Geographical information system for disaster relief distribution on natural disaster response

D Meilani, R A Hadiguna and C A Pradipta

Industrial Engineering Department, Faculty of Engineering, Universitas Andalas, Padang

Corresponding author: difana@eng.unand.ac.id

Abstract. The geographic information system that was designed was a geographic information system as a tool for the distribution process of earthquake and tsunami disasters in Padang City. This design is based on the problems that occur on the process of distributing the disaster relief such as obstruction of the distribution process of disaster relief due to abnormal road conditions, lack of information about the data of disaster relief needs at the evacuation posts so that the disaster relief provided does not match with the disaster relief needed on the evacuation post. Based on these problems, the system designed aims to provide information on optimal disaster relief distribution routes, as well as providing information about the disaster relief needs data so that the process of exchanging information about disaster relief needs data can be done more effectively. The determination of the disaster relief distribution network is using the Dijkstra Algorithm. That the shortest distribution path is obtained using the Dijkstra Algorithm with assuming that the path is traversed only to the main lane and the bridge that can be traversed is only the bridge in the Tsunami green zone. The system design is done using the waterfall method. The results obtained are that the system has four main functions. The first is to provide the optimal distribution routes, providing information about the shelter location data, providing information about disaster relief needs data, and providing information about disaster relief needs stock data. The distribution channel in the system consists of 5 safe routes to pass with the starting point is the Management Operation Center of Regional Disaster Management Authority. This research was conducted to simplify the process of distributing disaster relief because at this time officers who carry out the evacuation process are still doing data recap manually.

1. Introduction

1.1. Disaster potential in West Sumatera

Based on data released by the United Nation Office for Disaster Risk Reduction (UNDRR), Indonesia is one of the nations prone to the natural disaster. Indonesia located in the Ring of Fire area, Indonesia is not spared to tectonic activities in the form of earthquakes and tsunamis. West Sumatra is one of the provinces in Indonesia which is disturbed to natural disasters [1]. Based on DIBI (Indonesian disaster information data) during 2018, there have been more than 20 disasters that claimed lives in West Sumatera. Geologically, the negative impact of the West Sumatera is the region has the potential for natural disasters with geological aspects such as tectonic earthquakes [2]. This potential happened in the area around the Sumatran fault (Semangko Fault) and centered on the sea such as region on the West part of West Sumatera.
According to the Contingency Plan for Tsunami in Padang City 2017, it is stated that the impact of the Aceh earthquake and tsunami on December 25, 2004, raised public concerns about the earthquake and tsunami on the west coast of Padang City. One of the worries is that Padang City is directly confronted with the Indonesian Ocean. Based on the digitization results, it is known that the coastline of Padang City reaches 68,126 kilometers. A total of 6 districts in Padang City will be affected by the implications of the tsunami. Figure 1 shows the area that has the potential for a tsunami.

The data on the chart came from the area that has the potential for the tsunami. There are 104 villages in Padang City, and 50 of them have potential from the tsunami. The area that describes in the chart above is the total of the area from those 50 villages. There are 44 out of 50 villages have a high potential for tsunamis. Compared to the total area of the village, a total of 5,742.54 hectares or around 89.1% of the Padang City area is threatened by a high potential tsunami.

Based on the history of earthquakes that have occurred in the city of Padang, one of them was an earthquake on September 30th, 2009, with the strength of the earthquake about 7.6 Richter Scale (SR). Caused 1,125 victims died, 2,329 others were injured, 135,448 houses were severely damaged, 65,380 were moderately damaged, and 78,604 were slightly damaged. On another day, on August 16th, 2009, with magnitude 6.7 SR. Before 2009, Padang City also rocked by an earthquake with a magnitude 6.7 SR that could be felt up to Kuala Lumpur, Malaysia on April 10th, 2005.

