Journal of Theoretical and Applied Information Technology
28th February 2023. Vol.101. No 4

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

WEB OF THINGS ENABLED SMART CAMPUS IN SUPPORTING LEARNING

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ABSTRACT

Today the development of technology is growing rapidly. One of the fields that participate in technological developments is the field of education, especially universities. Technological developments help universities become smart campuses. Smart campuses require the use of technologies such as information systems, Internet of Things (IoT), Artificial Intelligence (AI) technology and so on. However, the focus of the problem in this paper is the utilization of IoT. IoT has a problem, namely the problem of interoperability. This interoperability problem can be solved using web resources, also known as the Web of Things (WoT). In this paper, we will discuss how to build a prototype WoT system where everything can be accessed via the web to solve IoT interoperability problems. The design that will be carried out in this writing to build WoT starts from controlling physical things, accessing data, and connecting things to things (web to web). The prototype development of this system will use the Raspberry Pi and Node-RED. The result of this prototype is that it can access lights and access data from a web, process it, and display it in graphic form by connecting it to Google charts. The results of this light control prototype can be a model that can be learned to control things on campus so that it can create a smart campus. The results of communication between things and things can also be used to integrate all data on campus so that it can be used easily. For further work it is necessary to evaluate to get feedback about the system and to find out that the system is running well and can help users on campus. Models or prototypes can be easily extended or scaled to wide implementation aspects of smart campuses, including ITS embedded in personalized learning facilitation.

Keywords: *Smart Campus*, *Internet of Things*, *Web of Things*, *Node-RED*, *Raspberry Pi*

1. INTRODUCTION

Nowadays, the development of technology is getting faster. Technological developments advance various fields, one of them is in the field of education that runs on campus. The use of technology in education is increasing in the 21st century [1], especially when the COVID-19 has forced many fields to transform from conventional to digital so that the spread of COVID-19 does not get worse [2]. Examples of technology used are the use of the Internet of Things to build smart things in the form of sensors and actuators with cloud server designs that can create smart campus models [3], the existence of a Learning Management System (LMS) which is used to manage materials, upload materials, give assignments, receive and respond to student work, create questions, conduct assessments, monitor student attendance, and conduct online discussions [4], and Web of Things (WoT) to be a solution to the interoperability problem of IoT [5].

Now the era of Web Technology has reached web 4.0. Web 4.0 is related to Ultra-Intelligent Electronic Agent, Symbiotic Web and Ubiquitos Web [6]. One implementation of web 4.0 is the Internet of Things (IoT) [7]. IoT is a system in which devices are plugged into an electronic system that can connect to the internet and be discovered, monitored, controlled, and interacted with via various network interfaces.The number of connected devices in the IoT network is huge. There is an estimate that the number of devices is nearly 40 billion, which is about 30 devices for every active social network user in the world [8]. However, IoT lacks a universal application protocol that prevents the integration of devices from multiple manufacturers into a single application [9]. Web of Things (WoT) can overcome this limitation by leveraging web standards to embedded devices, by integrating devices with web applications with minimal effort [9]. Web of Things (WoT) is an IoT device mechanism that can be accessed directly as a web resource [10].

The use of IoT itself has been widely applied in various places. Even for the universities themselves, there are already implementing IoT as the implementation of Smart Campus. IoT in universities can help faculty, students and other staff [11]. However, based on research from Abuarqoub et al (2017), the existence of interoperability, information supply, system integration and communication efficiency are the main factors to hinder the widespread adoption of IoT to deliver Smart Campus [12]. Due to the limitations of IoT, it is necessary to develop using the Web of Things (WoT). In WoT, devices will not only be implementing Internet Protocol (IP) and interconnected on the internet but can also speak the same language, and thus will be able to communicate and operate freely on the Web [13].

