Judul Artikel: **Spatial analysis model for traffic accident-prone roads classification: A proposed framework**

1) Paper Submission. Paper ID: 1570633263 has been registered (21 Februari 2020)
2) Re-upload review (27 Februari 2020)
3) Decision for Review paper MAJOR Revision (28 Maret 2020)
4) Notification for paper camera ready (28 April 2020)
5) Certificate and Paid Receipt for paper ID #1570633263 (2 Agustus 2020)
6) ID# 1570633263: Preparing paper for a Scopus indexed journal (19-28 September 2020)
   - Revision paper of IJAI June 2021 (5 Maret 2021 – 27 April 2021)
7) Sertifikat publish (30 September 2021)

1) Paper Submission. Paper ID: 1570633263 has been registered (21 Februari 2020)

ANIK VEGA V, S.Kom.,MT unitomo <vega@unitomo.ac.id>

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Cc: Watra Arsadiando <watra24arsadiando@gmail.com>, Ahmad Raditya Cahya Baswara <ahmadradityac@ee.uad.ac.id>, Alfian Maarif <alfianmaarif@ee.uad.ac.id>, Hendril Satrian Purnama <Lfriyan220@gmail.com>, Phisca Rosyady <adityaphisca@gmail.com>, Phisca Aditya Rosyady <phiscaaditya@ee.uad.ac.id>, Deris Stiawan <deris@unsri.ac.id>, Arsyad Cahya Subrata <arsyadcahya@gmail.com>, Imam Much Ibnu Subroto <imam@unissula.ac.id>, Tole Sutikno <thsutikno@ieee.org>, TH Sutikno <lppi@uad.ac.id>, Tri Wahono <triwahono060@gmail.com>, Nuryono Widodo <nuryono.sw@ee.uad.ac.id>, Nuryono Widodo <nuryono.sw@uad.ac.id>

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Spatial Analysis Model For Traffic Accident-Prone Roads Classification: A Proposed Framework

Anik Vega Vitianingsih[1], Nanna Suryana[2], and Zahriah Othman[3]
[1]Informatics Departments, Universitas Dr. Soetomo, Surabaya, Indonesia
[1, 2,3]Faculty of Information and Communication Technology, Universiti Teknikal Malaysia Melaka, Melaka, Malaysia

Article Info

Article history:

Received Jun 1, 2018
Revised Jul 10, 2018
Accepted Jul 25, 2018

Keywords:

GIS software engineering
Spatial analysis model
Proposed framework
Hybrid estimation model-based
MCDM-ANNs
Traffic accident-prone roads

ABSTRACT

The classification method in the spatial analysis modeling based on the multi-criteria parameter is currently widely used for the management of Geographic Information Systems (GIS) software engineering. The accuracy of the proposed model will be an essential role for the successful software development of GIS, and this is related to the nature of GIS used for mapping through spatial analysis. This paper aims to propose a framework of spatial analysis using a hybrid estimation model-based on a combination of Multi-criteria decision making (MCDM) and Artificial neural networks (ANNs) (MCDM-ANNs) classification. The proposed framework is based on the comparison of existing frameworks through the concept of a literature review. The model in the proposed framework will be used for future work on the traffic accident-prone road classification through testing with a private or public spatial dataset. Model validation testing on the proposed framework uses metaheuristic optimization techniques. Policymakers can use the results of the model on the proposed framework for initial planning developing GIS software engineering through spatial analysis models.

Corresponding Author:

Anik Vega Vitianingsih,
Informatics Departments,
Universitas Dr. Soetomo, Surabaya, Indonesia,
Jalan Semolowaru 84 Surabaya, 60118.
Email: vega@unitomo.ac.id

1. INTRODUCTION

Model accuracy prediction in the development of frameworks on GIS software be the first step in efforts to improve the quality of GIS software developed, this is part of quality control and quality assurance [1]. Quality control will determine the method of spatial analysis to test quality standards [1]. A spatial analysis modeling is a process to build an Artificial Intelligence (AI) model that is combined with trials on spatial datasets [2], gathering spatial knowledge through spatial datasets and providing knowledge of models in the framework through AI methods from various sources. The purpose of the spatial analysis model is to make a description of the GIS software that will be developed, conduct simulations to test spatial datasets through models on the AI method used on the proposed framework that has already been described. Spatial datasets in GIS relate to how primary and secondary data are obtained through the collection process, and then how the data is processed through spatial analysis to be information in the decision support system [3]. Visualization of spatial data can be done with Cloud-terminal Integration GIS to provide convenience in the process of spatial analysis on a large number of spatial datasets [4], aggregation-based spatial datasets information retrieval system [5]. Spatial datasets as the key to the value of big data in spatial data mining (SDM) that refers to the description of attribute data requirements, how the data is obtained, and what AI method is used to perform spatial analysis of the data [6][4]. Spatial datasets become the basic structure in GIS for the process of spatial analysis algorithms, analyzing algorithm principles, or adapting existing algorithms [7]. The classification model in machine learning is very popular [8] to be used research in the field of spatial analysis of GIS. However, there is no concrete statement regarding which classification

algorithm is best to use with certainty because the accuracy, precision, and recall (APR) tests in each study use different sample data. It is also based on the field of study, which is always different on the object of research conducted.

Previous research proposed a framework using the CART model (Classification and Regression Trees), which reported a 10-fold increase in the best value for crash severity prediction [9]. However, the CART model has a weakness in the number of training data samples, because changes in training and testing data samples affect the results of spatial analysis [10]. Spatial analysis model using data mining decision tree (J48, ID3, and CART) and Naïve Bayes classifiers [11] States that the accuracy value of 96.30% on the J48 method is higher than ID3, CART, and Naïve Bayes, where the Naïve Bayes have better performance even though the accuracy value is small. Different studies suggest that the accuracy of prediction of classification models with the Decision Tree Approach to reach 84.1% [12]. Also, suggest that the Enhanced Empirical Bayesian (EB) method is a spatial analysis approach that is preferred for prediction of the number of accidents in road segments [13]. Maximizes the accuracy value of the model for Geo-spatial data using the adaptive k-Nearest Neighbor (kNN) classifier, i.e., by dynamically selecting *k* for each instance the value being classified reaches a ROC AUC score of 0,9. The fuzzy deep-learning approach model is used to reduce the uncertainty of data in the prediction of traffic flows that affect road traffic accident rates [14]. Convolutional Long Short-Term Memory (ConvLSTM) neural network model [15] states that the proposed framework is sufficiently accurate and significant to improve accuracy in traffic accident prediction for heterogeneous data. The road accident classification model using random forests and boosted trees works equally well with an average value of 80% accuracy and a sensitivity value of 50% [16].

The discussion in this paper emphasizes the comparison in modeling spatial analysis using classification methods for hybrid models through the proposed framework. The general contribution of this proposed framework will be used for future work is integrated through the GIS-platform for the safe management and risk assessment [17],[18] of traffic accident prone roads classification, to analyze multi-criteria parameters that influence the results on the traffic accident-prone road classification, to purpose new parameters of spatial datasets, to enhance a framework of spatial analysis using a hybrid estimation model-based on a combination of MCDM-ANNs, and to evaluate the enhancement of the new model through the hybrid. Model evaluation needs to be done to provide best practices for the resulting model [19]. Model performance assessment is influenced by balanced data to describe the quality of the resulting model, so as not to lead to misleading conclusions [16]. The proposed framework of classification models with MCDM-ANNs hybrid to the implementation of prone-roads traffic accident classification and its differences with existing frameworks are presented of classification models. The selection of a model-based hybrid estimation on a combination of MCDM-ANNs classification in this proposed framework study is based on a literature review. The collection of dataset multi-criteria parameter for prone-roads traffic accident classification which has been used in the paper articles obtained to evaluate the proposed framework of classification models, explains also the validation and evaluation techniques of the proposed model. Modeling of Group Analytic Hierarchy Process (GAHP) technique to develop weighting technique on multi-parameter criteria applied to MCDM Methods which still use are a human assumption in weighting, proving through the sensitivity and stability test of GAHP technique modeling to MCDM Methods by comparing the weight was given the human by manual assumption.

Multi-criteria decision making (MCDM) methods are used in this study to process the determinant parameter data in the classification of accident-prone areas that include road conditions, traffic volume, accident rate [20],[21], assign weighting values to each factor based on literature and surveys to expert sources [22]. From the classification of the accident-prone areas, it becomes important to provide recommendations to the road auditor to conduct a traffic safety audit to obtain assessment criteria, implementation expenses, the number of involved traffic participants, the effect of road safety, protective effect and social factors presenting difficulties [23]. The traffic safety audit is carried out by the administration of the road auditor by conducting a feasibility study of the network of accident-prone road categories [24]. MCDM methods have been used for analysis with Simple Additive Weight (SAW), Analytical Hierarchy Process (AHP) and Fuzzy AHP method, used for Road Safety Analysis (RSA) that can help decisions process in n determining the priority of road management and provide mitigating actions against the most vulnerable to accidents [25]. The MCDM method with Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method is used in the management of road safety, and road safety is one of the factors to reduce the number of traffic accidents by knowing the position of a road safety study in Bushehr province Bushehr-Borazjan roads and Borazjan-Genaveh based on various quantitative and qualitative criteria [26]. The MCDM model is one of the right approach models to deal with the problem of Accident-prone road section (APRS) because it uses several road and environmental criteria both quantitative or qualitative, MCDM is related to the results of decision making for planning that involves stakeholders [27]. A framework to be proposed through the process of a literature review from several studies that have been done before. This proses to evaluate the benefits of research that has been done, to know the limitations

of the method used, to identify research gaps that have been conducted, and to advice development for further research to get the right framework in the research the new [28]. The research questions in research are intended to focus on the subject area of the study, by identifying and classifying the spatial analysis framework for accident-prone traffic roads to be done [29].

2. RESEARCH METHOD

The spatial analysis model using MCDM is a multi-criteria spatial decision support system (MC-SDSS) developed in the field of GIS technology by integrating MCDM as a method to determine the best alternative from the many alternative choices available based on the spatial datasets described [30]. ANNs classification is a Data Mining technique in machine learning, mapping various attributes as input layer in a node, adding the hidden layer, which is then used to get the threshold to the non-linear output layer [31]. The proposed framework with the steps in Figure 1.

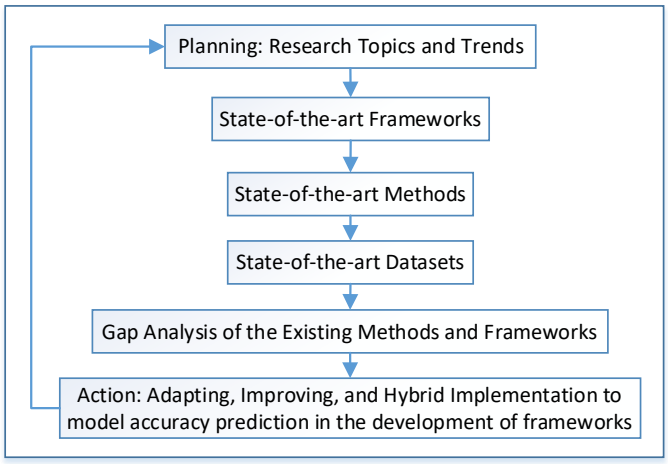

Figure 1. Research Method Steps

The initial stage a proposed framework in Figure 1 is to plan topics and research trends with identifying in research needs for the literature review process through state-of-the-art Frameworks, methods, datasets requirements, and gap analysis of existing methods and frameworks. Action adapting, improving, and hybrid implementation to model accuracy prediction in the development of frameworks. The state-of-the-art from the literature review within the primary study displayed in Table 1.

Table 1. Literature Review A Framework Comparison

Framework	Model & Method	Spatial Datasets	Results
[32]	Model-based spatial statistical methods: Poisson regression, Negative Binomial regression, Empirical Bayesian.	The accidents, injuries, and deaths by years	In this study comparing all methods used, where Empirical Bayes has the best accuracy and consistency, recommended by the Highway Safety Manual (HSM) and the European Union Acquis
[33]	Model-based spatial statistical methods: Kernel density analysis, Nearest neighbor, K-function	Intercity accidents, accidents leading to injury, accidents leading to death, and accidents leading to damages	The observed value curve on the spatial analysis process, the value of spatial datasets is above the 5% confidence interval
[34]	Spatial analysis techniques: Nearest Neighborhood Hierarchical (NNH) Clustering, Spatial-Temporal Clustering Analysis (STAC)	Road accidents involving all types of vehicles	The results of the spatial analysis vary according to the parameter values in the spatial datasets, where is STAC has a 461,57 higher Prediction Accuracy Index (PAI) compared to NNH 163,69.
[35]	ANNs techniques: Extreme learning machine (ELM), Probabilistic neural network (PNN), Radial basis function (RBF), and Multilayer perceptron (MLP).	V/C, speed, vehicle kilometer traveled (VKT), roadway width, the existence of median, and allowable/not-allowable parking	Evaluation method using Nash – Sutcliffe (NS), mean absolute error (MAE), and root mean square error (RMSE). ELM, as a feed-forward neural network, becomes the algorithm that has the best performance and the most accurate prediction results (RMSE=3,576; NS=0,81; MAE=2,5062) by randomly selecting hidden nodes using random weights.
[36]	Hot spot analysis (Getis-Ord Gi*): Network spatial weights, Kernel	The traffic accident)	Hotspot analysis gives better results because it is done by considering the weight of spatial

Framework	Model & Method	Spatial Datasets	Results
	Density method		datasets
[37]	The support vector machine combines the techniques of statistical learning, machine learning, the neural networks based: Support vector machine, Deep neural network	Accident, person, vehicle, road, and environment data	They proposed a real-time online deep learning framework Based on traffic accident black spots. SVM algorithm in machine learning has 63% precision and a 61% recall rate in the analysis of the black spots of traffic accidents. If the training data period is added, the SVM and deep neural network values increase by 95% and 89% accuracy, 69%, and 79% recall rates.
[38]	Black spot identification (BSID) method and Segmentation method: Empirical Bayesian (EB), Excess Empirical Bayesian (EEB), Accident Frequency (AF), Accident Rate (AR).	The traffic accident	AF method has the best performance with a consistency of 93.1% compared to EB 92.2%, and EEB 77.4%. The performance of the EEB and AR methods is the weakest in the case of segmentation in most cases of segmentation.
[39]	Machine learning techniques to prediction model: Decision tree regression (DTR) methods Regression tree framework, Ensemble techniques. Model assessment: Average Squared Error (ASE), Standard Deviation of Error (SDE)	Statewide Traffic Analysis Zone (STAZ)	The DTR model to prediction accuracy works better than the spatial DTR model. To improve prediction accuracy using ensemble techniques (bagging, random forest, and gradient boosting) with slightly better results, depending on the amount of training data.
[27]	Multicriteria decision making (MCDM) model: Weighted linear combination (WLC) method	The traffic accident Reports	The model was developed to determine the criteria weights that have been determined by experts with interest in subjective results.
[40]	Prediction model: Deep neural network model, Gene expression programming (GEP), Random effect negative binomial (RENB) models, Regular negative binomial model (FENB)	The road geometry, traffic, and road environment)	The DNN model experienced an increase in road prediction with 0.914 (RMSE = 7.474) by GEP, and 0.891 (RMSE = 8.862). GEP works better than RENB to measure the ranking of variables that influence accidents.
[16]	Random effects negative binomial model: Hierarchical cluster method	Real time-frequency of accident data and contributing factors	The model developed can provide information on the main causes of accidents at road intersections

The literature review is in Table 1. The research [32] not shown the comparison of the accuracy and consistency of each method used with the confusion matrix. The meaning of Empirical Bayes has the best accuracy and consistency value that is not really visible. Standard Deviation of the data distribution value in the sample data is only used to calculate the disaster-prone traffic accident rate, and there is no proof of the truth of the model used [33]. Discussion [35] is still limited to the use of an existing method, and knowledge combination has not been done as a hybrid model approach. The results of the comparison of the two methods are stated to be more accurate, but no precise accuracy value is given based on the value of the confusion matrix [36]. On research [34] have not considered the type of road type design, for example, arterial roads, collector roads, or roads based on their nature (geometric road), there are no studies on adaptive models that can expand machine learning through a combination of online learning and deep learning [37]. Paper discussion [38] still limited to the use of an existing method; knowledge combination has not been done as a hybrid model approach. The DTR model in conducting the prediction accuracy in this study is still a macro-level crash count [39]. The model has weaknesses in terms of data simulation because it requires accident data at the beginning of the calculation [27]. Mathematical modeling in the comparison algorithm does not exist, so the comparison of results is difficult [40], there is no evaluation of the models offered, because the test data collected does not have a long-time span [16]. MLP is more accurate for available spatial datasets but becomes very vulnerable when there is data noise that can cause errors in predictions [35]. PNN has probabilistic outputs with multilayer perceptron networks, producing fairly accurate predictions [35]. RBF is very weak in making predictions [35]. VKT parameters proved to be the most influential in the occurrence of road traffic accidents, then the V/C variable and driver speed based on the RReliefF algorithm calculation method [35]. The evaluation to perform the method, The site consistency test (SCT), The method consistency test (MCT), The total rank differences test (TRDT), and The total score test (TST) [38].

3. RESULTS AND DISCUSSION

The proposed framework is based on a literature study by comparing the existing framework to determine the performance of the spatial analysis model offered for Traffic Accident Prone Roads in Table 1 and the MCDM-based framework [41],[42],[43],[44],[27]. The framework being compared includes the method used for primary study (PS) spatial analysis for accident-prone traffic roads, the spatial analysis model used, spatial datasets used to test the model through method selection, and the value of the measurement results through the assessment.

The framework that has been developed by previous researchers will be described in this section. The framework model [44], was developed to create the Maycock and Hall's accident prediction model, this model provides sensitivity analysis on modeling results using multi-objective optimization (MOO) using multi-criteria decision making for the analytical hierarchy process (AHP model). The needs primary spatial data sets in the road geometry category, the necessity secondary spatial i.e the numbers and types of traffic accidents, traffic and demand for structural flow, visual distance and vehicle speed, road signs, and equipment, lighting, driver behaviour. The value of the multi-criteria parameters obtained will be done mathematic spatial data modeling to produce the sensitivity of spatial analysis, the results of multi-criteria optimization in the form of traffic efficiency (TS) and traffic safety (TS) to the predicted traffic accident. MOO model is measured using a consistency index (CI) and consistency ratio (CR), the model is proven to have a good structure with a value of CR $\leq$ 10 or the CR value is 0.00298, this shows that the MOO model with MCDM on the AHP model has a consistent value the good one.

The [41] framework, was developed by the PROMETREE-RS MCDM model. MCDM is used because it can use more than one parameter to get the best results from the alternatives produced. This model was developed to evaluate the DEA and TOPSIS methods in road safety to reduce risk the number of accidents on the road through the road safety index. The model is tested by using the Robustness of the composite index. The average correlation value, the average rank value, and the cluster variation average values will be entered into the MCDM PROMETHEE-RS to test the resulting model. Multi-criteria parameters tested in this model, i.e., the Police Department data, fatalities, serious injuries, number of inhabitants, number of registered vehicles, traffic risk, and public risk. This parameter will be used to mathematic spatial data modeling through DEA and TOPSIS, the produce optimal composite index through the value of final risk efficiency. DEA-WR provides the best ranking results compared to the DEA-based Composite Indicator model (DEA-CI).

The [45],[43] framework is a model built using MCDM, the purpose of this model is to create a knowledge data mining rule decision tree through FP-growth and Apache Spark framework. A trial model on road accident analysis, where the results have a high degree of accuracy and work well to improve road safety. The multi-parameter criteria used are the road accident data to death and injuries attribute. The testing model for the relevant association rule is done by testing and validation by measuring quality measurement. MCDM model involves many criteria, so it is suitable to overcome the problem of Accident-prone road section (APRS) on the type of horizontal alignment, vertical alignment, intersections, significant places, and shoulder widths with an accuracy value of 0.8830 for threshold values 1 [27].

