lertwipatrakul, 2011). The second step is planning the server installation, server configuration, open stack software installation, setting access rights. The third step is designing a virtual laboratory cloud network with online draw.io software tools. The fourth step is testing by implementing through the process of testing video data input, applications, simulations, animations into the cloud network. The fifth step performs trial operations of access speed, response time, access security, convenience, and the device used to operate. The final step is to optimize by testing and testing clouds repeatedly.

These steps are known as PPDIIO (Christanto & Sani Suprayogi, 2018). PPDIIO produces four main benefits, namely:

- i) Reducing the total costs to be incurred by the organization/company, by validating the technological requirements, planning changes in infrastructure and the need for a variety of resources.

- ii) Increasing the availability of network services, by producing network designs and validating operations on the network.
- iii) Improve the ability to accelerate business progress, by preparing business-oriented needs, which are supported by technology implementation strategies.

Increase the speed of access to applications (software) and services (services), by increasing the reliability, availability, security, scalability and performance. The minimum requirements for installation and use of Openstack vary according to the scale of the work environment. The following are the minimum requirements for openstack installation using 1 server computer:

- A PC with Centos Operating System 7.2
- 64-bit processor that supports virtualization (AMDV or Intel VT hardware virtualization)
- Minimum 4GB RAM
- Additional RAM adjusted to the instance to be created.
- Minimum 1 TB hard drive
- Additional hard drive allocation tailored to the needs and number of instances to be made.

A Network Interface Card / Ethernet with a speed of 8 Gbps This virtual cloud laboratory contains interactive digital multimedia content that contains training materials for repair, maintenance and assembly of light vehicle engineering or automotive engineering in accordance with industry occupational competencies. Besides containing CVL material, it also contains job sheets, practical guides and digital assessments. In accordance with its objectives, CVL will be used as a vocational learning media for automotive engineering using openstack software so that the learning process can be integrated with the work environment digitally (Yasak & Alias 2015). Server specifications used in this study, by comparing the recommendations of the official Red Hat site can be seen in the following Table 1.

Table 1 - Server specifications.

No	Parameter	Value	Suitability
1	Operating system	CentOs Linux Release 72.1511	Compatible
2	Processor	Intel xeon prosesor 5130	Compatible
3	RAM	4 GB	above recommendations
4	Hardisk	1 TB	above recommendations
5	Ethernet	Broadcom NetXtreme BCM5752 Gigabit Ethernet PCI Express	As recommended

Whereas PC, tablet and Android smartphone devices can be used by clients to access virtual labs on servers that have different specifications, ranging from different RAM capacities, different storage media capacities, to different processors. While the software needed is, the Windows operating system, Android and Mozilla Firefox, Opera, Safari or Google Chrome browser applications. The browser is used to access virtual computers on the server.

3. Result and Discussion

Implementation of CVL Design in the Prepare Phase, determining the needs of servers and network devices, Hubs, Rotors, computers, tablets and Android smartphones to develop network strategies, and propose high-level architectural concepts, to support a strategy, supported by capability organization of vocational education and training providers.

The third stage is the design of the Virtual Cloud Laboratory network developed based on technical requirements, and business obtained from the previous conditions. Network design specifications are designs that are comprehensive and detailed, which meet the technical requirements and vocational learning needs of automotive engineering today. The network must provide availability, reliability, security, scalability and performance. The results of the design include a network diagram, and a list of equipment. The design is made using online network design software using the link <https://www.draw.io> namely draw.io software. CVL network design that is built can be seen in Figure 4.