In this paper, we will discuss the technology that can be implemented to advance learning on campus in literature and this paper will also discuss how to make a prototype for the web of things in controlling things and the results of the prototype to describe how the web of things works and communication with a web and to retrieve data from the web whose data can be utilized by the campus. Prototyping will use raspberry pi 4 and Node-RED. The resulting prototype is expected to be an illustration to help every university in building and implementing a web of things in the future and making the university a smart campus that utilizes many advanced technologies as discussed in this paper.

2. LITERATURE REVIEW

2.1 Smart Campus

Smart campus is an educational institution concept that uses technology, such as information systems, internet of things (IoT), and context aware computing to support learning and administration activities [14]. The basic idea of a smart campus is an effort to integrate a set of intelligence technologies only by universities to improve performance, the quality of sophisticated graduates, and ease of life through the provision of decent, dynamic, and user-oriented information services to support automation and do reporting in real time, not doing activities. in real time learning but can cover other broader aspects, such as social interaction, environment, office management, energy saving and so on [15].

The following table illustrates the difference between the concept of a digital campus and a smart campus:

Table 1. Difference of Digital Campus and Smart Campus [15]

	Digital campus	Smart campus
Technical Environemnt	Local area network internet	IoT, cloud computing, wireless network, mobile terminal, RFID
Application	Learning resource in digtal form, distance learning, digital library, network management	Intelligent system using sensor, interoperability, and control ability
System Management	Isolated	System sharing, intelligent, push

The concept of a smart campus for education system was developed by Wahid (2021), by creating a “Smart Campus Framework” which consists of 4 information technology-based learning system solutions, namely the Smart Learning System which consists of a Learning Management System (LMS) and a Thesis Management System. (TMS), limited face-to-face learning by applying the Smart Blended Learning System so that learning can be done online and offline synchronously, academic services through Smart Academic Service and can control the classroom with a Smart Equipment Solution based on the Internet of Things (IoT) that can be controlled via an integrated information system to remotely control the class [16]

2.2 Internet of Things

The Internet of Things (IoT) is a network of physical objects or devices, instruments, vehicles, buildings, and others embedded with electronics, circuits, software, sensors, and network connectivity that allows an object to collect data and exchange data. IoT enables objects to be remotely controlled across all network infrastructures, creates opportunities for direct integration from the physical world to computer-based systems, and results in increased efficiency and accuracy [17]

The Internet of Things is defined as a physical object network. The Internet has evolved into a network of devices of all shapes and sizes, including vehicles, smartphones, household appliances, toys, cameras, medical equipment and industrial systems, animals, people, and buildings. Everything is linked, everything communicates, and everything shares information based on defined protocols in order to achieve intelligent reorganization, positioning, tracking, security, and control, as well as real-time online monitoring, online enhancement, process control, and administration. [18]

2.3 Web of Things

Web of Things (WoT) is a new paradigm that works on top of the Internet of Things (IoT) to visualize sensory data in IoT using today's web tools and services [19]. The Web of Things (WoT) has been identified as a core activity on the Internet of Things, with the goal of harnessing what makes the Web successful and applying its principles to physical devices. The Web of Things is responsible for making Internet of Things (IoT) development and data accessible to a large number of Web developers and business designers, allowing them to reuse knowledge already available on the web to improve IoT applications. This accessibility benefits system integrators and solution providers by enabling new and innovative cross-domain IoT applications. [20].

Another area where Semantic Web technology provides the foundation for effective data access is in WoT, where a unified data model realizes interoperability among all WoT concepts. There has been a lot of research done on implementing the Resource Description Framework (RDF), Web Ontology Language (OWL), and reasoning in various WoT scenarios like home automation, Industry 4.0, and others. [21].

Guinard and Trifa (2016) stated the benefits of the Web of Things (WoT) to be a solution to the limitations of IoT, such as : [5]

1. Easy to program

IoT uses a variety of protocols, many of which are complex and difficult to use. Learning to connect devices with various protocols and interfaces will make it difficult for people who are just starting to learn to program their smarts.