The proposed framework in previous research will be used by the author as a reference in developing further activities of the framework that will be proposed. The framework of the research proposed in Figure 2 has the main differences from the existing framework. Prepare data requirements for spatial datasets as primary and secondary spatial datasets in determining the road categories to be studied (using a private or public spatial dataset type). Perform a literature study relating to multi-criteria parameters used on each road category. Mathematics modeling for spatial analysis to the proposed framework for hybrid estimation model-based on a combination of MCDM-ANNs multi-class classification. In this case, the pre-processing data process will run for the classification analysis process. The range of classification will be performed through mathematical modeling using the Guttman method. The results of the multi-class classification will be validated with SCT, MCT, ARC validation. Focuses on the propose a classification of roads prone to accidents using multiple criteria parameters (data series), make a modeling of road prone to accidents by calculating the value of traffic accident by type of events and the index of the accidents, the density that of roads traffic accident happened to each zone and the amount of data in each year, risk factors based on the severity of the accidents, severity of roads traffic accident events, crash prediction models using data series, and the value of the societal cost of each type the accident. The ANN strategy has the most noteworthy rating of strategies that are regularly utilized in the literature review in essential considers. The empirical Bayes method and decision tree in data mining are also broadly utilized within the clustering category in spatial information modeling of accident-prone zones. This considers A proposed framework of classification used a hybrid estimation model based on a combination of MCDM-ANN classification. Test the consistency of the method from the model produced with the MCT, SCT, the value of ARC model evaluations.

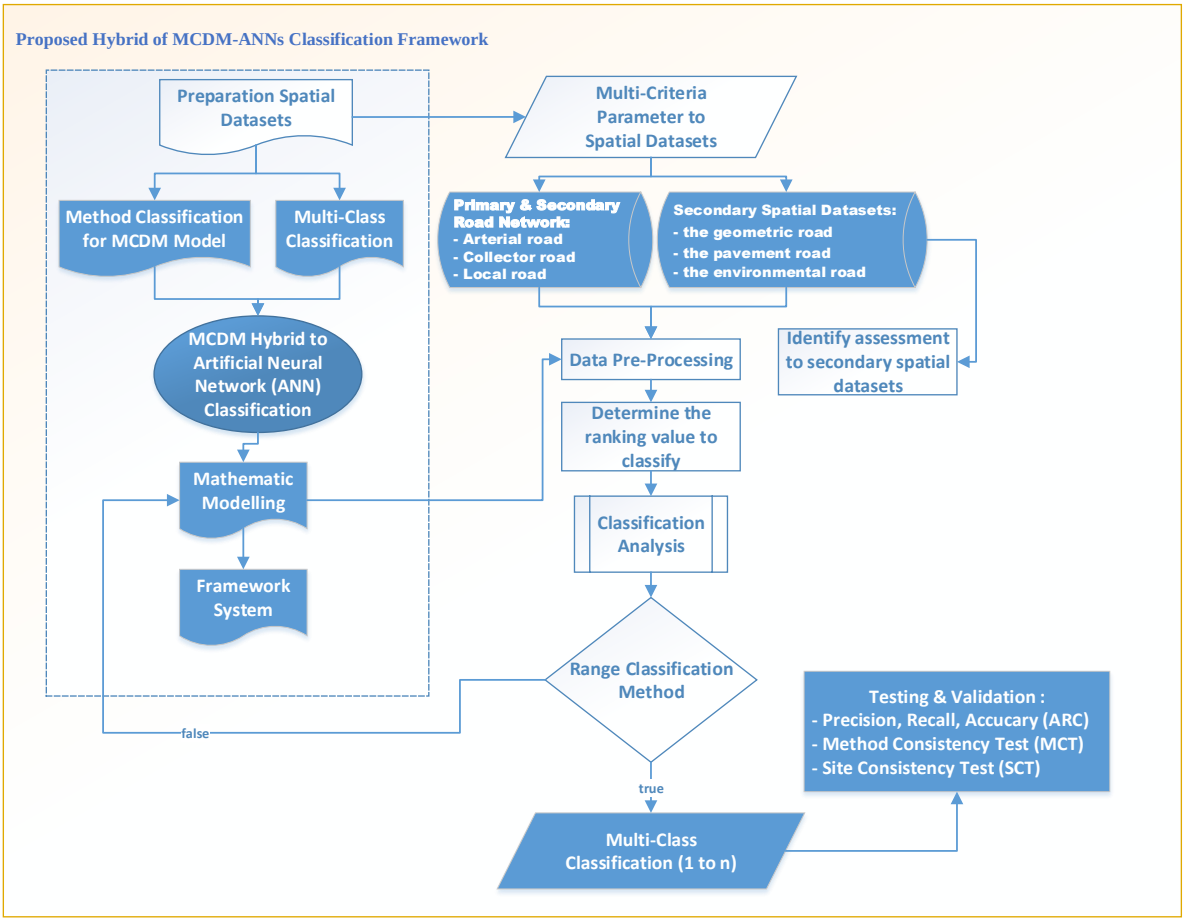

Figure 2. Proposed Hybrid of MCDM-ANNs Classification Framework to Evaluate and Rank Spatial Analysis Model Traffic Accident Prone Roads

4. CONCLUSION

The proposed framework in this study will act as a model-based hybrid estimation approach on a combination of MCDM-ANNs classification to strengthen data mining techniques in spatial multi-criteria analysis in multi-class classification decision making. In the literature review on the primary study, there are no research topics that discuss on the traffic accident-prone roads classification on the arterial road, collector road, and type of road based on its nature (pavement, geometry, and local road) categories. The Spatial Analysis Model using MCDM among others Analytic Hierarchy Process (AHP), Analytical Network Process (ANP), Weighted Sum Model (WSM), Weighted Product (WP), Weight Product Model (WPM), Simple Additive Weighting (SAW), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), Preference Ranking Organization Method for Enrichment of Evaluations (PROMETHEE), Multi-attribute utility theory (MAUT), Elimination and Choice Expressing Reality (ELECTRE), and VlseKriterijuska Optimizacija I Komoromisno Resenje (VIKOR). ANNs classification methods are the most popular data mining techniques in the field spatial analysis of accident-prone roads and the factors that affect the accident rate, among others (Neural networks, Extreme learning machines, k-Nearest Neighbor, Naive Bayes, Decision trees) [46],[31]. The results of the best methods through APR measurement will be a reference in decision making in road management. Existing research is still limited to one type of road used as an object (specific region), and 96 % is used Private Spatial Datasets. In this study, it was using an Inductive Qualitative Approach in the modeling of road prone to accidents to identify the findings of science that is done during the research process. The proposed a classification of roads prone to accidents using multiple criteria parameters, make modeling of road prone to accidents calculating by the value of traffic accident by type of events and the index of the accidents, the value of the density that of roads traffic accident happened to each zone and the amount of data in each year, the value of risk factors based on the severity of the accidents, the value of severity of roads traffic accident events, the value of crash prediction models, the value of the societal cost of each type the accident, and the test result is using the method the SCT, the MCT, and APR.

ACKNOWLEDGEMENTS

This research is supported by Universiti Teknikal Malaysia Melaka, Malaysia and Universitas Dr. Soetomo, Indonesia. It is the development of results of research funded by The Directorate General of Strengthening Research and Development of Research, Technology, and Higher Education Ministry-Indonesia in 2015-2016.

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3) Decision for Review paper MAJOR Revision (28 Maret 2020)

ANIK VEGA V, S.Kom.,MT unitomo <vega@unitomo.ac.id>

[CITEI 2020] Decision for paper 'A Proposed Spatial Analysis Framework for Traffic Accident Prone Roads Classification'

1 pesan

lppi@uad.ac.id <lppi=uad.ac.id@edas.info> 28 Maret 2020 pukul 09.14
Balas Ke: lppi@uad.ac.id
Kepada: Anik Vega Vitianingsih <vega@unitomo.ac.id>
Cc: Hendril Satrian Purnama <Lfriyan220@gmail.com>, TH Sutikno <lppi@uad.ac.id>, Tole Sutikno <thsutikno@ieee.org>, ts@ee.uad.ac.id

==========
URGENT: Your paper requires MAJOR changes for it to be accepted
PLEASE REVISE AND PERFECT YOUR MANUSCRIPT ACCORDING TO PEER-REVIEWERS' AND EDITOR COMMENTS.
It is good to remember that "this status decision" does not guarantee acceptance. Failing to do proper revisions may lead to the rejection of your paper!!
==========
-- Please Strictly use and follow to the template Manuscript:
-- http://bit.ly/template-citei2020 (Word Format)
-- Please upload the revised paper before April 27, 2020
-- to get benefit for Early Registration
==========

Dear Mrs. Anik Vitianingsih,

After careful review, your paper #1570633263 "A Proposed Spatial Analysis Framework for Traffic Accident Prone Roads Classification" for CITEI 2020 requires MAJOR REVISIONS before being accepted for publication. You are asked to submit a revised full manuscript, according to the the comment from reviewers and the guidelines for revisions. The Technical Program Committee (TPC) will check whether the revision already address the reviewers' & Editors' comments and the guidelines. Failing to do proper revisions may lead to the rejection of your paper.

The reviews are below or can be found at https://edas.info/showPaper.php?m=1570633263, using your EDAS login name vega@unitomo.ac.id.

Please submit your revised paper using EDAS on the "Revised Manuscript (After Review)" upload button within 4 weeks.

Thank you for your cooperation.

Best Regards,
Assoc. Prof. Tole Sutikno, Ph.D.
General Chair, CITEI 2020

COMMENTS FROM REVIEWERS:

======= Full paper review 1 =======

> *** Relevance and timeliness: Rate the importance and timeliness of the topic addressed in the paper within its area of research.
Acceptable (3)

> *** Technical content and scientific rigour: Rate the technical content of the paper (e.g.: completeness of the
analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.
Marginal work and simple contribution. Some flaws. (2)

> *** Novelty and originality: Rate the novelty and originality of the ideas or results presented in the paper.
Minor variations on a well investigated subject. (2)

> *** Quality of presentation: Rate the paper organization, the clearness of text and figures, the completeness and accuracy of references.
Substantial revision work is needed. (2)

> *** Strong aspects: Comments to the author: what are the strong aspects of the paper

The author(s) try to propose a spatial analysis framework by using MCDM-ANN method (unfortunately, it is not discussed at all in the content)

> *** Weak aspects: Comments to the author: what are the weak aspects of the paper?

The title, abstract, and content are not coherence, unclear focus of discussion

> *** Recommended changes: Recommended changes. Please indicate any changes that should be made to the paper if accepted.

* There are some grammatical errors, please recheck the paper
* Some of the paragraphs are not well written and the cohesive part of each sentence is not strong enough. This makes it quite difficult to understand the meaning/ intention of the author(s). For example, check the last paragraph in Section 1, the Conclusion section
* Be careful to use the correct abbreviations and check the consistency, for example, Highway Traffic Accident (RTA)?
* Recheck all the Equations' numbering, some equations are not numbered yet
* Check the formulation of Eq.(2), Eq.(4), Eq.(8), Eq.(25)
* Be consistent in using the case sensitive character for Equation! For example, T is not equal to T' in Eq.(2), k is not equal to K for Eq.(3)-(4)
* There are some methods being the focus of the (review) study, such as SAW, WSM, WPM, etc., but not discussed in detail
* After reading this manuscript, I found that the content describes the preliminary results of the study by doing some literature review of related findings. There is no discussion about the proposed framework (using MCDM-ANN) at all, moreover for the results of the proposed framework for the accident prone roads classification as implied in the Abstract. Therefore, the Title and Abstract are not suitable and tend to give the wrong impression for the readers

> *** Submission Policy: Does the paper list the same author(s), title and abstract (minor wording differences in the abstract are ok) in its PDF file and EDAS registration?

Yes, it does

======= Full paper review 2 =======

> *** Relevance and timeliness: Rate the importance and timeliness of the topic addressed in the paper within its area of research.
Good (4)

> *** Technical content and scientific rigour: Rate the technical content of the paper (e.g.: completeness of the
analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.
Marginal work and simple contribution. Some flaws. (2)

> *** Novelty and originality: Rate the novelty and originality of the ideas or results presented in the paper.
Minor variations on a well investigated subject. (2)

> *** Quality of presentation: Rate the paper organization, the clearness of text and figures, the completeness and accuracy of references.
Readable, but revision is needed in some parts. (3)

> *** Strong aspects: Comments to the author: what are the strong aspects of the paper

Paper highlights IOT use for Accident Protections

> *** Weak aspects: Comments to the author: what are the weak aspects of the paper?

No actual work or simulation either. Theoretical contents. Other researcher work summarized.

> *** Recommended changes: Recommended changes. Please indicate any changes that should be made to the paper if accepted.

Actual or min Simulation results expected

> *** Submission Policy: Does the paper list the same author(s), title and abstract (minor wording differences in the abstract are ok) in its PDF file and EDAS registration?

Not checked

======= Full paper review 3 =======

> *** Relevance and timeliness: Rate the importance and timeliness of the topic addressed in the paper within its area of research.
Acceptable (3)

> *** Technical content and scientific rigour: Rate the technical content of the paper (e.g.: completeness of the
analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.
Valid work but limited contribution. (3)

> *** Novelty and originality: Rate the novelty and originality of the ideas or results presented in the paper.
Some interesting ideas and results on a subject well investigated. (3)

> *** Quality of presentation: Rate the paper organization, the clearness of text and figures, the completeness and accuracy of references.
Readable, but revision is needed in some parts. (3)

> *** Strong aspects: Comments to the author: what are the strong aspects of the paper

The proposed idea is addressing the real time problem in daily life.

> *** Weak aspects: Comments to the author: what are the weak aspects of the paper?

The paper is more emphasizing on Literature Survey than the contribution towards the proposed technique/algorithm

> *** Recommended changes: Recommended changes. Please indicate any changes that should be made to the paper if accepted.

1. Future scope has to be included.

2. Some of the Literature is included in the Conclusion (Section 5), which is redundant.

3. Literature Review is included under Results and Analysis(Section 4) that can be part of Section 2.

4. The Research Methodology can be clear and straightforward.

> *** Submission Policy: Does the paper list the same author(s), title and abstract (minor wording differences in the abstract are ok) in its PDF file and EDAS registration?

YES

======= Full paper review 4 =======

> *** Relevance and timeliness: Rate the importance and timeliness of the topic addressed in the paper within its area of research.
Little (2)

> *** Technical content and scientific rigour: Rate the technical content of the paper (e.g.: completeness of the
analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.
Marginal work and simple contribution. Some flaws. (2)

> *** Novelty and originality: Rate the novelty and originality of the ideas or results presented in the paper.
Minor variations on a well investigated subject. (2)

> *** Quality of presentation: Rate the paper organization, the clearness of text and figures, the completeness and accuracy of references.
Substantial revision work is needed. (2)

> *** Strong aspects: Comments to the author: what are the strong aspects of the paper

No strong aspects found.

> *** Weak aspects: Comments to the author: what are the weak aspects of the paper?

Written English.
The description of the mathematical model is unclear.
It is very difficult, if not impossible, to follow the logic of the presentation.

> *** Recommended changes: Recommended changes. Please indicate any changes that should be made to the paper if accepted.

- Written English must be improved.
- The description of the mathematical model is unclear.
- It is very difficult, if not impossible, to follow the logic of the presentation.
- The figures are too small to understand the writing in them.

> *** Submission Policy: Does the paper list the same author(s), title and abstract (minor wording differences in the abstract are ok) in its PDF file and EDAS registration?

Yes

======= Full paper review 5 =======

> *** Relevance and timeliness: Rate the importance and timeliness of the topic addressed in the paper within its area of research.
Good (4)

> *** Technical content and scientific rigour: Rate the technical content of the paper (e.g.: completeness of the
analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.
Valid work but limited contribution. (3)

> *** Novelty and originality: Rate the novelty and originality of the ideas or results presented in the paper.
Some interesting ideas and results on a subject well investigated. (3)

> *** Quality of presentation: Rate the paper organization, the clearness of text and figures, the completeness and accuracy of references.
Readable, but revision is needed in some parts. (3)

> *** Strong aspects: Comments to the author: what are the strong aspects of the paper

content is good.

> *** Weak aspects: Comments to the author: what are the weak aspects of the paper?

the readability is not as good as it oculd be.

there are some similarities with previously published work, e.g.,

"APPLICATION OF A MULTI-CRITERIA APPROACH TO ROAD SAFETY EVALUATION IN THE BUSHEHR PROVINCE, IRAN"

"Road safety analysis using multi criteria approach: A case study in India"

"Identification and Prioritization of(Black Spots)without Using Accident Information"

however, i don't consider this as critical as it is not deeply related just some phrases are identical...

> *** Recommended changes: Recommended changes. Please indicate any changes that should be made to the paper if accepted.

go over each single sentence and think if the sentence is needed and how it could be simplified.

> *** Submission Policy: Does the paper list the same author(s), title and abstract (minor wording differences in the abstract are ok) in its PDF file and EDAS registration?

i don't see the authors in EDAS and it's not a PDF, it's a doc....

======= Full paper review 6 =======

> *** Relevance and timeliness: Rate the importance and timeliness of the topic addressed in the paper within its area of research.
Good (4)

> *** Technical content and scientific rigour: Rate the technical content of the paper (e.g.: completeness of the
analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.
Valid work but limited contribution. (3)

> *** Novelty and originality: Rate the novelty and originality of the ideas or results presented in the paper.
Some interesting ideas and results on a subject well investigated. (3)

> *** Quality of presentation: Rate the paper organization, the clearness of text and figures, the completeness and accuracy of references.
Well written. (4)

> *** Strong aspects: Comments to the author: what are the strong aspects of the paper

The article captured one of the most delicate and important topics related to people's safety in society. Appreciably good efforts are being made to develop a robust model for predicting zones prone to accidents. The information is real and is structured and well organized.

> *** Weak aspects: Comments to the author: what are the weak aspects of the paper?

Even if the article put forward different approaches related to the decision-making of multi-criteria for road safety, but there is no comparative synthetic analysis that builds the fact about individual model performance.
The proposed framework is supplemented by a detailed mathematical model but not tested for precision using real-time data. If tested, the article does not document statistical analysis which emphasizes the usefulness of the framework.
The database information used for performance analyzes, if any, are not included in the report.
I would recommend that the information be based on quantitative research as well because qualitative evaluations are being carried out but that should be accompanied by practical studies.
The conclusions should be more detailed regarding the aspects described in the article text and accompanied by results to ensure the model's acceptance of globules.

> *** Recommended changes: Recommended changes. Please indicate any changes that should be made to the paper if accepted.

I recommend that, with practical research, you analyze the performance of the proposed model and framework against existing state-of-the-art values.

> *** Submission Policy: Does the paper list the same author(s), title and abstract (minor wording differences in the abstract are ok) in its PDF file and EDAS registration?

Does the paper list the same author(s) : YES
Does the paper list the title : YES
Does the paper list the abstract: YES

======= Full paper review 7 =======

> *** Relevance and timeliness: Rate the importance and timeliness of the topic addressed in the paper within its area of research.
Good (4)

> *** Technical content and scientific rigour: Rate the technical content of the paper (e.g.: completeness of the
analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.
Solid work of notable importance. (4)

> *** Novelty and originality: Rate the novelty and originality of the ideas or results presented in the paper.

Significant original work and novel results. (4)

> *** Quality of presentation: Rate the paper organization, the clearness of text and figures, the completeness and accuracy of references.
Well written. (4)

> *** Strong aspects: Comments to the author: what are the strong aspects of the paper

good research
good presentation
need more up to date references

> *** Weak aspects: Comments to the author: what are the weak aspects of the paper?

I don't found any important weak aspects in this research

> *** Recommended changes: Recommended changes. Please indicate any changes that should be made to the paper if accepted.

Good idea but need more up to date references

> *** Submission Policy: Does the paper list the same author(s), title and abstract (minor wording differences in the abstract are ok) in its PDF file and EDAS registration?

no

======= Full paper review 8 =======

> *** Relevance and timeliness: Rate the importance and timeliness of the topic addressed in the paper within its area of research.
Acceptable (3)

> *** Technical content and scientific rigour: Rate the technical content of the paper (e.g.: completeness of the
analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.
Valid work but limited contribution. (3)

> *** Novelty and originality: Rate the novelty and originality of the ideas or results presented in the paper.
Some interesting ideas and results on a subject well investigated. (3)

> *** Quality of presentation: Rate the paper organization, the clearness of text and figures, the completeness and accuracy of references.
Readable, but revision is needed in some parts. (3)

> *** Strong aspects: Comments to the author: what are the strong aspects of the paper

The paper compared among previous frameworks of analysis and proposed the new framework.

