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IBC Tracer: Web-Based Application for Online Tracing the Spread of Covid-19 in Indonesia Using BFS Algorithm

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ABSTRACT

In the case of handling the Covid-19 pandemic in Indonesia, there is a 3T (Testing, Tracing, Treatment) movement promoted by the government to reduce the impact of the spread and transmission of Covid-19. For tracing, there are currently no Information Technology-based applications or services that can assist the public in simulating the tracing of the spread of Covid-19 from one location to another location and providing disaster mitigation education to users through suggestions provided by the application after the tracking process. For this reason, this study was designed and implemented using a web-based Artificial Intelligence (Breadth-First Search) algorithm called Indonesia BFS Covid-19 (IBC). This research uses Design Science Research Methodology (DSRM) and tested using BlackBox Testing. From the testing results, it is concluded that the application can simulate the process of tracing the spread of Covid-19 in Indonesia well based on the starting point and destination, and users can gain an understanding of disaster mitigation education from the advice given by the post-tracing application, as part of 3T, to help decide the impact of the spread of Covid-19 in Indonesia.

I. Introduction

The Corona Virus (COVID-19) is a virus that is transmitted through respiratory infections, first detected in Wuhan China in December 2019 and outbreak on January 30, 2020, so that it was declared a Health Emergency pandemic by WHO [1][2]. Indonesia is one of the countries that has been affected by Covid-19. In Indonesia, the handling of Covid-19 is carried out jointly by the government, medical officers, and the community. Handling is done medically (drugs, vaccines, treatments) and non-medical uses Information Technology (IT)-based services. IT-based services include Info on Covid19 Indonesia[3], Kawal Covid19[4], Emerging Infections Kemkes RI[5], and PeduliLindungi[6]. All of these services provide actual and useful information for the Indonesian people related to Covid19, which includes: the latest developments (statistics, graphs), distribution maps, number of cases per area, availability of rooms to stay in each hospital, to self-detection online.

The government also promotes a 3T (Testing, Tracing, Treatment) to reduce the impact of the spread and transmission of Covid19. For tracing, there are currently no IT-based applications or services that can assist the public in simulating the tracing of the spread of Covid19 from one location to another location and providing disaster mitigation education to users through suggestions provided by the application after the tracking process. In the case of Tracing, there is one thing that needs to be done but is not yet available, namely an application or service for the public to conduct a simulation of tracing the spread of Covid-19 in Indonesia from one place to another place along with disaster mitigation education after the tracing process. Indonesia as the largest archipelagic country in the world has its challenges in tracking the spread of Covid-19 from one place to another place, especially across islands. This is also supported by a large population and high mobility between regions (domestic and overseas). Indonesia also has several entrances to the country and abroad (land, sea, air). These things have the potential to spread Covid-19 in the public if there is no education regarding Covid-19 disaster mitigation as one of the IT-based prevention and public education efforts.

Based on the problems above, in this research, a web-based application solution is proposed as an online simulation of tracing the spread of Covid-19 in Indonesia from one place to another, utilizing the Artificial Intelligence-based Breadth-First Search (BFS) algorithm. The proposed and developed application is named the Indonesia BFS Covid19 Tracer (IBC Tracer) based on the web. The formulation of the problem in the form of research questions includes 1.) How is the design of the proposed web-based IBC Tracer? 2.) How is the implementation of the proposed web-based IBC Tracer related to the use of location data for every place in Indonesia and the tracing process carried out? 3.)How to do testing on the developer side and the user side? 4.) How to conduct Covid-19 disaster mitigation education to users after the search process? This research hypothesizes that IBC Tracer can perform a simulation of tracing the spread of Covid-19 from one place to another in Indonesia online, as well as providing disaster mitigation education to users after the tracing process.