1.2. Disaster management
Multiple organization is the one who is handling the vast amount of disaster related information about affected people, infrastructure, and resource needs during the large scale disaster [3], [4]. The high risk of disasters occurring in Indonesia and Padang makes the National Disaster Management Authority (BNPB) at the central level, and the Regional Disaster Management Authority (BPBD) for each region has a vital role in helping the Indonesian populace in facing the upcoming disasters. The emergency response system in Padang City has been refined in the 2017 Contingency Plan. Changes are focused on the division of zones handling the management of the Padang City emergency operation and the improvement of the Padang City Disaster Management Command Structure (SKPDB). In the command structure, several operating units work in disaster management. Table 1 shows the operating units under SKPDB along with the functions of each operating unit.
| Code | Operation Unit                                      | Task                                                                 | Task Scope |
|------|----------------------------------------------------|----------------------------------------------------------------------|------------|
| T1   | Rapid Reaction                                    | Ensure an overview of the situation developing in one region         | Sector     |
|      | (Automatically active when a disaster occurs in the sector or activated by the PB Emergency Operation Central for further under the command of the Sector Head) |                                                                      |            |
| T2   | Evacuation                                         | Provide support when the community conducts independent evacuations to a safe place. | Sector     |
|      | (Automatically active when a disaster occurs in the sector or activated by the PB Emergency Operation Central for further under the command of the Sector Head) |                                                                      |            |
| T3   | Shelter                                            | Provide temporary shelter facilities support to refugees.            | Sector     |
|      | (Automatically active when a disaster occurs in the sector or activated by the PB Emergency Operation Central for further under the command of the Sector Head) |                                                                      |            |
| S4   | Search and Rescue                                  | Search and Rescue the victims                                        | Branch     |
|      | (In times of crisis it can be activated by T1, henceforth under the command of the Field Zone Commander in its operational area) |                                                                      |            |
| T5   | Protection of Vulnerable Groups                    | Give special treatment in saving and handling vulnerable groups.     | Branch     |
|      | (In times of crisis it can be activated by T3, henceforth under the command of the Field Zone Commander in its operational area) |                                                                      |            |
| T6   | Medical Services                                   | Provide medical services to all affected communities.                | Zone       |
|      | (In times of crisis it can be activated by T3, henceforth under the command of the Field Zone Commander in its operational area) |                                                                      |            |
| T7   | Transportation                                     | Provide transportation services for the mobilization and demobilization of resources, officers, and victims. | Zone       |
|      | (Activated by the Commander of the Special Cluster Post) |                                                                      |            |
| T8   | Critical Facilities                                | Ensure the functioning of critical facilities affected in the exposed area. | Zone       |
|      | (Activated by the Commander of the Special Cluster Post) |                                                                      |            |
| T9   | Public Facilities                                  | Ensure the functioning of public facilities affected in the exposed area. | Zone       |
|      | (Activated by the Commander of the Special Cluster Post) |                                                                      |            |
| T10  | Localize Exposure                                  | Trying to avoid widespread exposure to disasters and prevent hereditary disasters | Zone       |
|      | (Activated by the Commander of the Special Cluster Post) |                                                                      |            |

(Source: Contingency Plan for Tsunami in Padang City 2017)
The unit teams that will help the distribution process is the Evacuation Team (T2), Shelter Team (T3), and the Transportation Team (T7). Shelters are buildings built with earthquake and tsunami resistant construction intended as temporary evacuation sites for the community during a tsunami disaster before being evacuated to the evacuation post. Whereas the evacuation post is the final location of the evacuation, which has the function as a gathering place for post-disaster family members, and where the refugees get help and carry out daily household activities until the recovery process begins.

There are four stages for disaster management, the first is mitigation and then preparedness, response, and recovery [5], [6]. The logistics characteristics of disaster management are certainly different from the commercial logistics in general, one of it is the primary purpose of disaster logistics activities is to fulfill the refugee needs because they are lack of goods. During the distribution process, several problems occur in the process. For example, the assistance provided is not fully distributed so that disaster relief piles up at one point, while other posts lack disaster relief. There is a shortage of specific commodities or vice versa; the assistance provided is too much, and not very useful. The existence of the problem above is caused by the lack of information regarding disaster victim's data, assistance data that have been given, and information about donors who assist.

1.3. Geographic information system
Geographic Information System is a technological information system regarding geography that is highly developed [7]. GIS has an excellent ability to visualize spatial data and its attributes, modifying shapes, colors, sizes, and symbols [8],[9],[10]. Haworth [11] and Wahyuni [12] revealed that the Geographic Information System could handle all aspects of disaster to help disaster management activities, when, where, how, by whom, to whom and what they have done.

The function of Geographic Information Systems, the evacuation process can be more easily done. The design of the geographic information system that will be carried out is expected to help the evacuation team to find the optimal disaster relief distribution route, to recapitulate the needs of disaster relief more effectively, and to get information on the lack of disaster relief from the field quickly.