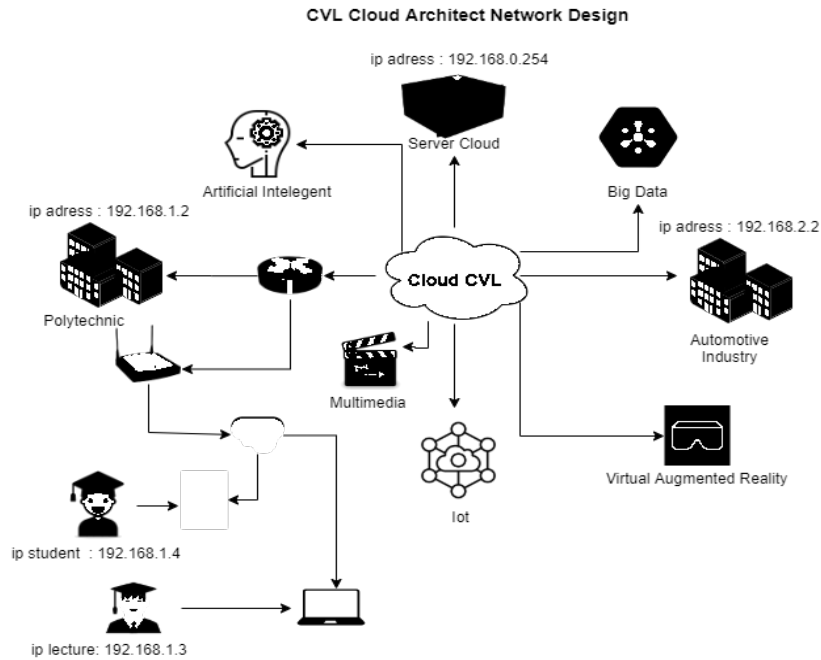


Fig. 4 - CVL cloud architect network design.

The fourth stage is implementation, the implementation process is done by installing the CentOS Linux Release 7.2.1511 operating system and installing a web server using xampp v3.2. The platform used on the server is Openstack. The difference with Proxmox, where OpenStack is not shared in an operating system. OpenStack must be run on operating systems supported by Ubuntu, Red Hat Enterprise Linux, CentOS or OpenSuse. In this experiment Openstack is run on Centos 7.2 and uses Mitaka Openstack for virtual laboratory (Afgan, Lonie, Taylor, Skala, & Goonasekera, 2016).

The Mitaka Openstack installation process is as follows.

- Configure the / etc / hosts file and add the hostname line for the Openstack server.
- Configuration files / etc / sysconfig / network-scripts / ifcfgbr-ex and / etc / sysconfig / network-scripts / ifcfgenp1s0 for host network settings.
- DNS configuration in the /etc/resolv.conf file.
- Installing openstack repositories # yum install -y https://rdoproject.org/repos/rdorelease.rpm
- Update package # yum update -y
- Installing the packstack installer # yum install -y openstack-packstack.
- The final step is to run opackstack for install OpenStack # yum install -y openstack-packstack

```
# Konfigurasi Server
127.0.0.1 localhost localhost.localdomain localhost4 localhost4.localadmin4
::1 localhost localhost.localdomain localhost6 localhost6.localadmin6
192.168.1.254 cloudVL cv10303b.cloudVL.id
# Konfigurasi BRIDGE
NAME="br-ex"
DEVICE="br-ex"
DEVICETYPE=ovs
TYPE=OVSBridge
ONBOOT=yes
IPV6INIT=no
BOOTPROTO=none
DNS1=192.168.1.200
DOMAIN= cloudVL cv10303b.cloudVL.id
DEFROUTE=yes
IPV4_FAILURE=no
IPADDR=174.162.42.30
PREFIX=22
GATEWAY=174.162.50.254
```

Fig. 5 - DNS and ethernet configurations.

Furthermore, Configuring a Virtual Computer on the Openstack server can be done with the following steps:

- Go to the Openstack server admin web page: <http://192.168.0.254>
- Enter the username and password from the admin user



Fig. 6 - Openstack start page.

The CVL application with OpenStack has the facility to set the network in accordance with the CVL design that has been made and setting the address of the server device. Next page after successful login. Click on the image and see URL: 192.168.1.200.

