Preface: Human-Dedicated Sustainable Product and Process Design: Materials, Resources, and Energy

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Preface: Human-Dedicated Sustainable Product and Process Design: Materials, Resources, and Energy

Proceedings of the 4th International Conference on Engineering, Technology, and Industrial Application (ICETIA) 2017

International Conference on Engineering, Technology and Industrial Application (ICETIA) is an international conference organized annually by the Engineering Faculty of Universitas Muhammadiyah Surakarta (UMS), known as the biggest private university in Central Java, Indonesia. The 4th ICETIA has been successfully held on 13-14 December 2017 at Alila Hotel, Surakarta, Central Java, Indonesia, attracting more than 300 participants.

This year's conference brought a theme of Human-Dedicated Sustainable Product and Process Design: Materials, Resources, and Energy. It provided an excellent atmosphere for academicians, researchers, industrial professionals and government bodies to share ideas and any breakthrough in terms of materials, resources and energy aiming at establishing sustainable industrial development.

The committee received more than 200 papers, 174 of which were selected and presented in the conference. In these proceedings, the papers are then organized by grouping them into five sub-themes namely: (i) Sustainable Industrial Process and System Optimization, (ii) Product Design, Material and Building Engineering, (iii) Sustainable Infrastructure and Built Environment, (iv) Preservation, Conservation and Water Management, (v) Green Energy and Computing. It is expected that materials presented in these proceedings contribute constructively to create sustainable products and processes beneficial to humans.

Surakarta, Indonesia

7 March 2018

Human-Dedicated Sustainable Product and Process Design: Materials, Resources, and Energy
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Event Schedule

The 4th International Conference on Engineering, Technology, and Industrial Application (THE 4TH ICETIA)

Hotel Alila Solo
Wednesday, December 13, 2017

Time	Program
07.30 - 08.30	Registration
08.30 - 09.00	Opening Ceremony
09.00 - 09.45	Plenary Lecture 1
09.45 - 10.00	Coffe Break
10.00 - 10.45	Plenary Lecture 2
10.45 - 11.30	Plenary Lecture 3
11.30 - 12.30	Luncheon
12.30 - 14.45	Oral Presentation - Parallel Session I
14.45 - 15.00	Coffe Break
15.00 - 17.00	Oral Presentation - Parallel Session II
17.00 - 17.30	Closing Ceremony

PAPER PRESENTATION SCHEDULE
The 4th International Conference on Engineering, Technology, and Industrial Application
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Room: Meeting Room 1
Moderator:

No	Time	Paper ID	Author	Title
1	12.30 - 12.45	119	Moh. Zaenal Efendi, Suhariningsih, Evi Inawati	Implementation of Modified P&O Method as Power Optimizer of Solar Panel under Partial Shading Condition for Charging Battery System
2	12.45 - 13.00	134	FIFI HESTY SHOLIHAH, DIAH SEPTI YANARATRI	Application of A Symmetrical Cascaded H-Bridge Multilevel Inverter with Modified Separated DC Sources (SDCS) in Centralized Solar Power Plant
3	13.00 - 13.15	144	ARIF SETYO NUGROHO, RAHMAD, MOCH CHAMIM	PLASTIC WASTE USE ONE OF ALTERNATIVE RENEWABLE ENERGY
4	13.15 - 13.30	191	Dan Mugisidi, Oktarina Heriyani, Zeinab S. Abdel-Rehim, Hamdi Fathurrohman	The Influence of Container Material Conductivity to Sea Water Evaporation
5	13.30 - 13.45	200	Arrad Ghani Safitra, Naili Husna Dewi, Lohdy Diana	Experimental Study on V-Corrugated Solar Air Heater with Various V-Angle
6	13.45 - 14.00	220	Joko Waluyo, IGBN Makertihartha, Herri Susanto	Intermediate pyrolysis of palm kernel shell: effect temperature and catalyst on production yield
7	14.00 - 14.15	232	Sutomo	Outlet Model of Coaxial Vacuum Tube Solar Collector on Ethanol Distillation
8	14.15 - 14.30	239	Mokhammad Fahmi Izdhiharrudin, Selvy Uftovia Hepriyadi, Muhammad Husain Amir, Ridho Hantoro	Solar Dryer and Photovoltaic for Fish Commodities Case Study : Fishery Community at Kenjeran Surabaya
9	14.30 - 14.45	258	Rochim B Cahyono, Muslikhin Hidayat, Tomohiro Akiyama	Tar Decomposition over Porous Low Grade Iron Ore

