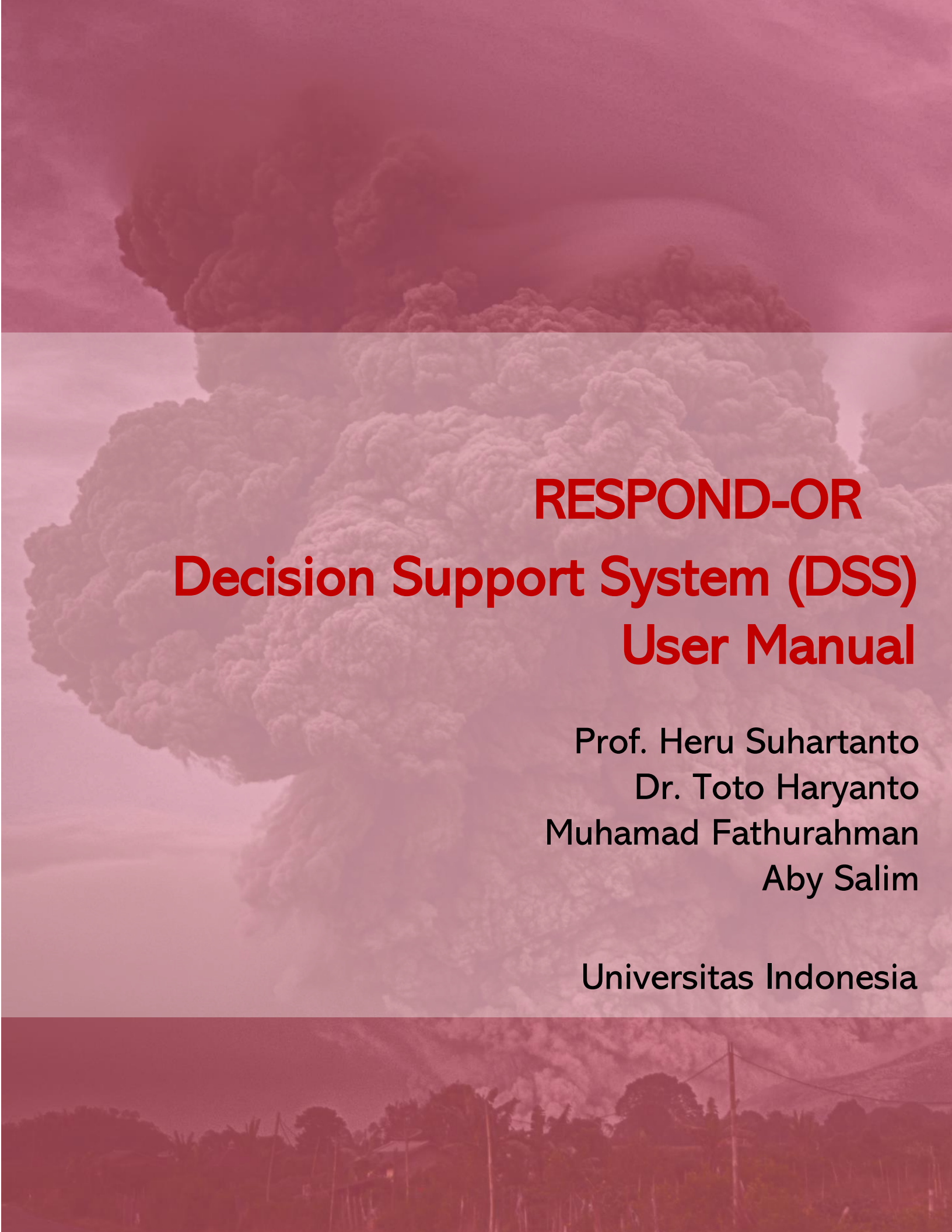

RESPOND-OR
Decision Support System (DSS)
User Manual

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Universitas Indonesia

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Executive Summary

The RESPOND-OR Decision Support System (DSS) aims to assist the disaster response agencies in Indonesia - the National Board for Disaster Management (BNPB), Regional Disaster Management (BPBD) and non-government organizations (NGOs) - in making two disaster response decisions: i) assisted evacuation, and ii) personnel routing and scheduling. Accordingly, the DSS has two main modules: i) Assisted Evacuation Planning (AEP), and ii) Personnel Routing and Scheduling (PRS). AEP and PRS modules will utilize the network data generated by the system to solutions/ recommendations for a defined disaster location. The AEP and PRS modules of the RESPOND-OR were developed by the RESPOND-OR Lancaster University research team (Prof. Konstantinos G. Zografos, Prof. Juliana Sutanto, Dr. Ahmed Kheiri, Dr. Aleksandr Pirogov, Dr. Istenc Tarhan). The description of the mathematical models and algorithms of the AEP module are provided in (Pirogov, et al., 2022); while the description of the PRS model and algorithm can be found in (Tarhan, et al., 2022a, and Tarhan et al., 2022b).

The figure below illustrates the general steps of using the DSS.

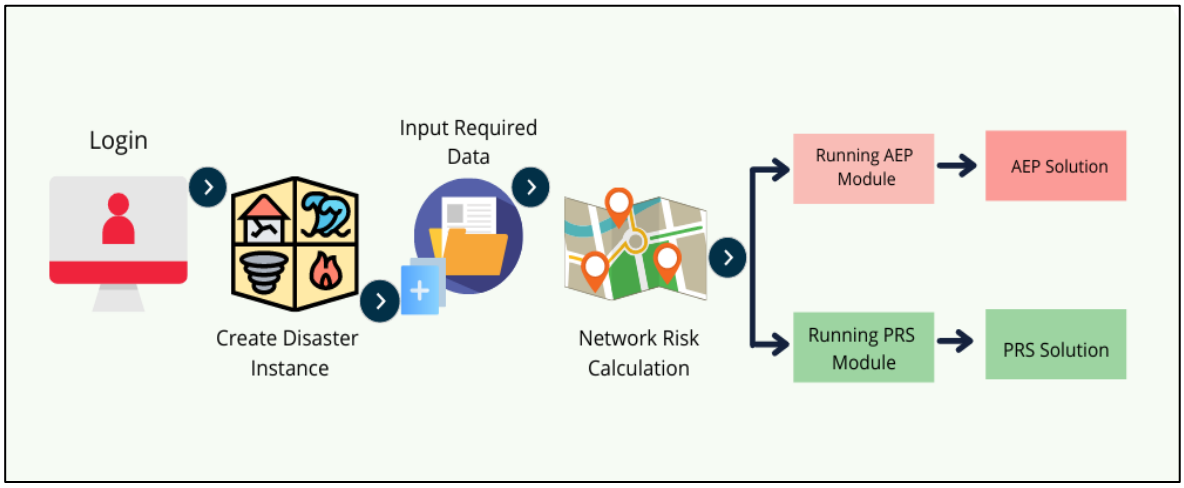


Figure 0-1 General steps of the Decision Support System

To access the DSS, the user needs to sign-in with an authorized account. After signing in, the user must firstly create a disaster instance that corresponds to the area that has been affected by the disaster under consideration. The User can then insert all the necessary input data such as the location of the centroid of the zones comprising the affected areas, the location of the shelters, the location of the depots of the vehicles that will be used for the evacuation, the location of the origin of the personnel that will be dispatched to provide emergency response services, the location of the candidate resting points of the disaster response personnel, the capacities and speeds of the evacuation vehicles, and the available capacity of the candidate shelter facilities for people and livestock (when applicable). Next, the data describing the underlying network of the disaster affected area that contains the risk values, the travel times of the underlying roadway network, and the points of interests (POIs), e.g., zones, shelters, depots, need to be generated. The network generation procedure developed by the RESPOND-OR Universitas Indonesia research team (Gultom et al. 2021) will generate a graph that connects all POIs, along with the risk and travel time associated with its links. The risk value is computed based on BNPB inaRISK data (https://inarisk.bnpb.go.id:6443/arcgis/rest/services/inaRISK/). The output file of the network risk

calculation will be used as an input to both the AEP and PRS modules. After the network risk calculation is completed, the user can begin running the AEP or PRS module. The AEP module will provide alternative solutions for assisted evacuation, whereas the PRS module will provide alternative solutions for personnel routing and scheduling in a disaster instance.

This manual will assist user in using the DSS, including accessing the DSS, storing data, preparing for network risk calculation, running the AEP and PRS modules, and interpreting the outputs of the AEP and PRS modules for a small disaster instance of earthquake disaster in Lombok City at Nusa Tenggara Barat province, Indonesia. The input data for this disaster instance was collected by the RESPOND-OR Universitas Indonesia research team.

Disclaimer

The RESPOND-OR DSS provides recommendations for assisted evacuation planning and personnel routing and scheduling. The users are responsible for the validation of the data input and the decisions made. The RESPOND-OR team is not liable for i) the data validation process, ii) any decisions made resulting from the use of the DSS, and iii) the misuse of the DSS.

1 Sign-in and User Navigation

The DSS can be accessed via a web browser[1] on these addresses: https://dss-respondor.cs.ui.ac.id (primary server) or http://101.50.3.107/respondorv2/ (secondary server, only for testing purposes)[2]. You should first log in with a valid username and password[3], and a correct captcha code. Figure 1-1 shows the DSS login page as it appears in a web browser.

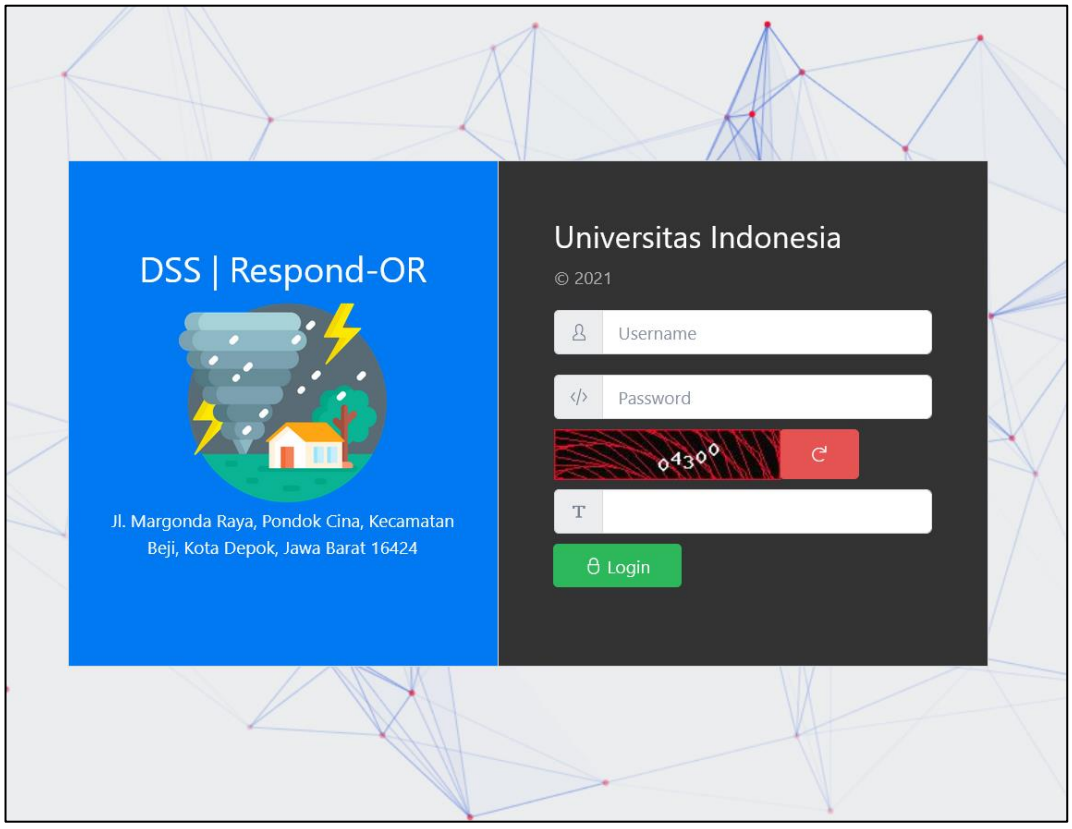


Figure 1-1 Login

After sucessfully signing-in, the system will redirect the user to the Dashboard page. This page will inform the user about the last disaster impacted areas, the total number of the disaster cases that have been added to the system, the total number of input data that have been added to the system, and the total number of assisted evacuation planing and personnel routing and scheduling instances that have been added to the system. The User can find the menu items on the left-hand side of the DSS, which include: Disaster, Master Data, Network Generation, Evacuation Plan, Routing & Scheduling, Settings, and Logout.

[1] We recommend to use the latest version of chrome or mozilla firefox.
[2] As we are improving the DSS, it is recommended to access the DSS from the secondary server. A new link of the secondary server will be provided for the new version of the DSS.
[3] type “admin” for username and password for testing account.

1.1 Menu Item: Disaster

'Disaster' menu provides the list of disaster instances that were created. Each disaster instance consists of disaster's location and date. User can add, remove, or modify a disaster instance. Adding a new disaster instance is the first step before running the AEP and PRS module. Each disaster instance will have its own AEP and PRS solutions.

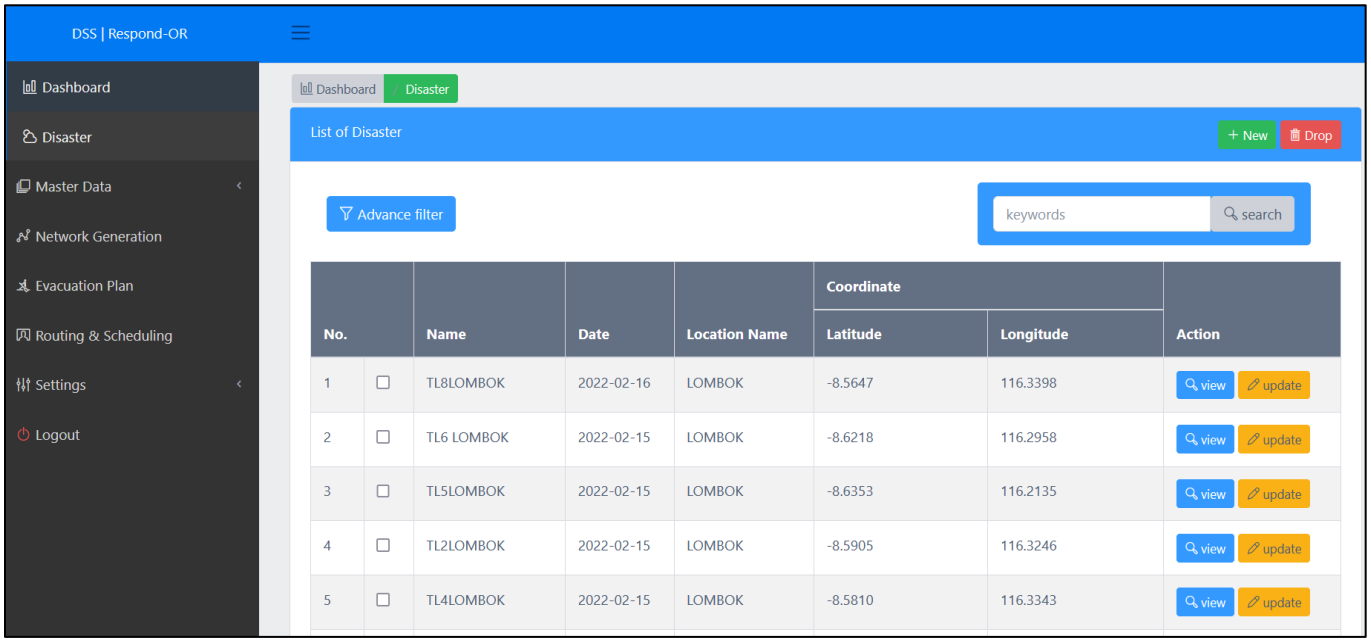


Figure 1-2 Menu Item: Disaster

1.2 Menu Item: Master Data

'Master Data' menu enables user to add, remove, or modify the input data for network risk calculation, AEP and PRS modules. The input data categories of the Master Data are listed in Table 1-1. These data can be reused if the same disaster strikes the same location, with the same attributes of the data.

Table 1-1. Input Categories of the Master Data

Input Category	Description
Depots	Locations of the evacuation vehicles
Shelters	Evacuation points. Each shelter contains information related to the capacity of people and livestock
Zone	The disaster-affected area. Each zone data includes the number of people and livestock that need assisted evacuation and the zone's coordinates.

1.2.1 Insert Depots, Shelters and Zones

To insert Depots, Shelters and Zones data, user may go to the Master Data menu item and select one of input data categories e.g Depots, Shelters and Zones as shown in Figure 1-3.