There are several researches related to the use of the BFS algorithm in the tracer process in various case studies as state of the art. Wijaya in his publication, describes the solution to the problem of a water jug and two empty jugs, using the BFS algorithm [7]. Zai, Budiati, and Berutu in their research explain the development of web-based applications using the BFS algorithm to facilitate the process of finding the shortest route from tourist sites on Nias Island which also includes gas stations, restaurants, hotels, and government offices [8]. Agung and Marselinus in their research developed an application based on the BFS algorithm to diagnose computer damage, then the application was tested using Black Box Testing [9]. Prasetiyo, Dewa, and Udjulawa in their publications describe the development of educational games based on the BFS algorithm to assist information technology learning to the public [10]. Wibowo, Budianto, Lasguido, and Fathurrahman developed a Lego Robot that can search for dynamic lanyards using the BFS algorithm [11]. Alkindi, Akhmad, Kartiko, Putro, Rumini in their research describe the application of the BFS algorithm in the Pacman game to manage the characters in it [12]. Prasetiyo and Hidayah implemented the BFS algorithm in the Kamen Rider Decade Game with a qualitative approach and descriptive method [13]. Yani, Pieter, Matdoan, in their research, designed and built a Sliding Puzzle Educational Game software using the BFS algorithm [14]. Rosdianah in her research uses the BFS algorithm to perform Artificial Intelligence (AI)-based searches for trajectories that can be traversed by an ant through the Cartesian plane [15]. Sulatri and Zuliarso conducted a research to compare the search for crawler programs on websites using the BFS algorithm and Backlink Count algorithms [16].

II. Method and Data

A. Hardware and Software

This research was conducted from April 2020 to June 2021. The hardware used is Dell Latitude E6440 (Intel i7-4610M (4) @ 3.700GHz, 16GB of RAM). The software used is Ubuntu Linux 20.04, JavaScript, P5.js, HMTL5, HTML5 canvas, Mappa, Leaflet, and Google Firebase.

B. Breadth First Search (BFS) Algorithm

The Breadth-First Search (BFS) algorithm is an Artificial Intelligence (AI) based search algorithm. This algorithm is commonly used in some cases that require tracing. The search for BFS starts from the root (level 0) to the next level by looking for all nodes or nodes that have the same level or level until a goal is obtained at the level or moves to the next level.[17]. An illustration of the BFS algorithm is shown in Figure 1. below:

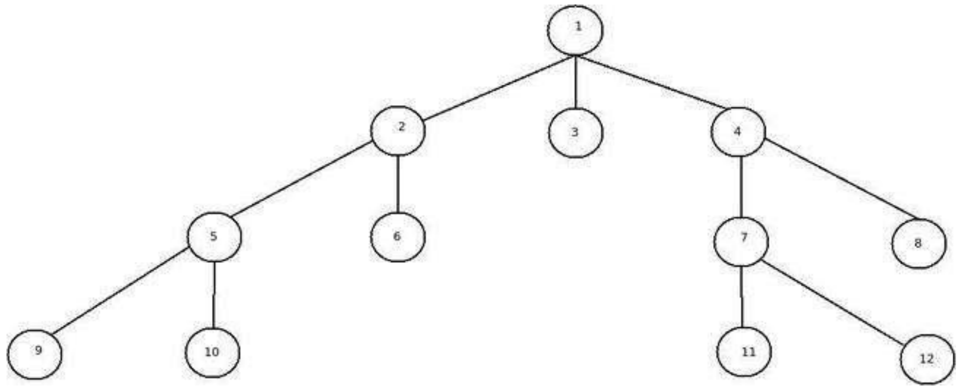


Fig. 1.Breadth First Search (BFS) algorithm.

Based on the picture above, the BFS algorithm can be explained as follows: 1.) First, input the root node into the queue, 2.) Select the starting node of the queue and check whether the node is the solution. 3.) Condition, if it is a solution, the search is complete, the results are displayed, put all child nodes into the queue, 4.) If it is not a solution, then the queue is empty, the search is complete, can be repeated from point 2. Fig. 2. below shown the flowchart of BFS algorithm:

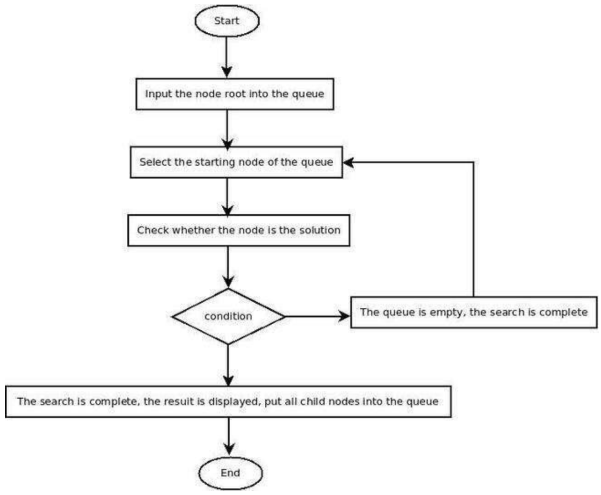


Fig. 2.Flowchart of the BFS algorithm.