	14.45 - 15.00		Coffe Break	
10	15.00 - 15.15	282	A Agus Wibowo, I.N.G Wardana, Slamet Wahyudi, Denny Widhiyanuriyawan	A Comparative Analysis of Spray Combustion of Kapok Seed Oil and Jatropha Oil
11	15.15 - 15.30	285	Jamal, Lewi	Utilization of Irrigation Flow for Construction of Micro-hydro Power Plant
12	15.30 - 15.45	286	Abram Tangkemanda, Tri Agus Susanto, Jamal	Analysis of Effect the Angle of Collector Slope on the Performance of Solar Water Heater
13	15.45 - 16.00	311	Nur Hidayati, Muhammad Mujiburohman, Hamid Abdillah, Herry Purnama, Arnaldi Dwilaksita, Fara R. Zubaida, Azhari Kahfi	Chitosan-ABS Membrane for DMFC: Effect of Sulfonation Time and Mass Ratio of Chitosan and ABS
14	16.00 - 16.15	321	Hari Prasetyo, Anandistya Lisa Putri, Gusti Fauza	Biased random key genetic algorithm design with multiple populations to solve capacitated vehicle routing problem with time windows
15	16.15 - 16.30	322	Gusti Fauza, Hari Prasetyo, Nyndia K Dania, Bambang S Amanto	Development of Food Inventory Model in an Integrated Vendor-Buyer System: Case Study in Food Industry

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Room: Meeting Room 2
Moderator:

No	Time	Paper ID	Author	Title
1	12.30 - 12.45	115	Iqbal Yulizar Mukti, Yudha Prambudia, Nissa Syifa Puspani	Challenges In Realizing IoT Based Smart City
2	12.45 - 13.00	142	Tri Listyorini	3D Hologram Introduction of Solar System Based on Android
3	13.00 - 13.15	175	Andie Setiyoko, Ruci Meiyanti, Nurbojatmiko, Syamsudin, Dana Indra Sensuse, Handrie Noprisson	Satellite Image Catalog System Improvement Based on Process Innovation Method
4	13.15 - 13.30	190	I Putu Susila, Istofa, Gina Kusuma, Sukandar, Ismet Isnaini	Development of a meteorological and environmental gamma radiation monitoring system based on IoT
5	13.30 - 13.45	192	Nunik Purwaningsih, Diana Ross Arief	Predicting Students' Performance in English Class
6	13.45 - 14.00	194	David Mushthofa, Mira Kania Sabariah, Veronikha Effendy	Modelling The User Interface Design Pattern for Designing Islamic E-Commerce Website Using User Centered Design Method
7	14.00 - 14.15	197	Almed Hamzah	The Exploration Through the Factors Affecting Studentsâ€™ Adoption on m-Learning Technologies
8	14.15 - 14.30	204	Esa Pawenang Panjiwa Putra, Bobby A. A. Nazief	Analysis of Main Cause Factors and Improvement Recommendation of IT Disaster Recovery Problems: A Case Study XYZ Organization
9	14.30 - 14.45	215	Purwanto Purwanto, Sunardi Sunardi, Fenty Tristanti Julfia	Neural Network Model Based on Data Preprocessing Technique for Foreign Tourists Prediction
	14.45 - 15.00		Coffe Break	

10	15.00 - 15.15	227	Fendi Aji Purnomo, Nanang Maulana Yoeseph, Berliana Kusuma Riasti, Ryan Wahyu Anggara	Water Level Detector for Early Warning Systems Using Color Difference Measurement
11	15.15 - 15.30	240	Ulfah Ranida Sari, Mira Kania Sabariah, Veronikha Effendy	Information Architecture Design for Travel Website using Top-Down Approach on Card Sorting Method
12	15.30 - 15.45	244	Budi Yulianto, Setiono	Implementation of Android-Based Urban Freight Transport Violations Reporting Application in Surakarta City
13	15.45 - 16.00	250	Rahadian Kurniawan, Erika Ramadhani, Restu Rakhmawati, Dimas Panji Eka JP	m-Health Based Technology for Handling Cancer in Women: literature review
14	16.00 - 16.15	271	Farida Yunita, Pranowo, A. Joko Santoso	Hybrid Model of Particle Swarm Optimization and Ant Colony in Lecture Scheduling Preparation
15	16.15 - 16.30	287	M. Khairudin, Efendi, N. Purwatiningsih, W. Irawan	Implementation of a Silicon Controlled Rectifiers for a DC Motor Control
16	16.30 - 16.45	291	Yuslena Sari, Muhammad Alkaff, Ricardus Anggi Pramunendar	Iris Recognation Based On Distance Similiarity And PCA
17	16.45 - 17.00	298	Rosdanelli Hasibuan, Muhammad Bairuni	Mathematical Modeling of Drying Kinetics of Ginger Slices
18	17.00 - 17.15	307	Prihatin Oktivasari	Smart Trash Based on Android
19	17.15 - 17.30	312	Heri Ardiansyah, Muhammad Rivai, Luhur Prihadi Eka Nurabdi	TRAIN ARRIVAL WARNING SYSTEM AT RAILROAD CROSSING USING ACCELEROMETER SENSOR AND NEURAL NETWORK