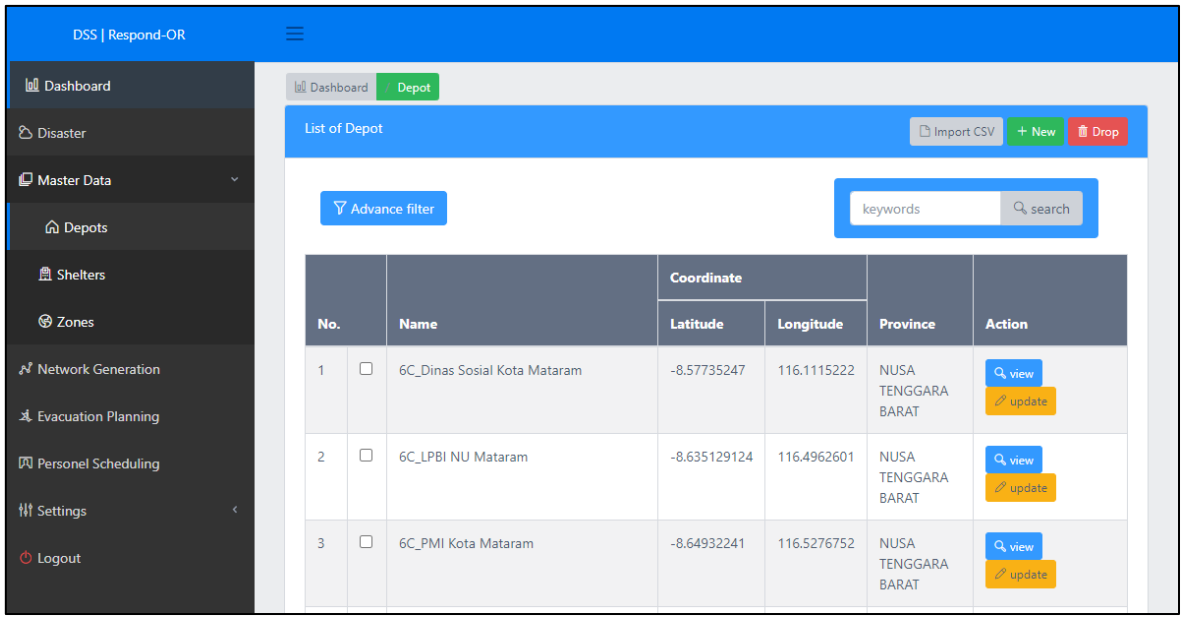


Figure 1-3. Master Data: Depots

To insert a new depot, click New (green button) at the top-right of the page and fill the corresponding information for the depots including the name of the depot, province and the coordinates which represented by the latitude and longitude. See Figure 1-4

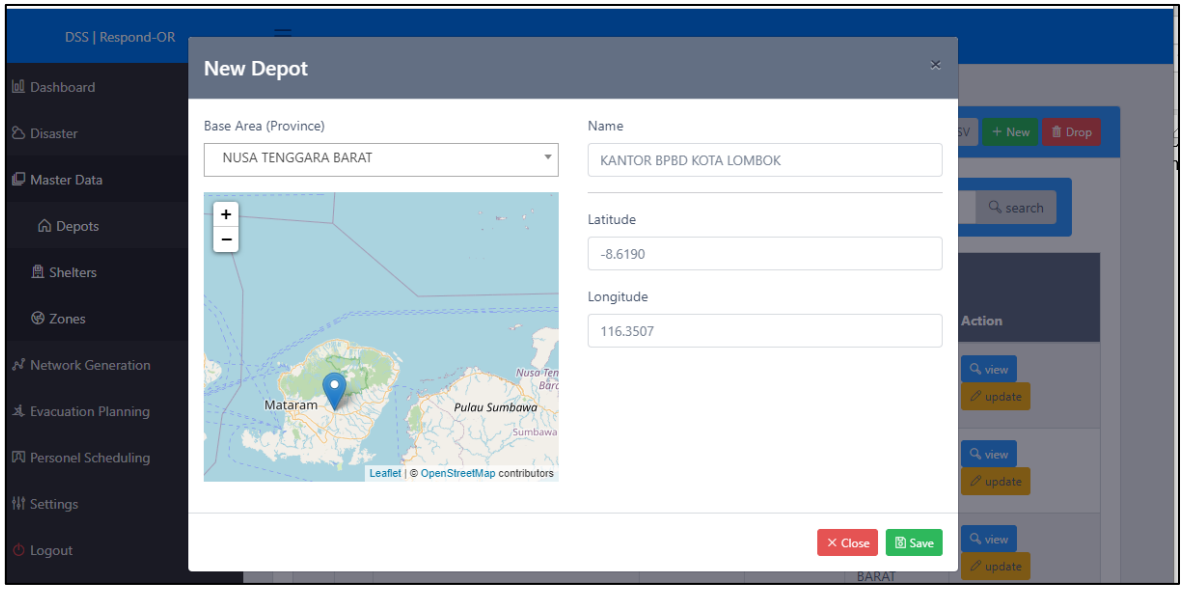


Figure 1-4 Master Data: Insert Depot

To insert a new shelter, at the Shelters page, click New at the top-right of the page and fill the corresponding information for the shelter including base area province, the name of the shelters, capacity of people, capacity of livestock and its coordinates. See Figure 1-5.

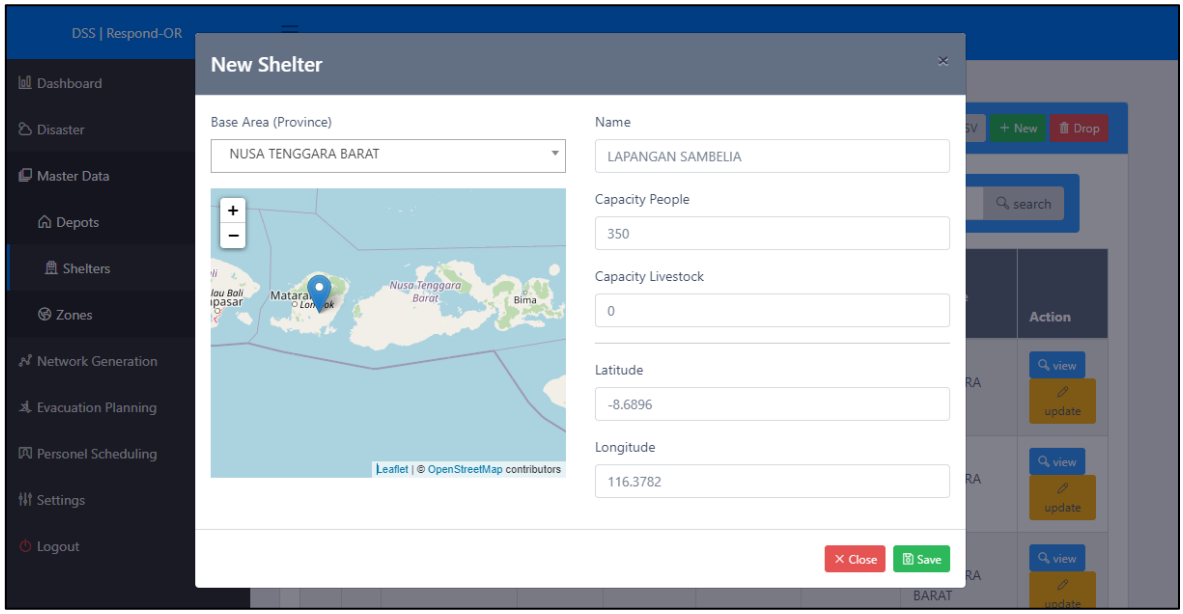


Figure 1-5 Master Data: Insert Shelters

To insert a new zone, at the Zones page, click New at the top-right of the page and fill the corresponding information for the zone including base area province, the name of the zone, number of population of people, capacity of livestock to be evacuated and its coordinates. See Figure 1-6.

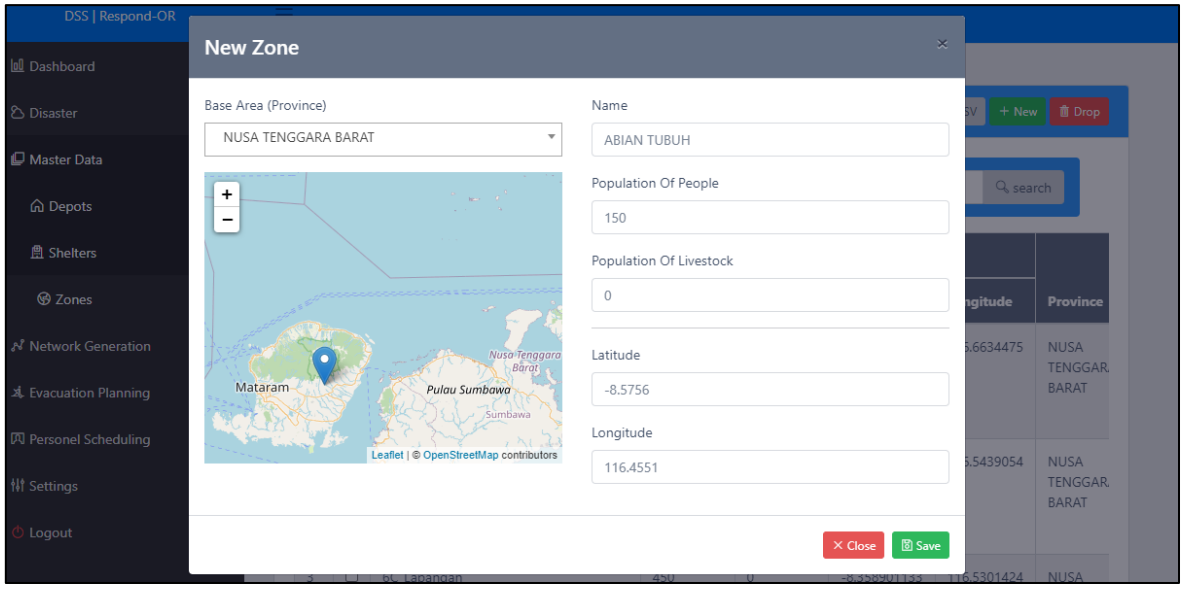
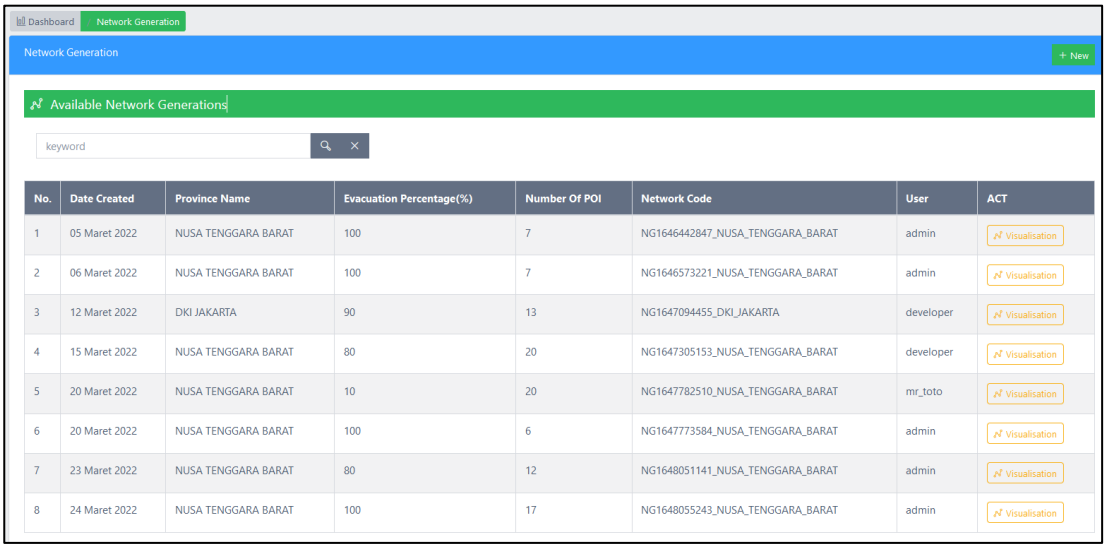


Figure 1-6 Master Data Insert Zones

1.3 Menu Item: Network Generation

'Network Generation' menu enables the user to create the network data around point of interests (POIs) such as shelter, disaster zone, resting point, and depot. The detailed steps of network generation are presented on section 2 of this user manual document. The output is a network/graph that connects all POIs such that there can be multiple paths between the POIs. Each path between two POIs represents a distinct trade-off between the transportation risks and the travel times among the paths between the relevant POIs. In other words, none of the paths between two given POIs can outperform any of the remaining paths between these POIS in terms of both its travel time and transportation risk. The transportation risk value is computed based on BNPB inaRISK data (https://inarisk.bnpb.go.id:6443/arcgis/rest/services/inaRISK/). The output file will be automatically integrated as an input to the AEP and PRS modules.



No.	Date Created	Province Name	Evacuation Percentage(%)	Number Of POI	Network Code	User	ACT
1	05 Maret 2022	NUSA TENGGARA BARAT	100	7	NG1646442847_NUSA_TENGGARA_BARAT	admin	Visualisation
2	06 Maret 2022	NUSA TENGGARA BARAT	100	7	NG1646573221_NUSA_TENGGARA_BARAT	admin	Visualisation
3	12 Maret 2022	DKI JAKARTA	90	13	NG1647094455_DKI_JAKARTA	developer	Visualisation
4	15 Maret 2022	NUSA TENGGARA BARAT	80	20	NG1647305153_NUSA_TENGGARA_BARAT	developer	Visualisation
5	20 Maret 2022	NUSA TENGGARA BARAT	10	20	NG1647782510_NUSA_TENGGARA_BARAT	mr_toto	Visualisation
6	20 Maret 2022	NUSA TENGGARA BARAT	100	6	NG1647773584_NUSA_TENGGARA_BARAT	admin	Visualisation
7	23 Maret 2022	NUSA TENGGARA BARAT	80	12	NG1648051141_NUSA_TENGGARA_BARAT	admin	Visualisation
8	24 Maret 2022	NUSA TENGGARA BARAT	100	17	NG1648055243_NUSA_TENGGARA_BARAT	admin	Visualisation

Figure 1-7. Network generation main page.

1.4 Menu Item: Evacuation Plan

'Evacuation Plan' menu allows the user to run the AEP module and see the recommended solutions for assisted evacuation in a selected disaster instance. The details are explained in section 3.

1.5 Menu Item: Personnel Routing & Scheduling

'Personnel Routing & Scheduling' menu allows user to run the PRS module and see the recommended solutions for personnel routing and scheduling in a selected disaster instance. The details are explained in section 4.

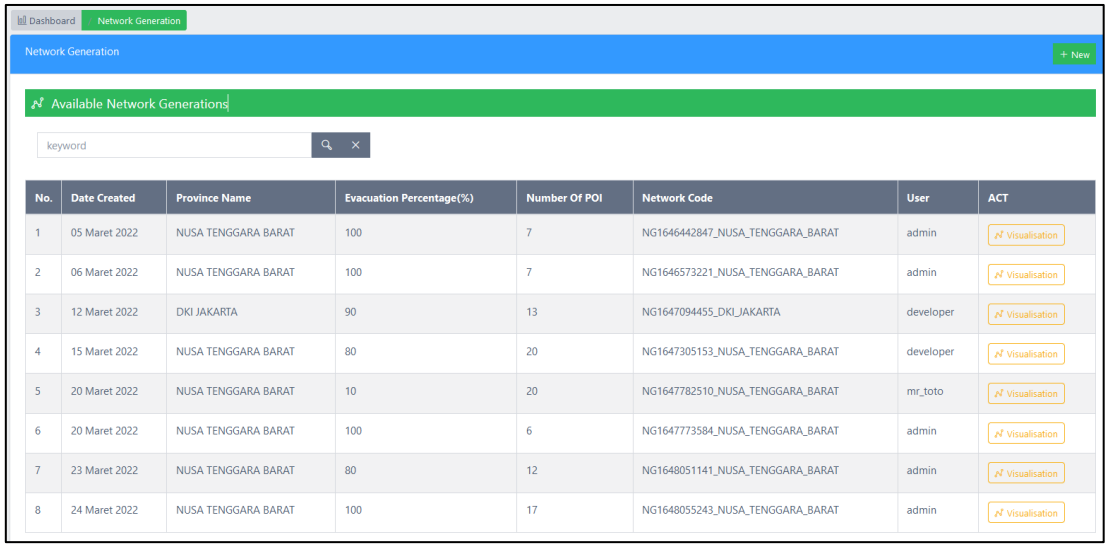
1.6 Menu Items: Settings and Logout

'Settings' menu allows user to manage user account and general setting of the DSS including DSS name, description, and user-list. 'Logout' menu terminates a usage session.

2 Network Generation (Risk Calculation)

2.1 Create Network Data

This section will demonstrate how to create a network data that can used for AEP and PRS module. The user may go straight to the Network Generation menu item in the first step, then the system will display the list of current network data as depicted in the Figure 2-1.