> *** Weak aspects: Comments to the author: what are the weak aspects of the paper?

This proposed framework is the adapted version of the previous framework. The paper described theories in section 3, discussed previous frameworks and proposed their own framework in section 4, but there is no detail about their proposed framework:
How these differences from previous frameworks can improve analysis?

Why use the new mathematics model instead of the old model?
...

> *** Recommended changes: Recommended changes. Please indicate any changes that should be made to the paper if accepted.

There are quite some plagiarism from other papers in section 2 and section 3.

> *** Submission Policy: Does the paper list the same author(s), title and abstract (minor wording differences in the abstract are ok) in its PDF file and EDAS registration?

yes

======= Full paper review 9 =======

> *** Relevance and timeliness: Rate the importance and timeliness of the topic addressed in the paper within its area of research.
Little (2)

> *** Technical content and scientific rigour: Rate the technical content of the paper (e.g.: completeness of the
analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.
Marginal work and simple contribution. Some flaws. (2)

> *** Novelty and originality: Rate the novelty and originality of the ideas or results presented in the paper.
Minor variations on a well investigated subject. (2)

> *** Quality of presentation: Rate the paper organization, the clearness of text and figures, the completeness and accuracy of references.
Readable, but revision is needed in some parts. (3)

> *** Strong aspects: Comments to the author: what are the strong aspects of the paper

The authors have conducted a good survey of prior-art on the topic and have discussed main ideas of the existing research work like a white-paper.

> *** Weak aspects: Comments to the author: what are the weak aspects of the paper?

The authors claim to propose a spatial analysis framework for traffic accident-prone road classification using Multi-criteria decision making. But there are no results shown, no alalysis provided and it’s hard to understand what framework they are proposing. The paper is more of a survey without any useful recommendation at the end.

> *** Recommended changes: Recommended changes. Please indicate any changes that should be made to the paper if accepted.

They survey part of the paper is neat. The authors should clearly identify the challenges with each of those problems and then propose a framework that solves all or most of those challenges with some novel way. They should provide a metric to classify a road as dangerous or safe and compare against the ground-truth to show their prediction accuracy.

> *** Submission Policy: Does the paper list the same author(s), title and abstract (minor wording differences in the abstract are ok) in its PDF file and EDAS registration?

yes

======= Full paper review 10 =======

> *** Relevance and timeliness: Rate the importance and timeliness of the topic addressed in the paper within its area of research.
Little (2)

> *** Technical content and scientific rigour: Rate the technical content of the paper (e.g.: completeness of the
analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.
Marginal work and simple contribution. Some flaws. (2)

> *** Novelty and originality: Rate the novelty and originality of the ideas or results presented in the paper.
It has been said many times before. (1)

> *** Quality of presentation: Rate the paper organization, the clearness of text and figures, the completeness and accuracy of references.
Substantial revision work is needed. (2)

> *** Strong aspects: Comments to the author: what are the strong aspects of the paper

Title relevance of the taken research problem

> *** Weak aspects: Comments to the author: what are the weak aspects of the paper?

Abstract of the paper, must describe your flow of work in a professionally organised section wise structure of the full article in a nutshell.
2) Your Review summary of related works cannot be the proposed system framework. The research problem is not exactly defined.
3) the justification of the mathematical models cited in your paper
doesn't have adequate application relevance of the research problem.
4) The is no coherence in the overall research design of this survey paper.

5) The conclusion section must be rewritten .

> *** Recommended changes: Recommended changes. Please indicate any changes that should be made to the paper if accepted.

Revise and resubmit

> *** Submission Policy: Does the paper list the same author(s), title and abstract (minor wording differences in the abstract are ok) in its PDF file and EDAS registration?

yes

COMMENTS FROM EDITORS: GUIDELINES FOR REVISIONS

For ORIGINAL/RESEARCH Paper Type, the paper should be presented with IMRaD model:
1. Introduction (I)
2. The Proposed Method/Algorithm/Procedure specifically designed (optional). Authors may present complex proofs of theorems or non-obvious proofs of correctness of algorithms after introduction section (obvious theorems & straightforward proofs of existing theorems are NOT needed).
3. Method (M)
4. Results and Discussion (RaD)
5. Conclusion.

We will usually expect a minimum of 25 references primarily to journal papers, depending on the length of the paper (number of minimum references = 2n+10, n=page length). Citations of textbooks should be used very rarely and citations to web pages should be avoided. All cited papers should be referenced within the text of the manuscript.

For REVIEW Paper Type, the paper should present a critical and constructive analysis of existing published literature in a field, through summary, classification, analysis and comparison. The function and goal of the review paper is:
1) to organize literature;
2) to evaluate literature;
3) to identify patterns and trends in the literature;
4) to synthesize literature; or
5) to identify research gaps and recommend new research areas.
The structure of a review paper includes:
1. Title – in this case does not indicate that it is a review article.
2. Abstract – includes a description of subjects covered.
3. Introduction includes a description of context (paragraph 1-3), motivation for review (paragraph 4, sentence 1) and defines the focus (paragraph 4, sentences 2-3)
4. Body – structured by headings and subheadings
5. Conclusion – states the implications of the findings and an identifies possible new research fields
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The organizing committee is aware that some participants are now facing travel restrictions and may have to cancel their schedule because of COVID-19. In order to encourage the participation, the conference adopts all available social media methods, such as online/video presentation, etc, except the regular presentation style (oral). Meanwhile, considering the safety of all participants, the organizer will provide mask, hand sanitizer, and other measures will also be taken during the conference to maintain a safe idea exchange environment.
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Spatial Analysis Model For Traffic Accident-Prone Roads Classification: A Proposed Framework

Anik Vega Vitianingsih[1], Nanna Suryana[2], and Zahriah Othman[3]
[1]Informatics Departments, Universitas Dr. Soetomo, Surabaya, Indonesia
[1, 2,3]Faculty of Information and Communication Technology, Universiti Teknikal Malaysia Melaka, Melaka, Malaysia

Article Info

Article history:

Received Jun 1, 2018
Revised Jul 10, 2018
Accepted Jul 25, 2018

Keywords:

GIS software engineering
Spatial analysis model
Proposed framework
Hybrid estimation model-based
MCDM-ANNs
Traffic accident-prone roads

ABSTRACT

The classification method in the spatial analysis modeling based on the multi-criteria parameter is currently widely used for the management of Geographic Information Systems (GIS) software engineering. The accuracy of the proposed model will be an essential role for the successful software development of GIS, and this is related to the nature of GIS used for mapping through spatial analysis. This paper aims to propose a framework of spatial analysis using a hybrid estimation model-based on a combination of Multi-criteria decision making (MCDM) and Artificial neural networks (ANNs) (MCDM-ANNs) classification. The model in the proposed framework will be used for future work on the traffic accident-prone road classification through testing with a private or public spatial dataset. Model validation testing on the proposed framework uses metaheuristic optimization techniques. The proposed framework is based on the comparison of existing frameworks through the concept of a literature review. Policymakers can use the results of the model on the proposed framework for initial planning developing GIS software engineering through spatial analysis models.

Corresponding Author:

Anik Vega Vitianingsih,
Informatics Departments,
Universitas Dr. Soetomo, Surabaya, Indonesia,
Jalan Semolowaru 84 Surabaya, 60118.
Email: vega@unitomo.ac.id

1. INTRODUCTION

Model accuracy prediction in the development of frameworks on GIS software be the first step in efforts to improve the quality of GIS software developed, this is part of quality control and quality assurance (Albrecht, College, York, & States, 2018). Quality control will determine the method of spatial analysis to test quality standards (Albrecht et al., 2018). A spatial analysis modeling is a process to build an Artificial Intelligence (AI) model that is combined with trials on spatial datasets (Banerjee & Ray, 2018), gathering spatial knowledge through spatial datasets and providing knowledge of models in the framework through AI methods from various sources. The purpose of the spatial analysis model is to make a description of the GIS software that will be developed, conduct simulations to test spatial datasets through models on the AI method used on the proposed framework that has already been described.

Spatial datasets in GIS relate to how primary and secondary data are obtained through the collection process, and then how the data is processed through spatial analysis to be information in the decision support system (Brassel & Weibel, 1988). Visualization of spatial data can be done with Cloud-terminal Integration GIS to provide convenience in the process of spatial analysis on a large number of spatial datasets (Wang, Zhong, & Wang, 2019), aggregation-based spatial datasets information retrieval system (Lacasta, Lopez-Pellicer, Espejo-García, Nogueras-Iso, & Zarazaga-Soria, 2017). Spatial datasets as the key to the value of big data in spatial data mining (SDM) that refers to the description of attribute data requirements, how the data is obtained, and what AI method is used to perform spatial analysis of the data (D. Li, Wang, Yuan, & Li, 2016)(Wang et al., 2019). Spatial datasets become the basic structure in GIS for the process of spatial analysis algorithms, analyzing algorithm principles, or adapting existing algorithms (Zhao, Chen, Ranjan,

Choo, & He, 2016). The classification model in machine learning is very popular (Hordri, Samar, Yuhaniz, & Shamsuddin, 2017) to be used research in the field of spatial analysis of GIS. However, there is no concrete statement regarding which classification algorithm is best to use with certainty because the accuracy, precision, and recall (APR) tests in each study use different sample data. It is also based on the field of study, which is always different on the object of research conducted.

Previous research proposed a framework using the CART model (Classification and Regression Trees), which reported a 10-fold increase in the best value for crash severity prediction (Effati & Sadeghi-Niaraki, 2015). However, the CART model has a weakness in the number of training data samples, because changes in training and testing data samples affect the results of spatial analysis (Raihan, Hossain, & Hasan, 2018). Spatial analysis model using data mining decision tree (J48, ID3, and CART) and Naïve Bayes classifiers (Bahiru, Kumar Singh, & Tessfaw, 2018) States that the accuracy value of 96.30% on the J48 method is higher than ID3, CART, and Naïve Bayes, where the Naïve Bayes have better performance even though the accuracy value is small. Different studies suggest that the accuracy of prediction of classification models with the Decision Tree Approach to reach 84.1% (Zheng, Lu, & Tolliver, 2016). (Lee, Lin, Gill, & Cheng, 2018) also, suggest that the Enhanced Empirical Bayesian (EB) method is a spatial analysis approach that is preferred for prediction of the number of accidents in road segments. Maximizes the accuracy value of the model for Geo-spatial data using the adaptive k-Nearest Neighbor (kNN) classifier, i.e., by dynamically selecting *k* for each instance the value being classified reaches a ROC AUC score of 0,9. The fuzzy deep-learning approach model is used to reduce the uncertainty of data in the prediction of traffic flows that affect road traffic accident rates (W. Chen et al., 2018). Convolutional Long Short-Term Memory (ConvLSTM) neural network model (Kibanov et al., 2018) states that the proposed framework is sufficiently accurate and significant to improve accuracy in traffic accident prediction for heterogeneous data. The road accident classification model using random forests and boosted trees works equally well with an average value of 80% accuracy and a sensitivity value of 50% (Schlögl, 2020).

The discussion in this paper emphasizes the comparison in modeling spatial analysis using classification methods for hybrid models through the proposed framework. The general contribution of this proposed framework will be used for future work is integrated through the GIS-platform for the safe management and risk assessment (W. Li & Wang, 2017)(Repetto et al., 2018) of traffic accident prone roads classification, to analyze multi-criteria parameters that influence the results on the traffic accident-prone road classification, to purpose new parameters of spatial datasets, to enhance a framework of spatial analysis using a hybrid estimation model-based on a combination of MCDM-ANNs, and to evaluate the enhancement of the new model through the hybrid. Model evaluation needs to be done to provide best practices for the resulting model (Gong, Wang, Brenda, & Dent, 2020). Model performance assessment is influenced by balanced data to describe the quality of the resulting model, so as not to lead to misleading conclusions (Schlögl, 2020). The proposed framework of classification models with MCDM-ANNs hybrid to the implementation of prone-roads traffic accident classification and its differences with existing frameworks are presented of classification models. The selection of a model-based hybrid estimation on a combination of MCDM-ANNs classification in this proposed framework study is based on a literature review study (Paper Pre-proof) [Anik Vega Vitianingsih, Nanna Suryana, Zahriah Othman-Spatial Analysis to Traffic Accident Prone Roads Classification: A Systematic Literature Review]. The collection of dataset multi-criteria parameter for prone-roads traffic accident classification which has been used in the paper articles obtained to evaluate the proposed framework of classification models, explains also the validation and evaluation techniques of the proposed model. Modeling of Group Analytic Hierarchy Process (GAHP) technique to develop weighting technique on multi-parameter criteria applied to MCDM Methods which still use are a human assumption in weighting, proving through the sensitivity and stability test of GAHP technique modeling to MCDM Methods by comparing the weight was given the human by manual assumption.

Multi-criteria decision making (MCDM) methods are used in this study to process the determinant parameter data in the classification of accident-prone areas that include road conditions, traffic volume, accident rate (Tibor Sipos, 2017) (Vitianingsih & Cahyono, 2016), assign weighting values to each factor based on literature and surveys to expert sources (Al-Ruzouq et al., 2019). From the classification of the accident-prone areas, it becomes important to provide recommendations to the road auditor to conduct a traffic safety audit to obtain assessment criteria, implementation expenses, the number of involved traffic participants, the effect of road safety, protective effect and social factors presenting difficulties (Török, 2016). The traffic safety audit is carried out by the administration of the road auditor by conducting a feasibility study of the network of accident-prone road categories (Huvarinen, Svatkova, Oleshchenko, & Pushchina, 2017). MCDM methods have been used for analysis with Simple Additive Weight (SAW), Analytical Hierarchy Process (AHP) and Fuzzy AHP method, used for Road Safety Analysis (RSA) that can help decisions process in n determining the priority of road management and provide mitigating actions against the most vulnerable to accidents (Kanuganti et al., 2017). The MCDM method with Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method is used in the management of road safety,

and road safety is one of the factors to reduce the number of traffic accidents by knowing the position of a road safety study in Bushehr province Bushehr-Borazjan roads and Borazjan-Genaveh based on various quantitative and qualitative criteria (Fatemeh Haghighat, 2011). The MCDM model is one of the right approach models to deal with the problem of Accident-prone road section (APRS) because it uses several road and environmental criteria both quantitative or qualitative, MCDM is related to the results of decision making for planning that involves stakeholders (Yakar, 2019).

A framework to be proposed through the process of a literature review from several studies that have been done before. This proses to evaluate the benefits of research that has been done, to know the limitations of the method used, to identify research gaps that have been conducted, and to advice development for further research to get the right framework in the research the new (Kitchenham & Charters, 2007). The research questions in research are intended to focus on the subject area of the study, by identifying and classifying the spatial analysis framework for accident-prone traffic roads to be done (Vierhauser, Rabiser, & Grünbacher, 2016).

2. RESEARCH METHOD

The spatial analysis model using MCDM is a multi-criteria spatial decision support system (MC-SDSS) developed in the field of GIS technology by integrating MCDM as a method to determine the best alternative from the many alternative choices available based on the spatial datasets described (Ghavami, 2019). ANNs classification is a Data Mining technique in machine learning, mapping various attributes as input layer in a node, adding the hidden layer, which is then used to get the threshold to the non-linear output layer (Sang & Aitkenhead, 2020). The state-of-the-art method from the literature review within the primary study displayed in Table 1.

Table 1. A Framework Literature Review

Framework	Model & Method	Spatial Datasets	Results
(Dereli & Erdogan, 2017)	Model-based spatial statistical methods: Poisson regression, Negative Binomial regression, Empirical Bayesian.	The accidents, injuries, and deaths by years	In this study comparing all methods used, where Empirical Bayes has the best accuracy and consistency, recommended by the Highway Safety Manual (HSM) and the European Union Acquis
(Shafabakhsh, Famili, & Bahadori, 2017)	Model-based spatial statistical methods: Kernel density analysis, Nearest neighbor, K-function	Intercity accidents, accidents leading to injury, accidents leading to death, and accidents leading to damages	The observed value curve on the spatial analysis process, the value of spatial datasets is above the 5% confidence interval
(Shariff, Maad, Halim, & Derasit, 2018)	Spatial analysis techniques: Nearest Neighborhood Hierarchical (NNH) Clustering, Spatial-Temporal Clustering Analysis (STAC)	Road accidents involving all types of vehicles	The results of the spatial analysis vary according to the parameter values in the spatial datasets, where is STAC has a 461,57 higher Prediction Accuracy Index (PAI) compared to NNH 163,69.
(Behbahani & Mohamadian, 2018)	ANNs techniques: Extreme learning machine (ELM), Probabilistic neural network (PNN), Radial basis function (RBF), and Multilayer perceptron (MLP).	V/C, speed, vehicle kilometer traveled (VKT), roadway width, the existence of median, and allowable/not-allowable parking	Evaluation method using Nash – Sutcliffe (NS), mean absolute error (MAE), and root mean square error (RMSE). ELM, as a feed-forward neural network, becomes the algorithm that has the best performance and the most accurate prediction results (RMSE=3,576;NS=0,81;MAE=2,5062) by randomly selecting hidden nodes using random weights.
(Colak, Memisoglu, Erbas, & Bediroglu, 2018)	Hot spot analysis (Getis-Ord Gi*): Network spatial weights, Kernel Density method	The traffic accident)	Hotspot analysis gives better results because it is done by considering the weight of spatial datasets
(Fan, Liu, Cai, & Yue, 2019)	The support vector machine combines the techniques of statistical learning, machine learning, the neural networks based: Support vector machine, Deep neural network	Accident, person, vehicle, road, and environment data	They proposed a real-time online deep learning framework Based on traffic accident black spots. SVM algorithm in machine learning has 63% precision and a 61% recall rate in the analysis of the black spots of traffic accidents. If the training data period is added, the SVM and deep neural network values increase by 95% and 89% accuracy, 69%, and 79% recall rates.
(Ghadi & Török, 2019)	Black spot identification (BSID) method and Segmentation method: Empirical Bayesian (EB), Excess Empirical Bayesian (EEB), Accident Frequency (AF), Accident Rate (AR).	The traffic accident	AF method has the best performance with a consistency of 93.1% compared to EB 92.2%, and EEB 77.4%. The performance of the EEB and AR methods is the weakest in the case of segmentation in most cases of segmentation.