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Room: Meeting Room 3
Moderator:

No	Time	Paper ID	Author	Title
1	12.30 - 12.45	102	Muh Amin, Muhammad Subri	Preparation and Properties of Porous Clay/CuZn Composite Produced by Extrusion Process
2	12.45 - 13.00	107	Moh. Hardiyanto	New Approaching of Thx DSrU2-x Nano-materials on Abrikosov-Balseiro-Russell (ABR) Model at 525 tesla Super Gyro-Magnetic
3	13.00 - 13.15	111	Samsudi Raharjo	Controlling Of Magnesium Carbonate Scale Deposition On The Piping System With Laminar Flow And In The Presence Of Alumina
4	13.15 - 13.30	112	Wiwik Purwadi, Beny Bandanadjaja, Ari Siswanto, Dewi Idamayanti	Spotwelding of Bimetallic Punch Made of White Cast Iron-Nodular Cast Iron
5	13.30 - 13.45	118	Prasetyo MT, Solechan	Efectiveness of Natural Stone with Silica Utilization, Silane, and Vinyl Silane as Filler Isolation of Vacuum Composite Resin Epoksi for Electrical Isolator
6	13.45 - 14.00	123	Joko Yunianto Prihatin	STUDY OF FLUIDS PRESSURE HYDRAULIC PRESS MACHINE 10 TON USE ARRAY ORTHOGONAL L8
7	14.00 - 14.15	124	Aulia Rahman, Januarti Jaya Ekaputri, Triwulan	Chemical and Physical Properties of Indonesian Fly Ash Paste
8	14.15 - 14.30	127	Sri Mulyo Bondan Respati, Rudy Soenoko, Yudy Surya Irawan, Wahyono Suprapto, Denny Kristianto Wicaksono, Helmy Purwanto	The Effect of the Palm Fibers Addition on Density, Porosity, Water Discharge and TDS of the Natural Zeolite Ceramic
9	14.30 - 14.45	148	Ignatius Henry Adi Nagoro, Triyono	Effect Of Pre-Strain On The Strength Of Welded Joint

	14.45 - 15.00		Coffe Break	
10	15.00 - 15.15	151	Hilfi Harisan Ahmad,Tavio	Experimental Study of Cold â€“ Bonded Artificial Lightweight Aggregate Concrete
11	15.15 - 15.30	153	Purnomo, Putu Hadi Setyarini	Zeolite-Based Biomaterials for Biomedical Applications: A Review
12	15.30 - 15.45	162	Winarto, Herry Oktadinata	Microstructure and Hardness Properties of Butt and Fillet GMAW Welded Joints on HY80 High Strength Steel Plate
13	15.45 - 16.00	163	Dewin Purnama, Winarto and Ferdy Hendarto Susilo	Mechanical Properties of Underwater Wet Welded Marine Steel Plates Using Different Low Hydrogen Electrodes
14	16.00 - 16.15	174	Rohmadi, Supriyono, Agus Dwi Anggono	Design and Static Analysis of Outer Rear Door Dies of Rajawali R2 SUV By Using CATIA V5
15	16.15 - 16.30	178	Abdul Hamid, Nurhatisyah, Nurhasan, Agung Setyo Darmawan, Muhammad Fitri, Basuki Rahmat	Mechanical and Physical Properties Improvement of Welded Carbon Steel S275J2
16	16.30 - 16.45	182	Reza Putra, Muhammad, Syifaul Huzni, Nurdin Ali, Syahrizal Fonna	Effect Of Soil Resistivity In Mapping Potential Corrosion In Underground Pipelines Area
17	16.45 - 17.00	128	Agung Setyo Darmawan, Tri Widodo Besar Riyadi, Abdul Hamid, Bambang Waluyo Febriantoko, Budi Satria Putra	Corrosion Resistant Improvement of Aluminum under Anodizing Process
18	17.00 - 17.15	238	Senja Rum Harnaeni, F. Pungky Pramesti, Arif Budiarto, Ary Setyawan	The Effect of Temperature Changes at Mechanistic Performance of Hotmix Asphalt as Wearing Course with Different Type Gradation
19	17.15 - 17.30	241	Tri Widodo Besar Riyadi, Bagus Radiant Utomo, Sarjito, Irianto, Suprapto, Tjipto Sujitno	Effect of Sputtering Times on the Properties of NiCr-Al

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Room: Meeting Room 4
Moderator:

No	Time	Paper ID	Author	Title
1	12.30 - 12.45	183	Zulhanif, Mohammad Badaruddin	Low Cycle Fatigue Properties of Extruded 6061-T6 Aluminum Alloy
2	12.45 - 13.00	186	Paryanto Dwi Setyawan, Sugiman, Julkarnain, Achmad Swarha Lingkar	Effect of Bamboo Fiber Length in Opened Cell Foam Core Sandwich Composite on Water Absorption and Their Mechanical Properties
3	13.00 - 13.15	187	S. Hadi Suryo, A.P. Bayuseno, J. Jamari, M. Arief Rahmat R	Analysis Of Material Power Of Aisi 4140 Bucket Teeth Excavator Using Influence Of Abrasive Wear
4	13.15 - 13.30	195	Rosyida Permatasari, Adhi Muhammd Yusuf	MATERIAL SELECTION FOR SHELL AND TUBE EXCHANGER USING CFD METHOD
5	13.30 - 13.45	216	Indah Widiastuti, M. Solikhun, Dwi Noor Cahyo, Yuniar Ratna Pratiwi, Heri Juwantono	Treatment of Bamboo Fibres in Improving Mechanical Performance of Polymer Composites – A Review
6	13.45 - 14.00	223	Jamiatul Akmal, Shirley Savetlana, Beby Theta Dertiny	Hoop Tensile Strength of Coal Fly Ash Based Geopolymer Composite Reinforced With Fiberglass
7	14.00 - 14.15	237	Arif Budiarto	THE ACCURACY OF FILLER DETECTION AT EACH AGGREGATE FRACTION THROUGH WET SIEVE ANALYSIS SYSTEM TO REDUCE THE RISK ON WEARING COURSE OF ASPHALT MIXURE
8	14.15 - 14.30	251	Arif Budiarto	THE INFLUENCE OF REPLACEMENT OF COURSE AGGREGATE MATERIAL WITH CRUSH STONE TO THE CBR VALUE ON AGGREGATE CLASS B
9	14.30 - 14.45	256	Ulfa Fitriati, Lailan Ni'mah, and Agus Suryani	RIVER WATER FILTRATION WITH FRESH COCONUT TRUNK
	14.45 - 15.00		Coffe Break	

10	15.00 - 15.15	257	Fendy Aristo Kusnadi, Rochim B Cahyono	Reduction of Indonesia Iron Ore using Biomass Palm Kernel Shell Charcoal: Effect of Residence Time
11	15.15 - 15.30	265	Ilham Taufik Maulana, Andy Permana Rusdja, Eko Surojo, Nurul Muhayat, Wijang Wisnu Raharjo	Effect of the cantala fiber on flexural strength of composite friction brake
12	15.30 - 15.45	277	Sudarmoyo, Boni Swadesi, Aulia Novi Andini, Septoratno Siregar, Rani Kurnia, Ari Buhari, I G S Budiaman	Laboratory Study: The Development of a Sodium Lignosulfonate (SLS) Surfactant Formulation for Light Oil Reservoir To Improve Oil Recovery
13	15.45 - 16.00	283	Adriana, Ramzi Jalal, Yuniati	Mechanical Properties of Nanocrystal Cellulose Reinforced Polystyrene with Glycerol Monostearic as Antistatic Agent
14	16.00 - 16.15	295	Ida Ayu Made Budiwati, Made Sukrawa	Numerical Study on Seismic Behaviour of Reinforced Concrete Structures with Steel Brace and Infill Wall
15	16.15 - 16.30	300	Binyamin, Sarjito	Investigation of Aluminum Alloy for Lightweight of Outer Hood Panel of Local Compact SUV Using Finite Element Modeling
16	16.30 - 16.45	304	Shirley Savetlana, Irza Sukmana, Agus Hendriyanto, Tri Cahyo Wahyudi	The Effect of Sintering Time and Temperature on the Characteristic of Hidroxiapatite (HA) made of Limestone for Application in Bone
17	16.45 - 17.00	309	Muh Alfatih Hendrawan, Pramuko Ilmu Purboputro	Influence of Zinc on Mechanical Behavior of Dissimilar Aluminum and Stainless-Steel Resistance Spot Welding
18	17.00 - 17.15	310	Mochamad Solikin, Naufal Ikhsan	STYROFOAM AS PARTIAL SUBSTITUTION OF FINE AGGREGATE IN LIGHTWEIGHT CONCRETE BRICKS

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Room: Meeting Room 5
Moderator:

No	Time	Paper ID	Author	Title
1	12.30 - 12.45	110	Siti Asmaniyah Mardiyani, Soemardi Hadi Sumarlan, Bambang Dwi Argo, Amin Setyo laksono	Determination of Physical and Thermophysical Characteristics of Red Peppers (Capsicum Annum) Using an
2	12.45 - 13.00	158	Fendi Aji Purnomo, Eko Harry Pratisto, Alvin Reza Mahendra Putra	Evaluation of Serious Game Based at Bukuran Cluster of Museum Sangiran
3	13.00 - 13.15	263	Dian Ariestadi, Antariksa, Lisa D. Wulandari, Surjono	Identification of Comunal Space in Historical Multi-Ethnich City of Gresik
4	13.15 - 13.30	267	Cucuk Budiyanto, Indah Widiastuti	Hands-on Learning on Renewable Energy â€“ a Proposed Approach for Technology
5	13.30 - 13.45	292	Yuslena Sari, Muhammad Alkaff, Ricardus Anggi Pramunendar	Classification of coastal and inland batik using GLCM and Canberra distance
6	13.45 - 14.00	113	Mohammed Ali Berawi, Perdana Miraj, Ega Religia Islamiah	Evaluating Port Cities Development Using Life Cycle Cost Approach
7	14.00 - 14.15	114	Mohammed Ali Berawi, Perdana Miraj, Abdur Rohim Boy Berawi, Kristy Mikaelse	Improving Toll Road Feasibility: Route Planning and Financial Modeling
8	14.15 - 14.30	117	Andri IRFAN, Ronal Al Rasyid, Susanty Handayani	Data Mining Applied for Prediction of Traffic Accident in Indonesia Toll Road
9	14.30 - 14.45	132	Budi Yulianto	Micro-Simulation VISSIM Model Viaduct Gilingan and Underpass Gilingan Surakarta
	14.45 - 15.00		Coffe Break	

10	15.00 - 15.15	150	Zakiah Hidayati, Mafazah Noviana	Non-Structural Measures for Landslide (Creeping Type) in Selili Hill Samarinda
11	15.15 - 15.30	154	Yusroniya Putri, Trijoko Wahyu Adi, Harun Alrasyid	Owner Estimate Model and Approximate Bid Price of Box Culvert Standardization
12	15.30 - 15.45	198	Deni Setiawan, Reini Wirahadikusumah, Krishna S. Pribadi3, Harun Al Rasyid Lubis	Overview of Dominant Risk for National Road Maintenance Project in Indonesia Under Performance Based Contracts:
13	15.45 - 16.00	202	Untung Rusmanto, Syafi'i, Dewi handayani,	Structural and Functional Prediction of Pavement Condition
14	16.00 - 16.15	224	Henri Siswanto, Bambang Supriyanto, Pranoto, Yusuf Akbar Megi Putra, Alfian Syahrul Huda	Evaluation of Road Maintenance Priority Using PCI and Road Note 1 For Indonesian District Road
15	16.15 - 16.30	231	Setiono, Wibowo, Sofa Marwoto	Application of Concrete Bridge Investigation Based on Fuzzy Expert
16	16.30 - 16.45	253	Rudi Sugiono Suyono	Developing of Modified Fuzzy Multi Actor
17	16.45 - 17.00	279	Safrilah, Jouvan Chandra Pratama Putra, M. Ihsan	THE DEVELOPMENT OF DRIVING BEHAVIOR QUESTIONNAIRE TO
18	17.00 - 17.15	294	Hana Wardani Puruhita	Research on the Readiness Of Contractor Companies In Building Projects to

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Room: Meeting Room 6
Moderator:

No	Time	Paper ID	Author	Title
1	12.30 - 12.45	125	Desyta Ulfiana, Nadjadji Anwar, Wasis Wardoyo	Model Test Variations of Baffled Block Installation Pattern in Energy Dissipator USBR type III for Reduce Flow Energy
2	12.45 - 13.00	131	Nurul Jannah Asid, Wasis Wardoyo	Detection Head Loss of Piped Irrigation System in Agropolitan Poncokusumo Malang
3	13.00 - 13.15	155	Hendra Putra Sudradjat, Umboro Lasminto, Edijatno	Determination of Discharge Coefficient On Linear Spillway and Multi Half-Circulars Spillway
4	13.15 - 13.30	157	Novitasari, Joko Sujono, Sri Harto, Azwar Maas, Rachmad Jayadi	Restoration of Peat Dome in Ex-Mega Rice Project Area in Central Kalimantan
5	13.30 - 13.45	168	Angela Jasmine Tanya Tjahyana, Umboro Lasminto	Study the Change of Width and Depth of Channel to Precipation Sediments in Box Culvert by SSIIM
6	13.45 - 14.00	173	Prayitno, Hadi Saroso, Hardjono, Sri Rulianah	The performance of AF2B/Ozon reactor in Treating of Hospital Wastewater
7	14.00 - 14.15	184	Eva Rolia, Dwita Sutjiningsih, Herr Soeryantono	Application Of Geoelectric Method For Groundwater Exploration From Surface (A Literature Study)
8	14.15 - 14.30	255	Fitria, Dwita Sutjiningsih, Titin Siswantining	The Modelling Study of Well Water Quality in Urban Area (A LiteratureStudy)
9	14.30 - 14.45	306	Ifiginia, Purwanti Sri Pudyastuti, Kuswartomo, Nurul Hidayati	The Analysis of Backwater Impact on the Increasing of Floodwater Level in River Palu
	14.45 - 15.00		Coffe Break	
10	15.00 - 15.15	156	Mochamad Yusuf Santoso, Sryang Tera Sarena	Muffle Furnace Temperature Control Design for Rice Husk Ash Burning Based on Fuzzy Gain Scheduling - PID