No.	Date Created	Province Name	Evacuation Percentage(%)	Number Of POI	Network Code	User	ACT
1	05 Maret 2022	NUSA TENGGARA BARAT	100	7	NG1646442847_NUSA_TENGGARA_BARAT	admin	Visualisation
2	06 Maret 2022	NUSA TENGGARA BARAT	100	7	NG1646573221_NUSA_TENGGARA_BARAT	admin	Visualisation
3	12 Maret 2022	DKI JAKARTA	90	13	NG1647094455_DKI_JAKARTA	developer	Visualisation
4	15 Maret 2022	NUSA TENGGARA BARAT	80	20	NG1647305153_NUSA_TENGGARA_BARAT	developer	Visualisation
5	20 Maret 2022	NUSA TENGGARA BARAT	10	20	NG1647782510_NUSA_TENGGARA_BARAT	mr_toto	Visualisation
6	20 Maret 2022	NUSA TENGGARA BARAT	100	6	NG1647773584_NUSA_TENGGARA_BARAT	admin	Visualisation
7	23 Maret 2022	NUSA TENGGARA BARAT	80	12	NG1648051141_NUSA_TENGGARA_BARAT	admin	Visualisation
8	24 Maret 2022	NUSA TENGGARA BARAT	100	17	NG1648055243_NUSA_TENGGARA_BARAT	admin	Visualisation

Figure 2-1 List of current network data

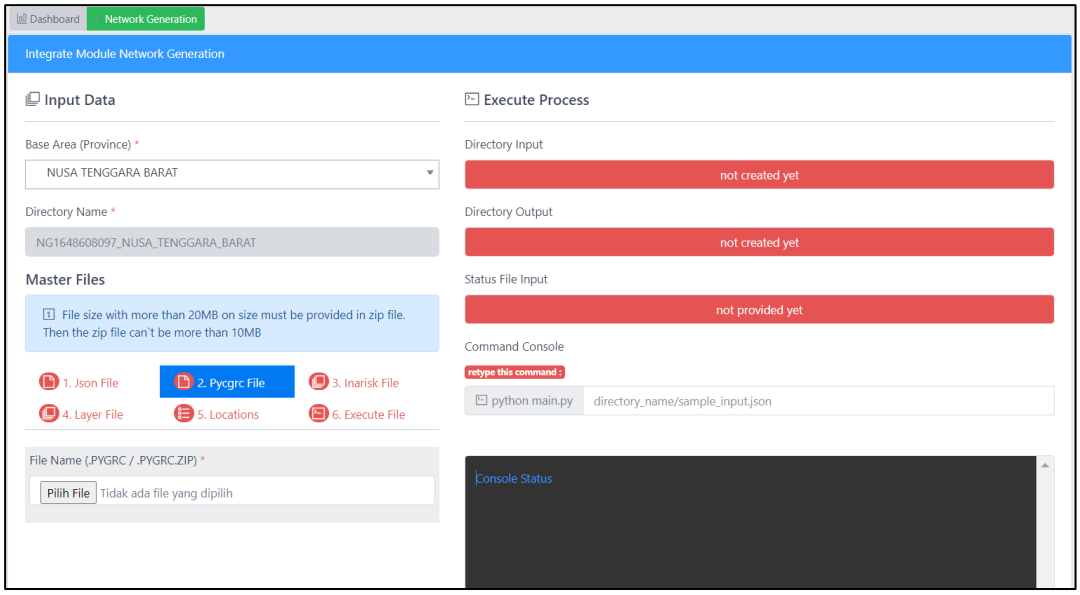


Figure 2-2 Upload file input data for network generation

To create new network data user should click New button at the top-right of the page, the system will redirect the user to upload the necessary input data for network generation as shown in Figure 2-2.

At the upload page, user may select the Base Area (Province) and upload nessesary input data namely Master Files. The Base Area (Province) refers to the Province in which a disaster might occur. In this case, we select Nusa Tenggara Barat as the Base Area (Province). The Master Files include several input data as decribe in the Table 2-1.

Table 2-1 List of Inputs for Network Risk Calculation

Supporting files	Description
(1) Json File and (2) Pygrc File - Open street digital map	A digital map of the disaster area. If a disaster occurs in Lombok area, then a digital map of Lombok area with *.osm or *.pbf format will be used. Before uploading to the DSS, the digital map should be converted to *.pycgrc and *_contracted.json format using the open source software osmconvert64 & OsmToRoadGraph[4].
(3) Inarisk File and (4) Layer File in image format	Inarisk File is an image of a map of a disaster location in *.png format (see Figure 2-3). Layer File is an image of a risk map of a disaster location (see Figure 2-4). These images can be accessed through InaRisk web services[5]
(5) Locations	User select number of depots, shelters, and villages (zones) from the database to be include as the point of interests. (see Figure 2-5, 2-6, 2-7, 2-8). User may also specify the Evacuation Percentage value. This value represents the percentage how many people in the zone should be evacuated. By specifiying the evacuation percentage into 100% the algorithm will accomodate to evacuate all people in selected villages or zones
(6) Execute File	A *.json file that contains the directory addresses of all supporting files and Pixel To Coordinate Pairs (see Figure 2-5).

Figure 2-3 Sample of Inarisk file of city of Lombok

[4] H0ttps://github.com/AndGem/OsmToRoadGraph
[5] https://inarisk.bnpb.go.id:6443/arcgis/rest/services/inaRISK/

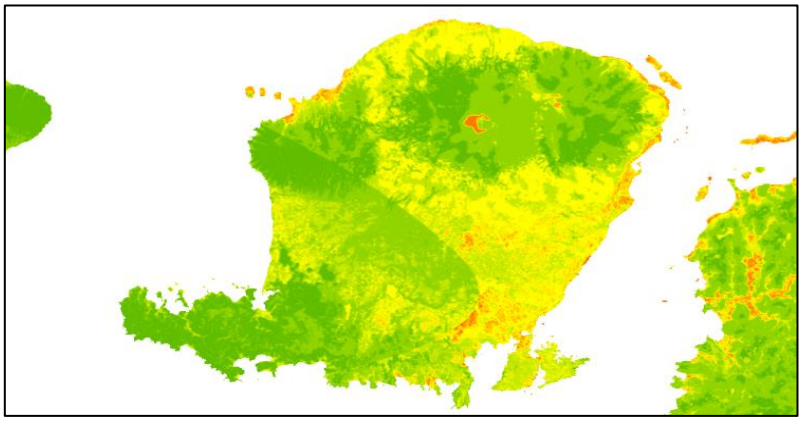


Figure 2-4 Sample of Risk Layer of City of Lombok

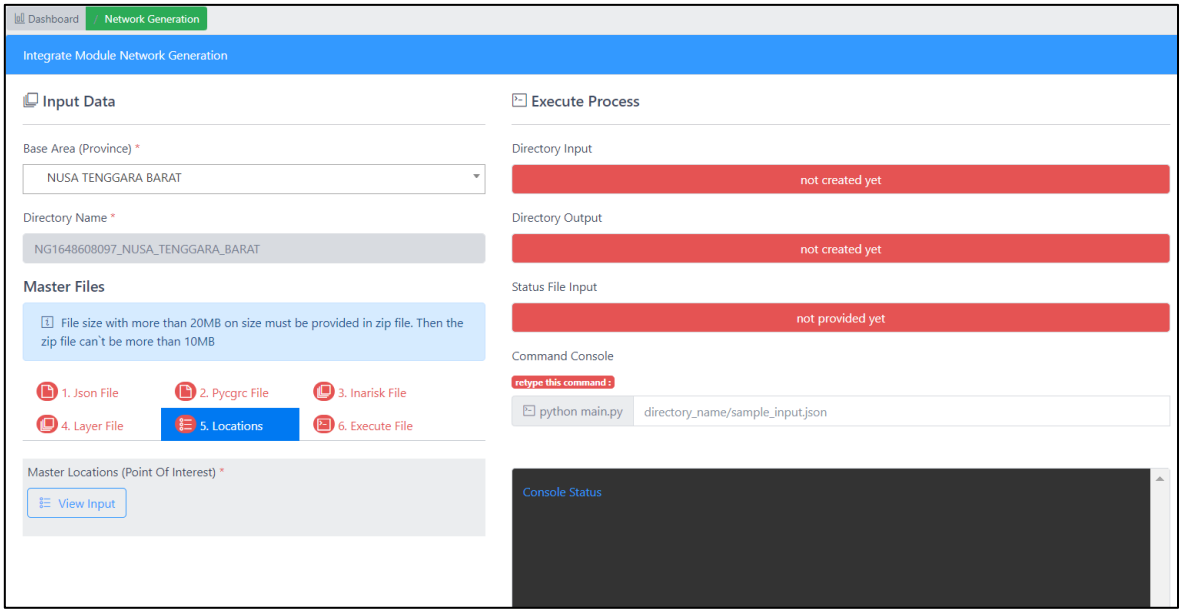


Figure 2-5. Network Generation – Input Location

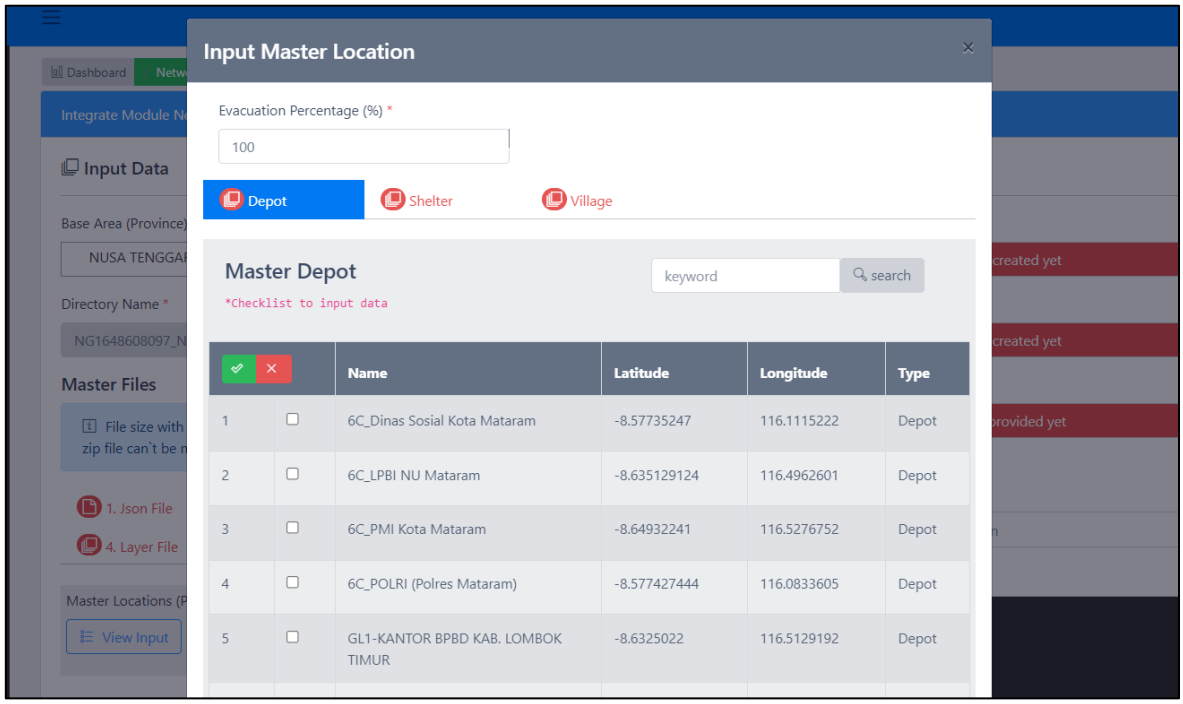


Figure 2-6 Network generation: selecting depots

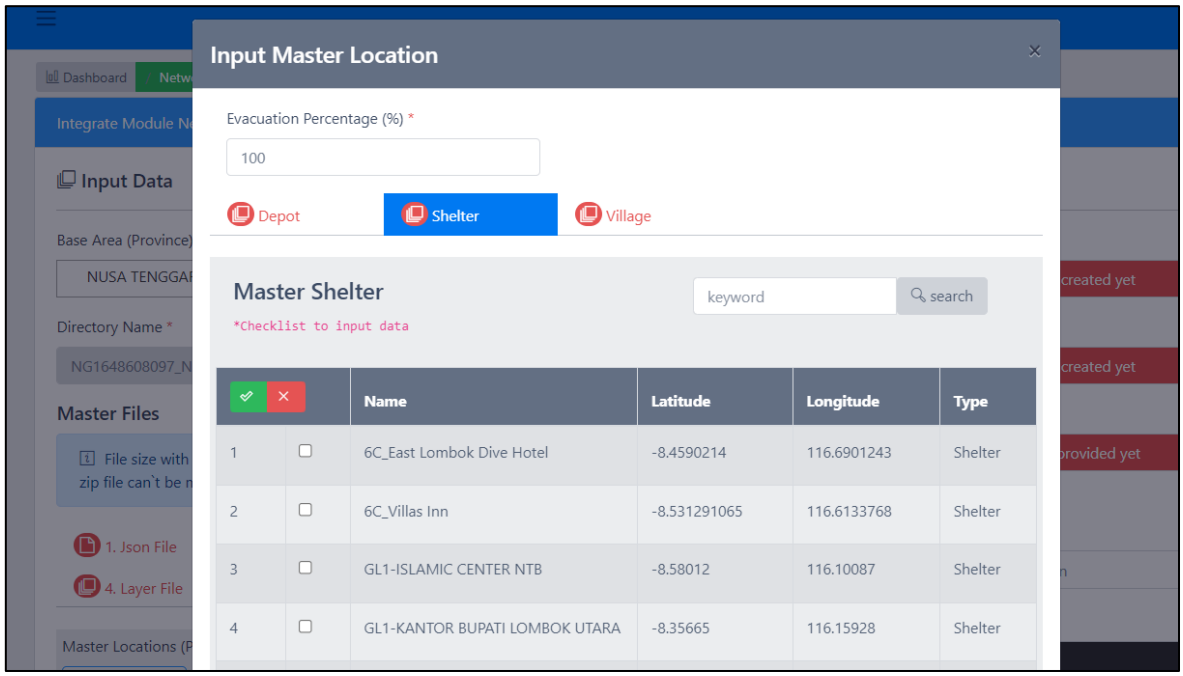


Figure 2-7 Network generation: selection shelters

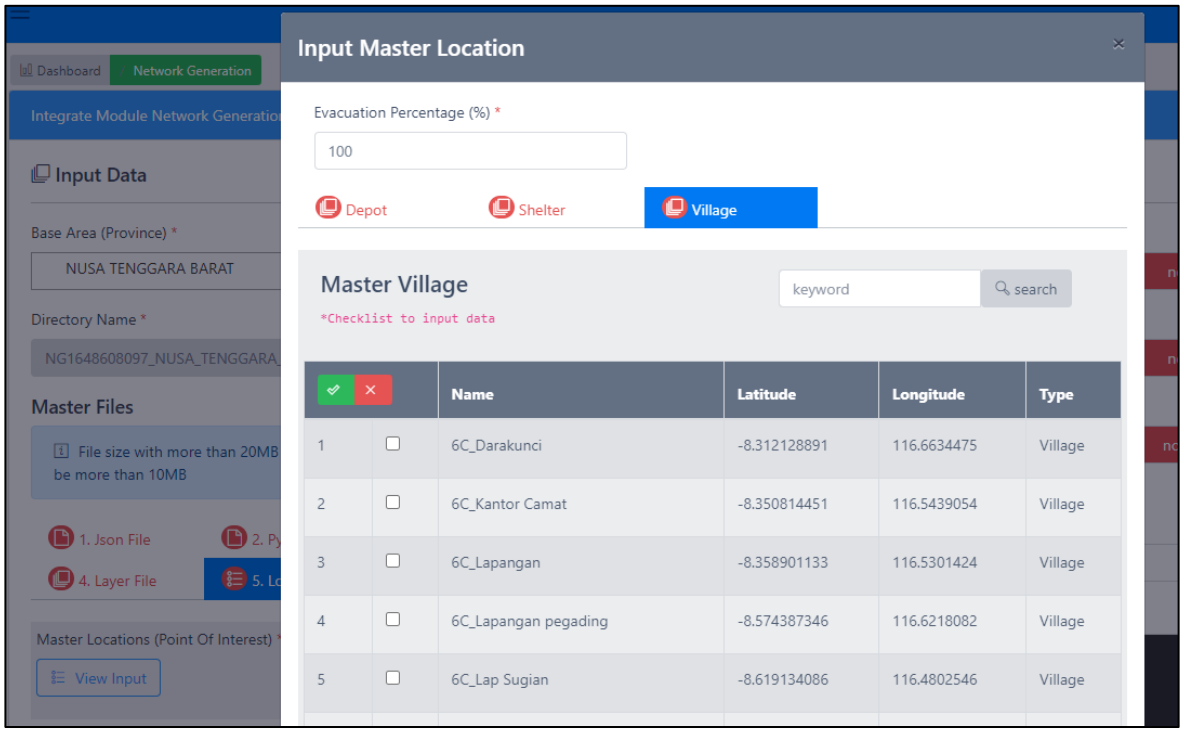


Figure 2-8. Network generation: selecting village or zones

```
{
    "name": "NG1648608097_NUSA_TENGGARA_BARAT",
    "output_dir":
"/var/www/html/respondorv2/network_generation/execute/NG1648608097_NUSA_TENGGARA_BARAT
/output/",
    "network_pycgr_file":
"/var/www/html/respondorv2/network_generation/execute/NG1648608097_NUSA_TENGGARA_BARAT
/lombok.pycgrc",
    "poi_file":
"/var/www/html/respondorv2/network_generation/execute/NG1648608097_NUSA_TENGGARA_BARAT
/master_locations.csv",
    "network_json_file":
"/var/www/html/respondorv2/network_generation/execute/NG1648608097_NUSA_TENGGARA_BARAT
/lombok_contracted.json",

"risk_layer_file":"/var/www/html/respondorv2/network_generation/execute/NG1648608097_N
USA_TENGGARA_BARAT/lombok_earthquake_risk_layer_inarisk.png",
    "risk_coordinates_samples": [
        [[355, 129], [-8.360141, 116.123455]],
        [[788, 148], [-8.388333, 116.71706]],
        [[465, 424], [-8.761341, 116.274014]]
    ]
}
```

Figure 2-9. Network generation: Pixel To Coordinate Pairs and input files directory in json format

Figure 2-9 shows the content of input.json. basically this file contains the name of the network id, output directory, all input file directories where input file are stored on the server. There are risk coordinates samples at the end of the file to indicate pixel-to-coordinate pairs. To avoid exceptions, make sure you type this file accurately.