2. Method
This research is the distribution of the disaster relief of the earthquake and tsunami disaster response in Padang City. The selection of the city of Padang as a research object is due to the high risk of disasters in various districts in the city of Padang (West Sumatra BPBD 2017). One of the most threatening disasters is the earthquake and tsunami. The cause of the earthquake in West Sumatra came from Mentawai Megathrust and tectonics in Sumatra [13].

The data collected in the design of geographic information systems for the evacuation of Padang City disasters are spatial data and non-spatial data. The spatial data is geographical data consisting of geographical locations in the form of geographic coordinates (latitude and longitude). The spatial data needed in this study is a map of the city of Padang. The City Map of Padang is needed as a geometry reference for the system. In this system, spatial data is obtained from Google Maps by creating an API Key so that later maps from Google Maps can be accessed in the system.

Furthermore, the non-spatial data is GIS data relating to the description of geographical areas. In this research, the non-spatial data needed is in the form of attributes from spatial data. The first data is in the way of coordinates from each temporary evacuation site. The data required is in the form of latitude and longitude coordinates from each temporary evacuation site. The coordinate location data can be accessed via Google Maps. The following data is the distance between the final evacuation sites which will be used to design the aid distribution line. The distance from the definitive evacuation site is also obtained from Google Maps. Next, the temporary evacuation data attribute is derived from the Padang City BPBD in the form of a shelter name, address, number of floors, type of building, and capacity of the shelter.
This research was conducted using two stages, namely the distribution channel planning stage and the design of geographic information systems for disaster evacuation aids. Geographic Information Systems are technology-based systems that can process data that has spatial references [14]. This method was chosen because GIS has a spatial reference, so the data that will appear on the system will have a location reference on earth so that it will make it easier for the volunteer team to find the location of the TES.

Distribution path planning uses the Dijkstra algorithm. Dijkstra's algorithm is a greedy algorithm in which this algorithm will find a route with the smallest weight [15], [16],[17]. This algorithm was chosen because distribution path planning requires the calculation of the shortest path to save time on distribution.

The testing process is done using the black-box testing method. The process of verification and validation to test the system that has been designed. The verification process is done by ascertaining whether the code that has been made gives the same results as what was planned. The validation process is carried out by testing the system that has been designed to be run by the person who will use the system and ascertain whether the system is following what is needed under existing problems.

3. Results and discussion

3.1. The Disaster relief distribution network

Distribution line planning is done with the assumption that the path is passing the mainline and does not cross the bridge. The reason is that if there is an earthquake with a large scale, the smaller paths will have more significant potential for damage and are difficult to pass. Then based on the design scenario of the Regional Disaster Management Authority, when an earthquake strikes, all bridges are considered broken. With these criteria, a path is determined using Google Maps and the path with the shortest distance is chosen. Calculation of the shortest path is carried out from the distribution center, Management Operation Center of Regional Disaster Management Authority to the 11 evacuations post. So based on the analysis, five distribution routes are obtained as in Table 2.

| Route | Road to be Passed | Evacuation Posts |
|-------|------------------|-----------------|
| Route 1 | Dr. Moh. Hatta St. - By Pass St. - Raya Anwar St. | Water Supply Utility Gunung Pangilun and Health Polytechnic Siteba |
| Route 2 | Dr. Moh. Hatta St. - By Pass St. | Police Station of Siteba and TVRI of West Sumatera |
| Route 3 | Dr. Moh. Hatta St. - Raya Lubuk Begalung St. - Raya Bandar Buat St. - Cupak Tangah St. - Padang Besi St. | Pauh District Office, Nation Police School Padang Besi |
| Route 4 | Dr. Moh. Hatta St. – Andalas St. – Sawahan St. - Dr. Sutomo St. - Jawa St. – Minangkabau St. | Putra Indonesia University, Kartika Vocational High School, PJKA Field Simpang Haru |
| Route 5 | Dr. Moh. Hatta St. - Lintas Barat Sumatera St. - Sutan Syahrir St. - Lintas Barat Sumatera St. | South Padang District Office – Bukit Lampu Lighthouse |

3.2. System design

Context Diagram describes the data flow on the system. The context diagram for this system can be seen in Figure 2.
Data Flow Diagrams depict information flow and information transportation. Figure 3 is DFD Level 1, which describes the process flow that occurs in the system from context diagrams (DFD Level 0). Based on the context diagram, there are two external entities, namely administrator and user. Administrators provide data into the system in the form of logistical assistance data needs which will be explained in more detail at DFD Level 2. Users provide data into the system in the form of distribution objectives so that the shortest path calculation process is carried out.