C. Design Science Research Methodology (DSRM)

This research uses Design Science Research Methodology (DSRM) introduced by Peffers, Tuunanen, Rothenberger, and Chatterjee, which includes 8 research steps, namely: literature study, research motivation, problem identification, solution design, prototyping, demo, documentation, and publication [18]. The literature study was carried out through the collection of several pieces of literature related to the Covid-19 case in Indonesia as well as several uses of the BFS algorithm as state of the art. The research motivation is determined through efforts to create a web-based system that can simulate the tracing of the spread of Covid-19 in Indonesia as well as provide disaster mitigation education. Problem identification is formulated into research questions using the 5W+1H formulation, namely: a.) How to implement the BFS algorithm into a web-based application to track the spread of Covid-19 from the starting point to the endpoint? b.) How to conduct disaster mitigation education to users through post-processing applications?

The solution design is given in the form of Unified Modeling Language (UML) in the form of Use Case Diagrams and Sequence Diagrams. The use case diagram in this research involves one actor (user) with six use cases, namely: 1.)URL access use case which displays the user actor accessing the application via a web browser at the URL https://ibctracer.web.app, 2.)Use case for determining the starting point (Geolocation/manual), 3.)Use case for determining the endpoint and destination point, 4.)Use case for tracing, 5.)Use case for information on search results, 6.)Use case for advice and post-tracing mitigation education. Each use case in the Use Case Diagram can be developed into a Sequence Diagram to describe in more detail each step of the process in it. The Fig. 3. and Fig 4. below show the Use Case Diagram and the Sequence Diagrams of URL access use case:

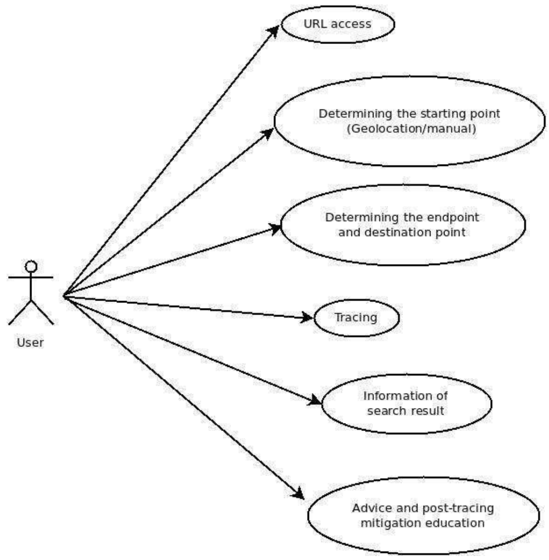


Fig. 3. Use Case Diagram.