With WoT, web protocols can be easily used to read and write data from/to devices, and especially are much simpler to use and faster to learn than complex IoT protocols. If a device can offer a web API, developers can use the same programming model, where if they already have basic skills in building simple web applications, they can quickly learn to talk to new devices.

2. Open and extensible standards

In IoT, there are many protocols that are constantly evolving made possible by the development of new technologies. Some of these standards are not as neutral as open-source projects because they are funded and regulated by one or a small number of large corporations. Some standards are also not publicly documented, making it difficult to apply and use them without paying a significant annual fee. There are much higher barriers in IoT because protocols sometimes require hardware changes, such as using a different radio chip. Application protocol switching will necessitate the use of difficult-to-implement firmware.

With WoT, web standards are gaining popularity because they are completely open and free, posing little risk of change overnight. Because HTTP and REST have the obvious choice of providing public access to some data, data can be moved quickly and easily across systems.

3. Fast and easy to implement, maintain, and integrate

In IoT, because all devices must use one protocol, it is necessary to create a special converter for each device so that they can be integrated with each other. When maintaining a complex set of custom code, it can be very risky.

With WoT, there is no risk if the web suddenly stops working and needs to be upgraded.

4. Loose coupling between elements

In IoT, leaving little room for ad hoc, unplanned interactions and reuse of services are becoming new use cases which are critical requirements in large scale open device networks

With WoT, HTTP is designed to be loosely coupled because the contract (API specification) between web actors is simple and well defined, leaving little room for ambiguity. As a result, each actor can change and develop independently of the others.

5. Widely used security and privacy mechanism

Security in IoT is always written from scratch, so it is rarely or never tested in the real world. Even today, many IoT devices lack adequate security, exposing their authentication keys to the outside world. This is also due to the fact that IoT security is frequently designed to work well in closed ecosystems.

In WoT, the benefit of using common web-based standards is that they have been extensively used and tested. Many system implementations (for example, Open SSL) are open source, which means that the code is constantly used, tested, updated, and improved by thousands of developers, lowering the risk of failure.

2.4 Learning Management System (LMS)

Learning Management System (LMS) is a very popular system, by using LMS lecturers can manage lecture material such as compiling course outlines, uploading materials, creating assignments, receiving and responding to student answers to assigned assignments, making questions, giving assessments, monitor student attendance, and interact with fellow lecturers or students in forums [4]. LMS is also known as the Course Management System (CMS) or Virtual Learning Environment (VLE) which has developed over the decades which has made technological innovation the cornerstone of institutional instructional technology infrastructure [22].

Modern LMS have been developed along with the rapid development of the web and have been key to the ability of Educational Institutions to offer online learning. As the learning environment can change as a result of technological developments, LMS needs to evolve itself and the evolving needs of learners and instructors to be more open, more personal, more social, more flexible, more analytic, and more mobile [23].

2.5 Intelligent Tutoring System (ITS)

Intelligent Tutoring System (ITS) is a system that can determine and adjust model parameters in helping teachers, helping students, and getting to know students according to their needs so that teachers can identify students who have more difficulties and greater failures which can make teachers dedicate more plenty of time to teach the student [24]. ITS is used in a wide variety of educational settings and is still evolving to enhance student learning and is also frequently used as a platform for studying science and studying research on artificial intelligence. There is a review of the effectiveness of ITS, where in one meta-analysis conducted by Ma, Adesope, Nesbit, & Liu [25], it was shown to provide an increase from moderate to large when compared to teacher-led instruction or large groups, computer-based instruction. non-ITS, and textbooks or workbooks [26].

There is a useful addition to ITS, namely adaptive hypermedia which modifies what students see to adapt content to their goals, abilities, interests, and knowledge of the subject, by providing the most relevant hyperlinks for students in an effort to shape students' cognitive abilities [27]. ITS, if embedded in this smart campus will be a real implementation of personalized learning that can help improve student performance and better time management [28].