Framework	Model & Method	Spatial Datasets	Results
(Rahman, Abdel-Aty, Hasan, & Cai, 2019)	Machine learning techniques to prediction model: Decision tree regression (DTR) methods Regression tree framework, Ensemble techniques. Model assessment: Average Squared Error (ASE), Standard Deviation of Error (SDE)	Statewide Traffic Analysis Zone (STAZ)	The DTR model to prediction accuracy works better than the spatial DTR model. To improve prediction accuracy using ensemble techniques (bagging, random forest, and gradient boosting) with slightly better results, depending on the amount of training data.
(Yakar, 2019)	Multicriteria decision making (MCDM) model: Weighted linear combination (WLC) method	The traffic accident Reports	The model was developed to determine the criteria weights that have been determined by experts with interest in subjective results.
(Singh, Pal, Yadav, & Singla, 2020)	Prediction model: Deep neural network model, Gene expression programming (GEP), Random effect negative binomial (RENB) models, Regular negative binomial model (FENB)	The road geometry, traffic, and road environment)	The DNN model experienced an increase in road prediction with 0.914 (RMSE = 7.474) by GEP, and 0.891 (RMSE = 8.862). GEP works better than RENB to measure the ranking of variables that influence accidents.
(Schlögl, 2020)	Random effects negative binomial model: Hierarchical cluster method	Real time-frequency of accident data and contributing factors	The model developed can provide information on the main causes of accidents at road intersections

The literature review is in Table 1. The research (Dereli & Erdogan, 2017) not shown the comparison of the accuracy and consistency of each method used with the confusion matrix. The meaning of Empirical Bayes has the best accuracy and consistency value that is not really visible. Standard Deviation of the data distribution value in the sample data is only used to calculate the disaster-prone traffic accident rate, and there is no proof of the truth of the model used (Shafabakhsh et al., 2017). Discussion (Behbahani & Mohamadian, 2018) is still limited to the use of an existing method, and knowledge combination has not been done as a hybrid model approach. The results of the comparison of the two methods are stated to be more accurate, but no precise accuracy value is given based on the value of the confusion matrix (Colak et al., 2018). On research (Shariff et al., 2018) have not considered the type of road type design, for example, arterial roads, collector roads, or roads based on their nature (geometric road). (Fan et al., 2019) there are no studies on adaptive models that can expand machine learning through a combination of online learning and deep learning. Paper discussion (Ghadi & Török, 2019) still limited to the use of an existing method; knowledge combination has not been done as a hybrid model approach. The DTR model in conducting the prediction accuracy in this study is still a macro-level crash count (Rahman et al., 2019). The model has weaknesses in terms of data simulation because it requires accident data at the beginning of the calculation (Yakar, 2019). Mathematical modeling in the comparison algorithm does not exist, so the comparison of results is difficult (Singh et al., 2020). (Schlögl, 2020) there is no evaluation of the models offered, because the test data collected does not have a long-time span. MLP is more accurate for available spatial datasets but becomes very vulnerable when there is data noise that can cause errors in predictions (Behbahani & Mohamadian, 2018). PNN has probabilistic outputs with multilayer perceptron networks, producing fairly accurate predictions (Behbahani & Mohamadian, 2018). RBF is very weak in making predictions (Behbahani & Mohamadian, 2018). VKT parameters proved to be the most influential in the occurrence of road traffic accidents, then the V / C variable and driver speed based on the RReliefF algorithm calculation method (Behbahani & Mohamadian, 2018). The evaluation to perform the method, The site consistency test (SCT), The method consistency test (MCT), The total rank differences test (TRDT), and The total score test (TST) (Ghadi & Török, 2019)

3. RESULTS AND DISCUSSION

The proposed framework is based on a literature study by comparing the existing framework to determine the performance of the spatial analysis model offered for Traffic Accident Prone Roads in Table 1 and the MCDM-based framework (Rosić et al., 2017), (Ait-Mlouk, Agouti and Gharnati, 2017) (Pilko, Mandžuka, & Barić, 2017)(Yakar, 2019). The framework being compared includes the method used for primary study (PS) spatial analysis for accident-prone traffic roads, the spatial analysis model used, spatial datasets used to test the model through method selection, and the value of the measurement results through the assessment.

The framework that has been developed by previous researchers will be described in this section. The framework model (Pilko et al., 2017), was developed to create the Maycock and Hall's accident prediction model, this model provides sensitivity analysis on modeling results using multi-objective

optimization (MOO) using multi-criteria decision making for the analytical hierarchy process (AHP model). The needs primary spatial data sets in the road geometry category, the necessity secondary spatial, i.e., the numbers and types of traffic accidents, traffic and demand for structural flow, visual distance and vehicle speed, road signs, and equipment, lighting, driver behavior. The value of the multi-criteria parameters obtained will be done mathematic spatial data modeling to produce the sensitivity of spatial analysis, the results of multi-criteria optimization in the form of traffic efficiency (TS), and traffic safety (TS) to the predicted traffic accident. MOO model is measured using a consistency index (CI) and consistency ratio (CR), the model is proven to have a good structure with a value of CR <= 10 or the CR value is 0.00298, this shows that the MOO model with MCDM on the AHP model has a consistent value the good one.

The (Rosić, Pešić, Kukić, Antić, & Božović, 2017) framework, was developed by the PROMETREE-RS MCDM model. MCDM is used because it can use more than one parameter to get the best results from the alternatives produced. This model was developed to evaluate the DEA and TOPSIS methods in road safety to reduce risk the number of accidents on the road through the road safety index. The model is tested by using the Robustness of the composite index. The average correlation value, the average rank value, and the cluster variation average values will be entered into the MCDM PROMETHEE-RS to test the resulting model. Multi-criteria parameters tested in this model, i.e., the Police Department data, fatalities, serious injuries, number of inhabitants, number of registered vehicles, traffic risk, and public risk. This parameter will be used to mathematic spatial data modeling through DEA and TOPSIS, the produce optimal composite index through the value of final risk efficiency. DEA-WR provides the best ranking results compared to the DEA-based Composite Indicator model (DEA-CI).

The (Ait-Mlouk, Gharnati, & Agouti, 2017)(Ait-Mlouk, Agouti, & Gharnati, 2017) framework is a model built using MCDM, the purpose of this model is to create a knowledge data mining rule decision tree through FP-growth and Apache Spark framework. A trial model on road accident analysis, where the results have a high degree of accuracy and work well to improve road safety. The multi-parameter criteria used are the road accident data between 2004-2014 to death and injuries attribute. The testing model for the relevant association rule is done by testing and validation by measuring quality measurement. MCDM model involves many criteria, so it is suitable to overcome the problem of Accident-prone road section (APRS) on the type of horizontal alignment, vertical alignment, intersections, significant places, and shoulder widths with an accuracy value of 0.8830 for threshold values 1 (Yakar, 2019).

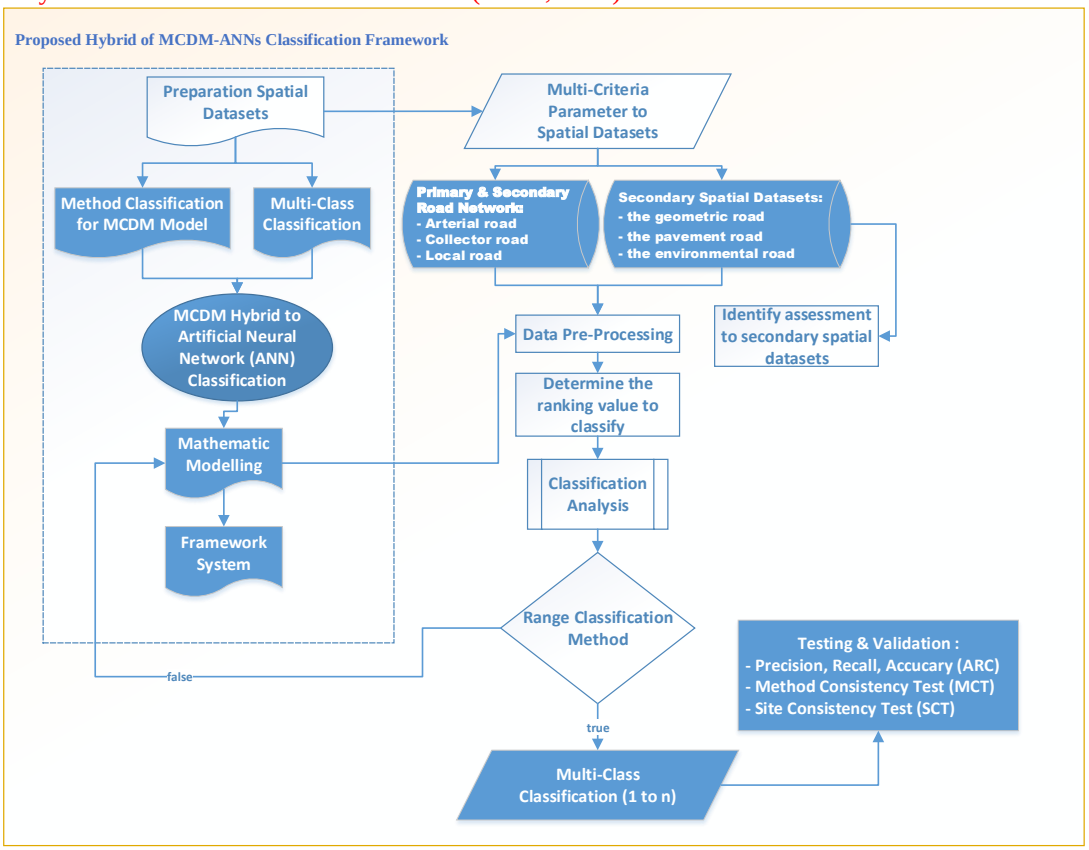

Figure 4. Proposed Hybrid of MCDM-ANNs Classification Framework to Evaluate and Rank Spatial Analysis Model Traffic Accident Prone Roads

The proposed framework in previous research will be used by the author as a reference in developing further activities of the framework that will be proposed. The framework of the research proposed

in Figure 4 has the main differences from the existing framework. Prepare data requirements for spatial datasets as primary and secondary spatial datasets in determining the road categories to be studied (using a private or public spatial dataset type). Perform a literature study relating to multi-criteria parameters used on each road category. Mathematics modeling for spatial analysis to the proposed framework for hybrid estimation model-based on a combination of MCDM-ANNs multi-class classification. In this case, the pre-processing data process will run for the classification analysis process. The range of classification will be performed through mathematical modeling using the Guttman method. The results of the multi-class classification will be validated with SCT, MCT, ARC validation. Focuses on the propose a classification of roads prone to accidents using multiple criteria parameters (data series), make a modeling of road prone to accidents by calculating the value of traffic accident by type of events and the index of the accidents, the density that of roads traffic accident happened to each zone and the amount of data in each year, risk factors based on the severity of the accidents, severity of roads traffic accident events, crash prediction models using data series, and the value of the societal cost of each type the accident. The ANN strategy has the most noteworthy rating of strategies that are regularly utilized in the literature review in essential considers. The empirical Bayes method and decision tree in data mining are also broadly utilized within the clustering category in spatial information modeling of accident-prone zones. This considers A proposed framework of classification used a hybrid estimation model based on a combination of MCDM-ANN classification. Test the consistency of the method from the model produced with the MCT, the value of Precision-Recall Accuracy (ARC), and SCT.

4. CONCLUSION

The proposed framework in this study will act as a model-based hybrid estimation approach on a combination of MCDM-ANNs classification to strengthen data mining techniques in spatial multi-criteria analysis in multi-class classification decision making. In the Literature review on the primary study, there are no research topics that discuss on the traffic accident-prone roads classification on the arterial road, collector road, and type of road based on its nature (pavement, geometry, and local road) categories. The Spatial Analysis Model using MCDM among others Analytic Hierarchy Process (AHP), Analytical Network Process (ANP), Weighted Sum Model (WSM), Weighted Product (WP), Weight Product Model (WPM), Simple Additive Weighting (SAW), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), Preference Ranking Organization Method for Enrichment of Evaluations (PROMETHEE), Multi-attribute utility theory (MAUT), Elimination and Choice Expressing Reality (ELECTRE), and Multi-criteria optimation and compromise solution (VIKOR). ANNs classification methods are the most popular data mining techniques in the field spatial analysis of accident-prone roads and the factors that affect the accident rate, among others (Neural networks, Extreme learning machines, K-nearest neighbors, Naive Bayes, Decision trees) (Rovšek, Batista, & Bogunović, 2017) (Sang & Aitkenhead, 2020). The results of the best methods through APR measurement will be a reference in decision making in road management. Existing research is still limited to one type of road used as an object (specific region), and 96 % is used Private Spatial Datasets. In this study, it was using an Inductive Qualitative Approach in the modeling of road prone to accidents to identify the findings of science that is done during the research process. The proposed a classification of roads prone to accidents using multiple criteria parameters, make modeling of road prone to accidents calculating by the value of traffic accident by type of events and the index of the accidents, the value of the density that of roads traffic accident happened to each zone and the amount of data in each year, the value of risk factors based on the severity of the accidents, the value of severity of roads traffic accident events, the value of crash prediction models, the value of the societal cost of each type the accident, and the test result is using the method site consistency test (SCT), the method consistency test (MCT), and precision-recall accuracy (APR).

ACKNOWLEDGEMENTS

This research is supported by Universiti Teknikal Malaysia Melaka-Malaysia and Universitas Dr. Soetomo-Indonesia. It is the development of results of research funded by The Directorate General of Strengthening Research and Development of Research, Technology, and Higher Education Ministry-Indonesia.

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4) Notification for paper camera ready (28 April 2020)

Unitomo Mail

ANIK VEGA V, S.Kom.,MT unitomo <vega@unitomo.ac.id>

[CITEI 2020] Notification for paper #1570633263 ('Spatial Analysis Model for Traffic Accident-Prone Roads Classification: A Proposed Framework')

3 pesan

lppi@uad.ac.id <lppi=uad.ac.id@edas.info> 28 April 2020 pukul 15.43
Balas Ke: lppi@uad.ac.id
Kepada: Anik Vega Vitianingsih <vega@unitomo.ac.id>

ANNOUNCEMENT!! The organizing committee is aware that almost all participants are now facing travel restrictions and may have to cancel their schedule because of COVID-19.

Submit your camera ready paper strictly adhere the guide of authors (http://bit.ly/template-citei2020) before May 25, 2020. AUTHOR IS ENOUGH to PAY JOURNAL PUBLICATION FEE only, WITHOUT CONFERENCE FEE. We hope you to use the time optimally to ensure that your final paper perfectly and strictly adhere the guide of authors and consider carefully the reviewers/editor's comments. Failing to do proper preparing final paper may lead to the rejection of your paper.

Dear Mrs. ,

It is my great pleasure to inform you that your paper entitled #1570633263 ('Spatial Analysis Model for Traffic Accident-Prone Roads Classification: A Proposed Framework') for 2020 1st Conference on Internet of Things and Embedded Intelligence (CITEI 2020) has been **ACCEPTED** for the CITEI 2020, which is planned to be held in Yogyakarta, Indonesia, between July 29th and 30th, 2020. Congratulations!!

Due to Coronavirus (COVID-19) in many countries, CITEI committee have make a decision that your attending for direct **oral presentation is not required**. We hope that we can attend and meet for discussion by oral presentation in future event (in the 2nd CITEI 2021). However, you should prepare a video presentation for your paper, and upload it to YouTube (or other sites), and inform us your video link (to email: lppi@uad.ac.id, cc: esperg@ee.uad.ac.id). State in your video that it is your presentation for "2020 1st Conference on Internet of Things and Embedded Intelligence (CITEI 2020)".

Then, your paper will be selected for possible publication in one of the Scopus indexed journals below (further review and minor revisions may be required):

- Indonesian Journal of Electrical Engineering and Computer Science (IJEECS)
- IAES International Journal of Artificial Intelligence (IJ-AI)
- International Journal of Evaluation and Research in Education (IJERE)

It is obvious that this is a special case and it is the reason that you MUST prepare your FINAL PAPER seriously to fullfil as a Scopus indexed journal article standard (NOT ONLY as a conference paper).

Just for your information, we received many paper submissions, which are all peer-reviewed by vetted PC members and only high quality papers will be published. Please address the reviewers comments, appended below, and submit your camera ready paper adhere the guide of authors (http://bit.ly/template-citei2020) before May 25, 2020. The goal of your camera ready paper is to describe NOVEL TECHNICAL RESULTS. We will usually expect a minimum of 25 and 50 references (primarily to journal papers) for research/original and review paper respectively. Citations of textbooks should be used very rarely and citations to web pages should be avoided. All cited papers should be referenced within the body text of the manuscript. Failing to do proper preparing camera ready paper may lead to the rejection of your paper (If authors have paid publication fee, even we will return it).

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I look forward to hearing form you

Best Regards,
Assoc. Prof. Tole Sutikno, Ph.D.
General Chair, CITEI 2020 Editor-in-Chief/Managing Editor/Principle Contact:

- Indonesian Journal of Electrical Engineering and Computer Science (Scopus indexed journal)
- IAES International Journal of Artificial Intelligence (Scopus indexed journal)

The reviews are below or can be found at https://edas.info/showPaper.php?m=1570633263.

Full paper review 1

Relevance and timeliness: Rate the importance and timeliness of the topic addressed in the paper within its area of research.

Acceptable (3)

Technical content and scientific rigour: Rate the technical content of the paper (e.g.: completeness of the analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.

Marginal work and simple contribution. Some flaws. (2)

Novelty and originality: Rate the novelty and originality of the ideas or results presented in the paper.

Minor variations on a well investigated subject. (2)

Quality of presentation: Rate the paper organization, the clearness of text and figures, the completeness and accuracy of references.

Substantial revision work is needed. (2)

Strong aspects: Comments to the author: what are the strong aspects of the paper

The author(s) try to propose a spatial analysis framework by using MCDM-ANN method (unfortunately, it is not discussed at all in the content)

Weak aspects: Comments to the author: what are the weak aspects of the paper?

The title, abstract, and content are not coherence, unclear focus of discussion

Recommended changes: Recommended changes. Please indicate any changes that should be made to the paper if accepted.

- There are some grammatical errors, please recheck the paper
- Some of the paragraphs are not well written and the cohesive part of each sentence is not strong enough. This makes it quite difficult to understand the meaning/ intention of the author(s). For example, check the last paragraph in Section 1, the Conclusion section
- Be careful to use the correct abbreviations and check the consistency, for example, Highway Traffic Accident (RTA)?
- Recheck all the Equations' numbering, some equations are not numbered yet
- Check the formulation of Eq.(2), Eq.(4), Eq.(8), Eq.(25)
- Be consistent in using the case sensitive character for Equation! For example, T is not equal to T' in Eq.(2), k is not equal to K for Eq.(3)-(4)
- There are some methods being the focus of the (review) study, such as SAW, WSM, WPM, etc., but not discussed in detail
- After reading this manuscript, I found that the content describes the preliminary results of the study by doing some literature review of related findings. There is no discussion about the proposed framework (using MCDM-ANN) at all, moreover for the results of the proposed framework for the accident prone roads classification as implied in the Abstract. Therefore, the Title and Abstract are not suitable and tend to give the wrong impression for the readers

Submission Policy: Does the paper list the same author(s), title and abstract (minor wording differences in the abstract are ok) in its PDF file and EDAS registration?

Yes, it does

Full paper review 2

Relevance and timeliness: Rate the importance and timeliness of the topic addressed in the paper within its area of research.

Good (4)

Technical content and scientific rigour: Rate the technical content of the paper (e.g.: completeness of the analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.

Marginal work and simple contribution. Some flaws. (2)

Novelty and originality: Rate the novelty and originality of the ideas or results presented in the paper.

Minor variations on a well investigated subject. (2)

Quality of presentation: Rate the paper organization, the clearness of text and figures, the completeness and accuracy of references.

Readable, but revision is needed in some parts. (3)

Strong aspects: Comments to the author: what are the strong aspects of the paper

Paper highlights IOT use for Accident Protections

Weak aspects: Comments to the author: what are the weak aspects of the paper?

No actual work or simulation either. Theoretical contents. Other researcher work summarized.

Recommended changes: Recommended changes. Please indicate any changes that should be made to the paper if accepted.

Actual or min Simulation results expected

Submission Policy: Does the paper list the same author(s), title and abstract (minor wording differences in the abstract are ok) in its PDF file and EDAS registration?

Not checked

Full paper review 3

Relevance and timeliness: Rate the importance and timeliness of the topic addressed in the paper within its area of research.

Acceptable (3)

Technical content and scientific rigour: Rate the technical content of the paper (e.g.: completeness of the analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.

Valid work but limited contribution. (3)

Novelty and originality: Rate the novelty and originality of the ideas or results presented in the paper.

Some interesting ideas and results on a subject well investigated. (3)

Quality of presentation: Rate the paper organization, the clearness of text and figures, the completeness and accuracy of references.

Readable, but revision is needed in some parts. (3)

Strong aspects: Comments to the author: what are the strong aspects of the paper

The proposed idea is addressing the real time problem in daily life.

Weak aspects: Comments to the author: what are the weak aspects of the paper?

The paper is more emphasizing on Literature Survey than the contribution towards the proposed technique/algorithm

Recommended changes: Recommended changes. Please indicate any changes that should be made to the paper if accepted.

1. Future scope has to be included.
2. Some of the Literature is included in the Conclusion (Section 5), which is redundant.
3. Literature Review is included under Results and Analysis(Section 4) that can be part of Section 2.
4. The Research Methodology can be clear and straightforward.

Submission Policy: Does the paper list the same author(s), title and abstract (minor wording differences in the abstract are ok) in its PDF file and EDAS registration?

YES

Full paper review 4

Relevance and timeliness: Rate the importance and timeliness of the topic addressed in the paper within its area of research.