Once all the nessecary inputs are selected and ready to be upload, user may go to 6.Execute tab and select the json file that contain directory address of input files then click upload and wait until Status input file complete (the color of the status change to green) as depicted in Figure 2-10

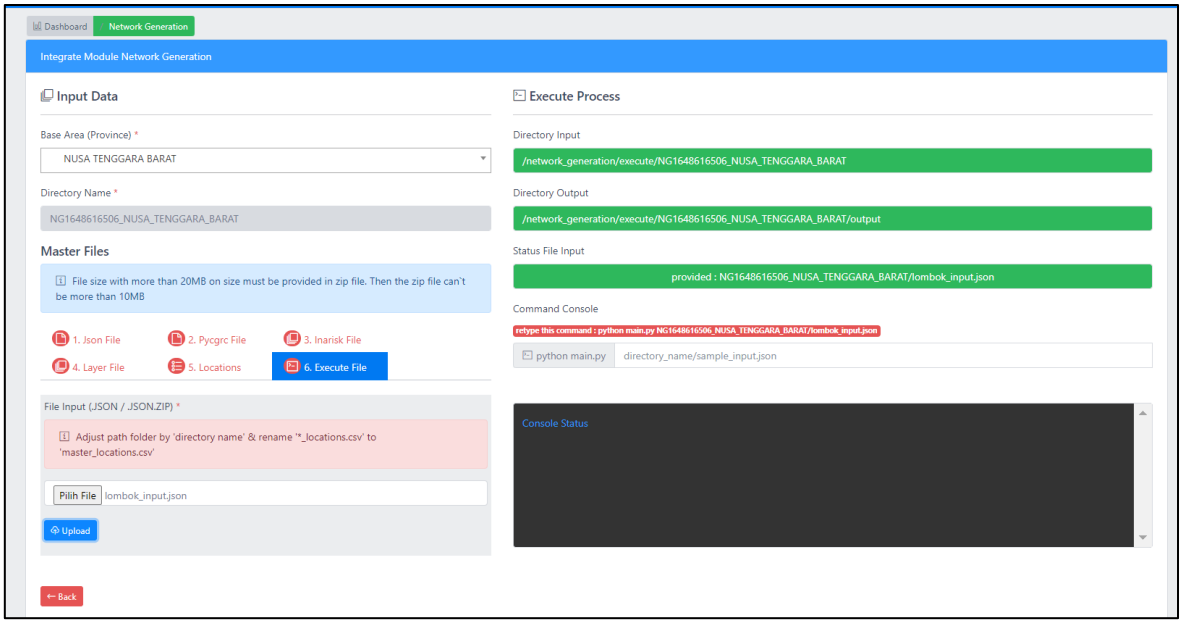


Figure 2-10 Network generation: Status of input file

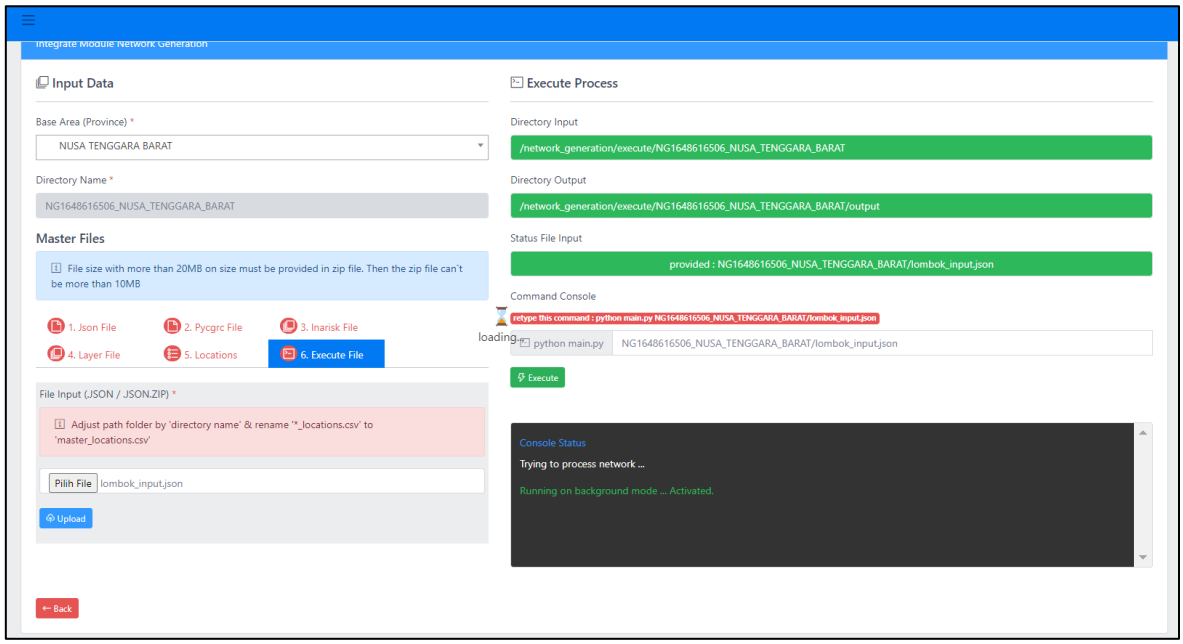


Figure 2-11 Network generation: running process

To execute network generation, user must retype the directoryname/input_name.json and click Execute then wait until the execution process complete, see Figure 2-11 and Figure 2-12

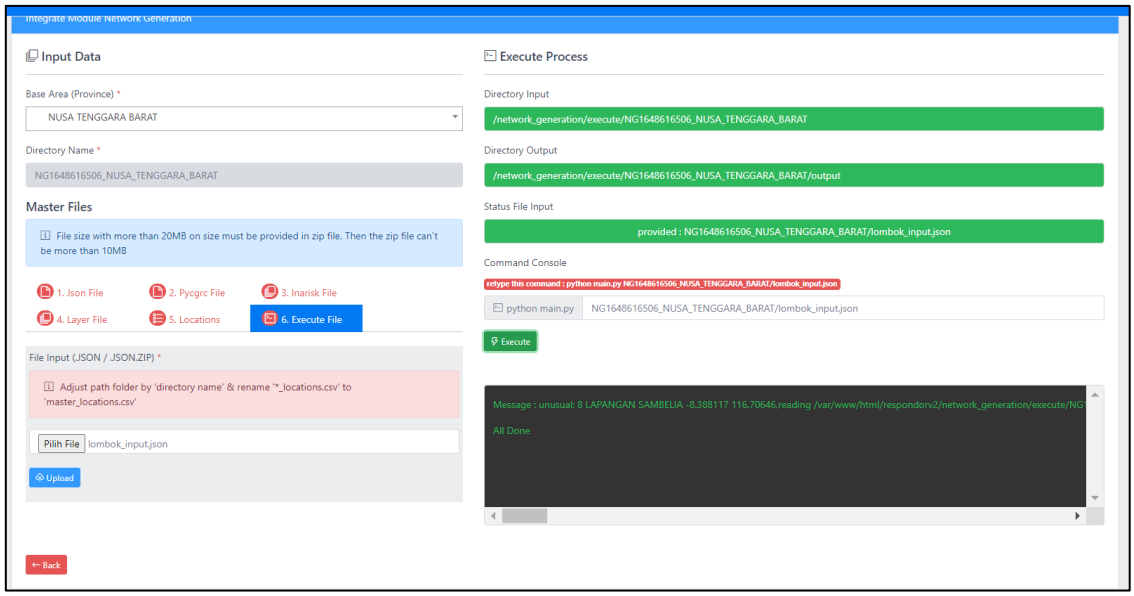


Figure 2-12. Network generation: execution complete

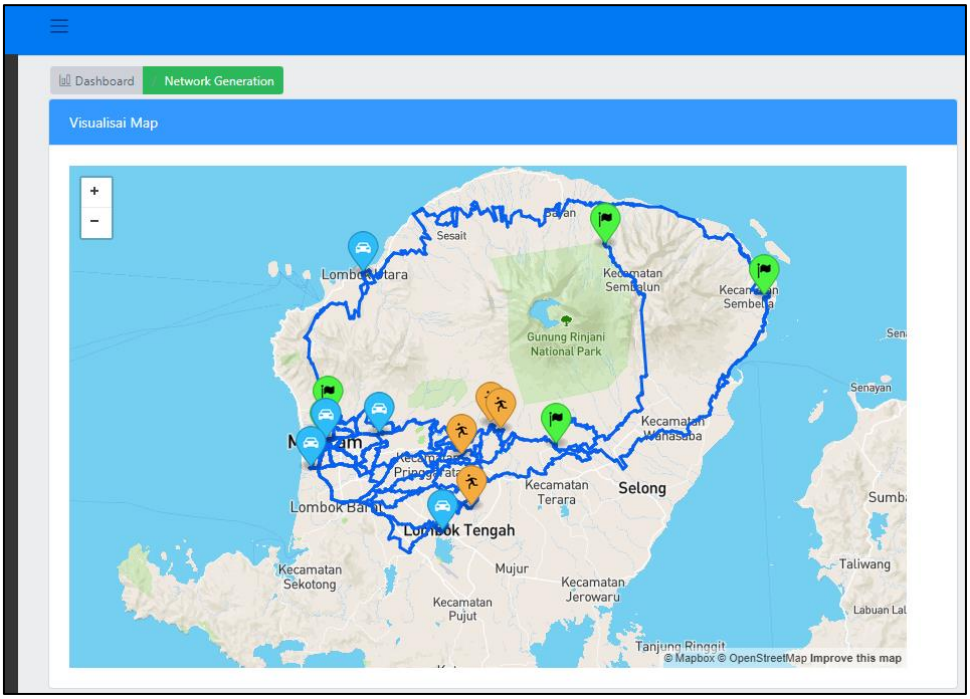


Figure 2-13. Network generation: Visualization of network data

Once the execution complete, the network generation output will appear at the front of network generation page. The network also can be visualized as shown in Figure 2-13.

2.2 Video Tutorial

In the following link, we provide a video tutorial on how to create network data : Video Demo of the Network Generation[6] . The sample input for network data can be access through this following link: Network data sample[7]

[6] https://drive.google.com/file/d/1nc0L-MDX5dU3KfWSH6o-ab7c_ksJnHVP/view?usp=sharing
[7] https://drive.google.com/drive/folders/1XgAV4vZ7pbwPZdOGMqnUgYGIBSau4s-u?usp=sharing

3 Assisted Evacuation Planning[7]

The Assisted Evacuation Planning (AEP) module provides solutions for assisted evacuation by minimizing the number of opened shelters, minimizing the maximum evacuation time (hour), minimizing the evacuation risks, and minimizing the total travel time (hour). To run the AEP module, user should perform the following steps. In explaining the steps below, we will use a small disaster instance of earthquake disaster in Lombok City at Nusa Tenggara Barat province, Indonesia.

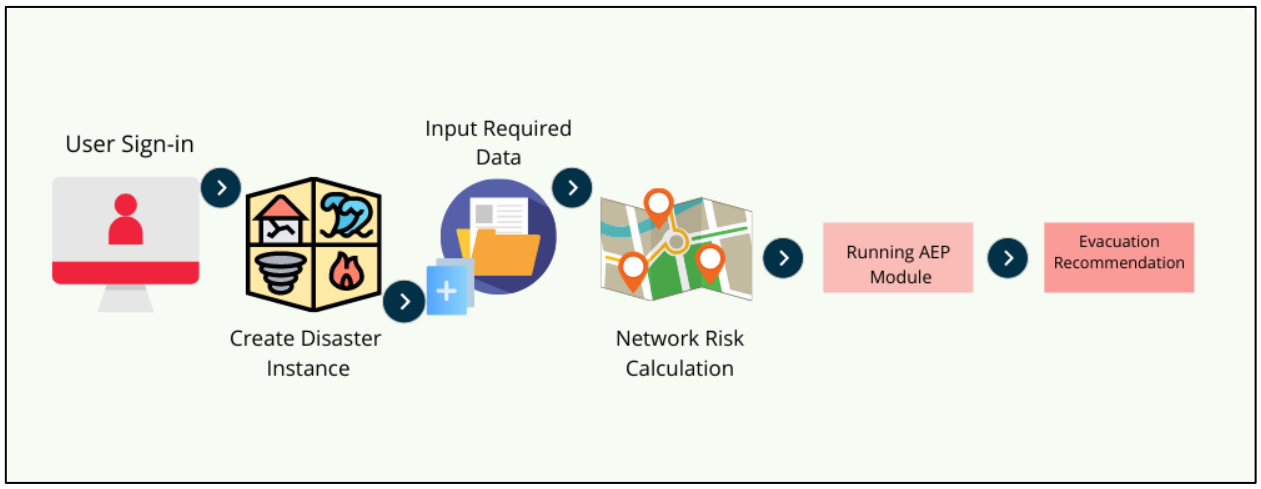


Figure 3-1. Assisted Evacuation Planning Flow

[7] Pirogov, A., Zografos, K. G., Sutanto, J., Kheiri, A., Suhartanto, H., Haryanto, T., Fathurahman, M., Sopha, B. M., Arini, H. M., Sakti, S., Abushama, H., Ali, H. H. S. M., Elbadawi, K. RESPOND-OR: Modelling and Solving the Assisted Evacuation Problem for Natural Disasters: A Multi-objective Programming Approach. 2022. *Technical report*

3.1 Input Preparation and Running AEP Module

1. Click on 'Disaster' menu to create a new disaster instance. Fill in the disasters's name, date, and location. To fill in the coordinate of the disaster's location, drag the location icon on the map to Lombok City; the latitude and longitude will be filled in automatically, as shown in Figure 3-2.

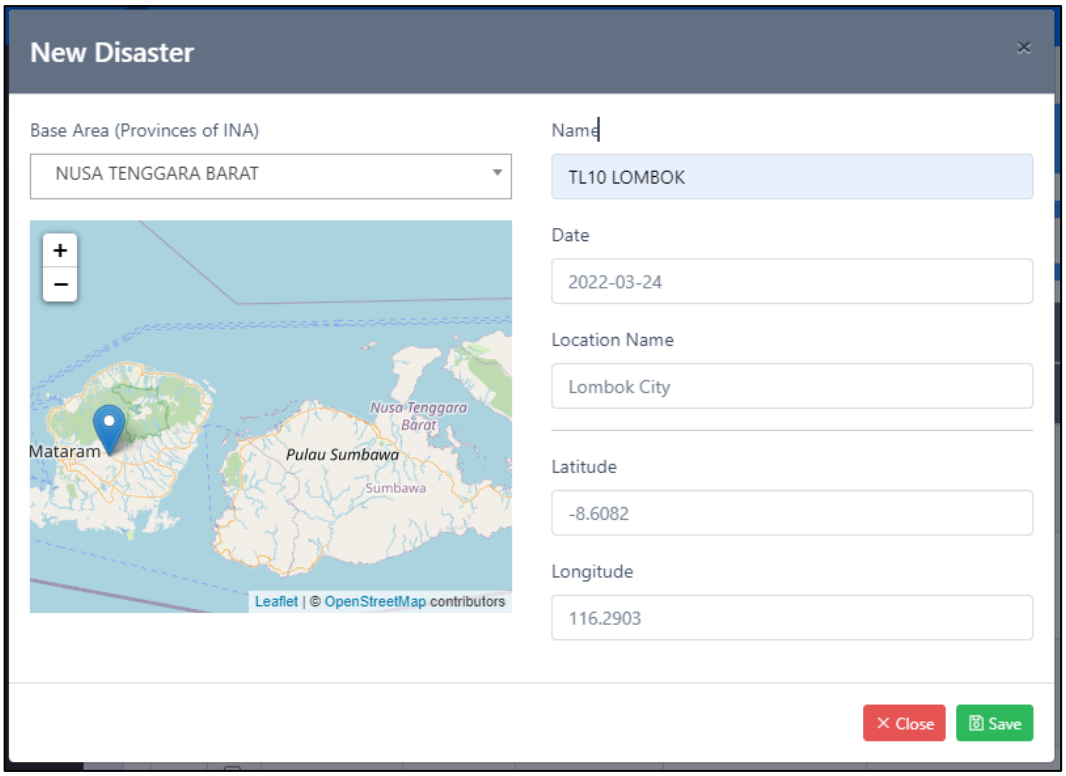


Figure 3-2. Create new disaster instance

2. After creating a new disaster instance, user should proceed to Evacuation Planning menu. At the beginning, user might see the current list of the AEP solutions as shown in Figure 3-3.

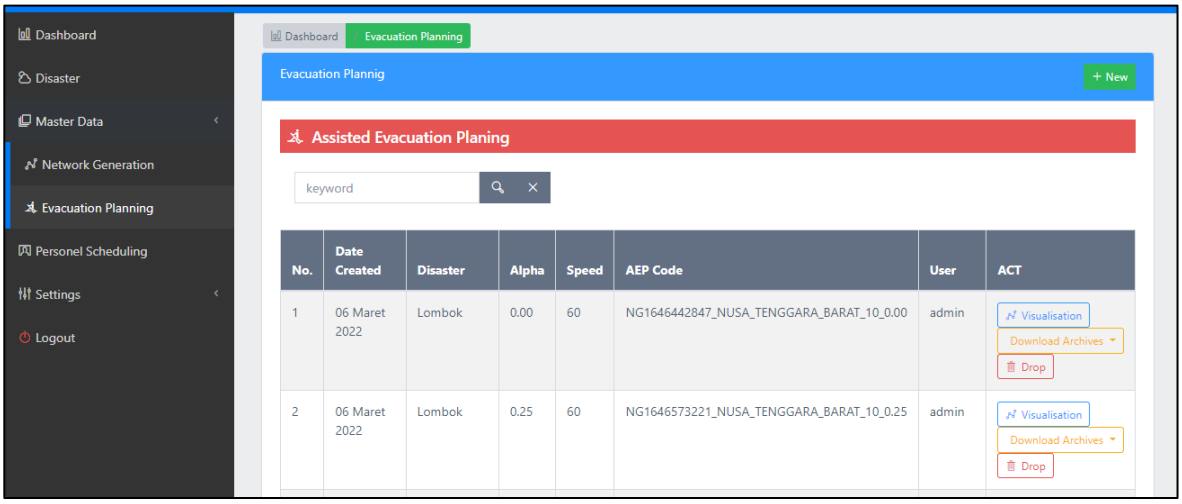


Figure 3-3 Evacuation Planning main page.