2.6 Web of Things (WoT) Enabled Smart Campus

The Web of Things aims to make physical world objects and their data accessible through standard web technologies to enable intelligent applications and sophisticated data analytics. Due to the amount of data heterogeneity, it is difficult to perform data analysis directly, especially when the data is drawn from a large number of distributed sources. Search is fundamental to the Web of Things as well as challenging in nature in this context, e.g. mobility of objects, opportunistic presence and sensing, continuous data flow with changing spatial and temporal properties, efficient indexing of historical and real-time data. The complex nature of WoT requires specialized search techniques not only for physical or virtual "things", but also the data generated from those things. Research conducted by Zhou [29] proposes several promising future research directions under the emerging challenges of big data in WoT.

New technological advances in user mobility and context immersion are enabling new adaptive and pervasive learning models in the surrounding environment.[30] Research conducted by Atif [30], produce new learning models for smart campus environments by defining smart campus models, and advocating learning practices in new paradigms, such as context-awareness, ubiquitous learning, pervasive environment resource virtualization, autonomic computing and adaptive learning using the Web of Things. The research also suggests a social community platform for knowledge sharing involving peer learners, domain experts, and campus physical resources.

3. RESEARCH QUESTION

The research question in this paper is how to build a Web of Things-based system to create a smart campus to support learning. There are 2 things discussed in this paper:

1.How to control campus operations in creating a smart campus environment?

2.How to access data on a large scale on the internet and connect it to the system owned by the campus?

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

3.1 Web of Things as Actuators

This paper will discuss how the Web of Things can control things on campus to create a smart campus in operational aspects. The thing discussed is how the system is made and how WoT can control things. The prototype examples discussed in this paper are just one to show that through the Web of Things you can control things without being hindered by interoperability problems.

3.2 Web of Things to Access Data

This paper will discuss how the Web of Things can access data from things. In this study, an example of a data access prototype of a thing will be given to be processed so that it can be used in the future for other studies related to data access and being able to communicate with each other between things to create a smart campus in the learning aspect, where students can access things matters relating to learning more broadly.

4. METHODOLOGY

4.1 Research Methodology

In this study several stages were carried out, namely by collecting data first by observing and studying the literature as part of a literature review for research through journals and books. Then, do a concept design for the prototype that will be built to answer research questions related to how to build the Web of Things system. In addition to designing the concept design, architectural design was also carried out to describe how the workflow of the Web of Things on the prototype that would later be made. After that, build the system and test the system whether the system works well as a thing controller and accessing data from a thing.

4.2 Concept Design

The Web of Things will be used to create a smart campus where everything such as controlling physical things and accessing data can be done using only a web. For the initial design in building the Web of Things, a limited prototype will be made. If this Web of Things can be developed properly, then all things related to the interests of learning on campus such as IoT, LMS, ITS can be integrated using a web. Making a concept design to design a prototyping of the web of things where there will be 3 things which will later be discussed as features of this web of things. First, the web of things can command physical things (act as an actuator). For the actuator, a simple example will be taken, namely controlling a lamp. This light control is an example of a case where stakeholders on campus can control things via the web. This can be part of creating a smart campus where there is the use of technology in it. Second, accessing data to a web which will later be processed and displayed on the web so that it can be used by students to support learning. This data access is also referred to as the relationship between things and things, where the thing in question is a web that can connect with other webs. The data from other webs will be integrated with the web created for prototyping using the Application Programming Interface (API). If the concept is to integrate things with these things, then all data and physical things on campus can be integrated for the benefit of campus and learning. Thirdly, the ability to create mashup or ecosystems of related webs as an integral part of the same system that benefitted one another. These are all will be supported by Representational State Transfer (REST) API and semantic web technology. For this exercise, we will only be implementing a prototype of to the aspect of WoT. For example, controlling devices (actuator), to a limited extend, and creating mashup. Of course, these can be easily scaled up to a more realistic situation of a smart campus.