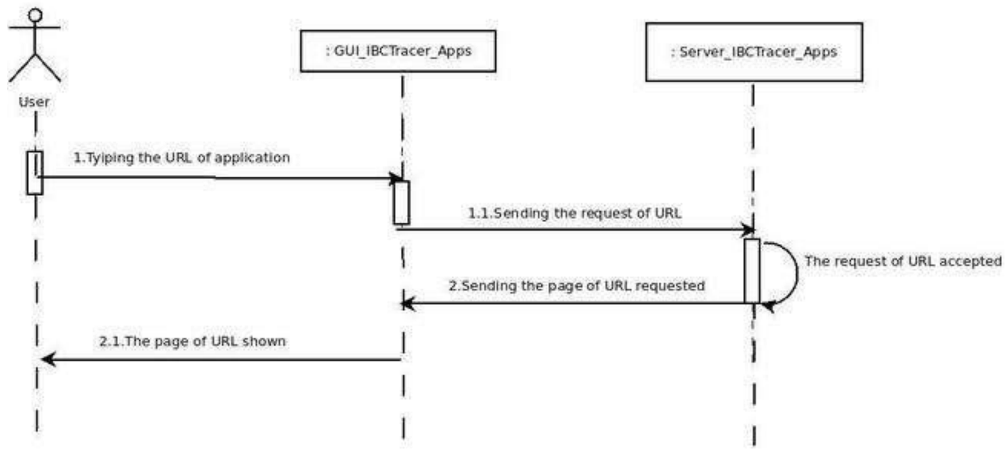
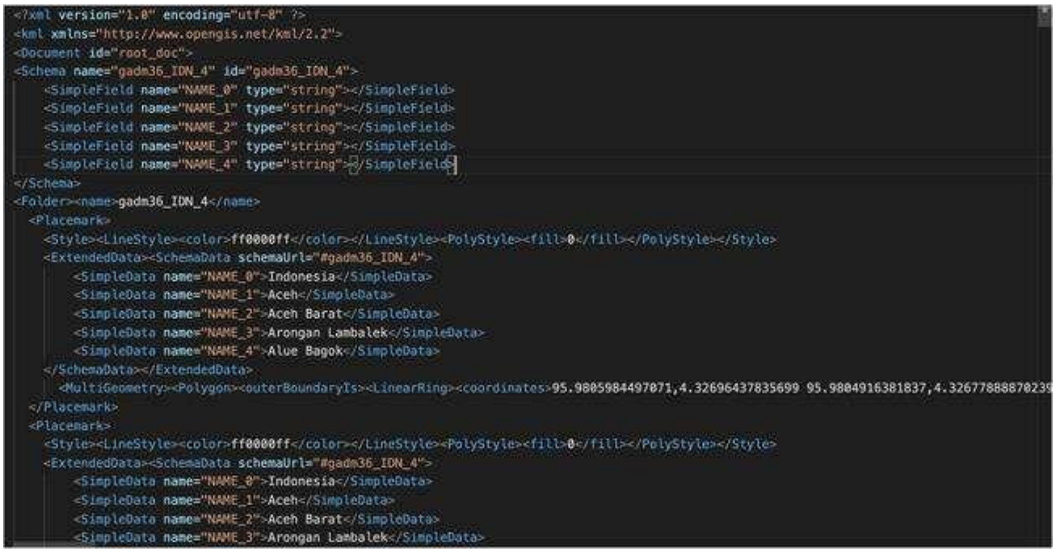


Fig. 4. Sequence Diagram of URL access

Application prototyping is carried out based on the solution design that has been created, using HTML5, JavaScript, P5.js, JSON, XML, Geolocation API, as well as province, city, district data throughout Indonesia along with its coordinates. The application prototype demo was carried out in the form of testing on the developer side using the Black Box Testing method. Documentation is done through recording data and recording test results. Publications are presented in the form of papers in scientific journals.