11	15.15 - 15.30	170	Isti Pudjihastuti, Siswo Sumardiono, Edy Supriyo, Heny Kusumayanti	Quality Of Analog Rice Composite Flour: Modified Starch, Colocasia Esculenta, Canna Edulis Ker High Protein
12	15.30 - 15.45	179	Naniek Utami Handayani, Ary Arvianto, Yuanita Sesariana	Design of Transportation System of Humanitarian Aids Logistic Using Algorithm Variable Neighborhood Search Method (VNS): Case Study in Merapi Eruption
13	15.45 - 16.00	193	Firstname Dea, Dana Lestari Firstname Djoko, Budiyanto Setyohadi Firstname Suyoto	Alternative Selection Scenarios Of Oil And Gas Using Fuzzy Analytical Hierarchy Process (FAHP)
14	16.00 - 16.15	314	Jaji Abdurrosyid, Gurawan Djati Wibowo, Ika Setiyaningsih, Pembra Juned Adipura	INFLUENCE OF BAFFLE BLOCK AND WEIR DOWNSTREAM SLOPE ON STILLING BASIN OF SOLID ROLLER BUCKET TYPE ON HYDRAULIC JUMP AND ENERGY Dissipation
15	16.15 - 16.30	320	Ida Nursanti, Ekalia Yanasari Putri	Water Footprint Assessment of Indonesian Batik Production

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Room: Meeting Room 7
Moderator:

No	Time	Paper ID	Author	Title
1	12.30 - 12.45	133	Fatimah Nur Hidayah	Design of Crack Detection on Concrete Built Infrastructure Based on Fiber Optic Sensors
2	12.45 - 13.00	135	Arief Alihudien	Potential Analysis Of Liquifaction Areas Near Puger Beach Jember East Java Using CPT Data
3	13.00 - 13.15	159	Anik Ratnaningsih, Yeny Dokhikah, Annisa Fitria	HAZARD IDENTIFICATION, RISK ANALYSIS AND RISK ASSESMENT ON THE HIGH RISE BUILDING CONSTRUCTION PROJECT
4	13.15 - 13.30	164	Dadang Iskandar, Sigit Pranowo Hadiwardoyo, Raden Jachrizal Sumabrata	Road Maintenance Strategy with Characteristics of Drainage Condition Based on Pavement Performance and User Cost
5	13.30 - 13.45	185	Rr. M. I. Retno Susilorini, Djoko Suwarno, Budi Santosa, Ludfi Hardian Putra, Erik Kurniawan	Rebound Hammer Test Result of Old Repaired Masonry Wall Using Premixed Mortar Additive in Tidal Flooding Prone Area
6	13.45 - 14.00	196	Ringgy Masuin, Yusuf Latief, T. Yuri Zagloel, Leni Sagita	Model Integrated Management System To Achieve Sustainable Construction - A Conceptual Framework
7	14.00 - 14.15	245	Budi Yulianto	Detector Technology for Demand Responsive Traffic Signal Control Under Mixed Traffic Conditions
8	14.15 - 14.30	248	Asnawi Lubis, Jamiatul Akmal	Strength and Structural Integrity Assessment of Fillet Weld Attachment Junction on Cylindrical Pressure Vessels
9	14.30 - 14.45	261	Alfia Magfirona, Nurul Hidayati, Sri Sunarjono	Review of Traffic Safety Management on Toll Road
	14.45 - 15.00		Coffe Break	

10	15.00 - 15.15	262	Ferry Rusgiyarto, Ade Sjafruddin, Russ Bona Frazila, Suprayogi and Jzolanda Tsavalista Burhani	Inland Container Depots Effect for Import Container Terminal Performance at Koja Container Terminal, Jakarta based on Optimization â€“ Simulation Model
11	15.15 - 15.30	278	Effy Hidayaty, Herlien D. Setio, Adang Surahman, Muslinang Moestopo	Energy Dissipation of Viscous Wall Dampers in Steel Frame
12	15.30 - 15.45	280	Mohammad Ihsan, Safrilah, Jouvan Chandra P.P, Fatin Adriati	The Influence of Water Fluctuation on Slope Stability using Strength Reduction Method on Coupled Hydro-Mechanical Model
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17	16.45 - 17.00	290	Anggun Fadhlin Librianti, Putri Ayu Rahayu, Abdi Suryadinata Telaga	Knowledge-Sharing Culture Readiness Analysis aAs aA Preliminary Stage of To Build Knowledge Management System (case study in Astra Manufaturing Polytechnic)
18	17.00 - 17.15	313	Purwanti Sri Pudyastuti, Nurmuntaha Agung Nugraha	Climate Change Risks to Infrastructures: A General Perspective