4.3 Architecture Design

The following Figure 1 illustrates the Web of Things architecture, where things with raspberry pi will be connected to each other and to manage these things will use REST API and web sockets via Web Application by the user.

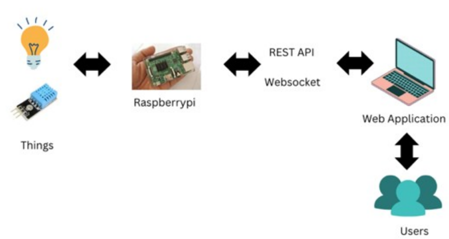

Figure 1: Architecture Design of Web of Things

In Figure 2 below, illustrates the Uniform Resource Locators (URL) architecture built on the web where there are URLs that are connected to raspberry pi to control physical things and there are URLs that are not connected to raspberries, but directly lead to pages to access data and connect between the web and the web.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

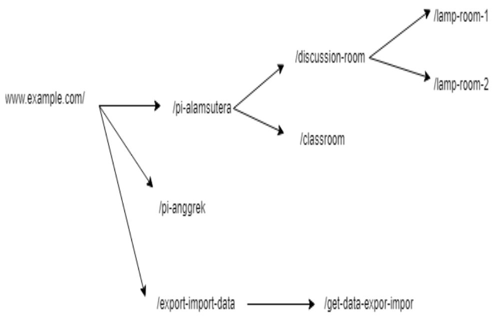

Figure 2: URL Architecture

4.4 Hardware Specification

In making the prototype it takes some hardware needed to design the physical device so that it can be controlled. For the design of the prototype in this paper, it takes the hardware used to design the lamp so that it can be controlled via the web. In Table 2 is a list of what hardware is used to build the prototype:

Table 2: Hardware Spesification

No	Name
1	RaspberryPi 4
2	SD Card
3	Relay 4 Module 5V
4	Lamp 5W
5	Jumper Cable

4.5 Software Specification

In making a prototype control physical device, it takes software that needs to be installed on the raspberry pi first. The following are the software used in building the prototype:

4.5.1 Raspbian OS

Raspbian is a Linux operating system created specifically for the Raspberry Pi. This Raspbian installation uses NOOBS (New Out Of Box Software) by downloading it on the raspberry website and copying it to the raspberry pi SD Card.

4.5.2 Node Package Manager (NPM) and Node.js

Node Package Manager (NPM) is a package manager that helps in developing web applications or nodes. This NPM is a standard provided by Node.js and will be installed automatically after installing Node.js. Node.js is commonly used to create web applications from the server side by running javascript code. Node.js needs to be installed before installing the Node-RED application on the raspberry pi.

4.5.3 Node-RED

Node-RED is a programming tool that can easily connect hardware, APIs, and online services. Node-RED has a flow editor based on a web browser application, made based on Nodejs and the flow that has been created will be stored in JSON form. Node-RED helps in designing and controlling things easily due to minimal coding. Designs can be made simply by drag and drop components/nodes owned by Node-RED so as to form a flow that already has logic and can control things.

5 RESULT AND DISCUSSION

5.1 Node-RED Flow Design

In Node-RED, the logic in controlling physical things, creating web displays, creating APIs, and communicating between APIs is done using the nodes provided by Node-RED. These nodes only need to be dragged and dropped into the provided worksheet, so there is no need to do too much coding. The flow in Figure 3 and Figure 4 is the result of prototyping in Node-RED to turn on the lights. URL and API creation is also done on Node-RED. These flows on the RED-node create a logic for turning the lights on or off.