Use Case Diagram is a functional model of a system that regulates activities or functions that can be used by actors in the system. As has been explained, two actors use the system, admin, and user. Use Case Diagrams of the system can be seen in Figure 4.
Entity Relationship Diagram (ERD) is a diagram that designs the data requirements of an information system. Entity Relationship Diagram will prevent data duplication on the information system. ERD of data in the system can be seen in Figure 5.

The system has two levels of users, namely admin and user. The system designed will be used within the scope of the Regional Disaster Management Authority of Padang City, mainly when a disaster occurs. The system developed is more focused as a tool in the evacuation process for the distribution of disaster relief. The determination of users in the system refers to the disaster management command structure. The disaster management command structure can be seen in Figure 6.

The next step is to design the user interface. The design of the web application user interface is made by the functional consisting of two pages, namely the user page and the admin page. For example, Figure 7 is interface design for the login page. So, the user who wants to enter the system needs to input their data first on this login page.
3.3. Implementation

The system implementation process consists of three stages, namely, programming, documentation, and testing [18]. After the design is done, the next step is to implement a geographic information system for disaster relief distribution process. The limits of implementation for the system are as follows:

- Program implementation using PHP programming
- The user interface in this system using CSS from Bootstrap
- The database used in this system is MySQL

Interface implementation is the result of making a system based on the design in the previous chapter. Display the user interface using the bootstrap front-end framework. Bootstrap is a CSS framework that provides a collection of website interface components that have been designed to assist users in building and developing a website. According to [19], the advantage of bootstrapping is that users can use CSS styles on the interface. Bootstrap can use less preprocessor technology that reduces and streamlines CSS code writing. Bootstrap can also be integrated with JavaScript so that it can make it more interesting with the effects that can be provided by JavaScript.
3.3.1. Implementation for login page. The login page is the first page that the user of the system will see when they access the system. The login page consists of two forms and two buttons. The user will input their username and password so they can access the system. The login button will direct the user to the main page if the users have filled in the username and password form. If one of the forms is left blank, the display will be shown in Figure 8.

![Figure 8. Implementation of login page and login page if the form is left blank](image)

3.3.2. Implementation of registration page. The registration page is the page for registering new users on the system. This page consists of four forms, namely full name, NIK, username, and password. The register button will enter the data into the database, and the page will go directly back to the login page. If there is a form that is not filled in, an alert will appear as shown in Figure 9.

![Figure 9. Implementation of registration page and if the form is left blank](image)

3.3.3. Home page implementation. The main page display of the website contains an explanation about the Regional Disaster Management Authority and also the addresses and contacts of the Regional Disaster Management Authority of West Sumatera and Regional Disaster Management Authority of Padang City. The implementation of the main page can be seen in Figure 10.

![Figure 10. Implementation of main page](image)
3.3.4. Implementation of routing page. The implementation of the disaster relief distribution route page consists of a dropdown menu containing the distribution destination, then the "run" button, which will process the system to find the paths based on the Dijkstra algorithm, as well as a map that will display the distribution path. The implementation of the disaster relief distribution channel page can be seen in Figure 11.

![Figure 11. Implementation of the distribution routing page](image)

3.3.5. Implementation of shelter location data. The shelter location data page displays attribute data from the shelter location. This page has restricted access rights between user-level and admin level. The display of the shelter location data page for the user level can be seen in Figure 12, while the display of the shelter location data page for the admin level can be seen in Figure 13. Admin is the user who can manage data in the system so that the page views of the admin have edited and delete buttons.

![Figure 12. Implementation of shelter location data page for user level](image)

![Figure 13. Implementation of shelter location data page for admin level](image)
3.3.6. Implementation of shelter location data input. The shelter location data input page implementation contains forms for entering data and buttons for processing data to stores the data to the database. This page will only appear if the user is logged in as an admin. The implementation of the shelter location data input page can be seen in Figure 14.

![Figure 14. Implementation of shelter location data input page](image)

3.3.7. Implementation of shelter detail data page. This page will appear when the system user presses the detail button on the Shelter Location Data page. This page contains detailed information about the location of the shelter, namely the name, address, number of floors, capacity, and type of shelter. Then there is also a map to find out the location of the shelter. The implementation of the shelter location details page can be seen in Figure 15.