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(THE 4TH ICETIA)

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3	13.00 - 13.15	137	Buchari, ST, M.Kes Dr. Ir. Nazaruddin, MT Ir. Nurhayati Sembiring, MT	Work Environment Engineering By Using HIRARC (Hazard Idenfitication, Risk Assessment and Risk Control) and 5S Method
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5	13.30 - 13.45	160	Novi Maulida Ni'mah and Lulu Mari Fitria	The Resilience of Yogyakarta Urbanized Area: Perspective of Policy for Disaster Risk Reduction
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9	14.30 - 14.45	207	Mochamad Sahrul Aripin, Anis Rahmawati, Taufiq Lilo Adi Sucipto	Implementing Energy Efficiency and Conservation in Green Home as Learning Media for Vocational Building Engineering in Indonesia
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16	16.30 - 16.45	252	Mohammad Sulton, Imam Alfianto, Astri Anindyasari	Energy Performance Of The Vocational High School Building For The Convenience Of Thermal And Lighting Comfort In Medan
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18	17.00 - 17.15	269	Santi, Hapsa Rianty, Siti Belinda Amri	Identification of Surface and Ambient Temperature to Review the Potential Green Open Space in Urban Area
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4	13.15 - 13.30	121	R Rifano, MA Ivananda, R Ismail, H Prastawa, AP Bayuseno	Ergonomic Analysis on Driver Seat of Electric Car and its Comparison with LCGC Car Seat
5	13.30 - 13.45	126	Gervasius Herry Purwoko, Tri Novianto Puji Utomo, Wina Christina	Lurik Weaving Fabrics As an Aesthetic Element in Furniture Design
6	13.45 - 14.00	130	Trio Setiyawan, Rifky Ismail, A.P. Bayuseno	The Electric Car Battery Analysis towards Various Types of Main Lighting
7	14.00 - 14.15	146	Yansen Theopilus, Thedy Yogasara, Johanna Renny Octavia	Using Persuasive-Universal Design Model for Creating User Experience in Product to Solve Behavior Problems.
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2	12.45 - 13.00	140	Renita Manurung, Aulia Arief, Gilang Ramadhan Hutauruk	Purification Of Red Palm Biodiesel By Using K2CO3 Based Deep Eutectic Solvent (DES) With Glycerol As Hydrogen Bond Donor (HBD)
3	13.00 - 13.15	141	Renita Manurung, Gilang Ramadhan Hutauruk, Aulia Arief	Vitamin E Extraction From Red Palm Biodiesel By Using K2CO3 Based Deep Eutectic Solvent With Glycerol As Hydrogen Bond Donor
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7	14.00 - 14.15	177	Amalia Suzianti, Hajid Naufal Atthousi, Ian Berlian Pratama, Zahrina Hasyati	Implementing Fairtrade Requirements for Ensuring the Supply Chain Sustainability: Case Study South Halmahera Agriculture Products
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13	15.45 - 16.00	260	Dwi Handayani, Rizka Amalia, Mohamad Endy Yulianto, Murni	Nanoemulsion Production of Ginger Oil from Enzymatic Extraction of Isolated Cowâ€™s Rumen
14	16.00 - 16.15	205	Moh. Zaenal Efendi, Moch Machmud Rifadil	Design and Implementation of The Utilization of BIFRED Converter As An Improvement of Power Factor For LED Lamp Loads
15	16.15 - 16.30	276	Jouvan Chandra Pratama Putra Safrilah M. Ihsan	The Prediction of Indoor Air Quality in Office Room Using Artificial Neural Network
16	16.30 - 16.45	289	Hardika Dwi Hermawan, Agatha Saputri	Augmented Reality on T-Shirt for Promoting Product
17	16.45 - 17.00	303	P. Vitasari, Dayal Gustopo, Budi Fathoni	Workplace Instruments Test for University Occupation
18	17.00 - 17.15	308	Much. Djunaidi, M. Abdul Azis Sholeh, Nur Muhammad Mufiid	Analysis of Green Supply Chain Management Application in Indonesian Wood Furniture Industry
19	17.15 - 17.30	317	Indah Pratiwi, Indah Kartikasari	Evaluation Of Work Posture Non Repetitive Job In Kampoeng Batik Laweyan Using PATH And OWAS Method

Data mining applied for accident prediction model in Indonesia toll road

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Data Mining Applied for Accident Prediction Model in Indonesia Toll Road

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Abstract. The current research on toll road accident (TRA) is mainly conducted using conventional descriptive statistics, which, however, fail to properly identify cause-effect relationships and are unable to construct models that could predict accidents. Alternative to decrease traffic accident is by developing accident prediction model. The model relates accident frequencies with traffic flow and various roadway environment characteristics contributing to accident occurrences. This paper presents the TRA prediction model for Jakarta Outer Ring Road Toll Road (JORR), to identify the most important causes of accidents and to develop predictive models. Data mining (DM) techniques (artificial neural networks (ANNs) and support vector machines (SVM)) were used to model accident and incident data compiled from the historical data. Based on the R-Tools, results were compared with those from some classical statistical techniques (logistic regression (LR), revealing the superiority of ANNs and SVM in predicting and identifying the factors underlying accidents in toll road.