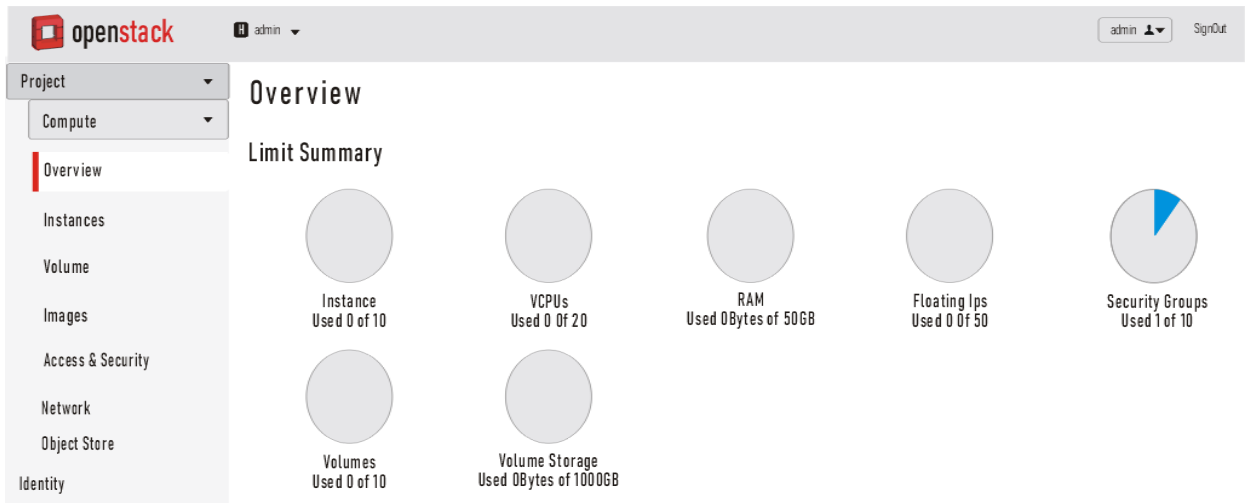


Fig. 7 - Administrator dashboard page.

The Cloud Virtual lab feature allows creating new virtual machines for internal purposes and to provide users with a VM that can be used to store, access, manage multimedia data, audio video, animation, AR and VR simulations by lecturers, students and web services through API facilities.

Cluster Detail : astratoyota.3dtvet.net

Logged in as: admin Settings Help Sign Out

Overview Instances

Instances

Name	Cluster	Status	State	CPU's	Memory
PT Astra Toyota Indonesia	astratoyota.3dtvet.net	Active	Running	1	128MB
PT Indomobil suzuki motor	indomobil.3dtvet.net	Active	Running	1	128MB

Displaying 2 items

Fig. 8 - Virtual machine manufacturing and changing facilities.

OpenStack was developed by Ubuntu but not only can run on Ubuntu based operating systems but can also run on operating systems from other distributions such as Red Hat. In this test using Openstack on the Centos 7.2 operating system from the Red Hat distribution. In testing it requires some supporting software such as Italc, Macro Recorder and Camstudio. Macro recorder is used to run virtual computers, virtual reality applications and execute algorithms with the AR principle (Hirve, Kunjir, Shaikh, & Shah, 2017). Italc is used to execute macro scenarios that have been made together on multiple computers. Activities that are carried out automatically with macros are recorded to retrieve data with the Camstudio application.

3.1. StartUp Testing

Testing is planned for up to 3 virtual computers, 3 tablets and 3 Androids. The following is a table of the results of the average startup time testing carried out 6 times starting from all tested devices running gradually. This test is carried out in a limited manner by only being able to run up to 9 different virtual devices, this is due to limited server resources. Test the webserver at the Open Automobile Virtual Laboratory using computers, tablets, and Android smartphones via the Httpperf method to get the execution time on different devices. Testing is done with a localhost instance with the initial web when the Apache web server is installed for the first time. The results of the webserver overhead test can be seen in Table 2.

Table 2 - Result testing the overhead access to the server.

Client Device	Openstack (second)	Cloudstack (second)	Host (second)
Computer 1	84,986	8,136	31,254
Computer 2	86,648	84,672	31,254
Computer 3	87,632	88,068	31,254
Tablet 1	88,048	88,868	31,254
Tablet 2	89,424	90,304	31,254
Tablet 3	92,532	93,322	31,254
Android 1	95,312	94,234	31,254
Android 2	91,757	94,598	31,254
Android 3	87,316	98,056	31,254

Based on the test data shown in Table 2, it can be seen that the different devices used in testing to access the OpenCloud webserver, namely computers, tablets, and Android smartphones have stable performance. This shows that the SaaS Platform on OpenCloud can be used to accommodate the Automotive industry database as a renewable learning resource that is connected in one cloud network and can be accessed properly by different devices as a medium for learning skills in the form of 3D web displays, videos, audio visuals that can be used. accessed by students, lecturers in enriching the vocational aspects of automotive skills. Testing runs a virtual computer with different devices, namely computers, tablets and Android smartphones as shown in Figure 8.