![Figure 15. Implementation of Shelter Detail Data Page](image)

3.3.8. Implementation of shelter mapping page. This page is a set of all shelter locations from the data of the shelter location. Users can see the distribution of shelter locations in Padang City and also see details of the location of shelters, which will be directed to the shelter location details page. Implementation of the Shelter Map Page Location can be seen in Figure 16.
3.4. System verification and validation

3.4.1. System verification. System testing is done by the black-box testing method. This test will focus on the functional requirements of the software. If the result of the system matches the function that it should, then the system is functioning properly. But if the results of the system are not following the functions that should be, then it must be improved on the system. There are ten functional pages on this system that will be tested.

For example, the Login page. This test is done to find out whether the login page is functioning properly. The result of this process is the user will enter the system and can access the system so that it can access the data that is in the system. Login page testing is performed according to the testing procedure in Table 3.

Table 3. Login Page Testing

| Test Number | Action | Expectation | Result | Error |
|-------------|--------|-------------|--------|-------|
| 01          | The user is entering the username and password and clicks the “Login” button. | The users will be directed to the main page. | Success | No error |

If the user logs in with a username and password that is not registered in the database, then the process will not continue to the main page, and the "Login Failed" notification will appear. Testing the login page if the username and password are not registered in the database is performed according to the testing procedure in Table 4.

Table 4. Login page testing

| Test Number | Action | Expectation | Result | Error |
|-------------|--------|-------------|--------|-------|
| 02          | The user is entering the username and password that is not registered on the database and click the “Login” button. | The users will be directed back to the login page, and notification “Login Gagal” will appears. | Success | No error |
3.4.2. System validation The validation process is carried out to system users. Validation is said to be successful if the software function in accordance with user needs. All test cases are designed to ensure that all functional, performance and document met the user’s requirement. How the users will use the software cannot be predicted, so acceptance testing can be performed to allow users to validate all requirements.

Validation is done by interviewing and using forms. Validation was carried out by two people a representative of the Regional Disaster Management Authority of Padang City and a representative from the Operation Management Center of Regional Disaster Management Authority of Padang City. The system is designed based on problems that occur in several evacuation processes that have been carried out both in Padang City and outside Padang City. There are three problems chosen in this study, the difficulty of distributing disaster relief because the road traversed is not under normal conditions. Then it is unclear how much the disaster relief needs for each evacuation post so that the disaster relief needs provided are not following what is needed at the evacuation post. The results of interviews regarding the suitability of the system with existing problems can be seen in Table 5 and Table 6.

Table 5. Interview result with the regional disaster management authority of Padang City staff

| Functional | Goals | Comments |
|------------|-------|----------|
| Optimal Distribution Route | Help the volunteers and the operation team to distribute disaster relief in a short time and the safe route. | The track is suitable because it is designed not to cross critical paths and bridges. So, it is used even if there is no information on road conditions at the time of the disaster. |
| Shelter Location Data | Giving information about the shelter location in Padang City |

| Functional | Goals | Comments |
|------------|-------|----------|
| Disaster Relief Needs Data | Giving information about disaster relief needed on the evacuation post | A page should be added where fieldworkers can immediately update the disaster relief needed (already added). |

Table 6. Interview result with the operation management center of regional disaster management authority of Padang City staff

| Functional | Goals | Comments |
|------------|-------|----------|
| Optimal Distribution Route | Help the volunteers and the operation team to distribute disaster relief in a short time and the safe route. |
| Shelter Location Data | Giving information about the shelter location in Padang City |
| Disaster Relief Needs Data | Giving information about disaster relief needed on the evacuation post | A page should be added where fieldworkers can immediately update the disaster relief needed (already added). |

4. Conclusion

Based on the research that has been done, it can be concluded that the geographic information system that was designed can help the distribution process of earthquake and tsunami disasters in the city of Padang. The system has four main functions. First, the system can display an optimal distribution route to help the operating unit distribute disaster relief quickly and pass through a safe path. Second, the system has information about shelters in Padang City, which can be used as guidelines for officers and distributed to residents of Padang City when a disaster occurs. Third, the system has information
about disaster relief data needed at the evacuation post. Fourth, the system also provides information about the disaster relief stock data owned by the Regional Disaster Management Authority of Padang City as a guide for issuing other requests for disaster relief to the Regional Disaster Management Authority of West Sumatera.