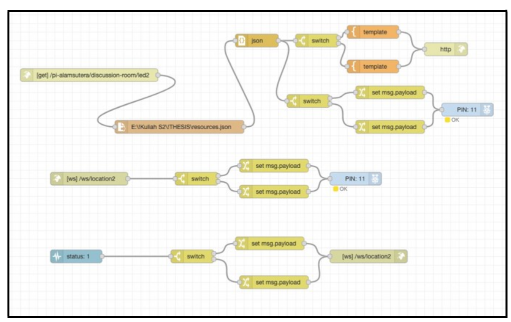

Figure 3: Node-RED Flow for Actuating Lamp and Get Lamp State

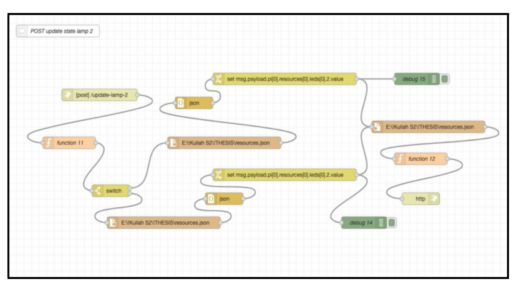

Figure 4: Node-RED Flow for Update Lamp State

The properties owned by the lamp are made into JSON data which later to update the state of the lamp, a REST API call will be made using POST verbs to update the state from true to false and vice versa. In addition to the state of the lamp, there is also a description related to the lamp. In

Figure 5 the following is the contents of the JSON file used.

```
{
    "pi": {
        "name": "Alam Sutera Pi",
        "description": "Binus Alama Sutera Pi for Build Smart Kampus",
        "port": 1880,
        "resources": {
            "leds": {
                "1": {
                    "name": "LAMP 1",
                    "value": false,
                    "gpio": 4
                },
                "2": {
                    "name": "LAMP 2",
                    "value": false,
                    "gpio": 17
                }
            }
        }
    }
}
```

Figure 5: JSON Resource Data of Lamp

In addition to being an actuator for lights, there is also a Node-RED design to access data from a web, namely the Central Statistics Agency of the Government (BPS) web using the API provided by BPS on the https://webapi.bps.go.id/ web for draw statistical data that can be displayed in the form of graphic data. One of the data taken is data on the level of the total value of exports and imports per year in Indonesia by displaying a comparison of the level of value each month between the value of exports and the value of imports. The following in Figure 6 illustrates the flow of the data access design.

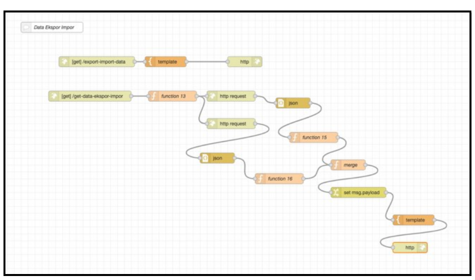

Figure 6: Node-RED Flow for Access Statistic Data

The data display from the given API will be in the form of JSON data and display values per category. Therefore, to find out the monthly amount, it is necessary to give logic to calculate the total value of exports/imports per month. The results of the calculations that have been carried out are displayed using graphs from the Google library to display a comparison between the level of total export value and the level of total import value each month in a certain year. The following in Figure 7 describes the data displayed from the API and Figure 8 is the result of a graph displayed from processed BPS data

```
{
    "status": "OK",
    "data-availability": "available",
    "metadata": {
        "source": "Sumber : https://www.bps.go.id diakses pada 14-10-2022 15:46:10 WIB",
        "value": "Nilai Ekspor/Impor dalam US Dollar ($)",
        "netweight": "Berat Ekspor/Impor dalam Kilogram (KG)",
        "kodehs": "Kode dan Deskripsi dari HS",
        "pod": "Pelabuhan Masuk/Keluar di Indonesia",
        "ctr": "Negara Asal/Tujuan",
        "tahun": "Tahun Data"
    },
    "data": [
        {
            "value": 5210537,
            "netweight": 1367500,
            "kodehs": "[01] Live animals",
            "pod": "BELAWAN",
            "ctr": "AUSTRALIA",
            "tahun": "2022",
            "bulan": "[08] Agustus"
        },
        {
            "value": 2824948,
            "netweight": 818247,
            "kodehs": "[01] Live animals",
            "pod": "BELAWAN",
```