D. Data Collection Method

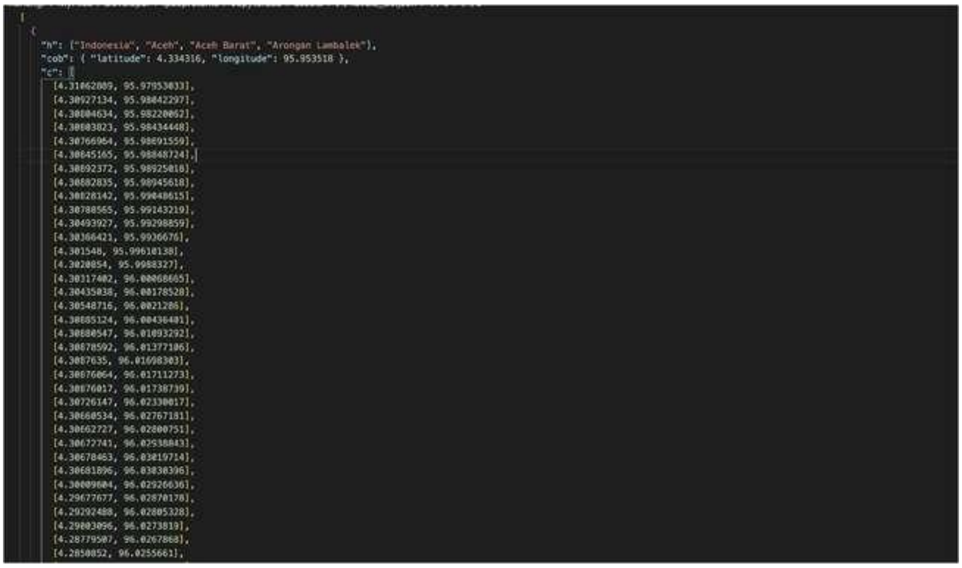
Sources of data for cities and districts in Indonesia in the application, obtained from Google Earth through the GADM service [19]. The data from Google Earth is very large and complex, containing images, signs, and coordinates, in the form of Keyhole Markup Language (KML), and then compressed into KML Zipped (KMZ) form, so that it can be run through the IBC Tracer application. The KML/KMZ data snippet on the IBC Tracer is shown in the Fig. 5. below:




```xml
<?xml version="1.0" encoding="utf-8" ?>
<kml xmlns="http://www.opengis.net/kml/2.2">
<Document id="root_doc">
<Schema name="gadm36_IDN_4" id="gadm36_IDN_4">
    <SimpleField name="NAME_0" type="string"></SimpleField>
    <SimpleField name="NAME_1" type="string"></SimpleField>
    <SimpleField name="NAME_2" type="string"></SimpleField>
    <SimpleField name="NAME_3" type="string"></SimpleField>
    <SimpleField name="NAME_4" type="string"></SimpleField>
</Schema>
<Folder><name>gadm36_IDN_4</name>
  <Placemark>
    <Style><LineStyle><color>ff0000ff</color></LineStyle><PolyStyle><fill>0</fill></PolyStyle></Style>
    <ExtendedData><SchemaData schemaUrl="#gadm36_IDN_4">
        <SimpleData name="NAME_0">Indonesia</SimpleData>
        <SimpleData name="NAME_1">Aceh</SimpleData>
        <SimpleData name="NAME_2">Aceh Barat</SimpleData>
        <SimpleData name="NAME_3">Arongan Lambalek</SimpleData>
        <SimpleData name="NAME_4">Alue Bagok</SimpleData>
    </SchemaData></ExtendedData>
      <MultiGeometry><Polygon><outerBoundaryIs><LinearRing><coordinates>95.9805984497071,4.32696437835699 95.9804916381837,4.3267788887023
  </Placemark>
  <Placemark>
    <Style><LineStyle><color>ff0000ff</color></LineStyle><PolyStyle><fill>0</fill></PolyStyle></Style>
    <ExtendedData><SchemaData schemaUrl="#gadm36_IDN_4">
        <SimpleData name="NAME_0">Indonesia</SimpleData>
        <SimpleData name="NAME_1">Aceh</SimpleData>
        <SimpleData name="NAME_2">Aceh Barat</SimpleData>
        <SimpleData name="NAME_3">Arongan Lambalek</SimpleData>
```


Fig. 5. The KML/KMZ data snippet at IBC Tracer based on web application.