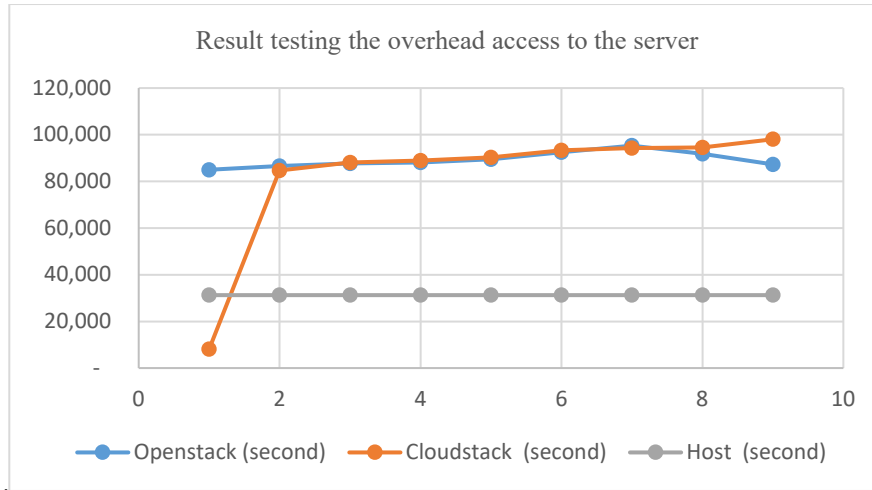


Fig. 8 - Overhead test results graph.

The purpose of computational testing is to determine the execution time required to complete a calculation on Openstack and Cloudstack instances. Some web-based 3D multimedia applications, Augmented Reality, require a CPU to complete the programming algorithm. In addition, other services that are tasked with running the operating system also depend on the CPU's performance. With better CPU performance, service processing such as access to 3D virtual applications in the form of 3D Web in Virtual Reality and Augmented Reality applications can run stably.

3.2. Testing Running AR Simulation Application

Testing of running Virtual Reality and Augmented Reality applications to determine the time it takes for a virtual computer to run a Virtual Augmented Reality Simulation application called VAR. Applications that are installed and tested on the opencloud server are the Automotive digital practicum application, the 3D Automotive application, and the 3d web application. This application is an application that uses Augmented Reality and Virtual Reality technology which serves as a simulation medium in the automotive virtual laboratory in this study. The application was tested using different devices; the results are as shown in Table 3.

Table 3 - Testing data for installing the VAR application on a different device.

Client Device	AR Module Application	3D Engineering application	Otto Enggine's Four Stroke Application	3D WEB Application Automotive
Computer 1	Not Good	Not Good	Not Good	Very good
Computer 2	Not Good	Not Good	Not Good	Very good
Computer 3	Not Good	Not Good	Not Good	Very good
Tablet 1	Well	Well	Well	Enough
Tablet 2	Well	Well	Well	Enough
Tablet 3	Well	Well	Well	Enough
Android 1	Very good	Very good	Very good	Not good
Android 2	Very good	Very good	Very good	Not good
Android 3	Very good	Very good	Very good	Not good

4. Conclusion

Based on the results of the design and discussion of cloud computing network design in the Virtual Automotive Engineering Laboratory, the writer can draw the conclusion that by using the Infrastructure As a Service (IaaS) system layer so that it can integrate realtime learning data sources in the form of digital content and can design private cloud computing by utilizing an existing infrastructure network internally. Then the centralized data center can be accessed using a WAN network, so that it can overcome the differences in the IP address segment that is in the vocational higher education institutions so that every practicum, experiment and observation material can be stored, analyzed and accessed

in realtime. So with the open cloud-based private cloud server design, lecturers, students and industry can access data or documents through computers, laptops and smartphones wherever and whenever they have an internet network.

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