Little (2)

Technical content and scientific rigour: Rate the technical content of the paper (e.g.: completeness of the analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.

Marginal work and simple contribution. Some flaws. (2)

Novelty and originality: Rate the novelty and originality of the ideas or results presented in the paper.

Minor variations on a well investigated subject. (2)

Quality of presentation: Rate the paper organization, the clearness of text and figures, the completeness and accuracy of references.

Substantial revision work is needed. (2)

Strong aspects: Comments to the author: what are the strong aspects of the paper

No strong aspects found.

Weak aspects: Comments to the author: what are the weak aspects of the paper?

Written English. The description of the mathematical model is unclear. It is very difficult, if not impossible, to follow the logic of the presentation.

Recommended changes: Recommended changes. Please indicate any changes that should be made to the paper if accepted.

- Written English must be improved.
- The description of the mathematical model is unclear.
- It is very difficult, if not impossible, to follow the logic of the presentation.
- The figures are too small to understand the writing in them.

Submission Policy: Does the paper list the same author(s), title and abstract (minor wording differences in the abstract are ok) in its PDF file and EDAS registration?

Yes

Full paper review 5

Relevance and timeliness: Rate the importance and timeliness of the topic addressed in the paper within its area of research.

Good (4)

Technical content and scientific rigour: Rate the technical content of the paper (e.g.: completeness of the analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.

Valid work but limited contribution. (3)

Novelty and originality: Rate the novelty and originality of the ideas or results presented in the paper.

Some interesting ideas and results on a subject well investigated. (3)

Quality of presentation: Rate the paper organization, the clearness of text and figures, the completeness and accuracy of references.

Readable, but revision is needed in some parts. (3)

Strong aspects: Comments to the author: what are the strong aspects of the paper

content is good.

Weak aspects: Comments to the author: what are the weak aspects of the paper?

the readability is not as good as it oculd be.

there are some similarities with previously published work, e.g.,

"APPLICATION OF A MULTI-CRITERIA APPROACH TO ROAD SAFETY EVALUATION IN THE BUSHEHR PROVINCE, IRAN"

"Road safety analysis using multi criteria approach: A case study in India"

"Identification and Prioritization of(Black Spots)without Using Accident Information"

however, i don't consider this as critical as it is not deeply related just some phrases are identical...

Recommended changes: Recommended changes. Please indicate any changes that should be made to the paper if accepted.

go over each single sentence and think if the sentence is needed and how it could be simplified.

Submission Policy: Does the paper list the same author(s), title and abstract (minor wording differences in the abstract are ok) in its PDF file and EDAS registration?

i don't see the authors in EDAS and it's not a PDF, it's a doc....

Full paper review 6

Relevance and timeliness: Rate the importance and timeliness of the topic addressed in the paper within its area of research.

Good (4)

Technical content and scientific rigour: Rate the technical content of the paper (e.g.: completeness of the analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.

Valid work but limited contribution. (3)

Novelty and originality: Rate the novelty and originality of the ideas or results presented in the paper.

Some interesting ideas and results on a subject well investigated. (3)

Quality of presentation: Rate the paper organization, the clearness of text and figures, the completeness and accuracy of references.

Well written. (4)

Strong aspects: Comments to the author: what are the strong aspects of the paper

The article captured one of the most delicate and important topics related to people's safety in society. Appreciably good efforts are being made to develop a robust model for predicting zones prone to accidents. The information is real and is structured and well organized.

Weak aspects: Comments to the author: what are the weak aspects of the paper?

Even if the article put forward different approaches related to the decision-making of multi-criteria for road safety, but there is no comparative synthetic analysis that builds the fact about individual model performance. The proposed framework is supplemented by a detailed mathematical model but not tested for precision using real-time data. If

tested, the article does not document statistical analysis which emphasizes the usefulness of the framework. The database information used for performance analyzes, if any, are not included in the report. I would recommend that the information be based on quantitative research as well because qualitative evaluations are being carried out but that should be accompanied by practical studies. The conclusions should be more detailed regarding the aspects described in the article text and accompanied by results to ensure the model's acceptance of globules.

Recommended changes: Recommended changes. Please indicate any changes that should be made to the paper if accepted.

I recommend that, with practical research, you analyze the performance of the proposed model and framework against existing state-of-the-art values.

Submission Policy: Does the paper list the same author(s), title and abstract (minor wording differences in the abstract are ok) in its PDF file and EDAS registration?

Does the paper list the same author(s) : YES Does the paper list the title : YES Does the paper list the abstract: YES

Full paper review 7

Relevance and timeliness: Rate the importance and timeliness of the topic addressed in the paper within its area of research.

Good (4)

Technical content and scientific rigour: Rate the technical content of the paper (e.g.: completeness of the analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.

Solid work of notable importance. (4)

Novelty and originality: Rate the novelty and originality of the ideas or results presented in the paper.

Significant original work and novel results. (4)

Quality of presentation: Rate the paper organization, the clearness of text and figures, the completeness and accuracy of references.

Well written. (4)

Strong aspects: Comments to the author: what are the strong aspects of the paper

good research good presentation need more up to date references

Weak aspects: Comments to the author: what are the weak aspects of the paper?

I don't found any important weak aspects in this research

Recommended changes: Recommended changes. Please indicate any changes that should be made to the paper if accepted.

Good idea but need more up to date references

Submission Policy: Does the paper list the same author(s), title and abstract (minor wording differences in the abstract are ok) in its PDF file and EDAS registration?

no

Full paper review 8

Relevance and timeliness: Rate the importance and timeliness of the topic addressed in the paper within its area of research.

Acceptable (3)

Technical content and scientific rigour: Rate the technical content of the paper (e.g.: completeness of the analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.

Valid work but limited contribution. (3)

Novelty and originality: Rate the novelty and originality of the ideas or results presented in the paper.

Some interesting ideas and results on a subject well investigated. (3)

Quality of presentation: Rate the paper organization, the clearness of text and figures, the completeness and accuracy of references.

Readable, but revision is needed in some parts. (3)

Strong aspects: Comments to the author: what are the strong aspects of the paper

The paper compared among previous frameworks of analysis and proposed the new framework.

Weak aspects: Comments to the author: what are the weak aspects of the paper?

This proposed framework is the adapted version of the previous framework. The paper described theories in section 3, discussed previous frameworks and proposed their own framework in section 4, but there is no detail about their proposed framework: How these differences from previous frameworks can improve analysis? Why use the new mathematics model instead of the old model? ...

Recommended changes: Recommended changes. Please indicate any changes that should be made to the paper if accepted.

There are quite some plagiarism from other papers in section 2 and section 3.

Submission Policy: Does the paper list the same author(s), title and abstract (minor wording differences in the abstract are ok) in its PDF file and EDAS registration?

yes

Full paper review 9

Relevance and timeliness: Rate the importance and timeliness of the topic addressed in the paper within its area of research.

Little (2)

Technical content and scientific rigour: Rate the technical content of the paper (e.g.: completeness of the analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.

Marginal work and simple contribution. Some flaws. (2)

Novelty and originality: Rate the novelty and originality of the ideas or results presented in the paper.

Minor variations on a well investigated subject. (2)

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The authors have conducted a good survey of prior-art on the topic and have discussed main ideas of the existing research work like a white-paper.

Weak aspects: Comments to the author: what are the weak aspects of the paper?

The authors claim to propose a spatial analysis framework for traffic accident-prone road classification using Multi-criteria decision making. But there are no results shown, no alalysis provided and it’s hard to understand what framework they are proposing. The paper is more of a survey without any useful recommendation at the end.

Recommended changes: Recommended changes. Please indicate any changes that should be made to the paper if accepted.

They survey part of the paper is neat. The authors should clearly identify the challenges with each of those problems and then propose a framework that solves all or most of those challenges with some novel way. They should provide a metric to classify a road as dangerous or safe and compare against the ground-truth to show their prediction accuracy.

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It is my great pleasure to inform you that your paper entitled #1570633263 ('Spatial Analysis Model for Traffic Accident-Prone Roads Classification: A Proposed Framework') for 2020 1st Conference on Internet of Things and Embedded Intelligence (CITEI 2020) has been **ACCEPTED** for the CITEI 2020, which is planned to be held in Yogyakarta, Indonesia, between July 29th and 30th, 2020. Congratulations!!

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Balas Ke: lppi@uad.ac.id
Kepada: Anik Vega Vitianingsih <vega@unitomo.ac.id>
Cc: Hendril Satrian Purnama <Lfriyan220@gmail.com>, TH Sutikno <lppi@uad.ac.id>, Tole Sutikno <thsutikno@ieee.org>, ts@ee.uad.ac.id

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IAES International Journal of Artificial Intelligence (IJ-AI)
Vol. 8, No. 1, March 2020, pp. xx~xx
ISSN: 2252-8938, DOI: 10.11591/ijai.v8.i1.ppxx-xx

Spatial Analysis Model For Traffic Accident-Prone Roads Classification: A Proposed Framework

Anik Vega Vitianingsih[1], Nanna Suryana[2], and Zahriah Othman[3]
[1]Informatics Departments, Universitas Dr. Soetomo, Surabaya, Indonesia
[1, 2,3]Faculty of Information and Communication Technology, Universiti Teknikal Malaysia Melaka, Melaka, Malaysia

Article Info

Article history:

Received Jun 12, 201x
Revised Aug 20, 201x
Accepted Aug 26, 201x

Keywords:

GIS software engineering
Spatial analysis model
Proposed framework
Hybrid estimation model-based
MCDM-ANNs
Traffic accident-prone roads

ABSTRACT

The classification method in the spatial analysis modeling based on the multi-criteria parameter is currently widely used to manage Geographic Information Systems (GIS) software engineering. The accuracy of the proposed model will play an essential role in the successful software development of GIS. This is related to the nature of GIS used for mapping through spatial analysis. This paper aims to propose a framework of spatial analysis using a hybrid estimation model-based on a combination of Multi-criteria decision-making (MCDM) and Artificial neural networks (ANNs) (MCDM-ANNs) classification. The proposed framework is based on the comparison of existing frameworks through the concept of a literature review. The model in the proposed framework will be used for future work on the traffic accident-prone road classification through testing with a private or public spatial dataset. Model validation testing on the proposed framework uses metaheuristic optimization techniques. Policymakers can use the results of the model on the proposed framework for initial planning developing GIS software engineering through spatial analysis models.

Corresponding Author:

Anik Vega Vitianingsih,
Informatics Departments,
Universitas Dr. Soetomo, Surabaya, Indonesia,
Jalan Semolowaru 84 Surabaya, 60118.
Email: vega@unitomo.ac.id

1. INTRODUCTION

Model accuracy prediction in the development of frameworks on GIS software is the first step in efforts to improve the quality of GIS software developed and is part of quality control and quality assurance [1]. Quality control will determine the method of spatial analysis to test quality standards [1]. A spatial analysis modeling is a process to build an Artificial Intelligence (AI) model that is combined with trials on spatial datasets [2], gathering spatial knowledge through spatial datasets and providing knowledge of models in the framework through AI methods from various sources. The purpose of the spatial analysis model is to make a description of the GIS software that will be developed, conduct simulations to test spatial datasets through models on the AI method used on the proposed framework that has already been described. Spatial datasets in GIS relate to how primary and secondary data are obtained through the collection process, and then how the data is processed through spatial analysis to be information in the decision support system [3]. Visualization of spatial data can be done with Cloud-terminal Integration GIS to provide convenience in the process of spatial analysis on a large number of spatial datasets [4], aggregation-based spatial datasets information retrieval system [5]. Spatial datasets as the key to the value of big data in spatial data mining (SDM) that refers to the description of attribute data requirements, how the data is obtained, and what AI

method is used to perform spatial analysis of the data [6][4]. Spatial datasets become the basic structure in GIS for the process of spatial analysis algorithms, analyzing algorithm principles, or adapting existing algorithms [7]. The classification model in machine learning is prevalent [8] to be used research in the field of spatial analysis of GIS. However, there is no concrete statement regarding which classification algorithm is best to use with certainty because the accuracy, precision, and recall (APR) tests in each study use different sample data. It is also based on the field of study, which is always other on the object of research conducted.

Previous research proposed a framework using the CART model (Classification and Regression Trees), which reported a 10-fold increase in the best value for crash severity prediction [9]. However, the CART model has a weakness in the number of training data samples because changes in training and testing data samples affect the results of spatial analysis [10]. Spatial analysis model using data mining decision tree (J48, ID3, and CART) and Naïve Bayes classifiers [11] States that the accuracy value of 96.30% on the J48 method is higher than ID3, CART, and Naïve Bayes, where the Naïve Bayes have better performance even though the accuracy value is small. Different studies suggest that the accuracy of prediction of classification models with the Decision Tree Approach to reach 84.1% [12]. Also, indicate that the Enhanced Empirical Bayesian (EB) method is a spatial analysis approach that is preferred for prediction of the number of accidents in road segments [13]. Maximizes the accuracy value of the model for Geo-spatial data using the adaptive k-Nearest Neighbor (kNN) classifier, i.e., by dynamically selecting *k* for each instance, the value being classified reaches a ROC AUC score of 0,9. The fuzzy deep-learning approach model is used to reduce the uncertainty of data in the prediction of traffic flows that affect road traffic accident rates [14]. Convolutional Long Short-Term Memory (ConvLSTM) neural network model [15] states that the proposed framework is sufficiently accurate and significant to improve accuracy in traffic accident prediction for heterogeneous data. The road accident classification model using random forests and boosted trees works equally well with an average value of 80% accuracy and a sensitivity value of 50% [16].

The discussion in this paper emphasizes the comparison in modeling spatial analysis using classification methods for hybrid models through the proposed framework. The general contribution of this proposed framework will be used for future work is integrated through the GIS-platform for the safe management and risk assessment [17],[18] of traffic accident-prone roads classification, to analyze multi-criteria parameters that influence the results on the traffic accident-prone road classification, to purpose new parameters of spatial datasets, to enhance a framework of spatial analysis using a hybrid estimation model-based on a combination of MCDM-ANNs, and to evaluate the enhancement of the new model through the hybrid. Model evaluation needs to be done to provide best practices for the resulting model [19]. Model performance assessment is influenced by balanced data to describe the quality of the resulting model, so as not to lead to misleading conclusions [16]. The proposed framework of classification models with MCDM-ANNs hybrid to the implementation of prone-roads traffic accident classification and its differences with existing frameworks are presented of classification models. The selection of a model-based hybrid estimation on a combination of MCDM-ANNs classification in this proposed framework study is based on a literature review. The collection of dataset multi-criteria parameter for prone-roads traffic accident classification which has been used in the paper articles obtained to evaluate the proposed framework of classification models, explains also the validation and evaluation techniques of the proposed model. Modeling of Group Analytic Hierarchy Process (GAHP) technique to develop weighting technique on multi-parameter criteria applied to MCDM Methods which still use are a human assumption in weighting, proving through the sensitivity and stability test of GAHP technique modeling to MCDM Methods by comparing the weight was given the human by manual assumption.

Multi-criteria decision making (MCDM) methods are used in this study to process the determinant parameter data in the classification of accident-prone areas that include road conditions, traffic volume, accident rate [20],[21], assign weighting values to each factor based on literature and surveys to expert sources [22]. From the classification of the accident-prone areas, it becomes crucial to provide recommendations to the road auditor to conduct a traffic safety audit to obtain assessment criteria, implementation expenses, the number of involved traffic participants, the effect of road safety, protective effect, and social factors presenting difficulties [23]. The traffic safety audit is carried out by the administration of the road auditor by conducting a feasibility study of the network of accident-prone road categories [24]. MCDM methods have been used for analysis with Simple Additive Weight (SAW), Analytical Hierarchy Process (AHP), and Fuzzy AHP method, used for Road Safety Analysis (RSA) that can help decisions process in n determining the priority of road management and provide mitigating actions against the most vulnerable to accidents [25]. The MCDM method with Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) method is used in the management of road safety, and road safety is one of the factors to reduce the number of traffic accidents by knowing the position of a road safety study in Bushehr province Bushehr-Borazjan roads and Borazjan-Genaveh based on various quantitative and qualitative criteria [26]. The MCDM model is one of the right approach models to deal with the problem of

Accident-prone road section (APRS) because it uses several road and environmental criteria, both quantitative or qualitative; MCDM is related to the results of decision making for planning that involves stakeholders [27]. A framework to be proposed through the process of a literature review from several studies that have been done before. This proses to evaluate the benefits of research that has been done, to know the limitations of the method used, to identify research gaps that have been conducted, and to advise development for further research to get the right framework in the research the new [28]. The research questions in research are intended to focus on the subject area of the study by identifying and classifying the spatial analysis framework for accident-prone traffic roads to be done [29].

2. RESEARCH METHOD

The spatial analysis model using MCDM is a multi-criteria spatial decision support system (MC-SDSS) developed in GIS technology by integrating MCDM as a method to determine the best alternative from the many choices available based on the spatial datasets described [30]. ANNs classification is a Data Mining technique in machine learning, mapping various attributes as input layer in a node, adding the hidden layer, which is then used to get the threshold to the non-linear output layer [31]. The proposed framework with the steps in Figure 1.

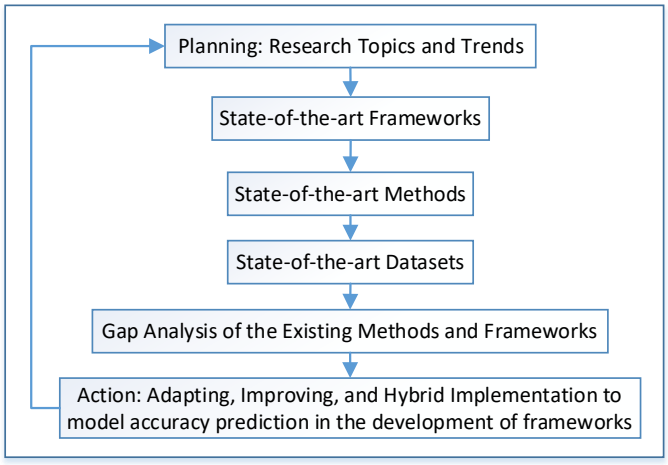

Figure 1. Research method steps

The initial stage a proposed framework in Figure 1 is to plan topics and research trends with identifying in research needs for the literature review process through state-of-the-art Frameworks, methods, datasets requirements, and gap analysis of existing methods and frameworks. Action adapting, improving, and hybrid implementation to model accuracy prediction in the development of frameworks. The state-of-the-art from the literature review within the primary study is displayed in Table 1.