To create new AEP solutions, click New button at the top-left of the page, then the system will redirect user to specify the parameters for AEP module as depicted in Figure 3-4.

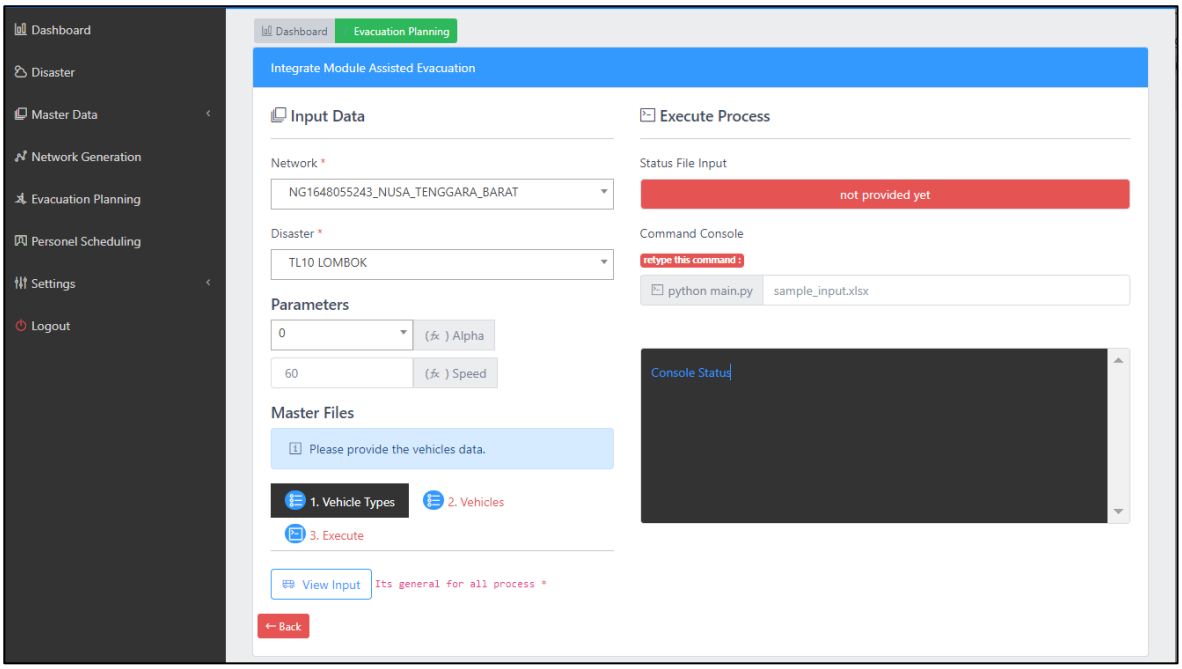


Figure 3-4. Configuration of AEP module

Before executing the AEP module, Firtsly, user should select the Network Data and Disaster Instance. Network data already associated with the shelters, depots and zones. If user may have a new point of shelters, depots or zones, the user should create a new disaster data. Secondly, user should specify the parameters of the AEP module including the value of Alpha and Speed. Alpha value indicates risk. The higher the value of alpha, the less risky but longer the route is for the evacuation. The Speed value indicate the average speed at the route. Master Files allow user to

specify the type of vehicle and the total number of vehicle availability in each depot for evacuation. To insert new type of vehicle, user may select vehicle type and click View Input as depicted in Figure 3-5

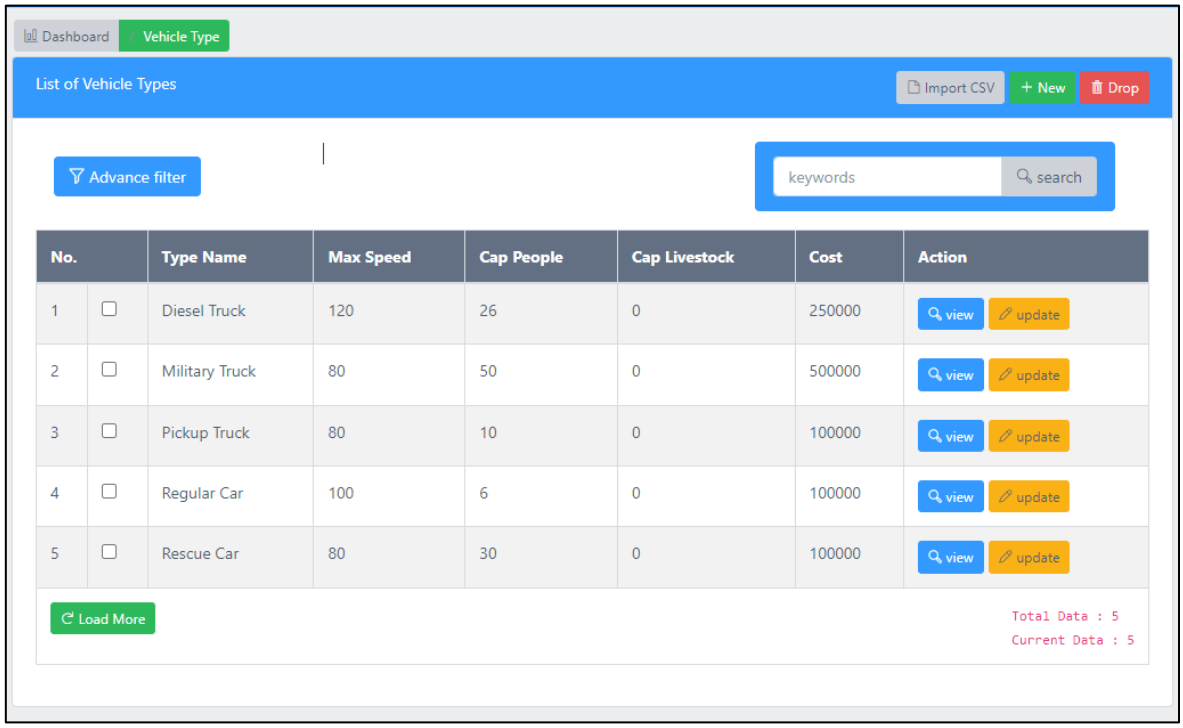


Figure 3-5. Vehicle type

To add new type of vehicle,user should click New button at the top-right of the page, then user will redirect to insert new type of vehicle as shown in Figure 3-6.

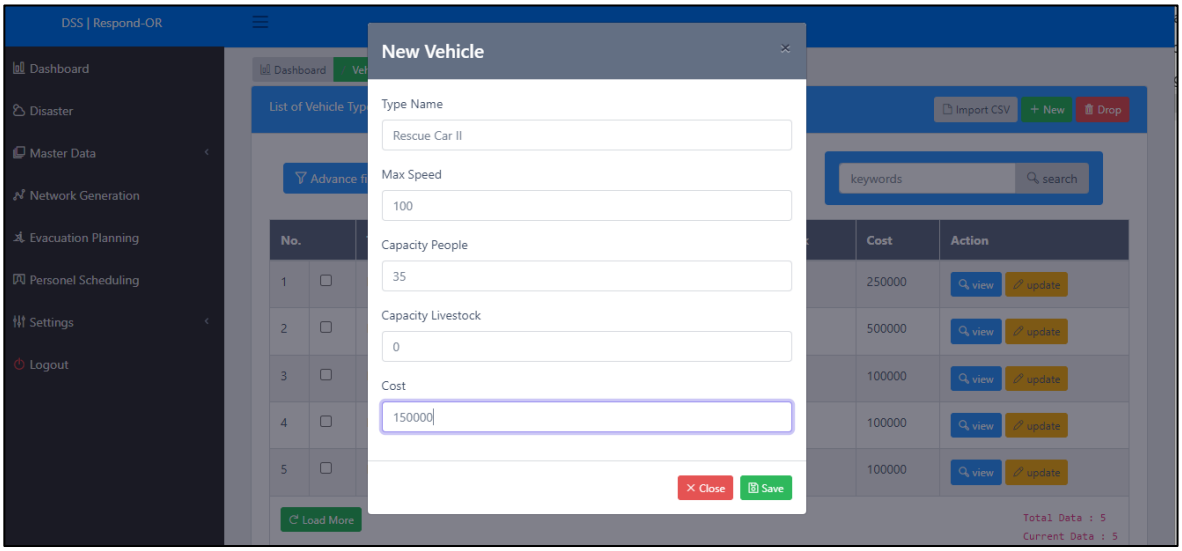


Figure 3-6. Add new type of vehicle.

To specify the total number of vehicle for each depots that ready for evacuation, user should select Vehicles and click View Input as depicted in Figure 3-7. The system will display all the vehicle list that associated with the depots.

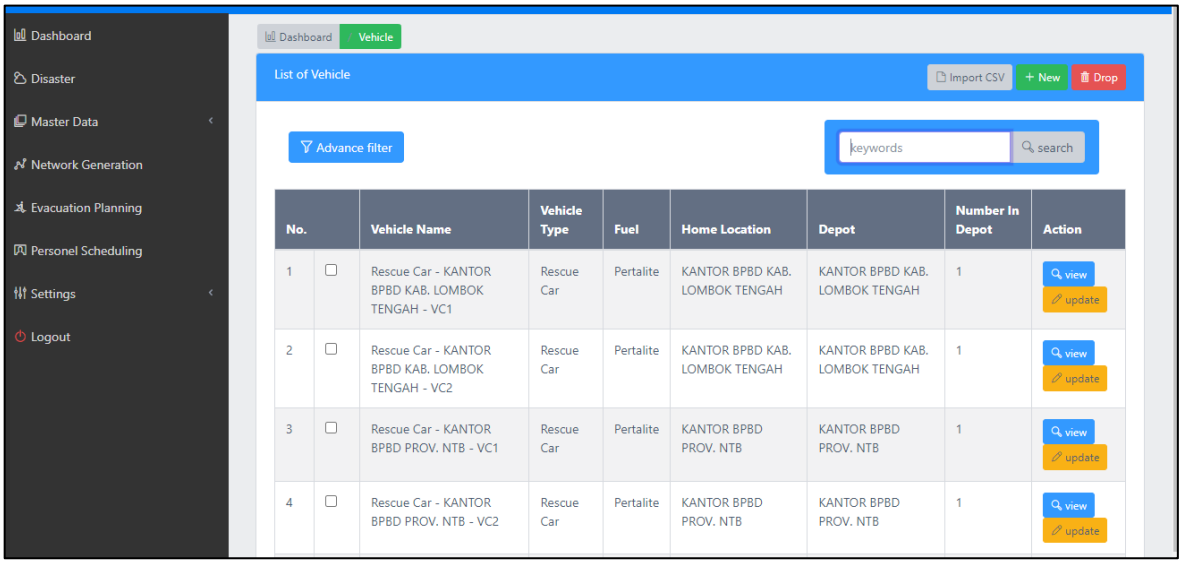


Figure 3-7. List of vehicles for each depots.

To add new vehicle at specific depots, user should click New button at the top-right of the page then fill or choose the corresponding attributes including Home (Depot), Vehicle name, type of Fuel, and total number in depot as shows in Figure 3-8.

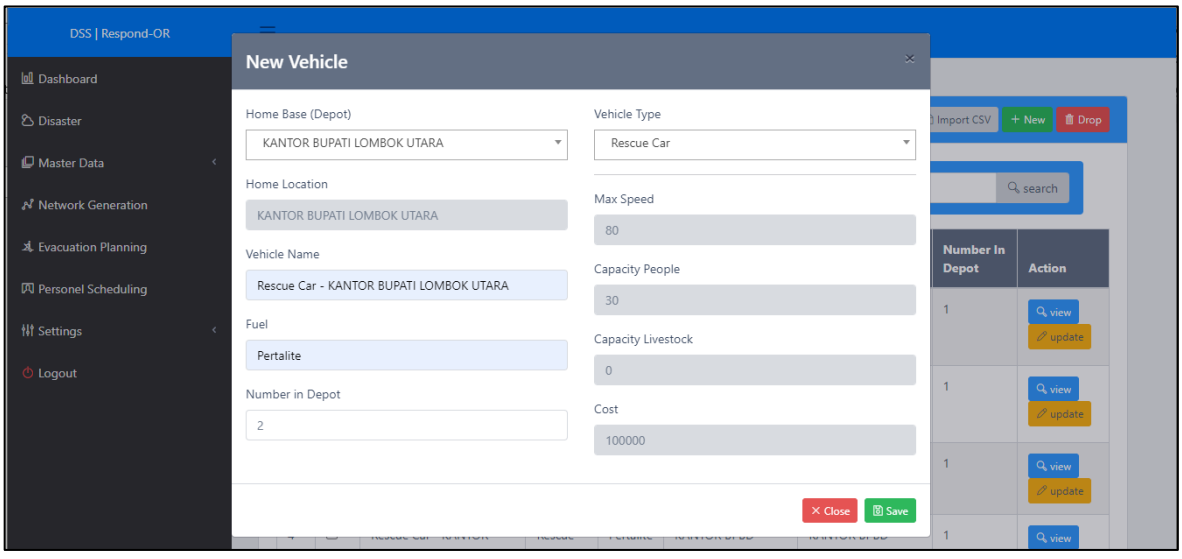


Figure 3-8. Adding new vehicle at specific depot

After specifiy the availability of vehicle in each depots, user may select Execute tab and Click ‘Generate’ button, then wait until Status file Input changes into green-colour, as shown in Figure 3-9.

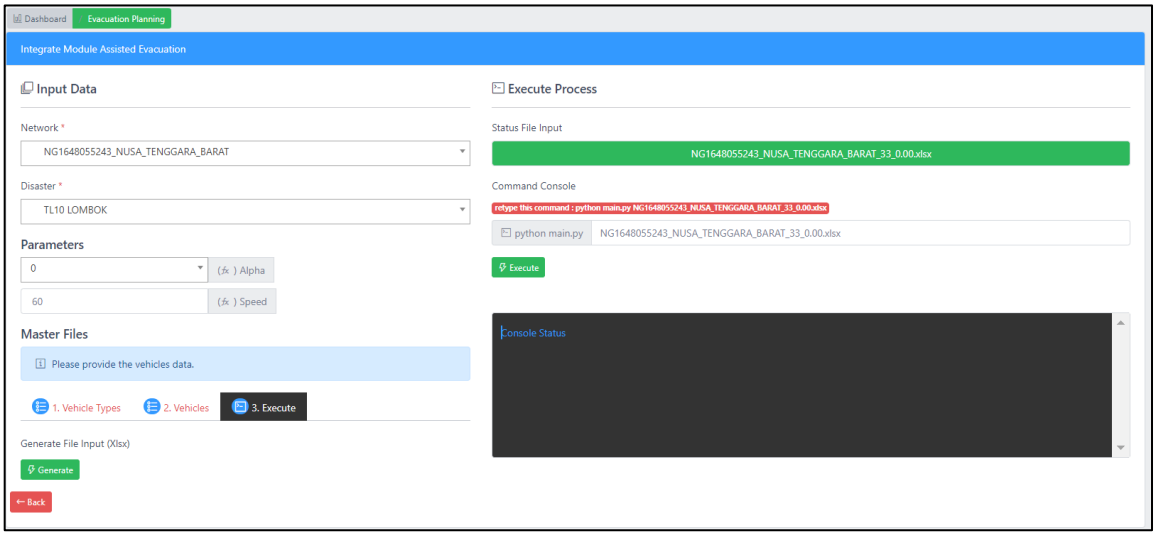


Figure 3-9. Input Preparation before running AEP module

Once the status file input complete, then AEP module is ready to execute. User should retype the directory input file that show in the status file input to the command console then click **Execute.** please wait until the process is completed. After the execution of AEP module complete, user should refresh the ‘Evacuation Planning’ page to see the solutions as shown in Figure 3-10.

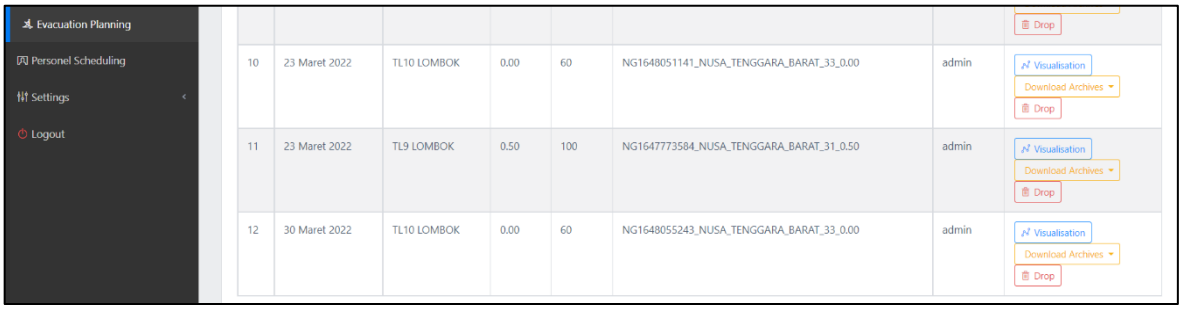


Figure 3-10. List of AEP solutions

The new generated solution will be displayed at the end of the list. In this case, the new solution refers to the TL 10 LOMBOK. There are three Buttons which are Visualization, Download Archive and Drop. Visualization will display the detail of the solution, Donwload Archive will allow user to download input dan output of the AEP module in csv format for further analysis, Drop button will remove the AEP solution.