Figure 7: Result Data of BPS

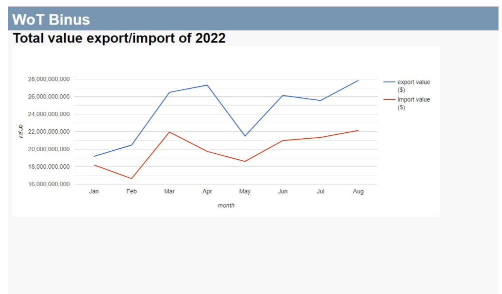

Figure 8: Result Data After Processing

5.2 Prototype Design

5.2.1 Lamp Design

The lamp is made by connecting it to a 5V relay module and a raspberry pi 4. The relay module is connected using a cable to the lamp, then the relay module is connected to the raspberry pi by connecting a jumper cable to the GPIO pin of the raspberry pi. In Figure 9 is a picture of the lamp design that has been described.

Journal of Theoretical and Applied Information Technology
28th February 2023. Vol.101. No 4

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

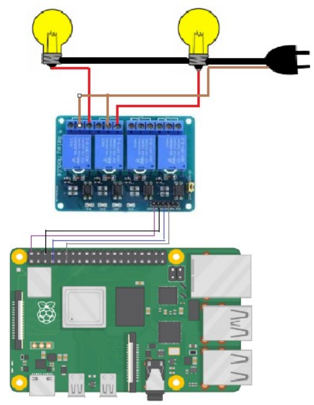

Figure 9: Lamp Design

The following table 3 describes the relay connection information with jumper cables on the raspberry pi.

Table 3: Relay and GPIO Pin Details

Relay	GPIO Pin Raspberry Pi	Deskripsi
DC+	Pin 2	5V DC Power
DC-	Pin 6	GROUND (GND)
In1	Pin 7	GPIO4
In2	Pin 11	GPIO17

Here is the result of the lamp that has been made based on Figure 10

Figure 10: Lamp Prototype

This lamp will later be installed in a room such as a discussion room or classroom. Figure 11 illustrates the floor plan of applying lights to the room so that the room can become a smart classroom or smart discussion room on a campus.

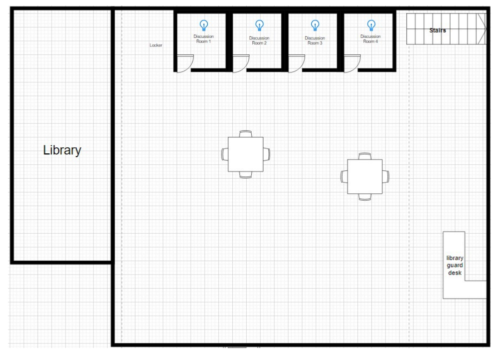

Figure 11: Room Plan

The lights that are made are still assisted by cables that need to connect the relay with lights and raspberry pi. The lamp used can also be a lamp that has Bluetooth or WiFi to reduce the use of cables today.

5.2.2 Website Display Design

The following is a web application display design to control physical things that are designed and access data from other websites that students can later use to do research and so on. For the prototype website, it still uses the local URL from Node-RED.

a. Home Page

This Home Page is the main page of the root url for example http://www.example.com/. This home page is the initial display of the opening of the website.

b. Discussion Room Page

On this page, it is used to select which room you want to control the room lights in. For example, the room selection from the discussion room will be displayed as shown in Figure 12

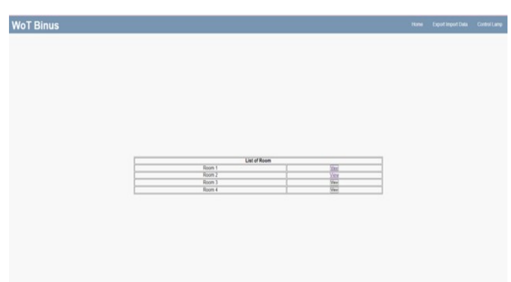

Figure 12: Discussion Room Page

c. Control Discussion Room Lamp Page

On this page, it is used to control the room lights in the previously selected discussion room.