References

[1] Khairul K, Purnweni H, and Suwiti S., 2016 “Institutional empowerment policy of the municipal disaster management board in Padang City, West Sumatera Province, Indonesia,” no. 24, pp. 2007–2009.

[2] Rachmawati T. A, Apriyenson H, and Hasyim A. W, 2018 “The impact of disaster risk reduction information on the change of spatial pattern of Padang City,” in IOP Conference Series: Earth and Environmental Science, 202, no. 1.

[3] Tomaszewski B, Judex M, and Szarzynski J, 2015 “Geographic information systems for disaster response: a review,” J. Homel. Secur. Emerg. Manag., no.

[4] Meilani D, Arief I, and Habibitullah M, 2019 “Designing disaster recovery plan of data system for university,” IOP Conf. Ser. Mater. Sci. Eng., 697, no. 1.

[5] Jiang Y and Yuan Y 2019, “Emergency logistics in a large-scale disaster context: achievements and challenges,” Int. J. Environ. Res. Public Health, 16, no. 5.

[6] Haworth B and Bruce E, 2015 “Article title: A review of volunteered geographic information for disaster management,” Geogr. Compass, 5, pp. 237–250.

[7] Sharma A. K. and Parkash S, January, 2016 “Geographical information systems for disaster response and management,” no.

[8] Binabar S. W, Siregar D. J. S. H, and Pratama W, 2019 “Geographic information system for mapping the potency of batik industry centre,” J. Inf. Syst. Eng. Bus. Intell., 5, no. 1, pp. 40–47

[9] Harfizar H, Mulyati M, and Fikri M. A, 2019 “Design of geographic information systems monitoring waqf at the cikupa sub-district religious affairs office,” Aptisi Trans. Manag., 3, no. 2, pp. 131–141

[10] Zhu J, Wright G, Wang J, and Wang X, 2018 “A critical review of the integration of geographic information system and building information modelling at the data level,” ISPRS Int. J. Geo-Information, 7, no. 2, pp. 1–16

[11] Haworth B. T, 2018 “Implications of volunteered geographic information for disaster management and giscience: a more complex world of volunteered geography,” Ann. Am. Assoc. Geogr., 108, no. 1, pp. 226–240

[12] Wahyunii L, Rohmat D, and Setiawan I, 2018 “Hazard analysis of earthquake in the main campus of Universitas Pendidikan Indonesia,” J. Pendidik. Ilmu Sos., 27, no. 2, p. 116.

[13] Haridhi H. A, Huang B. S, Wen K. L, Denzema D, R. Agung Prasetyo, and C. S. Lee 2018, “A study of large earthquake sequences in the Sumatra subduction zone and its possible implications,” Terr. Atmos. Ocean. Sci., 29, no. 6, pp. 635–652.

[14] Akossi O , 2014 , “Contribution of remote sensing and geographic information system to identify potential areas of groundwater in the department of M’Bahiakro (Central-East of Côte d’Ivoire),” Br. J. Appl. Sci. Technol., 4, no. 18, pp. 2551–2575.

[15] Series C, “Analysis of Dijkstra’s Algorithm and A * Algorithm in Shortest Path Problem Analysis of Dijkstra’s Algorithm and A * Algorithm in Shortest Path Problem,” J. Phys. Conf. Ser., 1566, 2020.

[16] Fitriansyah A, Parwati N. W, Wardhani D. R, and Kustian N , 2019 , “Dijkstra’s algorithm to find shortest path of tourist destination in Bali,” J. Phys. Conf. Ser., 1338, no. 1.

[17] Gunawan R. D and Napianto R, “Implementation of Dijkstra’s Algorithm in Determining the Shortest Path (Case Study: Specialist Doctor Search in Bandar Lampung),” Int. J. Inf. Syst. Comput. Sci., pp. 98–106.

[18] Bhatia M. P. S, Kumar A, and Beniwal R , 2016 , “Ontologies for software engineering: Past, present and future,” Indian J. Sci. Technol., 9, no. 9.
[19] Xiao H. et al., 2016 “Towards confidence in the truth: A bootstrapping based truth discovery approach,” in Proceedings of the ACM SIGKDD International Conference on Knowledge Discovery and Data Mining, 13-17-Augu, pp. 1935–1944.