3. AEP Solutions: Select 'Visualisation' button to view the detail solution. User will see solution value path and solution table. The y-axis of the value path provides user with information about the percentage deviation of the solutions to the optimal one (see Figure 3-11). In the example above, the optimal solution is the 'Obj Order 1243' represented by Solution ID number 2 (see No. 2 at the solution table). The solution table provides list of all the AEP solutions (see Figure 3-12). Please note that in this example, the solution for 'Obj Order 1342' is the quite similar with the solution for 'Obj Order 4123'. When two or more objectives-orders ('Obj Order') have the same solution, the value path only shows one of them; whereas the solution table shows all solutions.

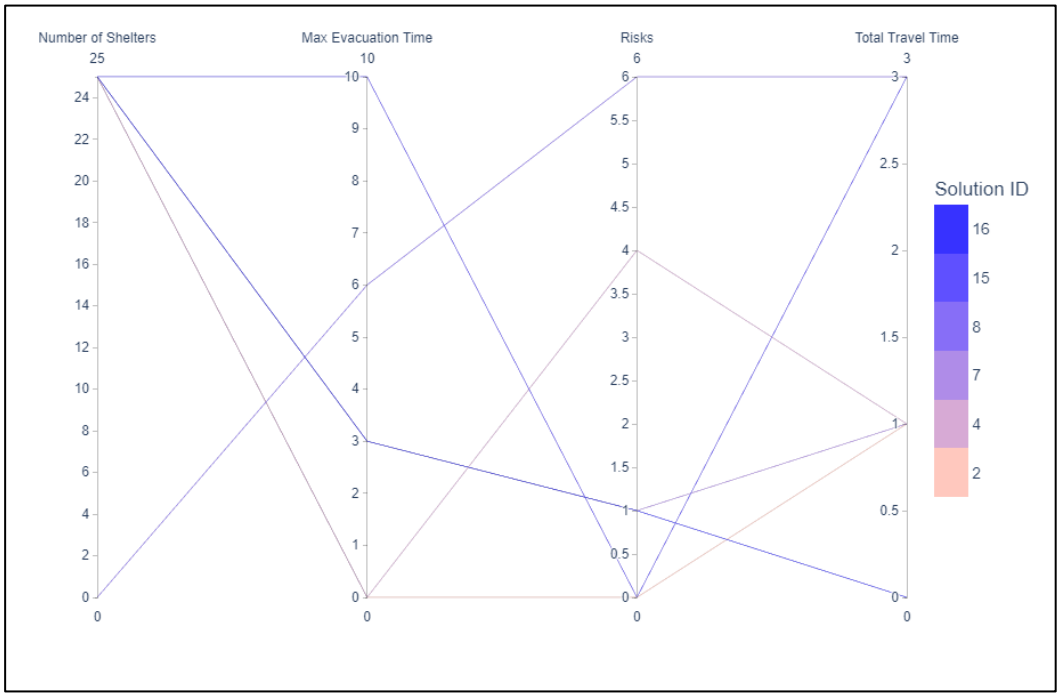


Figure 3-11. AEP value-path

No.	Problem Type	Obj Order	Number Of Shelter	Max Evacuation Time (hr)	Risk	Total Time Travel (hr)	Fleet Cost	Action
2	FSC	1243	5	5.88	1512.4	35.45	800000.0	Detail
4	FSC	1342	5	5.88	1561.71	35.14	800000.0	Detail
19	FSC	4123	5	5.89	1555.79	36.61	800000.0	Detail
6	FSC	1432	5	5.95	1557.63	36.13	800000.0	Detail
23	FSC	4312	5	5.95	1584.14	35.82	800000.0	Detail
13	FSC	3124	5	5.99	1522.94	36.84	800000.0	Detail
20	FSC	4132	5	5.99	1515.26	35.52	800000.0	Detail
1	FSC	1234	5	6.05	1623.76	38.05	800000.0	Detail
5	FSC	1423	5	6.05	1542.54	36.96	800000.0	Detail
16	FSC	3241	5	6.05	1524.7	34.95	800000.0	Detail

Showing 1 to 10 of 24 entries Previous 1 2 3 Next

Figure 3-12. List of AEP solution sorted by Max Evacuation Time.

Click ‘Detail’ button next to a solution to see the more details (see Figure 3-13).

Figure 3-13 More detail AEP solution

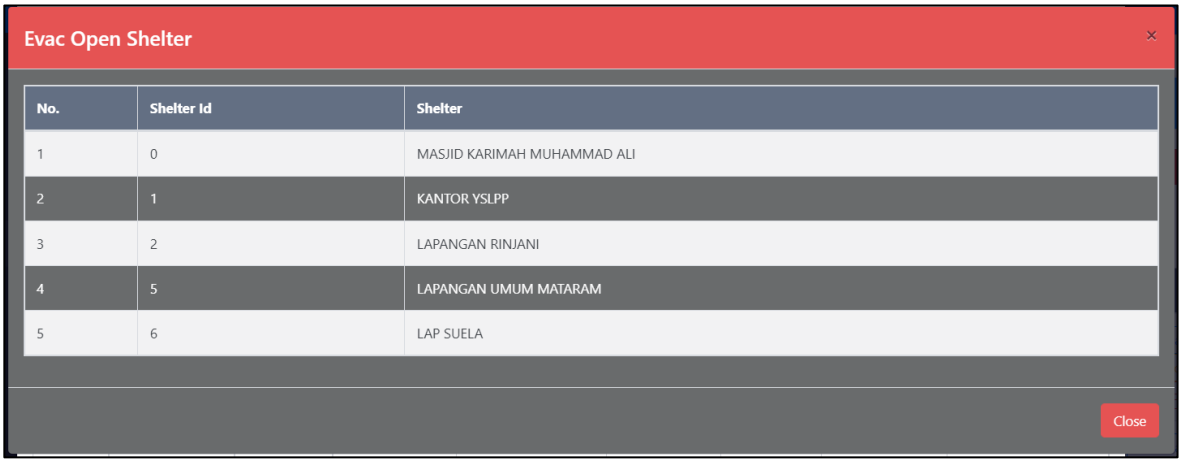
Vehicle dispatch (‘Evac Dispatch’) informs user which vehicle should be dispathed to a specific zone for assisted evacuation (see Figure 3-14). The opened shelters (‘Evac Open Shelter’) informs user which shelters should be used (see Figure 3-15)

Evac Dispatch

No.	Obj Order	Vehicle Id	Type Id	Dispatched To
1	1243	Rescue Car - KANTOR BPBD KAB. LOMBOK TENGAH - VC1	Rescue Car	ABIAN TUBUH
2	1243	Rescue Car - KANTOR BPBD KAB. LOMBOK TENGAH - VC2	Rescue Car	ABIAN TUBUH
3	1243	Rescue Car - KANTOR KECAMATAN LINGSAR - VC1	Rescue Car	AIK BERIK
4	1243	Rescue Car - KANTOR KECAMATAN LINGSAR - VC2	Rescue Car	AIK BERIK
5	1243	Rescue Car - KANTOR BPBD PROV. NTB - VC1	Rescue Car	AIK BERIK
6	1243	Rescue Car - KANTOR BPBD PROV. NTB - VC2	Rescue Car	ABIAN TUBUH
7	1243	Rescue Car - KANTOR BUPATI LOMBOK UTARA - VC1	Rescue Car	AIK BERIK
8	1243	Rescue Car - KANTOR BUPATI LOMBOK UTARA - VC2	Rescue Car	AIK DAREK

Close

Figure 3-14. AEP- Evacuation dispatch



Evac Open Shelter

No.	Shelter Id	Shelter
1	0	MASJID KARIMAH MUHAMMAD ALI
2	1	KANTOR YSLPP
3	2	LAPANGAN RINJANI
4	5	LAPANGAN UMUM MATARAM
5	6	LAP SUELA

Close

Figure 3-15. AEP- Evac Open Shelter

Figure 3-16. AEP- Evacuation Path

Evacuation path informs user the evacuation route from zone to shelter (see Figure 3-16). Click ‘map view’ button to view the evacuation route on the map (see Figure 3-17).

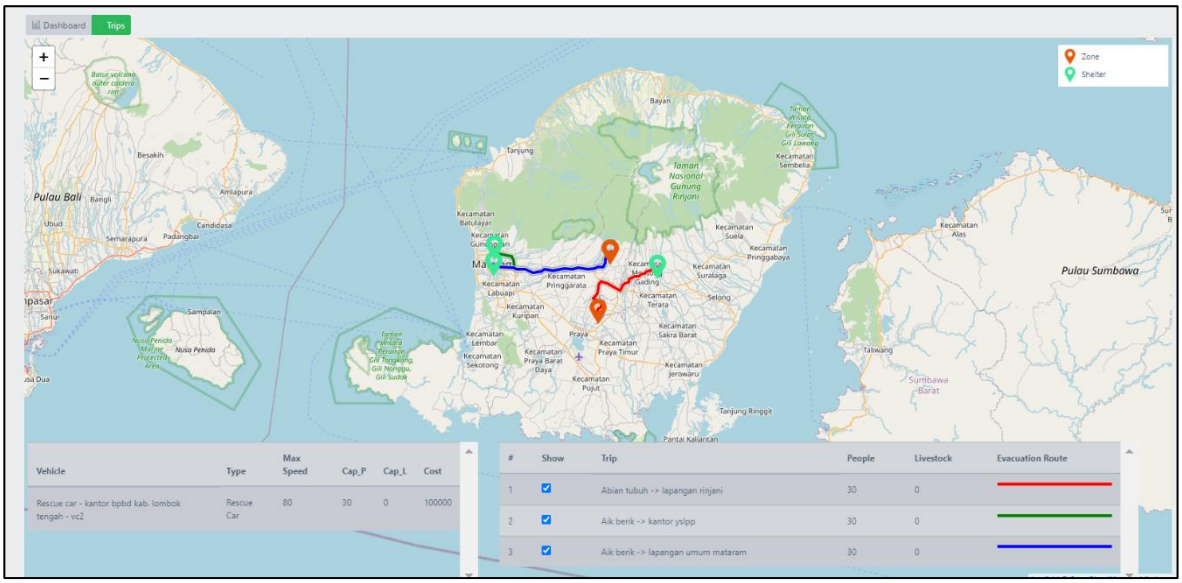


Figure 3-17. AEP- Evacuation routes

3.2 Video Tutorial

In the following link, we provide a video tutorial on how to run the AEP module: Video Demo of the AEP Module[8]

[8] https://drive.google.com/file/d/152rPdxxAbVXkoc6UNF7hZwz7fWMqdjD0/view?usp=sharing

4. Personnel Routing and Scheduling[9,10]

The Personnel Routing and Scheduling (PRS) module provides solutions for personnel routing and scheduling by minimizing i) the unmet demand, ii) the average completion time of the services, iii) the gap between different locations in terms of the amount of services they are provided, and iv) the total transportation risk. To run the PRS module, user should perform the following steps. In explaining the steps below, we will use a small disaster instance of earthquake disaster in Lombok City that is located in Nusa Tenggara Barat province in Indonesia. The input categories of the PRS module is shown in Table 3-1.

Table 4-1. Input Categories of PRS Module

Input category	Description
Services	Disaster response services, such as evacuation and medical services
Demand Points	The locations that require the services under consideration
Demands	The attributes of the services required at demand points
Resting Points	The locations where the personnel can rest
Depots	The locations where the personnel start working
Network Data	The network represented as a multi-graph connecting all points of interest (POIs) as described in Section 1.3
Personnel	Personnel teams who provide specific services. The minimum number of personnel in a team is one (1).
Settings	The parameters to set the specifics of the module implementation

4.1 Input Preparation and Running PRS Module

Click 'Routing & Scheduling' menu. The page will display all the PRS solutions for each disaster instance. To run new PRS solution, click 'New' button at the top-right of the page to prepare the following input data for the disaster instance (see Figure 4-1):

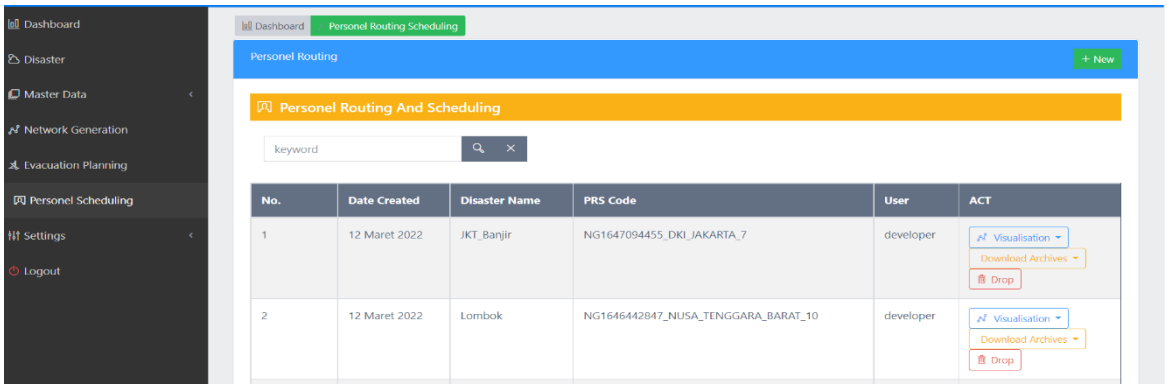


Figure 4-1. Current List of PRS solutions.

[9] Tarhan, İ., Zografos, K. G., Sutanto, J., Kheiri, A. and Suhartanto, H. 2022a. A multi-objective rolling horizon personnel routing and scheduling model for large-scale natural disasters, *Technical Report*.
[10] Tarhan, İ., Zografos, K. G., Sutanto, J. and Kheiri, A. 2022b. Dynamic personnel routing and scheduling, *Technical Report*.

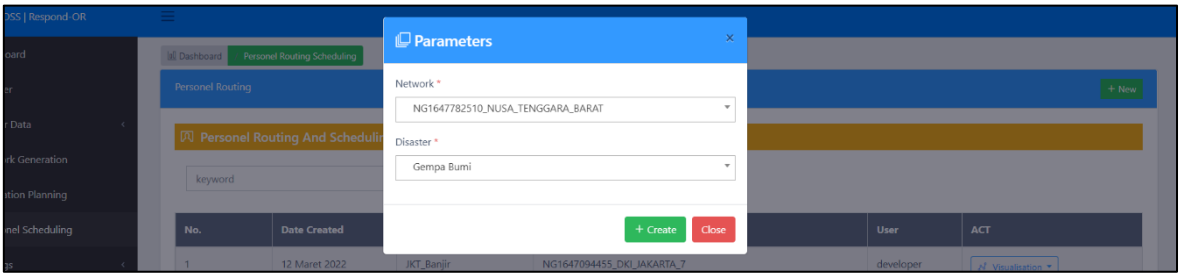


Figure 4-2. Create new PRS solutions

After user click New button, user should specify the network data and disaster instance, then click Create. User will automatically redirect to insert several type of input data see Figure (4-3).