Journal of Theoretical and Applied Information Technology
28th February 2023. Vol.101. No 4

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Status will display the state of the light whether it is on or off. Users can press the ON button to turn on the lights and OFF to turn off the lights. The color of the symbol next to the lamp status will also change according to the lamp status. If the light is ON, then the color of the symbol will be green and if the light is OFF, then the color of the symbol will be red. Figure 13 below illustrates the appearance of the Control Discussion Room Lamp Page

Figure 13: Control Discussion Room Lamp Page

d. Access Export Import Data Page

On this page, the user will first input the year for which he wants to view the data, then the user will be directed to a page where a comparison graph will be displayed between the total export value and the total import value per month in the year selected by the user as illustrated in Figure 14.

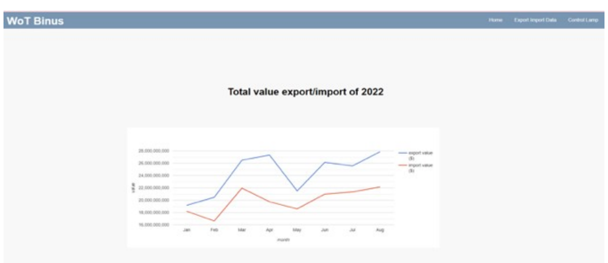

Figure 14: Access Export and Import Data Page

5.3 Discussion

The prototype has been successfully created using RaspberryPi and Node-RED. The design of the lamp control using Raspberry Pi and the use of the web to control the lamp made using Node-RED is one of the designs to create a smart campus. This room light control can be used by stakeholders on campus without having to turn off the lights manually by checking the rooms one by one. In the future, the design for this actuator can be developed so that it can command more devices in the campus area using only a web. The system design for data access from the API provided by the Central Statistics Agency in the Web of Things is a form of implementing the concept of communication between things and things. This shows that with the web we can communicate and exchange data between one thing and another. To support data exchange or data communication, a RESTful API can be used with the provided methods such as GET, POST, PUT, DELETE and the output of the API can be in the form of JSON, XML, or other data. This communication between things can also be called the creation of mashups, which can also be developed later using semantic web technology. This model or prototype can also be further developed so that it can be integrated with learning technology, one of which is ITS. If the web of things is embedded with ITS, then it can facilitate ITS in building a personalized learning because using the web can easily integrate data from anywhere that can help ITS obtain data for the needs of creating personalized learning.

6 CONCLUSION

There are many technologies that can be used to increase the effectiveness and efficiency of teaching and learning activities, especially in universities. Technology can help in turning the university into a smart campus. A smart campus is a campus that utilizes technology such as information systems, IoT, and so on. The results of the research conducted have answered several research questions related to how to create a Web of Things-based smart campus to support learning. The system can be built using web resources built using Node-RED, which is an application whose programming language is based on Node.js which can support the development of the Web of Things. This paper has shown the results of making a prototype of a Web of Things-based system where users on campus can create a smart campus by controlling things for operational aspects, accessing data, and communicating things with things that can be used for learning aspects in one application, namely a web application. In this paper, we show a prototype of making light control using the web, accessing export and import statistical data then processing it and displaying it using graphs from a library owned by Google so that this includes the relationship between the web and the web that connects our web with data from the Central Statistics Agency (BPS) website, processing it and connecting it to the graph application owned by Google. This data can later be used by students, for example for research purposes, so that this data is useful for learning. For further work, it is necessary to evaluate to get feedback regarding the system and to know that the system is working well and can help users on campus. The model or the prototype can be easily extended or scale up to a wide implementation aspect of smart campus, including embedded ITS in facilitation personalized learning.

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