Table 1. Literature review a framework comparison

Framework	Model & Method	Spatial Datasets	Results
[32]	Model-based spatial statistical methods: Poisson regression, Negative Binomial regression, Empirical Bayesian.	The accidents, injuries, and deaths by years	In this study comparing all methods used, where Empirical Bayes has the best accuracy and consistency, recommended by the Highway Safety Manual (HSM) and the European Union Acquis
[33]	Model-based spatial statistical methods: Kernel density analysis, Nearest neighbor, K-function	Intercity accidents, accidents leading to injury, accidents leading to death, and accidents leading to damages	The observed value curve on the spatial analysis process, the value of spatial datasets is above the 5% confidence interval
[34]	Spatial analysis techniques: Nearest Neighborhood Hierarchical (NNH) Clustering, Spatial-Temporal Clustering Analysis (STAC)	Road accidents involving all types of vehicles	The results of the spatial analysis vary according to the parameter values in the spatial datasets, where is STAC has a 461,57 higher Prediction Accuracy Index (PAI) compared to NNH 163,69.
[35]	ANNs techniques: Extreme learning machine (ELM), Probabilistic neural network (PNN), Radial basis function (RBF), and Multilayer perceptron (MLP).	V/C, speed, vehicle kilometer traveled (VKT), roadway width, the existence of median, and allowable/not-	Evaluation method using Nash – Sutcliffe (NS), mean absolute error (MAE), and root means square error (RMSE). ELM, as a feed-forward neural network, becomes the algorithm that has the best performance and

Framework	Model & Method	Spatial Datasets	Results
		allowable parking	the most accurate prediction results (RMSE=3,576; NS=0,81; MAE=2,5062) by randomly selecting hidden nodes using random weights.
[36]	Hot spot analysis (Getis-Ord Gi*): Network spatial weights, Kernel Density method	The traffic accident)	Hotspot analysis gives better results because it is done by considering the weight of spatial datasets
[37]	The support vector machine combines the techniques of statistical learning, machine learning, the neural networks based: Support vector machine, Deep neural network	Accident, person, vehicle, road, and environment data	They proposed a real-time online deep learning framework Based on traffic accident black spots. SVM algorithm in machine learning has 63% precision and a 61% recall rate in analyzing the black spots of traffic accidents. If the training data period is added, the SVM and deep neural network values increase by 95% and 89% accuracy, 69%, and 79% recall rates.
[38]	Black spot identification (BSID) method and Segmentation method: Empirical Bayesian (EB), Excess Empirical Bayesian (EEB), Accident Frequency (AF), Accident Rate (AR).	The traffic accident	AF method has the best performance with a consistency of 93.1% compared to EB 92.2%, and EEB 77.4%. The performance of the EEB and AR methods is the weakest in the case of segmentation in most cases of segmentation.
[39]	Machine learning techniques to prediction model: Decision tree regression (DTR) methods Regression tree framework, Ensemble techniques. Model assessment: Average Squared Error (ASE), Standard Deviation of Error (SDE)	Statewide Traffic Analysis Zone (STAZ)	The DTR model to prediction accuracy works better than the spatial DTR model. To improve prediction accuracy using ensemble techniques (bagging, random forest, and gradient boosting) with slightly better results, depending on the amount of training data.
[27]	Multicriteria decision making (MCDM) model: Weighted linear combination (WLC) method	The traffic accident Reports	The model was developed to determine the criteria weights that have been determined by experts with interest in subjective results.
[40]	Prediction model: Deep neural network model, Gene expression programming (GEP), Random effect negative binomial (RENB) models, Regular negative binomial model (FENB)	The road geometry, traffic, and road environment)	The DNN model experienced an increase in road prediction with 0.914 (RMSE = 7.474) by GEP, and 0.891 (RMSE = 8.862). GEP works better than RENB to measure the ranking of variables that influence accidents.
[16]	Random effects negative binomial model: Hierarchical cluster method	Real time-frequency of accident data and contributing factors	The model developed can provide information on the main causes of accidents at road intersections

The literature review is in Table 1. The research [32] not shown the comparison of the accuracy and consistency of each method used with the confusion matrix. The meaning of Empirical Bayes has the best accuracy and consistency value that is not really visible. The standard deviation of the data distribution value in the sample data is only used to calculate the disaster-prone traffic accident rate, and there is no proof of the truth of the model used [33]. Discussion [35] is still limited to the use of an existing method, and knowledge combination has not been done as a hybrid model approach. The results of the comparison of the two methods are stated to be more accurate, but no precise accuracy value is given based on the value of the confusion matrix [36]. On research [34] have not considered the type of road type design, for example, arterial roads, collector roads, or roads based on their nature (geometric road), there are no studies on adaptive models that can expand machine learning through a combination of online learning and deep learning [37]. Paper discussion [38] is still limited to the use of an existing method; knowledge combination has not been done as a hybrid model approach. The DTR model in conducting the prediction accuracy in this study is still a macro-level crash count [39]. The model has weaknesses in terms of data simulation because it requires accident data at the beginning of the calculation [27]. Mathematical modeling in the comparison algorithm does not exist, so the comparison of results is difficult [40]; there is no evaluation of the models offered because the test data collected does not have a long-time span [16]. MLP is more accurate for available spatial datasets but becomes very vulnerable when there is data noise that can cause errors in predictions [35]. PNN has probabilistic outputs with multilayer perceptron networks, producing fairly accurate predictions [35]. RBF is very weak in making predictions [35]. VKT parameters proved to be the

most influential in road traffic accidents, then the V/C variable and driver speed based on the RReliefF algorithm calculation method [35]. The evaluation to perform the technique, The site consistency test (SCT), The method consistency test (MCT), The total rank differences test (TRDT), and The total score test (TST) [38].

3. RESULTS AND DISCUSSION

The proposed framework is based on a literature study by comparing the existing framework to determine the performance of the spatial analysis model offered for Traffic Accident Prone Roads in Table 1 and the MCDM-based framework [41],[42],[43],[44],[27]. The framework being compared includes the method used for primary study (PS) spatial analysis for accident-prone traffic roads, the spatial analysis model used, spatial datasets used to test the model through method selection, and the value of the measurement results through the assessment.

The framework that has been developed by previous researchers will be described in this section. The framework model [44], was developed to create the Maycock and Hall's accident prediction model. This model provides sensitivity analysis on modeling results using multi-objective optimization (MOO) using multi-criteria decision making for the analytical hierarchy process (AHP model). The needs primary spatial data sets in the road geometry category, the necessity secondary spatial, i.e., the numbers and types of traffic accidents, traffic and demand for structural flow, visual distance and vehicle speed, road signs, and equipment, lighting, driver behavior. The value of the multi-criteria parameters obtained will be done mathematic spatial data modeling to produce the sensitivity of spatial analysis, the results of multi-criteria optimization in the form of traffic efficiency (TS), and traffic safety (TS) to the predicted traffic accident. MOO model is measured using a consistency index (CI) and consistency ratio (CR), the model is proven to have a good structure with a value of CR $\leq$ 10, or the CR value is 0.00298; this shows that the MOO model with MCDM on the AHP model has a consistent value the good one.

The [41] framework was developed by the PROMETREE-RS MCDM model. MCDM is used because it can use more than one parameter to get the best results from the alternatives produced. This model was developed to evaluate the DEA and TOPSIS methods in road safety to reduce risk the number of accidents on the road through the road safety index. The model is tested by using the Robustness of the composite index. The average correlation value, the average rank value, and the cluster variation average values will be entered into the MCDM PROMETHEE-RS to test the resulting model. Multi-criteria parameters tested in this model, i.e., the Police Department data, fatalities, serious injuries, number of inhabitants, number of registered vehicles, traffic risk, and public risk. This parameter will be used to mathematic spatial data modeling through DEA and TOPSIS, the produce optimal composite index through the value of final risk efficiency. DEA-WR provides the best ranking results compared to the DEA-based Composite Indicator model (DEA-CI).

The [45],[43] framework is a model built using MCDM. The purpose of this model is to create a knowledge data mining rule decision tree through FP-growth and Apache Spark framework. A trial model on road accident analysis, where the results have a high degree of accuracy and work well to improve road safety. The multi-parameter criteria used are the road accident data to death and injuries attribute. The testing model for the relevant association rule is done by testing and validation by measuring quality measurement. MCDM model involves many criteria, so it is suitable to overcome the problem of Accident-prone road section (APRS) on the type of horizontal alignment, vertical alignment, intersections, significant places, and shoulder widths with an accuracy value of 0.8830 for threshold values 1 [27].

The proposed framework in previous research will be used by the author as a reference in developing further activities of the framework that will be proposed. The framework of the research proposed in Figure 2 has the main differences from the existing framework. Prepare data requirements for spatial datasets as primary and secondary spatial datasets in determining the road categories to be studied (using a private or public spatial dataset type). Perform a literature study relating to multi-criteria parameters used on each road category. Mathematics modeling for spatial analysis to the proposed framework for hybrid estimation model-based on a combination of MCDM-ANNs multi-class classification. In this case, the pre-processing data process will run for the classification analysis process. The range of classification will be performed through mathematical modeling using the Guttman method. The results of the multi-class classification will be validated with SCT, MCT, ARC validation. Focuses on the propose a classification of roads prone to accidents using multiple criteria parameters (data series), make modeling of road prone to accidents by calculating the value of traffic accident by type of events and the index of the accidents, the density that of roads traffic accident happened to each zone and the amount of data in each year, risk factors based on the severity of the accidents, severity of roads traffic accident events, crash prediction models using data series, and the value of the societal cost of each type the accident. The ANN strategy has the most

noteworthy rating of techniques that are regularly utilized in the literature review in essential considers. The empirical Bayes method and decision tree in data mining are also broadly used within the clustering category in spatial information modeling of accident-prone zones. This considers A proposed framework of classification used a hybrid estimation model based on a combination of MCDM-ANN classification. Test the consistency of the method from the model produced with the MCT, SCT, the value of ARC model evaluations.

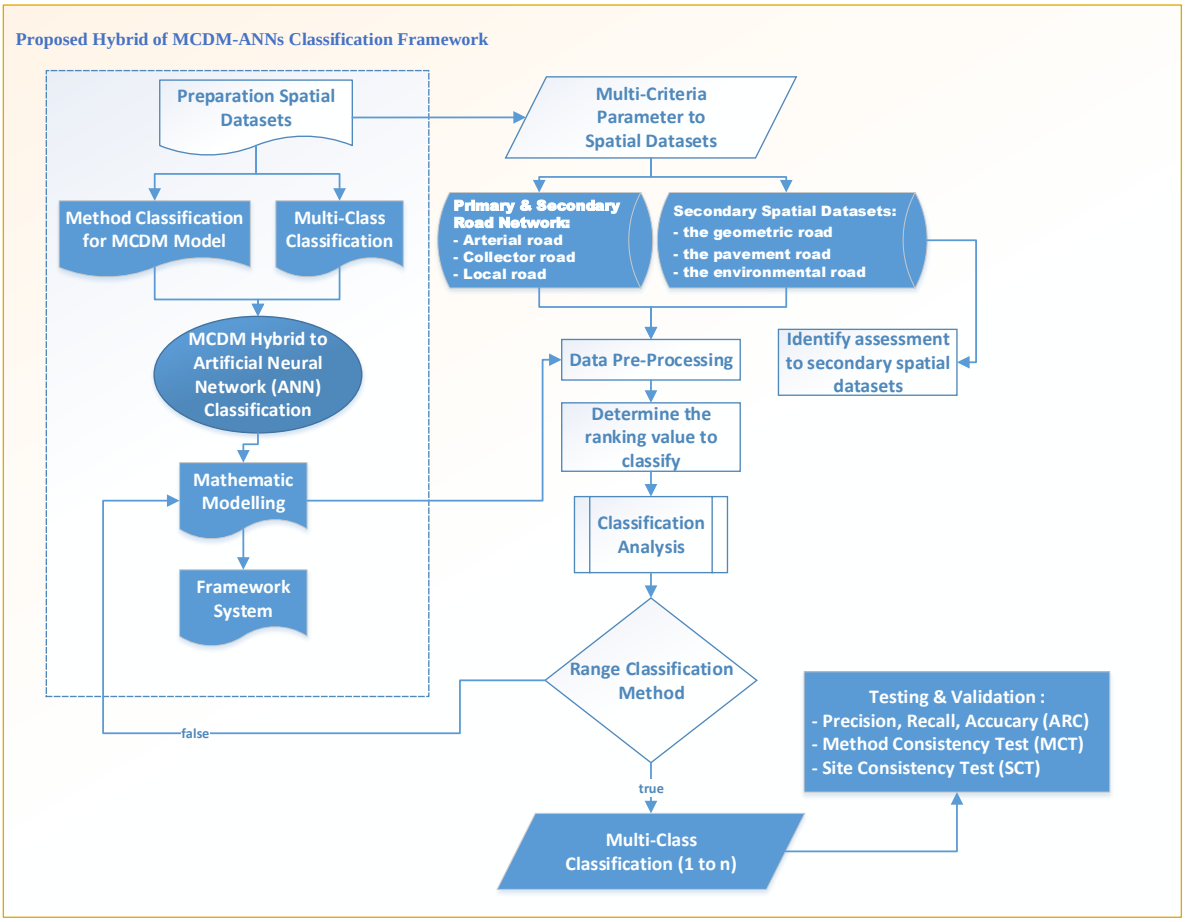

Figure 2. Proposed Hybrid of MCDM-ANNs Classification Framework to Evaluate and Rank Spatial Analysis Model Traffic Accident Prone Roads

4. CONCLUSION

The proposed framework in this study will act as a model-based hybrid estimation approach on a combination of MCDM-ANNs classification to strengthen data mining techniques in spatial multi-criteria analysis in multi-class classification decision making. In the literature review on the primary study, there are no research topics that discuss on the traffic accident-prone roads classification on the arterial road, collector road, and type of road based on its nature (pavement, geometry, and local road) categories. The Spatial Analysis Model using MCDM among others, Analytic Hierarchy Process (AHP), Analytical Network Process (ANP), Weighted Sum Model (WSM), Weighted Product (WP), Weight Product Model (WPM), Simple Additive Weighting (SAW), Technique for Order Preference by Similarity to Ideal Solution (TOPSIS), Preference Ranking Organization Method for Enrichment of Evaluations (PROMETHEE), Multi-attribute utility theory (MAUT), Elimination and Choice Expressing Reality (ELECTRE), and VlseKriterijuska Optimizacija I Komoromisno Resenje (VIKOR). ANNs classification methods are the most popular data mining techniques in the field spatial analysis of accident-prone roads and the factors that affect the accident rate, among others (Neural networks, Extreme learning machines, k-Nearest Neighbor, Naive Bayes, Decision trees) [46],[31]. The results of the best methods through APR measurement will be a reference in decision making in road management. Existing research is still limited to one type of road used as an object (specific region), and 96 % is used Private Spatial Datasets. In this study, it was using an Inductive Qualitative Approach in the modeling of road prone to accidents to identify the findings of science

that is done during the research process. The proposed a classification of roads prone to accidents using multiple criteria parameters, make a modeling of road prone to accidents calculating by the value of traffic accident by type of events and the index of the accidents, the value of the density that of roads traffic accident happened to each zone and the amount of data in each year, the value of risk factors based on the severity of the accidents, the value of severity of roads traffic accident events, the value of crash prediction models, the value of the societal cost of each type the accident, and the test result is using the method the SCT, the MCT, and APR.

ACKNOWLEDGEMENTS

This research is supported by Universiti Teknikal Malaysia Melaka, Malaysia, and Universitas Dr. Soetomo, Indonesia. The development of results of a study funded by The Directorate General of Strengthening Research and Development of Research, Technology, and Higher Education Ministry-Indonesia in 2015-2016.

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BIOGRAPHIES OF AUTHORS

Anik Vega Vitianingsih. A bachelor's degree in Informatics Engineering in 2004 and a Master's Degree in Game Tech was obtained in 2011. The author is a Permanent Lecturer in the Informatics Department, editor in chief of the International Journal of Artificial Intelligence & Robotics Universitas Dr. Soetomo, and students in the Ph.D. at the Faculty of Information and Communication Technology (FTMK), Universiti Teknikal Malaysia Melaka, Malaysia. The field of interest in Spatial Analysis, and Spatial Data Modeling, Artificial Intelligence in Geographical Information Systems. Experiences in writing papers according to their fields in the Scopus Journal include 2019-International Journal of Intelligent Engineering and Systems, 2019-Data in Brief, 2018-International Journal of Engineering and Technology (UAE), 2018-Journal of Telecommunication, Electronic and Computer Engineering. The author has been a reviewer for Taylor and Francis Ltd publishers, including the Journal of Transportation Safety and Security, IETE Technical Review (Institution of Electronics and Telecommunication Engineers, India), and International Journal of Injury Control and Safety Promotion, as well as a reviewer on the International Social Science Journal Publisher Wiley-Blackwell Publishing Ltd.

Prof. Dr. Nanna Suryana Herman. Professor at the Faculty of Information and Communication Technology (FTMK), Universiti Teknikal Malaysia Melaka, Malaysia. Bachelor's degree in Soil and Water Engineering from Padjadjaran University, Bandung, Indonesia. Master's degree in Computer Assisted Regional Planning at the International Institute for Geoinformatics and Earth Observation (ITC), Enschede, The Netherlands. Doctoral Degree in Department of Remote sensing and GIS, Research University of Wageningen, Holland. His research interests are spatial data analytics, image processing, and spatial modeling, and remote sensing. Active as the Editorial Board of International Journals, member of The ASEAN European Academic University Network (ASEA-UNINET), and EURAS-Eurasian Universities Union.

Zahriah Othman. Lecturer at the Software Engineering department, Faculty of Information and Communication Technology, Universiti Teknikal Malaysia Melaka. Bachelor's degree in Information Technology from Universiti Utara Malaysia in 2001. In 2003 he received a master of science degree in Software Engineering from the School of Informatics, Department of Computing, University of Bradford, United Kingdom. Ph.D. in Computer Science from Universiti Teknikal Malaysia Melaka, Malaysia. His areas of research interest are Software Engineering, Artificial Intelligence, information retrieval, specifically on terminology disagreement in retrieving geospatial data.

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ijeecs.iaes@gmail.com <ijeecs.iaes=gmail.com@edas.info> 19 September 2020 pukul 01.12
Balas Ke: ijeecs.iaes@gmail.com
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Cc: Atika Ayu Shaputri <atikaiaes@gmail.com>, Iqbal Busthomi <iq.iaes@gmail.com>, Hendril Satrian Purnama <Lfriyan220@gmail.com>, Nooria Sukmaningtyas <nooria13@gmail.com>, Ahmad Sulaiman <ahmadsapi@gmail.com>, TH Sutikno <ts@ee.uad.ac.id>, Tole Sutikno <thsutikno@ieee.org>, Ijeecs Editor T Sutikno <ijeecs.iaes@gmail.com>, Karim Hashim Al-Saedi <karimnav6@gmail.com>, Natarajan Ayyanathan <greencoffee2008@gmail.com>, Ravilla Dilli <dilli.ravilla@gmail.com>, Mihai Gavrilas <mgavril@ee.tuiasi.ro>, Munir Georges <munir@suheel.de>, Seng Hansun <senghansun@gmail.com>, Vivek B Kute <vivekkute@rediffmail.com>, Pakawan Pugsee <pakawan.p@chula.ac.th>, Jatin Sharma <jatin.joy.sharma@gmail.com>, Pritish Vibhute <vibhutepm@gmail.com>

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COMMENTS FROM REVIEWERS:

======= Full paper review 1 =======

> *** Relevance and timeliness: Rate the importance and timeliness of the topic addressed in the paper within its area of research.
Acceptable (3)

> *** Technical content and scientific rigour: Rate the technical content of the paper (e.g.: completeness of the
analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.
Marginal work and simple contribution. Some flaws. (2)

> *** Novelty and originality: Rate the novelty and originality of the ideas or results presented in the paper.
Minor variations on a well investigated subject. (2)

> *** Quality of presentation: Rate the paper organization, the clearness of text and figures, the completeness and accuracy of references.
Substantial revision work is needed. (2)

> *** Strong aspects: Comments to the author: what are the strong aspects of the paper

The author(s) try to propose a spatial analysis framework by using MCDM-ANN method (unfortunately, it is not discussed at all in the content)

> *** Weak aspects: Comments to the author: what are the weak aspects of the paper?

The title, abstract, and content are not coherence, unclear focus of discussion

> *** Recommended changes: Recommended changes. Please indicate any changes that should be made to the paper if accepted.

* There are some grammatical errors, please recheck the paper
* Some of the paragraphs are not well written and the cohesive part of each sentence is not strong enough. This makes it quite difficult to understand the meaning/ intention of the author(s). For example, check the last paragraph in Section 1, the Conclusion section
* Be careful to use the correct abbreviations and check the consistency, for example, Highway Traffic Accident (RTA)?
* Recheck all the Equations' numbering, some equations are not numbered yet
* Check the formulation of Eq.(2), Eq.(4), Eq.(8), Eq.(25)
* Be consistent in using the case sensitive character for Equation! For example, T is not equal to T' in Eq.(2), k is not equal to K for Eq.(3)-(4)
* There are some methods being the focus of the (review) study, such as SAW, WSM, WPM, etc., but not discussed in detail
* After reading this manuscript, I found that the content describes the preliminary results of the study by doing some literature review of related findings. There is no discussion about the proposed framework (using MCDM-ANN) at all, moreover for the results of the proposed framework for the accident prone roads classification as implied in the Abstract. Therefore, the Title and Abstract are not suitable and tend to give the wrong impression for the readers

> *** Submission Policy: Does the paper list the same author(s), title and abstract (minor wording differences in the abstract are ok) in its PDF file and EDAS registration?