There are three stages in the data collection method, namely: data transformation, data analysis, and data visualization. At the data transformation stage, 400MB of KML/KMZ data is converted into a simpler data format of 129kB while maintaining the data structure in it, making it easier for applications to load. This process uses NodeJS and XML in JSON form. Fig. 6. below shows the data of cities and regions in Indonesia as a result of data transformation along with coordinate points and bounding boxes to facilitate the running of the BFS algorithm through neighbors between nodes.




```json
[
  {
    "n": ["Indonesia", "Aceh", "Aceh Barat", "Arongan Lambalek"],
    "cob": { "latitude": 4.334316, "longitude": 95.953518 },
    "c": [
      [4.31062009, 95.97953033],
      [4.30927134, 95.98042297],
      [4.30804634, 95.98220062],
      [4.30803823, 95.98434448],
      [4.30766964, 95.98691559],
      [4.30845165, 95.98848724],
      [4.30892372, 95.98925018],
      [4.30882835, 95.98945618],
      [4.30828142, 95.99048615],
      [4.30788565, 95.99143219],
      [4.30493927, 95.99298859],
      [4.30366421, 95.9936676],
      [4.301548, 95.99610138],
      [4.3020854, 95.9988327],
      [4.30317402, 96.00068665],
      [4.30435038, 96.00178528],
      [4.30548716, 96.0021286],
      [4.30885124, 96.00436401],
      [4.30880547, 96.01093292],
      [4.30878592, 96.01377106],
      [4.3087635, 96.01698303],
      [4.30876064, 96.01712273],
      [4.30876017, 96.01738739],
      [4.30726147, 96.02330017],
      [4.30660534, 96.02767181],
      [4.30662727, 96.02800751],
      [4.30672741, 96.02538843],
      [4.30678463, 96.03019714],
      [4.30681896, 96.03030396],
      [4.30009604, 96.02926636],
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      [4.29292488, 96.02805328],
      [4.29003096, 96.0273819],
      [4.28779507, 96.0267868],
      [4.2850052, 96.0255661],
```


Fig. 6. The KML/KMZ data snippet at IBC Tracer.

In the data analysis stage, the Jupyter Notebook tool is used. At the data visualization stage, JavaScript and P5.js are used to make it easier to draw onto the HMTL5 canvas, an autocomplete library to make it easier to create UI for selecting starting and destination points, Geolocation for auto-detect the user location, and also Mappa and Leaflets for drawing a world map. The web-based IBC Tracer application prototype is hosted online on Google's Cloud Computing-based Firebase service at the URL https://ibctracer.web.app which supports availability, reliability, and security.

E. Black Box Testing

Testing of the application prototype is carried out on both the developer side and user sides. The Black Box Testing method is used on the developer side to test the suitability between the prototype and the design [20]. All features and menus in the application are tested to then be observed for compatibility with the desired design and purpose.

III. Result and Discussion

A. IBC Tracer Tracing (from Denpasar, Bali to Central Jakarta, Special Capital Region of Jakarta)

The testing was carried out with the starting point from the author's location (Denpasar, Bali) to the destination in Central Jakarta (Special Capital Region of Jakarta). IBC Tracer automatically detects the author's location based on the Geolocation library at coordinates Latitude -8.72272 and Longitude 115.232758 and destination coordinates at Latitude -6.182313 and Longitude 106.836609. Fig. 7. below shows the tracing process carried out by the application:

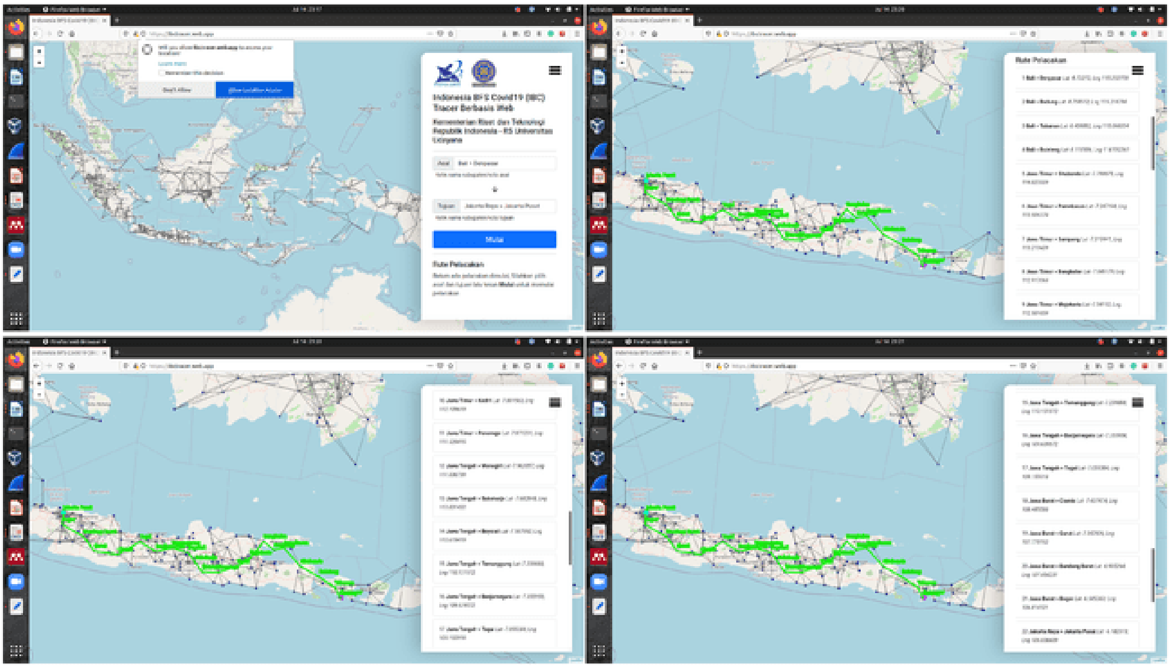

Fig. 7. The tracing process.

After the simulating of tracking process and its node, then the IBC Tracer displays suggestions to users (the suggestion shown in Bahasa Indonesia). This suggestions purpose is for Covid-19 disaster mitigation education for user, government, and citizen according the result of tracking process. For the example: the suggestion to checking at every border (province, district, city, region), provision of Covid-19 checking services to citizens, vaccinations, and outreach to the public regarding health protocols. The suggestion shown at Fig. 8. below:

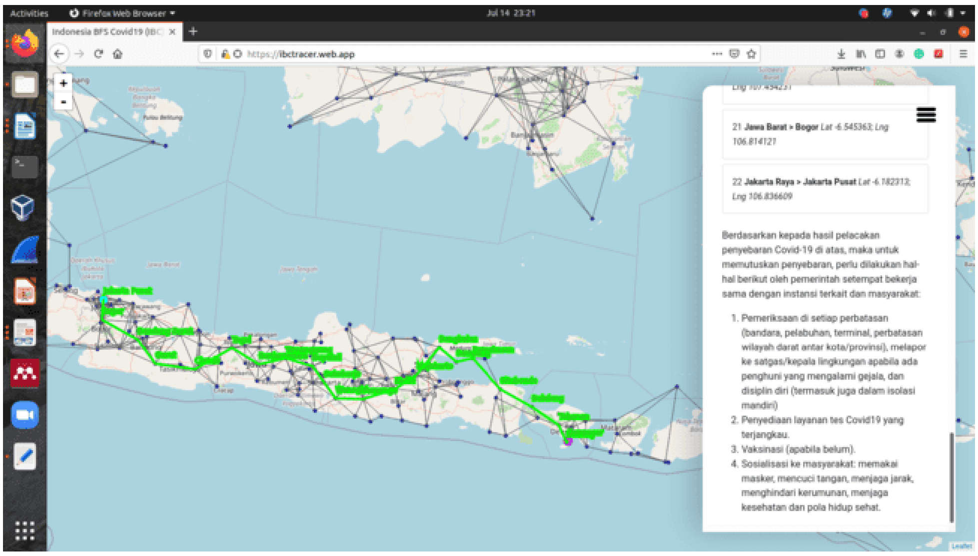

Fig. 8. Suggestions to user after the tracing process (in Bahasa Indonesia).

B. *Table of Tracing Results Based on the BFS Algorithm*

Testing of the IBC Tracer application prototype was carried out by simulating the tracking of the spread of Covid-19 from the starting point of Denpasar City (Bali) to the destination in Central Jakarta (Special Capital Region of Jakarta). During the tracing process, there were a number of cities and regions in Indonesia were passed. The list of cities or areas that are passed along with their respective coordinates (Latitude, Longitude) is shown in the Table 1. below:

Table 1. Table of Tracing Result

Tracing Process	***Position***	***Latitude***	***Longitude***
Denpasar (Bali)	nodes, starting point	-8.72272	115.232758
Badung (Bali)	nodes, neighbors	-8.758512	115.214794
Tabanan (Bali)	nodes, neighbors	-8.438882	115.066334
Buleleng (Bali)	nodes, neighbors	-8.118306	114.592361
Situbondo (East Java)	nodes, neighbors	-7.798675	114.020309
Pamekasan (East Java)	nodes, neighbors	-7.247166	113.506378
Sampang (East Java)	nodes, neighbors	-7.310441	113.213409
Bangkalan (East Java)	nodes, neighbors	-7.046179	112.910568
Mojokerto (East Java)	nodes, neighbors	-7.541120	112.501659
Kediri (East Java)	nodes, neighbors	-7.801563	112.109619
Ponorogo (East Java)	nodes, neighbors	-7.971231	111.529415
Wonogiri (Central Java)	nodes, neighbors	-7.962057	111.036739
Sukoharjo (Central Java)	nodes, neighbors	-7.682848	110.831432
Boyolali (Central Java)	nodes, neighbors	-7.387092	110.619419
Temanggung (Central Java)	nodes, neighbors	-7.239888	110.131512
Banjarnegara (Central Java)	nodes, neighbors	-7.355958	109.639572
Tegal (Central Java)	nodes, neighbors	-7.055384	109.155918
Ciamis (West Java)	nodes, neighbors	-7.437474	108.485588
Garut (West Java)	nodes, neighbors	-7.342926	107.778152
West Bandung (West Java)	nodes, neighbors	-6.905264	107.454231
Bogor (West Java)	nodes, neighbors	-6.545363	106.814121
Central Jakarta (Special Capital Region of Jakarta)	nodes, destination/endpoint	-6.182313	106.836609

C. *Black Box Testing*

Black Box testing is carried out to test the extent of the suitability between the application design and the application prototype that has been built, seen from each feature and menu tested according to the test scenario. Black Box Testing of IBC Tracer application is shown in Table 2. below:

Table 2. Black Box Testing of IBC Tracer

No	***Testing Scenario***	***Test Case***	***Expected Result***	***Result***	***Conclusion***
1	Open the IBC Tracer in a web browser	Open a web browser, type the URL of IBC Tracer, press Enter	The IBC Tracer page appears in the web browser as soon as the Enter key is pressed	According to expectations	Valid
2	Determining starting point automatically based on Geolocation	Access IBC Tracer URL then select Allow Location Access option	IBC Tracer has successfully set the starting point according to the user's location using Geolocation	According to expectations	Valid

3	Manually specifying the starting point	Access the IBC Tracer URL, type in the location manually, the Auto Completes feature will complete automatically	IBC Tracer successfully set the starting point according to the user's location manually using Auto Complete	According to expectations	Valid
4	Determining endpoint	Accessing IBC Tracer URL, typing destination point (endpoint) manually, Auto Completes feature autocompletes	IBC Tracer successfully set the destination point according to the user's location manually using Auto Complete	According to expectations	Valid
5	Start tracing after specifying start point and endpoint	Clicking the Start button and displaying each location point (city/district) passed along with their respective coordinates	IBC Tracer starts the tracing process and displays each point (city/district) that is passed along with their respective coordinates	According to expectations	Valid
6	Displays the coordinates of each point (city/district) that is passed	Observing in the tracing section below the endpoint column	IBC Tracer displays the coordinates of each point (city/district) that is passed vertically according to the tracking process based on the BFS algorithm	According to expectations	Valid
7	Showing suggestions to users after tracing process	Observing the suggestions given by the application to the user after the tracing process	IBC Tracer show several suggestions to users regarding efforts to decide the spread of Covid-19 in Indonesia after the tracing process	According to expectations	Valid
8	Restart a new tracing process	Reaccess IBC Tracer URL, select start point and endpoint, press Start button	IBC Tracer restarts a new trace according to the start point and endpoint	According to expectations	Valid

IV. Conclusion

Based on the tests that have been carried out in this research, it can be concluded that the design and implementation of the IBC Tracer application based on the Breadth-First Search (BFS) algorithm can be carried out well. The results of Black Box Testing and the table of results of the tracing process show that the functionality of the application is running well by the desired goal is to simulate tracking the spread of Covid-19 from one place to another in Indonesia using coordinate points (Latitude, Longitude) as neighboring nodes. It is also providing disaster mitigation advice to users after the tracing process. Users can gain an understanding of disaster mitigation education from the advice given by the post-tracing application, as part of 3T, to help decide the impact of the spread of Covid-19 in Indonesia.

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