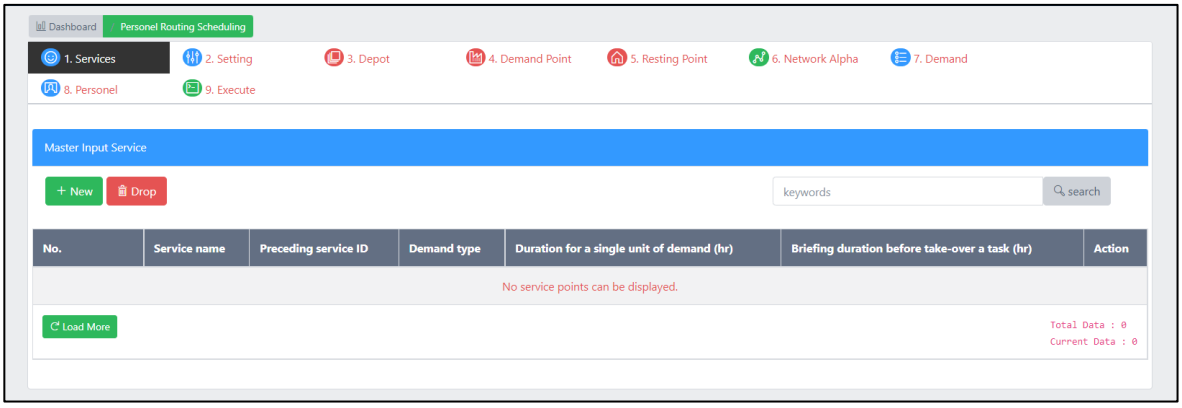


Figure 4-3. Input data preparation for PRS module

a) Services: What services that will be performed on the affected areas. Click the 'Services' tab, and then click 'New' button to input the services. For instance, in Figure 4-4, user inputted two services, which are Evacuation and Medical. The 'Preceding service ID' indicates the sequential dependency of the services. In this example, the evacuation service precedes the medical service. Demand type column shows whether the type of the demand for the relevant service is discrete or continuous. Demand type's being equal to zero (one) corresponds to a discrete (continuous) demand. Evacuation service has discrete demand as it is defined by the number of tents to set-up at demand points. On the other hand, medical service has continuous demand as it is defined by the duration of the medical services to be provided at demand points. 'Duration for a single unit of demand' is the time duration (in hour) of a single service, e.g., setting a single tent for the evacuation service. 'Briefing duration before take-over a task' is the time duration (in hour) of a briefing session among the personnel handing-over an ongoing service

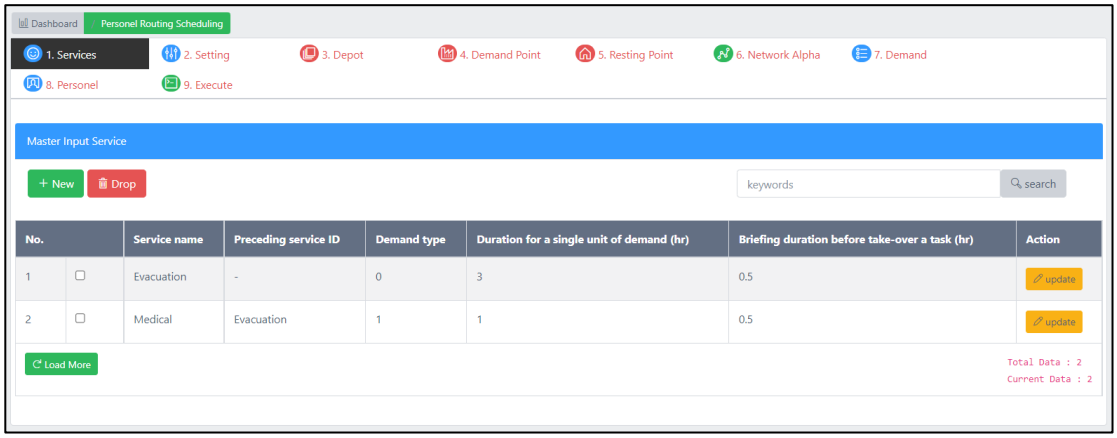


Figure 4-4. Services Input data

b. Setting: The configuration of each service includes the strategy, number of networks, and starting time (see Figure 4-5). Click 'Setting' tab, and then click 'Add' button (see Figure 4-5). In this example, the strategy of the evacuation service is a full demand strategy ('Strategy' = 1). In this strategy, there is no restriction on the number of tents that can be set at a demand points whereas it is restricted in the partial demand fulfilment strategy ('Strategy' =0). Details of the relevant strategies can be found in Tarhan et al. (2022a). "Starting time" is used to set the time at which the services under consideration can start. By default, it can be set to "0:00". User can update the setting configuration by clicking on the 'update' button (see Figure 4-5).

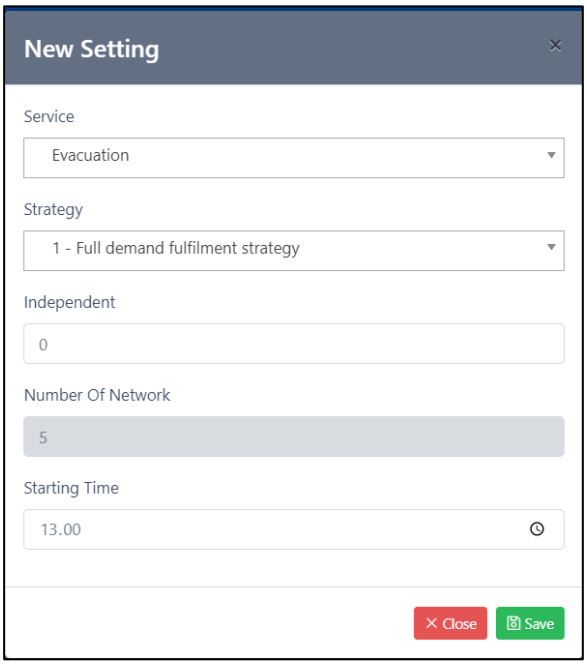


Figure 4-5. Adding PRS setting

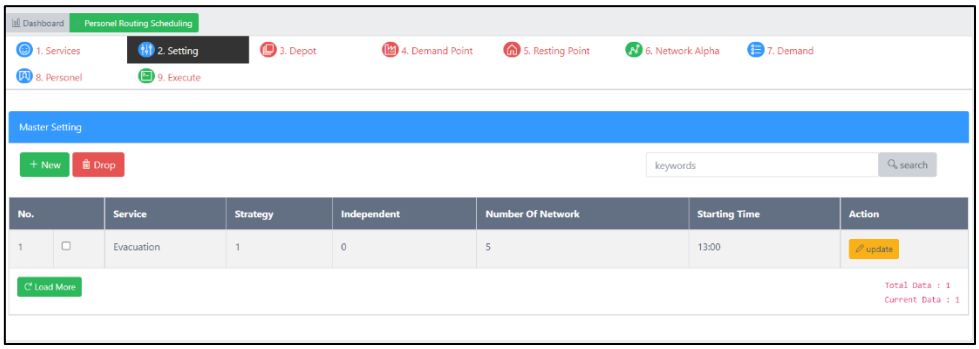


Figure 4-6. Setting for the service

c. Depot, Demand Point, and Resting Point are the locations where the personnels start working, the locations of the services, and the locations where the personnel will take a rest. To add these data, Click the respective 'Depot', 'Demand Point', and 'Resting Point' tabs, and Click 'New' (see Figure 4-7, 4-8, and 4-9).

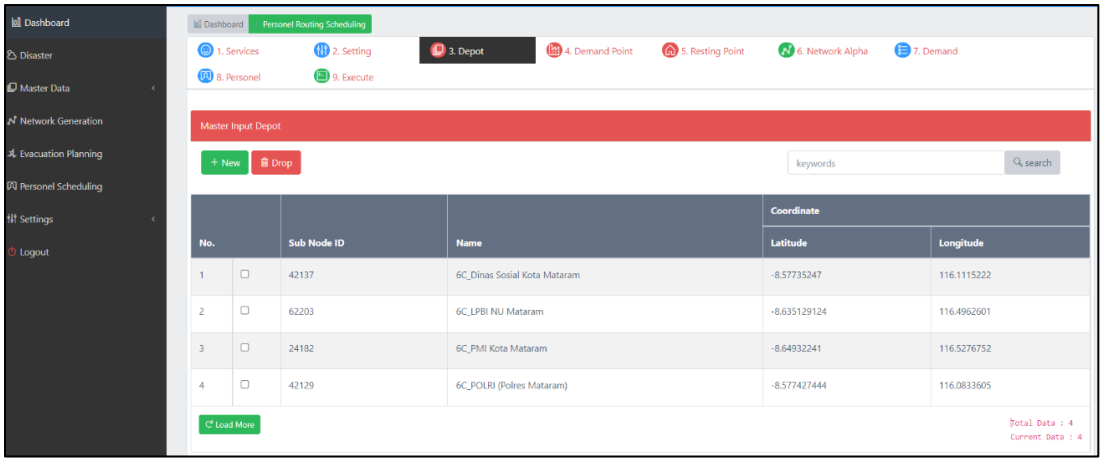


Figure 4-7 List of selected depots

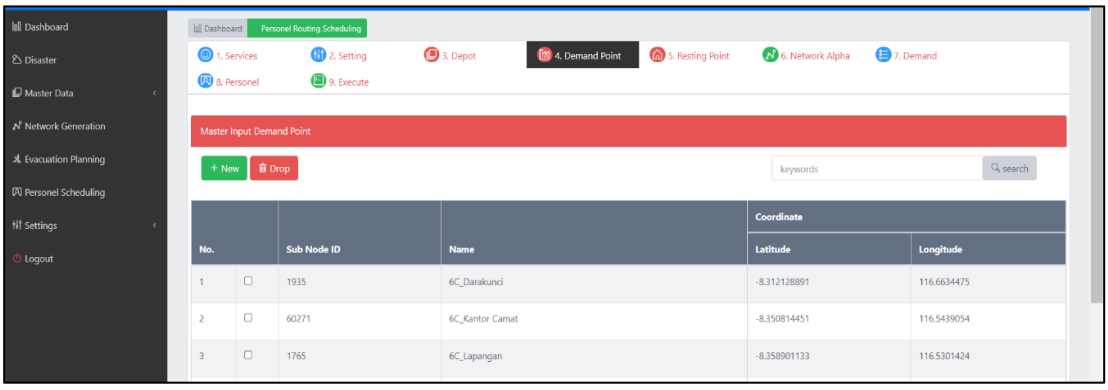


Figure 4-8. List of selected Demand Points

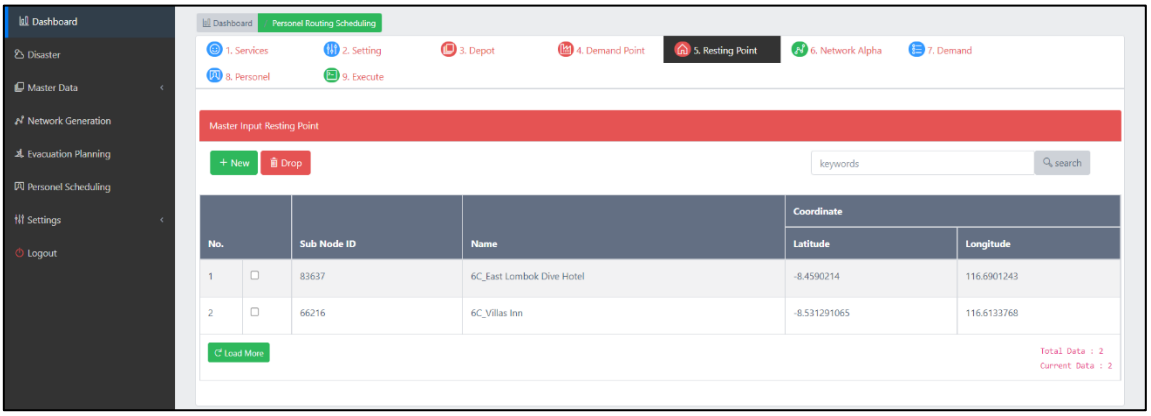


Figure 4-9. List of selected Resting Point

d) Network Alpha: Click 'Generate File Input', retype the command shown under the 'Command Console', and then click 'Execute'. As shown in Figure 4-10, it generates five networks with different alpha values each of which represents a different trade-off level between the travel time and transportation risk (the higher the value of alpha, the less risky yet longer paths between the POIs). These networks construct all together the multi-graph described in Section 1.3.

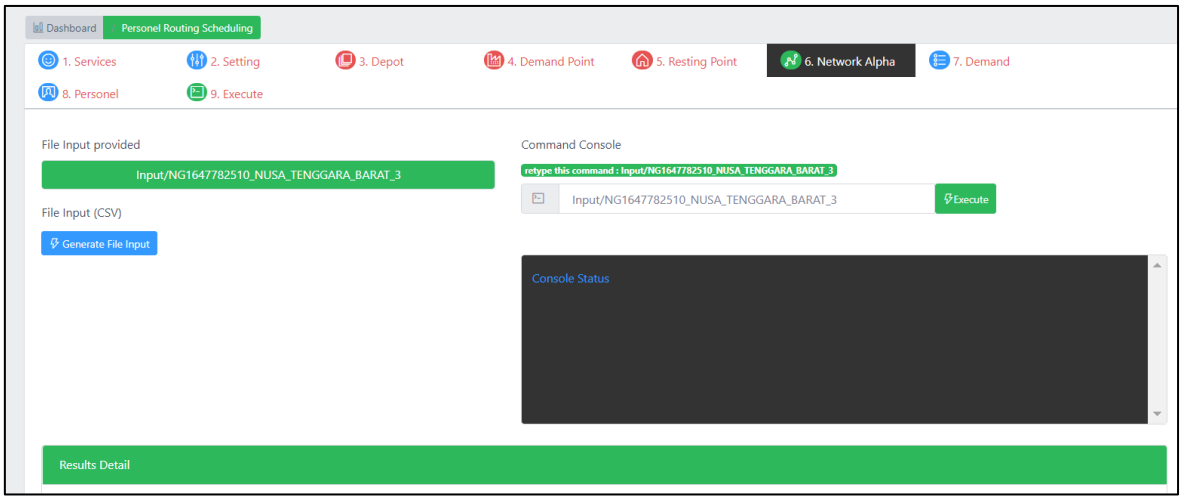
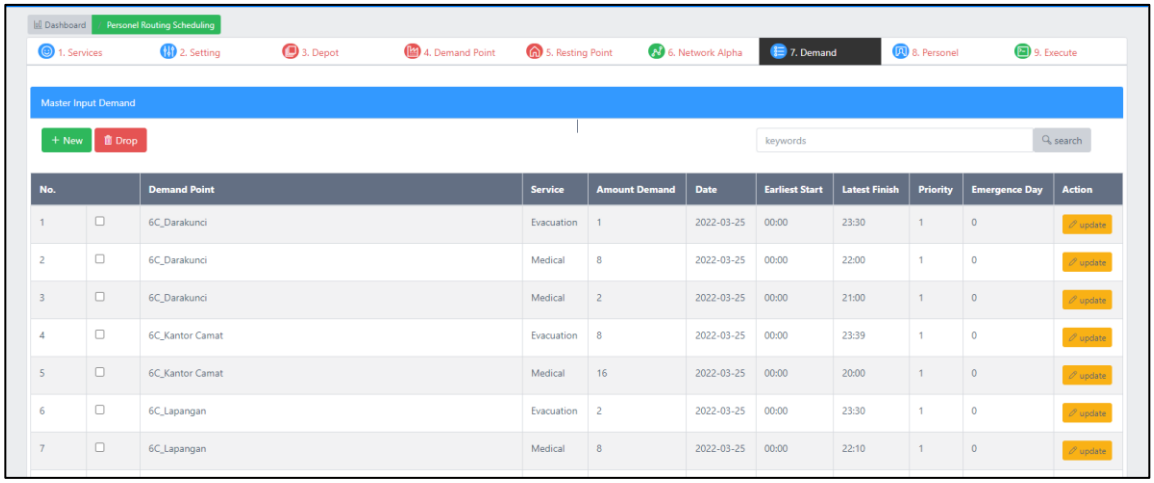


Figure 4-10. Generate alpha network values for PRS

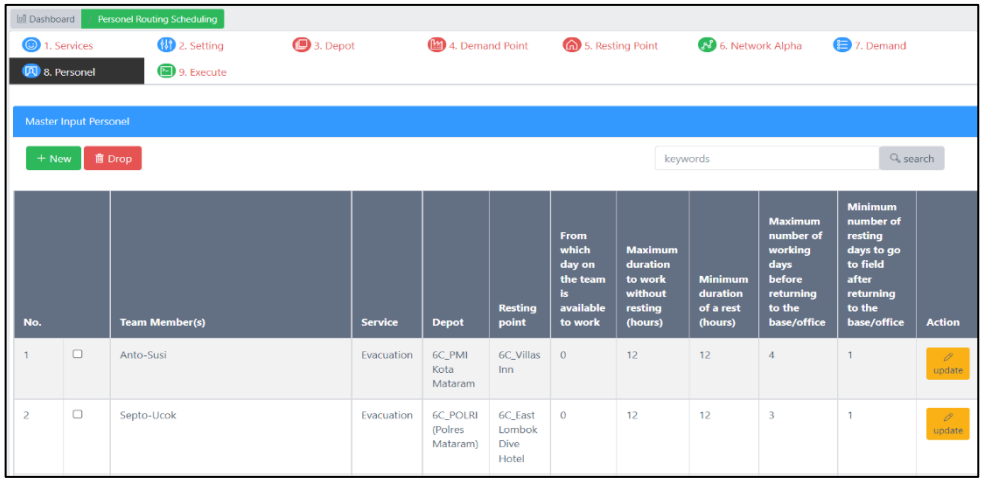
e) Demand: Click 'Demand' tab, and then click 'New' to input the amount of service demanded, its date and time, its earliest start and latest finish time during the day, its priority (the higher the priority, the more urgent the relevant demand) and its emergence day (e.g., emergence day of zero means that the relevant demand emerged/arised at the beginning of the planning horizon) for every service in every demand point (see Figure 4-11).



No.		Demand Point	Service	Amount Demand	Date	Earliest Start	Latest Finish	Priority	Emergence Day	Action
1	☐	6C_Darakunci	Evacuation	1	2022-03-25	00:00	23:30	1	0	update
2	☐	6C_Darakunci	Medical	8	2022-03-25	00:00	22:00	1	0	update
3	☐	6C_Darakunci	Medical	2	2022-03-25	00:00	21:00	1	0	update
4	☐	6C_Kantor Camat	Evacuation	8	2022-03-25	00:00	23:39	1	0	update
5	☐	6C_Kantor Camat	Medical	16	2022-03-25	00:00	20:00	1	0	update
6	☐	6C_Lapangan	Evacuation	2	2022-03-25	00:00	23:30	1	0	update
7	☐	6C_Lapangan	Medical	8	2022-03-25	00:00	22:10	1	0	update

Figure 4-11 List of demand of services

f) Personnel: Click 'Personnel' tab, and then click 'New' to input the information related to the personnels who perform the service, including the name of the personnel/team members, what service they provide, which day they can start the service, the maximum duration of working without resting (hour), the minimum duration of resting (hour), the maximum number of continuous working days, and the minimum resting days to go the field again after returning to the base/office. The sample input of the personnels/teams for evacuation service is shown in Figure 4-12.