Yes, it does

======= Full paper review 2 =======

> *** Relevance and timeliness: Rate the importance and timeliness of the topic addressed in the paper within its area of research.
Good (4)

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analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.
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Minor variations on a well investigated subject. (2)

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Readable, but revision is needed in some parts. (3)

> *** Strong aspects: Comments to the author: what are the strong aspects of the paper

Paper highlights IOT use for Accident Protections

> *** Weak aspects: Comments to the author: what are the weak aspects of the paper?

No actual work or simulation either. Theoretical contents. Other researcher work summarized.

> *** Recommended changes: Recommended changes. Please indicate any changes that should be made to the paper if accepted.

Actual or min Simulation results expected

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======= Full paper review 3 =======

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> *** Technical content and scientific rigour: Rate the technical content of the paper (e.g.: completeness of the
analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.
Valid work but limited contribution. (3)

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> *** Strong aspects: Comments to the author: what are the strong aspects of the paper

The proposed idea is addressing the real time problem in daily life.

> *** Weak aspects: Comments to the author: what are the weak aspects of the paper?

The paper is more emphasizing on Literature Survey than the contribution towards the proposed technique/algorithm

> *** Recommended changes: Recommended changes. Please indicate any changes that should be made to the paper if accepted.

1. Future scope has to be included.

2. Some of the Literature is included in the Conclusion (Section 5), which is redundant.

3. Literature Review is included under Results and Analysis(Section 4) that can be part of Section 2.

4. The Research Methodology can be clear and straightforward.

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======= Full paper review 4 =======

> *** Relevance and timeliness: Rate the importance and timeliness of the topic addressed in the paper within its area of research.
Little (2)

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Marginal work and simple contribution. Some flaws. (2)

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> *** Quality of presentation: Rate the paper organization, the clearness of text and figures, the completeness and accuracy of references.
Substantial revision work is needed. (2)

> *** Strong aspects: Comments to the author: what are the strong aspects of the paper

No strong aspects found.

> *** Weak aspects: Comments to the author: what are the weak aspects of the paper?

Written English.
The description of the mathematical model is unclear.

It is very difficult, if not impossible, to follow the logic of the presentation.

> *** Recommended changes: Recommended changes. Please indicate any changes that should be made to the paper if accepted.

- Written English must be improved.
- The description of the mathematical model is unclear.
- It is very difficult, if not impossible, to follow the logic of the presentation.
- The figures are too small to understand the writing in them.

> *** Submission Policy: Does the paper list the same author(s), title and abstract (minor wording differences in the abstract are ok) in its PDF file and EDAS registration?

Yes

======= Full paper review 5 =======

> *** Relevance and timeliness: Rate the importance and timeliness of the topic addressed in the paper within its area of research.
Good (4)

> *** Technical content and scientific rigour: Rate the technical content of the paper (e.g.: completeness of the
analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.
Valid work but limited contribution. (3)

> *** Novelty and originality: Rate the novelty and originality of the ideas or results presented in the paper.
Some interesting ideas and results on a subject well investigated. (3)

> *** Quality of presentation: Rate the paper organization, the clearness of text and figures, the completeness and accuracy of references.
Readable, but revision is needed in some parts. (3)

> *** Strong aspects: Comments to the author: what are the strong aspects of the paper

content is good.

> *** Weak aspects: Comments to the author: what are the weak aspects of the paper?

the readability is not as good as it oculd be.

there are some similarities with previously published work, e.g.,

"APPLICATION OF A MULTI-CRITERIA APPROACH TO ROAD SAFETY EVALUATION IN THE BUSHEHR PROVINCE, IRAN"

"Road safety analysis using multi criteria approach: A case study in India"

"Identification and Prioritization of(Black Spots)without Using Accident Information"

however, i don't consider this as critical as it is not deeply related just some phrases are identical...

> *** Recommended changes: Recommended changes. Please indicate any changes that should be made to the paper if accepted.

go over each single sentence and think if the sentence is needed and how it could be simplified.

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i don't see the authors in EDAS and it's not a PDF, it's a doc....

======= Full paper review 6 =======

> *** Relevance and timeliness: Rate the importance and timeliness of the topic addressed in the paper within its area of research.
Good (4)

> *** Technical content and scientific rigour: Rate the technical content of the paper (e.g.: completeness of the
analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.
Valid work but limited contribution. (3)

> *** Novelty and originality: Rate the novelty and originality of the ideas or results presented in the paper.
Some interesting ideas and results on a subject well investigated. (3)

> *** Quality of presentation: Rate the paper organization, the clearness of text and figures, the completeness and accuracy of references.
Well written. (4)

> *** Strong aspects: Comments to the author: what are the strong aspects of the paper

The article captured one of the most delicate and important topics related to people's safety in society. Appreciably good efforts are being made to develop a robust model for predicting zones prone to accidents. The information is real and is structured and well organized.

> *** Weak aspects: Comments to the author: what are the weak aspects of the paper?

Even if the article put forward different approaches related to the decision-making of multi-criteria for road safety, but there is no comparative synthetic analysis that builds the fact about individual model performance.
The proposed framework is supplemented by a detailed mathematical model but not tested for precision using real-time data. If tested, the article does not document statistical analysis which emphasizes the usefulness of the framework.
The database information used for performance analyzes, if any, are not included in the report.
I would recommend that the information be based on quantitative research as well because qualitative evaluations are being carried out but that should be accompanied by practical studies.
The conclusions should be more detailed regarding the aspects described in the article text and accompanied by results to ensure the model's acceptance of globules.

> *** Recommended changes: Recommended changes. Please indicate any changes that should be made to the paper if accepted.

I recommend that, with practical research, you analyze the performance of the proposed model and framework against existing state-of-the-art values.

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Does the paper list the same author(s) : YES
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======= Full paper review 7 =======

> *** Relevance and timeliness: Rate the importance and timeliness of the topic addressed in the paper within its area of research.
Good (4)

> *** Technical content and scientific rigour: Rate the technical content of the paper (e.g.: completeness of the
analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.
Solid work of notable importance. (4)

> *** Novelty and originality: Rate the novelty and originality of the ideas or results presented in the paper.
Significant original work and novel results. (4)

> *** Quality of presentation: Rate the paper organization, the clearness of text and figures, the completeness and accuracy of references.
Well written. (4)

> *** Strong aspects: Comments to the author: what are the strong aspects of the paper

good research
good presentation
need more up to date references

> *** Weak aspects: Comments to the author: what are the weak aspects of the paper?

I don't found any important weak aspects in this research

> *** Recommended changes: Recommended changes. Please indicate any changes that should be made to the paper if accepted.

Good idea but need more up to date references

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======= Full paper review 8 =======

> *** Relevance and timeliness: Rate the importance and timeliness of the topic addressed in the paper within its area of research.
Acceptable (3)

> *** Technical content and scientific rigour: Rate the technical content of the paper (e.g.: completeness of the
analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.
Valid work but limited contribution. (3)

> *** Novelty and originality: Rate the novelty and originality of the ideas or results presented in the paper.
Some interesting ideas and results on a subject well investigated. (3)

> *** Quality of presentation: Rate the paper organization, the clearness of text and figures, the completeness and accuracy of references.

Readable, but revision is needed in some parts. (3)

> *** Strong aspects: Comments to the author: what are the strong aspects of the paper

The paper compared among previous frameworks of analysis and proposed the new framework.

> *** Weak aspects: Comments to the author: what are the weak aspects of the paper?

This proposed framework is the adapted version of the previous framework. The paper described theories in section 3, discussed previous frameworks and proposed their own framework in section 4, but there is no detail about their proposed framework:
How these differences from previous frameworks can improve analysis?
Why use the new mathematics model instead of the old model?
...

> *** Recommended changes: Recommended changes. Please indicate any changes that should be made to the paper if accepted.

There are quite some plagiarism from other papers in section 2 and section 3.

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======= Full paper review 9 =======

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Little (2)

> *** Technical content and scientific rigour: Rate the technical content of the paper (e.g.: completeness of the
analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.
Marginal work and simple contribution. Some flaws. (2)

> *** Novelty and originality: Rate the novelty and originality of the ideas or results presented in the paper.
Minor variations on a well investigated subject. (2)

> *** Quality of presentation: Rate the paper organization, the clearness of text and figures, the completeness and accuracy of references.
Readable, but revision is needed in some parts. (3)

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The authors have conducted a good survey of prior-art on the topic and have discussed main ideas of the existing research work like a white-paper.

> *** Weak aspects: Comments to the author: what are the weak aspects of the paper?

The authors claim to propose a spatial analysis framework for traffic accident-prone road classification using Multi-criteria decision making. But there are no results shown, no alalysis provided and it’s hard to understand what framework they are proposing. The paper is more of a survey without any useful recommendation at the end.

> *** Recommended changes: Recommended changes. Please indicate any changes that should be made to the paper if accepted.

They survey part of the paper is neat. The authors should clearly identify the challenges with each of those problems and then propose a framework that solves all or most of those challenges with some novel way. They should provide a metric to classify a road as dangerous or safe and compare against the ground-truth to show their prediction accuracy.

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yes

======= Full paper review 10 =======

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Little (2)

> *** Technical content and scientific rigour: Rate the technical content of the paper (e.g.: completeness of the
analysis or simulation study, thoroughness of the treatise, accuracy of the models, etc.), its soundness and scientific rigour.
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It has been said many times before. (1)

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Title relevance of the taken research problem

> *** Weak aspects: Comments to the author: what are the weak aspects of the paper?

Abstract of the paper, must describe your flow of work in a professionally organised section wise structure of the full article in a nutshell.
2) Your Review summary of related works cannot be the proposed system framework. The research problem is not exactly defined.
3) the justification of the mathematical models cited in your paper
doesn't have adequate application relevance of the research problem.
4) The is no coherence in the overall research design of this survey paper.

5) The conclusion section must be rewritten .

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Revise and resubmit

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For ORIGINAL/RESEARCH Paper Type, the paper should be presented with IMRaD model:
1. Introduction (I)
2. The Proposed Method/Algorithm/Procedure specifically designed (optional). Authors may present complex proofs of theorems or non-obvious proofs of correctness of algorithms after introduction section (obvious theorems & straightforward proofs of existing theorems are NOT needed).
3. Method (M)
4. Results and Discussion (RaD)
5. Conclusion.
We will usually expect a minimum of 25-30 references primarily to journal papers, depending on the length of the paper (number of minimum references = 2n+10, n=page length). Citations of textbooks should be used very rarely and citations to web pages should be avoided. REMOVE ALL LOCAL REFERENCES. All cited papers should be referenced within the text of the manuscript. Choose ONLY the most important figures and/or tables, and prepare all figures in high quality images. Avoid paper with too many Figures and/or Tables. Figures and Tables are each MAX 4 entries.

For REVIEW Paper Type, the paper should present a critical and constructive analysis of existing published literature in a field, through summary, classification, analysis and comparison. The function and goal of the review paper is:
1) to organize literature;
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The structure of a review paper includes:
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4. Body – structured by headings and subheadings
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(2) Authors may present complex proofs of theorems or non-obvious proofs of correctness of algorithms after introduction section (obvious theorems & straightforward proofs of existing theorems are NOT needed).

(3) Introduction section within 3-6 paragraphs: explain the context of the study and state the precise objective. An Introduction should contain the following three (3) parts:
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(4) Method section: the presentation of the experimental methods should be clear and complete in every detail facilitating reproducibility by other scientists.

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(6) (URGENT)!!! About Figures & Tables in your manuscript:
- Because tables and figures supplement the text, all tables and figures should be REFERENCED in the text. Authors MUST EXPLAIN what the reader should look for when using the table or figure. Focus only on the important point the reader should draw from them, and leave the details for the reader to examine on her own.
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(7) Conclusion section: Summarize sentences the primary outcomes of the study in a paragraph. Are the claims in this section supported by the results, do they seem reasonable? Have the authors indicated how the results relate to expectations and to earlier research? Does the article support or contradict previous theories? Does the conclusion explain how the research has moved the body of scientific knowledge forward?

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ID# 1570633263: Preparing paper for a Scopus indexed journal caliber

1 pesan

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Best regards
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I will adjust it according to the command

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Revision:
Number the citations consecutively according to the first mention of each source in the text (sequential order). First citation in your text is written [1], second citation is written [2], third citaion is written [3], etc.
Answer: I have using Mendeley with IEEE style, so the sequence order references occur automatically.

Revision:

Added the doi or web link for all references
Answer: I have added the DOI according to the revision given.

Thank a lot.

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We have check your revision, but we still found a little thing that you must revise it. 1) Your references number 42 and 45 are same, please check it, and don't forget to remove one of them on the body text. 2) and Please check page number 33 on your paper, Please make this citation [33], [35], [36], [34] squential. We wait your revision today (26th April, 2021), because we will process your paper as soon as possible to publish on June 2021,

Thank you for your cooperation
Best regards

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Dear Ms. Anik

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IAES International Journal of Artificial Intelligence (IJ-AI)
Vol. 10, No. 2, June 2021, pp. xx~xx
ISSN: 2252-8938, DOI: 10.11591/ijai.v10.i2.ppxx-xx

Spatial analysis model for traffic accident-prone roads classification: a proposed framework

Anik Vega Vitianingsih[1], Nanna Suryana[2], Zahriah Othman[3]
[1]Department of Informatics, Universitas Dr. Soetomo, Surabaya, Indonesia
[1,2,3]Faculty of Information and Communication Technology, Universiti Teknikal Malaysia Melaka, Melaka, Malaysia

Article Info

Article history:

Received Jun 12, 201x
Revised Aug 20, 201x
Accepted Aug 26, 201x

Keywords:

GIS software engineering
Hybrid estimation model-based MCDM-ANNs
Proposed framework
Spatial analysis model
Traffic accident-prone roads

ABSTRACT

The classification method in the spatial analysis modeling based on the multi-criteria parameter is currently widely used to manage geographic information systems (GIS) software engineering. The accuracy of the proposed model will play an essential role in the successful software development of GIS. This is related to the nature of GIS used for mapping through spatial analysis. This paper aims to propose a framework of spatial analysis using a hybrid estimation model-based on a combination of multi-criteria decision-making (MCDM) and artificial neural networks (ANNs) (MCDM-ANNs) classification. The proposed framework is based on the comparison of existing frameworks through the concept of a literature review. The model in the proposed framework will be used for future work on the traffic accident-prone road classification through testing with a private or public spatial dataset. Model validation testing on the proposed framework uses metaheuristic optimization techniques. Policymakers can use the results of the model on the proposed framework for initial planning developing GIS software engineering through spatial analysis models.

Corresponding Author:

Anik Vega Vitianingsih
Department of Informatics
Universitas Dr. Soetomo
Jalan Semolowaru 84 Surabaya, 60118, Surabaya, Indonesia
Email: vega@unitomo.ac.id

1. INTRODUCTION

Model accuracy prediction in the development of frameworks on GIS software is the first step in efforts to improve the quality of GIS software developed and is part of quality control and quality assurance [1]. Quality control will determine the method of spatial analysis to test quality standards [1]. A spatial analysis modeling is a process to build an artificial intelligence (AI) model that is combined with trials on spatial datasets [2], gathering spatial knowledge through spatial datasets and providing knowledge of models in the framework through AI methods from various sources. The purpose of the spatial analysis model is to make a description of the GIS software that will be developed, conduct simulations to test spatial datasets through models on the AI method used on the proposed framework that has already been described. Spatial datasets in GIS relate to how primary and secondary data are obtained through the collection process, and then how the data is processed through spatial analysis to be information in the decision support system [3]. Visualization of spatial data can be done with cloud-terminal integration GIS to provide convenience in the process of spatial analysis on a large number of spatial datasets [4], aggregation-based spatial datasets information retrieval system [5]. Spatial datasets as the key to the value of big data in spatial data mining (SDM) that refers to the description of attribute data requirements, how the data is obtained, and what AI

method is used to perform spatial analysis of the data [6], [4]. Spatial datasets become the basic structure in GIS for the process of spatial analysis algorithms, analyzing algorithm principles, or adapting existing algorithms [7]. The classification model in machine learning is prevalent [8] to be used research in the field of spatial analysis of GIS. However, there is no concrete statement regarding which classification algorithm is best to use with certainty because the accuracy, precision, and recall (APR) tests in each study use different sample data. It is also based on the field of study, which is always other on the object of research conducted.

Previous research proposed a framework using the CART model (classification and regression trees), which reported a 10-fold increase in the best value for crash severity prediction [9]. However, the CART model has a weakness in the number of training data samples because changes in training and testing data samples affect the results of spatial analysis [10]. Spatial analysis model using data mining decision tree (J48, ID3, and CART) and naïve bayes classifiers [11] States that the accuracy value of 96.30% on the J48 method is higher than ID3, CART, and naïve bayes, where the naïve bayes have better performance even though the accuracy value is small. Different studies suggest that the accuracy of prediction of classification models with the decision tree approach to reach 84.1% [12]. Also, indicate that the enhanced empirical bayesian (EB) method is a spatial analysis approach that is preferred for prediction of the number of accidents in road segments [13]. Maximizes the accuracy value of the model for Geo-spatial data using the adaptive k-nearest neighbor (kNN) classifier, i.e., by dynamically selecting k for each instance, the value being classified reaches a ROC AUC score of 0,9. The fuzzy deep-learning approach model is used to reduce the uncertainty of data in the prediction of traffic flows that affect road traffic accident rates [14]. Convolutional long short-term memory (ConvLSTM) neural network model [15] states that the proposed framework is sufficiently accurate and significant to improve accuracy in traffic accident prediction for heterogeneous data. The road accident classification model using random forests and boosted trees works equally well with an average value of 80% accuracy and a sensitivity value of 50% [16].

The discussion in this paper emphasizes the comparison in modeling spatial analysis using classification methods for hybrid models through the proposed framework. The general contribution of this proposed framework will be used for future work is integrated through the GIS-platform for the safe management and risk assessment [17], [18] of traffic accident-prone roads classification, to analyze multi-criteria parameters that influence the results on the traffic accident-prone road classification, to purpose new parameters of spatial datasets, to enhance a framework of spatial analysis using a hybrid estimation model-based on a combination of MCDM-ANNs, and to evaluate the enhancement of the new model through the hybrid. Model evaluation needs to be done to provide best practices for the resulting model [19]. Model performance assessment is influenced by balanced data to describe the quality of the resulting model, so as not to lead to misleading conclusions [16]. The proposed framework of classification models with MCDM-ANNs hybrid to the implementation of prone-roads traffic accident classification and its differences with existing frameworks are presented of classification models. The selection of a model-based hybrid estimation on a combination of MCDM-ANNs classification in this proposed framework study is based on a literature review. The collection of dataset multi-criteria parameter for prone-roads traffic accident classification which has been used in the paper articles obtained to evaluate the proposed framework of classification models, explains also the validation and evaluation techniques of the proposed model. Modeling of group analytic hierarchy process (GAHP) technique to develop weighting technique on multi-parameter criteria applied to MCDM Methods which still use are a human assumption in weighting, proving through the sensitivity and stability test of GAHP technique modeling to MCDM methods by comparing the weight was given the human by manual assumption.

Multi-criteria decision making (MCDM) methods are used in this study to process the determinant parameter data in the classification of accident-prone areas that include road conditions, traffic volume, accident rate [20],[21], assign weighting values to each factor based on literature and surveys to expert sources [22]. From the classification of the accident-prone areas, it becomes crucial to provide recommendations to the road auditor to conduct a traffic safety audit to obtain assessment criteria, implementation expenses, the number of involved traffic participants, the effect of road safety, protective effect, and social factors presenting difficulties [23]. The traffic safety audit is carried out by the administration of the road auditor by conducting a feasibility study of the network of accident-prone road categories [24]. MCDM methods have been used for analysis with simple additive weight (SAW), analytical hierarchy process (AHP), and fuzzy AHP method, used for road safety analysis (RSA) that can help decisions process in n determining the priority of road management and provide mitigating actions against the most vulnerable to accidents [25]. The MCDM method with technique for order preference by similarity to ideal solution (TOPSIS) method is used in the management of road safety, and road safety is one of the factors to reduce the number of traffic accidents by knowing the position of a road safety study in Bushehr province Bushehr-Borazjan roads and Borazjan-Genaveh based on various quantitative and qualitative criteria [26]. The MCDM model is one of the right approach models to deal with the problem of accident-prone road

section (APRS) because it uses several road and environmental criteria, both quantitative or qualitative; MCDM is related to the results of decision making for planning that involves stakeholders [27]. A framework to be proposed through the process of a literature review from several studies that have been done before. This proses to evaluate the benefits of research that has been done, to know the limitations of the method used, to identify research gaps that have been conducted, and to advise development for further research to get the right framework in the research the new [28]. The research questions in research are intended to focus on the subject area of the study by identifying and classifying the spatial analysis framework for accident-prone traffic roads to be done [29].