No.		Team Member(s)	Service	Depot	Resting point	From which day on the team is available to work	Maximum duration to work without resting (hours)	Minimum duration of a rest (hours)	Maximum number of working days before returning to the base/office	Minimum number of resting days to go to field after returning to the base/office	Action
1	☐	Anto-Susi	Evacuation	6C_PMI Kota Mataram	6C_Villas Inn	0	12	12	4	1	update
2	☐	Septo-Ucok	Evacuation	6C_POLRI (Polres Mataram)	6C_East Lombok Dive Hotel	0	12	12	3	1	update

Figure 4-12. Sample input of personnel / teams

Once all the inputs required for the PRS module are entered, it can be executed as follows.

g) Execute: Click first the 'Execute' tab and then the 'Generate' button to prepare the input files. The file input is complete when it turns into green-colour. After the file input is complete, retype the name of the disaster instance under the 'Console Command' and click 'Execute' to run the PRS module, as shown in Figure 4-13

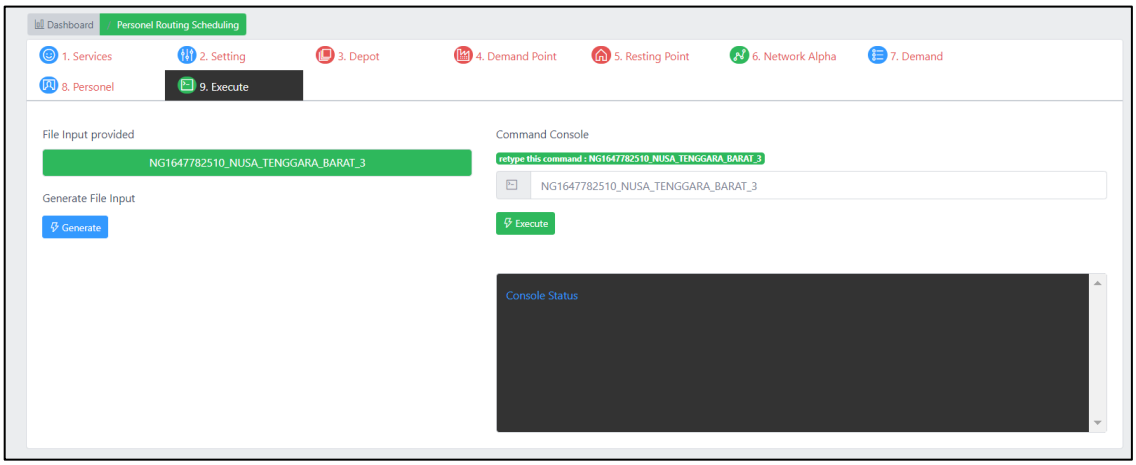


Figure 4-13. Executing PRS module

After the the process is completed, return to the 'Routing & Scheduling' page, and see the solutions by clicking the 'Visualization' button next to the disaster instance (see Figure 4-14).

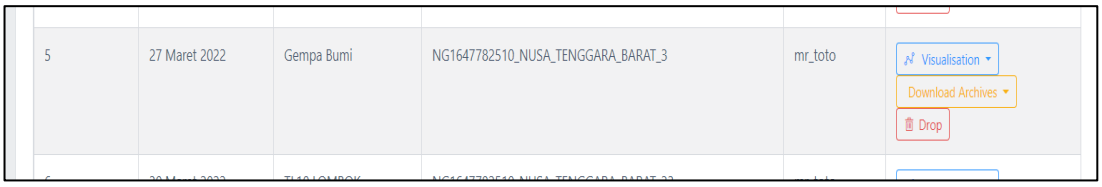


Figure 4-14. PRS Solutions

h. Solutions: After clicking the 'Visualisation' button, user will see all PRS solutions. The y-axis of the value-path plot shows how much each solution deviates from the optimal values for the objectives under consideration over the planning horizon (see Figure 4-15). The x-axis shows the objective functions: UD = Unsatisfied Demand, ACT = Average demand completion time, F= Fairness, and TR = Transportation Risk. In this example, the value-path plot shows that the evacuation services will be completed in 10 days. Below the value-path plot is a table showing the detail percentages of the value-path (see Figure 4-16) and summary table of the solutions (see Figure 4-17). In this example, there are ~13 solutions for the evacuation services. Click 'Detail' button to see the detail of each solution. For example, Figure 4-18 shows the detail of the first solution (solution id = 1).

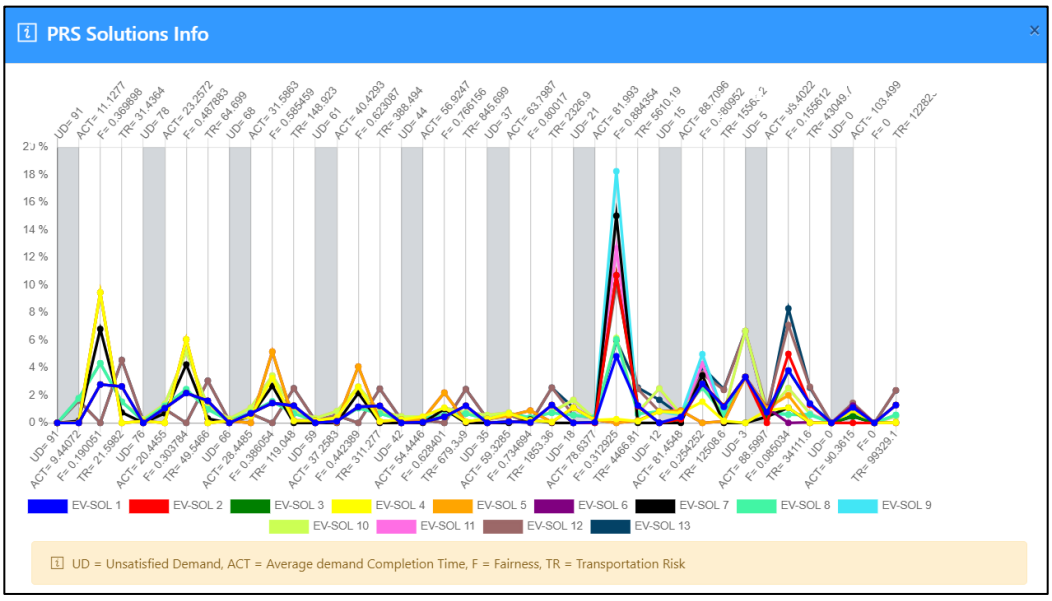


Figure 4-15. PRS value-path

UD = Unsatisfied Demand, ACT = Average demand Completion Time, F = Fairness, TR = Transportation Risk

Label	UD	ACT	F	TR	UD	ACT	F	TR	UD	ACT	F	TR
EV-SOL 1	0	0	0.278523	0.264575	0	0.10639	0.216235	0.16008	0	0.0690241	0.143722	0.124607
EV-SOL 2	0	0	0.278523	0.264575	0	0.10639	0.216235	0.16008	0	0.0690241	0.143722	0.124607
EV-SOL 3	0	0	0.278523	0.264575	0	0.10639	0.216235	0.16008	0	0.0690241	0.143722	0.124607
EV-SOL 4	0	0.00434046	0.946309	0	0.0131579	0	0.606018	0	0.0151515	0.0473327	0.32489	0.0146684
EV-SOL 5	0	0.00434046	0.946309	0	0.0131579	0	0.606018	0	0.0151515	0	0.51652	0.0167367

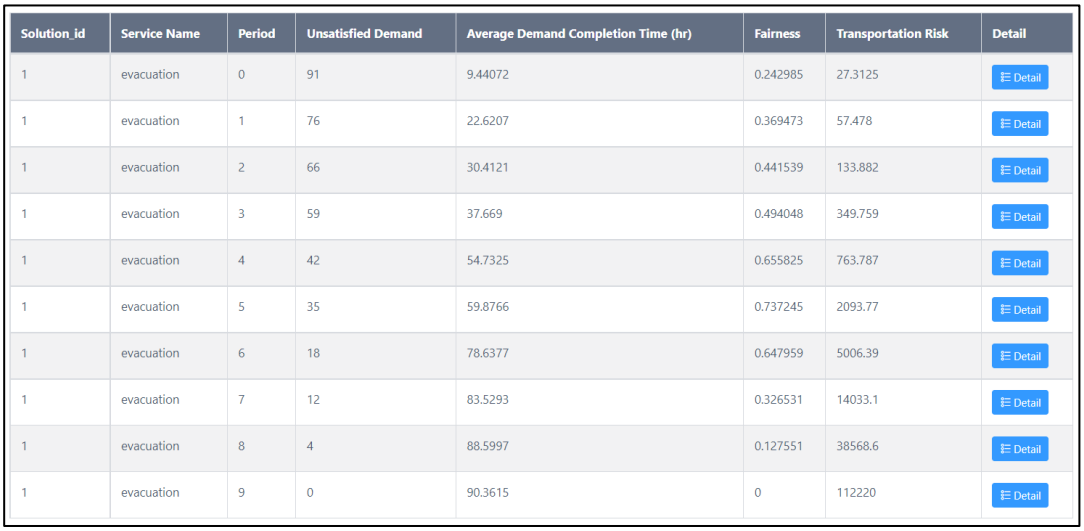
Figure 4-16. PRS detail percentages of value-path

Solution_id	Service Name	Planning Horizon Length	Average Demand Completion Time (hr)	Transportation Risk	Action
0	evacuation	227.137	100.471	112152	Detail
1	evacuation	228.022	90.3615	112220	Detail
2	evacuation	225.94	94.6381	112205	Detail
3	evacuation	225.522	98.2491	99695.7	Detail
4	evacuation	225.522	99.4716	99329.1	Detail
5	evacuation	226.224	101.719	99341	Detail
6	evacuation	222.94	94.5305	99706.6	Detail
7	evacuation	225.874	97.6739	105038	Detail
8	evacuation	225.874	97.8102	105065	Detail
9	evacuation	226.49	99.7739	104123	Detail

Showing 1 to 10 of 13 entries

Previous 1 2 Next

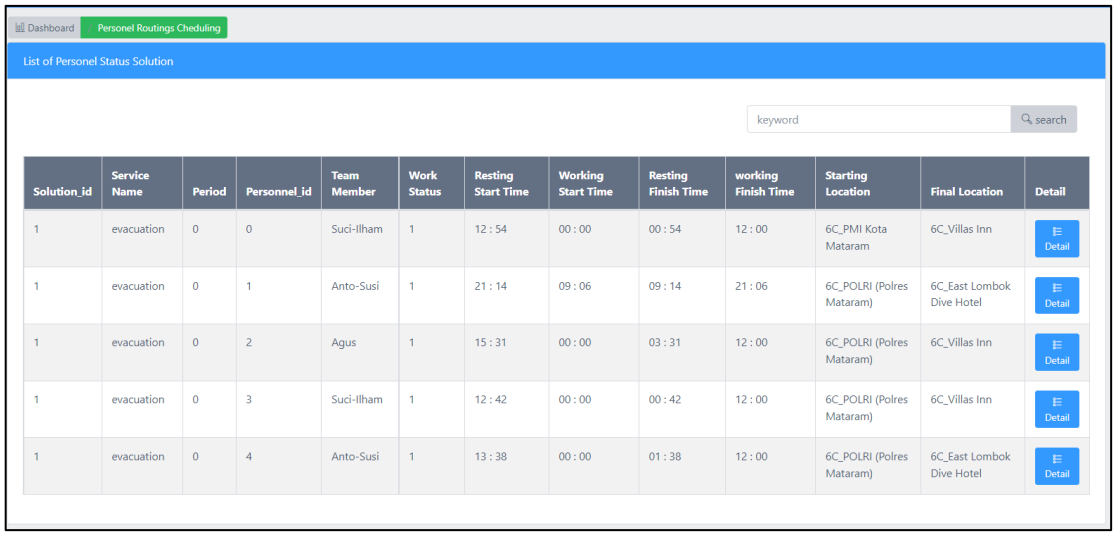
Figure 4-17. Summary of the PRS solutions



Solution_id	Service Name	Period	Unsatisfied Demand	Average Demand Completion Time (hr)	Fairness	Transportation Risk	Detail
1	evacuation	0	91	9.44072	0.242985	27.3125	Detail
1	evacuation	1	76	22.6207	0.369473	57.478	Detail
1	evacuation	2	66	30.4121	0.441539	133.882	Detail
1	evacuation	3	59	37.669	0.494048	349.759	Detail
1	evacuation	4	42	54.7325	0.655825	763.787	Detail
1	evacuation	5	35	59.8766	0.737245	2093.77	Detail
1	evacuation	6	18	78.6377	0.647959	5006.39	Detail
1	evacuation	7	12	83.5293	0.326531	14033.1	Detail
1	evacuation	8	4	88.5997	0.127551	38568.6	Detail
1	evacuation	9	0	90.3615	0	112220	Detail

Figure 4-18. Detail of a PRS solution across the planning horizon

In the solution detail (Figure 4-18), 'Period' refers to the days of the planning horizon. In this example, the planning horizon consists of 10 days as aforementioned. Click 'Detail' button (see Figure 4-18) to see the detail information of the personnel schedule on a given day, as shown in Figure 4-19. Click 'Detail' button to see the map view of the personnel routes on a given day, as shown in Figure 4-20.



Solution_id	Service Name	Period	Personnel_id	Team Member	Work Status	Resting Start Time	Working Start Time	Resting Finish Time	working Finish Time	Starting Location	Final Location	Detail
1	evacuation	0	0	Suci-Ilham	1	12 : 54	00 : 00	00 : 54	12 : 00	6C_PMI Kota Mataram	6C_Villas Inn	Detail
1	evacuation	0	1	Anto-Susi	1	21 : 14	09 : 06	09 : 14	21 : 06	6C_POLRI (Polres Mataram)	6C_East Lombok Dive Hotel	Detail
1	evacuation	0	2	Agus	1	15 : 31	00 : 00	03 : 31	12 : 00	6C_POLRI (Polres Mataram)	6C_Villas Inn	Detail
1	evacuation	0	3	Suci-Ilham	1	12 : 42	00 : 00	00 : 42	12 : 00	6C_POLRI (Polres Mataram)	6C_Villas Inn	Detail
1	evacuation	0	4	Anto-Susi	1	13 : 38	00 : 00	01 : 38	12 : 00	6C_POLRI (Polres Mataram)	6C_East Lombok Dive Hotel	Detail

Figure 4-19. Personnel schedule on a given day

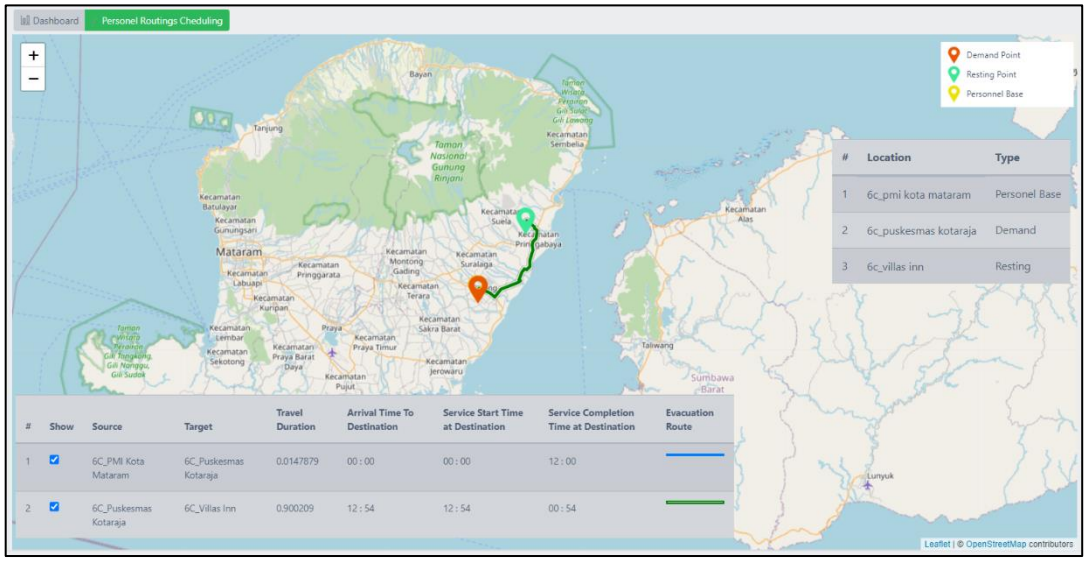


Figure 4-20. Personnel routing map on a given day

4.2 Video Tutorial

In the following link, we provide a video tutorial on how to run the PRS module: Video Demo of the PRS Module [11]

[11] https://drive.google.com/file/d/1BxCjw9lmp4U5D1FaAO7zG8yF21fe6CFY/view?usp=sharing

Concluding Remarks

The RESPOND-OR Decision Support System (DSS) provides two main modules for disaster response: i) Assisted Evacuation Planning (AEP), and ii) Personnel Routing and Scheduling (PRS) modules. The AEP module asssists the disaster response agencies by providing recommendations for assisted evacuations based on four objectives, namely minimizing the number of opened shelters, minimizing the maximum evacuation time (hour), minimizing the evacuation risks, and minimizing the total travel time (hour). The PRS module assists the disaster response agencies by providing recommendations for personnel routing and scheduling for a single or multiple services in a disaster area based on four objectives, namely minimizing the number of unmet demand, minimizing the average completion time of the services, minimizing the gap between different locations in terms of the amount of services provided, and minimizing the transportation risk. A step-by-step guide and a video tutorial link on how to run each module is provided in this manual.

Disclaimer

The RESPOND-OR DSS provides recommendations for assisted evacuation planning and personnel routing and scheduling. The users are responsible for the validation of the data input and the decisions made. The RESPOND-OR team is not liable for i) the data validation process, ii) any decisions made resulting from the use of the DSS, and iii) the misuse of the DSS.

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