2. RESEARCH METHOD

The spatial analysis model using MCDM is a multi-criteria spatial decision support system (MC-SDSS) developed in GIS technology by integrating MCDM as a method to determine the best alternative from the many choices available based on the spatial datasets described [30]. ANNs classification is a data mining technique in machine learning, mapping various attributes as input layer in a node, adding the hidden layer, which is then used to get the threshold to the non-linear output layer [31]. The proposed framework with the steps in Figure 1.

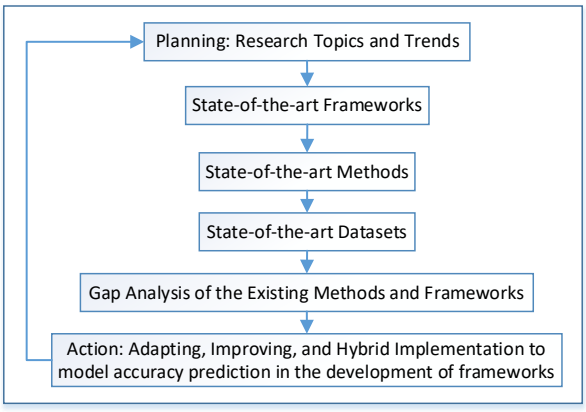

Figure 1. Research method steps

The initial stage a proposed framework in Figure 1 is to plan topics and research trends with identifying in research needs for the literature review process through state-of-the-art frameworks, methods, datasets requirements, and gap analysis of existing methods and frameworks. Action adapting, improving, and hybrid implementation to model accuracy prediction in the development of frameworks. The state-of-the-art from the literature review within the primary study is displayed in Table 1.

The literature review is in Table 1. The research [32] not shown the comparison of the accuracy and consistency of each method used with the confusion matrix. The meaning of empirical bayes has the best accuracy and consistency value that is not really visible. The standard deviation of the data distribution value in the sample data is only used to calculate the disaster-prone traffic accident rate, and there is no proof of the truth of the model used [33]. Discussion [34] is still limited to the use of an existing method, and knowledge combination has not been done as a hybrid model approach. The results of the comparison of the two methods are stated to be more accurate, but no precise accuracy value is given based on the value of the confusion matrix [35]. On research [36][MOU1] have not considered the type of road type design, for example, arterial roads, collector roads, or roads based on their nature (geometric road), there are no studies on adaptive models that can expand machine learning through a combination of online learning and deep learning [37]. Paper discussion [38] is still limited to the use of an existing method; knowledge combination has not been done as a hybrid model approach. The DTR model in conducting the prediction accuracy in this study is still a macro-level crash count [39]. The model has weaknesses in terms of data simulation because it requires accident data at the beginning of the calculation [27]. Mathematical modeling in the comparison algorithm does not exist, so the comparison of results is difficult [40]; there is no evaluation of the models offered because the test data collected does not have a long-time span [16]. MLP is more accurate for available spatial datasets but becomes very vulnerable when there is data noise that can cause errors in predictions [34]. PNN has probabilistic outputs with multilayer perceptron networks, producing fairly

accurate predictions [34]. RBF is very weak in making predictions [34]. VKT parameters proved to be the most influential in road traffic accidents, then the V/C variable and driver speed based on the RReliefF algorithm calculation method [34]. The evaluation to perform the technique, The site consistency test (SCT), The method consistency test (MCT), The total rank differences test (TRDT), and The total score test (TST) [38].

Table 1. Literature reviews a framework comparison

Framework	Model and method	Spatial datasets	Results
[32]	Model-based spatial statistical methods: Poisson regression, Negative Binomial regression, Empirical Bayesian.	The accidents, injuries, and deaths by years	In this study comparing all methods used, where Empirical Bayes has the best accuracy and consistency, recommended by the Highway Safety Manual (HSM) and the European Union Acquis
[33]	Model-based spatial statistical methods: Kernel density analysis, Nearest neighbor, K-function	Intercity accidents, accidents leading to injury, accidents leading to death, and accidents leading to damages	The observed value curve on the spatial analysis process, the value of spatial datasets is above the 5% confidence interval
[36]	Spatial analysis techniques: Nearest Neighborhood Hierarchical (NNH) Clustering, Spatial-Temporal Clustering Analysis (STAC)	Road accidents involving all types of vehicles	The results of the spatial analysis vary according to the parameter values in the spatial datasets, where is STAC has a 461,57 higher Prediction Accuracy Index (PAI) compared to NNH 163,69.
[34]	ANNs techniques: Extreme learning machine (ELM), Probabilistic neural network (PNN), Radial basis function (RBF), and Multilayer perceptron (MLP).	V/C, speed, vehicle kilometer traveled (VKT), roadway width, the existence of median, and allowable/not-allowable parking	Evaluation method using Nash – Sutcliffe (NS), mean absolute error (MAE), and root means square error (RMSE). ELM, as a feed-forward neural network, becomes the algorithm that has the best performance and the most accurate prediction results (RMSE =3,576; NS =0,81; MAE =2,5062) by randomly selecting hidden nodes using random weights.
[35]	Hot spot analysis (Getis-Ord Gi*): Network spatial weights, Kernel Density method	The traffic accident)	Hotspot analysis gives better results because it is done by considering the weight of spatial datasets
[37]	The support vector machine combines the techniques of statistical learning, machine learning, the neural networks based: Support vector machine, Deep neural network	Accident, person, vehicle, road, and environment data	They proposed a real-time online deep learning framework Based on traffic accident black spots. SVM algorithm in machine learning has 63% precision and a 61% recall rate in analyzing the black spots of traffic accidents. If the training data period is added, the SVM and deep neural network values increase by 95% and 89% accuracy, 69%, and 79% recall rates.
[38]	Black spot identification (BSID) method and Segmentation method: Empirical Bayesian (EB), Excess Empirical Bayesian (EEB), Accident Frequency (AF), Accident Rate (AR).	The traffic accident	AF method has the best performance with a consistency of 93.1% compared to EB 92.2%, and EEB 77.4%. The performance of the EEB and AR methods is the weakest in the case of segmentation in most cases of segmentation.
[39]	Machine learning techniques to prediction model: Decision tree regression (DTR) methods Regression tree framework, Ensemble techniques. Model assessment: Average Squared Error (ASE), Standard Deviation of Error (SDE)	Statewide Traffic Analysis Zone (STAZ)	The DTR model to prediction accuracy works better than the spatial DTR model. To improve prediction accuracy using ensemble techniques (bagging, random forest, and gradient boosting) with slightly better results, depending on the amount of training data.
[27]	Multicriteria decision making (MCDM) model: Weighted linear combination (WLC) method	The traffic accident Reports	The model was developed to determine the criteria weights that have been determined by experts with interest in subjective results.
[40]	Prediction model: Deep neural network model, Gene expression programming (GEP), Random effect negative binomial (RENB) models, Regular negative binomial model (FENB)	The road geometry, traffic, and road environment)	The DNN model experienced an increase in road prediction with 0.914 (RMSE =7.474) by GEP, and 0.891 (RMSE =8.862). GEP works better than RENB to measure the ranking of variables that influence accidents.
[16]	Random effects negative binomial model: Hierarchical cluster method	Real time-frequency of accident data and contributing factors	The model developed can provide information on the main causes of accidents at road intersections

3. RESULTS AND DISCUSSION

The proposed framework is based on a literature study by comparing the existing framework to determine the performance of the spatial analysis model offered for traffic accident prone roads in Table 1 and the MCDM-based framework [27], [41], [42], [43], [44][avv2]. The framework being compared includes the method used for primary study (PS) spatial analysis for accident-prone traffic roads, the spatial analysis model used, spatial datasets used to test the model through method selection, and the value of the measurement results through the assessment.

The framework that has been developed by previous researchers will be described in this section. The framework model [44], was developed to create the Maycock and Hall's accident prediction model. This model provides sensitivity analysis on modeling results using multi-objective optimization (MOO) using multi-criteria decision making for the analytical hierarchy process (AHP model). The needs primary spatial data sets in the road geometry category, the necessity secondary spatial, i.e., the numbers and types of traffic accidents, traffic and demand for structural flow, visual distance and vehicle speed, road signs, and equipment, lighting, driver behavior. The value of the multi-criteria parameters obtained will be done mathematic spatial data modeling to produce the sensitivity of spatial analysis, the results of multi-criteria optimization in the form of traffic efficiency (TS), and traffic safety (TS) to the predicted traffic accident. MOO model is measured using a consistency index (CI) and consistency ratio (CR), the model is proven to have a good structure with a value of CR≤10, or the CR value is 0.00298; this shows that the MOO model with MCDM on the AHP model has a consistent value the good one.

The [41] framework was developed by the PROMETREE-RS MCDM model. MCDM is used because it can use more than one parameter to get the best results from the alternatives produced. This model was developed to evaluate the DEA and TOPSIS methods in road safety to reduce risk the number of accidents on the road through the road safety index. The model is tested by using the Robustness of the composite index. The average correlation value, the average rank value, and the cluster variation average values will be entered into the MCDM PROMETHEE-RS to test the resulting model. Multi-criteria parameters tested in this model, i.e., the Police Department data, fatalities, serious injuries, number of inhabitants, number of registered vehicles, traffic risk, and public risk. This parameter will be used to mathematic spatial data modeling through DEA and TOPSIS, the produce optimal composite index through the value of final risk efficiency. DEA-WR provides the best ranking results compared to the DEA-based composite indicator model (DEA-CI).

The [42], [43] framework is a model built using MCDM. The purpose of this model is to create a knowledge data mining rule decision tree through FP-growth and apache spark framework. A trial model on road accident analysis, where the results have a high degree of accuracy and work well to improve road safety. The multi-parameter criteria used are the road accident data to death and injuries attribute. The testing model for the relevant association rule is done by testing and validation by measuring quality measurement. MCDM model involves many criteria, so it is suitable to overcome the problem of accident-prone road section (APRS) on the type of horizontal alignment, vertical alignment, intersections, significant places, and shoulder widths with an accuracy value of 0.8830 for threshold values 1 [27].

The proposed framework in previous research will be used by the author as a reference in developing further activities of the framework that will be proposed. The framework of the research proposed in Figure 2 has the main differences from the existing framework. Prepare data requirements for spatial datasets as primary and secondary spatial datasets in determining the road categories to be studied (using a private or public spatial dataset type). Perform a literature study relating to multi-criteria parameters used on each road category. Mathematics modeling for spatial analysis to the proposed framework for hybrid estimation model-based on a combination of MCDM-ANNs multi-class classification. In this case, the pre-processing data process will run for the classification analysis process. The range of classification will be performed through mathematical modeling using the Guttman method. The results of the multi-class classification will be validated with SCT, MCT, and ARC validation. Focuses on the propose a classification of roads prone to accidents using multiple criteria parameters (data series), make modeling of road prone to accidents by calculating the value of traffic accident by type of events and the index of the accidents, the density that of roads traffic accident happened to each zone and the amount of data in each year, risk factors based on the severity of the accidents, severity of roads traffic accident events, crash prediction models using data series, and the value of the societal cost of each type the accident. The ANN strategy has the most noteworthy rating of techniques that are regularly utilized in the literature review in essential considers. The empirical Bayes method and decision tree in data mining are also broadly used within the clustering category in spatial information modeling of accident-prone zones. This considers a proposed framework of classification used a hybrid estimation model based on a combination of MCDM-ANN classification. Test the consistency of the method from the model produced with the MCT, SCT, and the value of ARC model evaluations. ANNs classification methods are the most popular data mining techniques in the field spatial

analysis of accident-prone roads and the factors that affect the accident rate, among others (neural networks, extreme learning machines, k-nearest neighbor, naive bayes, decision trees) [45], [31].

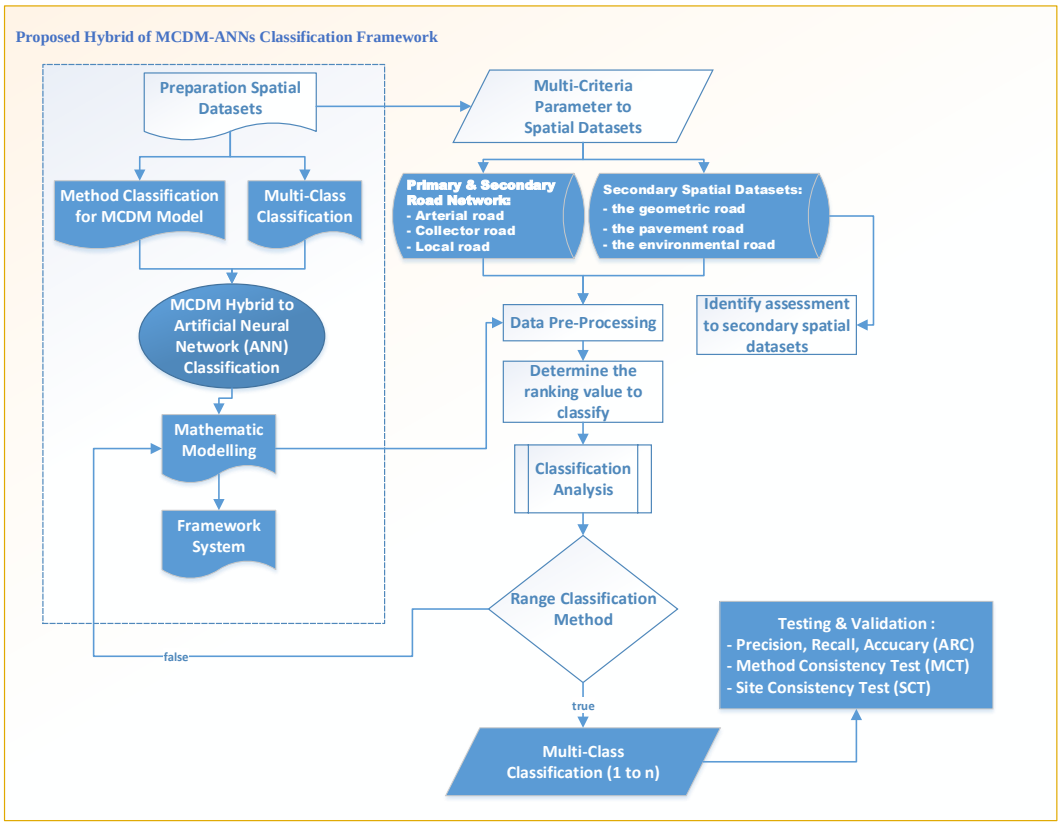

Figure 2. Proposed hybrid of MCDM-ANNs classification framework to evaluate and rank spatial analysis model traffic accident prone roads

4. CONCLUSION

The proposed framework in this study will act as a model-based hybrid estimation approach on a combination of MCDM-ANNs classification to strengthen data mining techniques in spatial multi-criteria analysis in multi-class classification decision making. In the literature review on the primary study, there are no research topics that discuss on the traffic accident-prone roads classification on the arterial road, collector road, and type of road based on its nature (pavement, geometry, and local road) categories. The spatial analysis model using MCDM among others, analytic hierarchy process (AHP), analytical network process (ANP), weighted sum model (WSM), weighted product (WP), weight product model (WPM), simple additive weighting (SAW), technique for order preference by similarity to ideal solution (TOPSIS), preference ranking organization method for enrichment of evaluations (PROMETHEE), multi-attribute utility theory (MAUT), elimination and choice expressing reality (ELECTRE), and vlsekriterijuska optimizacija i komoromisno resenje (VIKOR). The results of the best methods through APR measurement will be a reference in decision making in road management. Existing research is still limited to one type of road used as an object (specific region), and 96% is used private spatial datasets. In this study, it was using an Inductive qualitative approach in the modeling of road prone to accidents to identify the findings of science that is done during the research process. The proposed a classification of roads prone to accidents using multiple criteria parameters, make a modeling of road prone to accidents calculating by the value of traffic accident by type of events and the index of the accidents, the value of the density that of roads traffic accident happened to each zone and the amount of data in each year, the value of risk factors based on the severity of the accidents, the value of severity of roads traffic accident events, the value of crash prediction models, the value of the societal cost of each type the accident, and the test result is using the method the SCT, the MCT, and APR.

ACKNOWLEDGEMENTS

This research is supported by Universiti Teknikal Malaysia Melaka, Malaysia, and Universitas Dr. Soetomo, Indonesia. The development of results of a study funded by The Directorate General of Strengthening Research and Development of Research, Technology, and Higher Education Ministry-Indonesia in 2015-2016.

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BIOGRAPHIES OF AUTHORS

Anik Vega Vitianingsih. A bachelor's degree in Informatics Engineering in 2004 and a Master's Degree in Game Tech was obtained in 2011. The author is a Permanent Lecturer in the Informatics Department, editor in chief of the International Journal of Artificial Intelligence and Robotics Universitas Dr. Soetomo, and students in the Ph.D. at the Faculty of Information and Communication Technology (FTMK), Universiti Teknikal Malaysia Melaka, Malaysia. The field of interest in Spatial Analysis, and Spatial Data Modeling, Artificial Intelligence in Geographical Information Systems. Experiences in writing papers according to their fields in the Scopus Journal include 2019-International Journal of Intelligent Engineering and Systems, 2019-Data in Brief, 2018-International Journal of Engineering and Technology (UAE), 2018-Journal of Telecommunication, Electronic and Computer Engineering. The author has been a reviewer for Taylor and Francis Ltd publishers, including the Journal of Transportation Safety and Security, IETE Technical Review (Institution of Electronics and Telecommunication Engineers, India), and International Journal of Injury Control and Safety Promotion, as well as a reviewer on the International Social Science Journal Publisher Wiley-Blackwell Publishing Ltd.

Prof. Dr. Nanna Suryana Herman. Professor at the Faculty of Information and Communication Technology (FTMK), Universiti Teknikal Malaysia Melaka, Malaysia. Bachelor's degree in Soil and Water Engineering from Padjadjaran University, Bandung, Indonesia. Master's degree in Computer Assisted Regional Planning at the International Institute for Geoinformatics and Earth Observation (ITC), Enschede, The Netherlands. Doctoral Degree in Department of Remote sensing and GIS, Research University of Wageningen, Holland. His research interests are spatial data analytics, image processing, and spatial modeling, and remote sensing. Active as the Editorial Board of International Journals, member of The ASEAN European Academic University Network (ASEA-UNINET), and EURAS-Eurasian Universities Union.

Zahriah Othman. Lecturer at the Software Engineering department, Faculty of Information and Communication Technology, Universiti Teknikal Malaysia Melaka. Bachelor's degree in Information Technology from Universiti Utara Malaysia in 2001. In 2003 he received a master of science degree in Software Engineering from the School of Informatics, Department of Computing, and University of Bradford, United Kingdom. Ph.D. in Computer Science from Universiti Teknikal Malaysia Melaka, Malaysia. His areas of research interest are Software Engineering, Artificial Intelligence, and information retrieval, specifically on terminology disagreement in retrieving geospatial data.

7) Sertifikat publish (30 September 2021)

Intelektual Pustaka
Media Utama

Institute of Advanced Engineering and Science

Scopus indexed
CiteScoreTracker 2021: 1.6 | h-index: 8
(Last updated on 04 August, 2021)

SJR SCImago Journal & Country Rank
Q2 Electrical and Electronic Engineering
SJR 2020 0.341 | SNIP 2020 1.276 | CiteScore 2020 1.6

CERTIFICATE

No. 20855/IJAI/A/09/2021

IAES International Journal of Artificial Intelligence

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Spatial analysis model for traffic accident-prone roads classification: a proposed framework

for Vol 10, No 2: June 2021

ISSN 2089-4872
http://ijai.iaescore.com

Yogyakarta: September 30, 2021

Tole Sutikno
Managing Director, journals