INTRODUCTION

Traffic accidents have been one of the most causes of death and injury in Indonesia. Last year, about 25,859 were killed and hundred thousand people were injured in traffic accidents in Indonesia. In addition, traffic accidents often result in enormous costs to society, including an excessive delay for roadway users and public property damage. In fact, it happens globally in which more than 1.17 million people die in road crashes around the world [1], and over 10 million are crippled or injured each year. Based on the data from the Traffic Corp of Indonesian National Police, the national trend of traffic accident has increased from year to year. The number has increased since 2014. Throughout 2014, there were 95,906 cases, which increased into 98,970 cases in 2015 and into 105,374 cases in 2016. Such increases are contrast with the number of cases in 2012, which was 117,949 cases and decreased into 100,106 cases in 2013 [2]. There are several factors allegedly related with the increasingly number of accidents from year to year, including the human factor, vehicle factor and environments factor. From these three factors, human factor is estimated to be the highest contributor for road accidents. However, the annual number of traffic accidents remains nearly the same every year. Clearly, there is an increasing need for efficient methodologies for identifying the risk factors for accidents.

Toll roads have a relatively high risk of accidents in compared to other road types. In relation with the factors as mentioned previously, approximately 75% of accidents on toll roads were caused by human factors [2]. On toll roads, individual vehicle operators have a wide range of physical and mental abilities, different perceptions of risk, different reactions to external stimuli, and their operating abilities may be further complicated by varying degrees of self-inflicted impaired driving. Very little is known about the primary contributing factors of highway traffic accidents in developing countries, simply because most of them either do not keep any good records or have no records at all [3].

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The fundamental effort required to improve the toll road safety level in Indonesia is by developing TRA prediction model. The function of this model is to provide estimation or prediction of traffic accident numbers which are free of impact bias from the regression-to-the-mean phenomenon. At the toll operator company level, understanding the relationship between the standards and the real accident number can be important to determine the effect of regulating one standard to the safety level of the road. Furthermore, it can serve as a guidance to a toll road improvement program, especially for developing countries, like Indonesia that are struggling to build roads in compliance with their toll road standard [4]. By identifying which elements of toll road standards contribute to the real number of accidents, the authority can effectively target highway expenditure to the improvement of deficient roads. At the same time, while the accident database system is being improved in operator level, the development of TRA prediction model can help the other operator with weak accident database. Thus, the final goal of the development of TRA prediction model is to improve the level of toll road traffic safety.

This paper presents TRA prediction model developed for JORR. The application of the developed model is expected to identify and rank the causes of the accident. Traditional statistical models used accident record to predict current road safety conditions, and their disadvantages highlight that the complete situation of the accident cannot be completely known [5]. Based on condition the accident rate is discrete and cannot be negative and unique, the TRA prediction model has been built by using a non-linear regression model with ANNs and SVM approach. The developed model utilizes large data owned by toll road operators through DM processing with r-miner. Due to the record of large amounts of data, it is necessary to produce a good and continuous pattern [6]. Approach to new techniques and the use of the latest technology is necessary, therefore the set of data that has been collected through the measurement of accidents can be utilized in a structured and scalable scheme to support the interpretation and prediction of accurate data [7]. The best model performance of DM results is used to develop TRA prediction model on toll road in Indonesia.

TOLL ROAD ACCIDENT PREDICTION

The occurrence of TRA can be caused by several causes, i.e. the user, the vehicle and the road geometry. Environmental and weather conditions also become the causes of accidents. Of the factors causing traffic accidents, infrastructure factor is the factor that can be directly engineered by toll road service providers in an effort to improve road safety through a quality improvement. This is different from other efforts related to human factors, where the role of the regulator is more directed to the rules, policy, and education, which will eventually return to the character of the perpetrator. Similarly, on the efforts to improve safety related to facilities, the regulator cannot provide direct action on the process of preparing the vehicle to be used. It is linked to the authority of the company as the producer of vehicles and the owners of vehicles as prospective users.

The TRA has many impacts. In addition to causing physical harm to the victims of accidents, it will also cause derivative effects, such as economic losses, social, and environmental damage. The consequences of an accident can be calculated based on the potential impacts, such as the estimation of medical costs, production losses, human losses, property damage, settlement costs and accident-induced congestion costs. Regulator has several possibilities to regulate the accident externalities, including efficient control of the insurance markets, upgrade the road network, and control of road users' attitudes and behavior [8]. In order to reduce the accident rate, it is essential to know the possibility of an accident in the future. Some traffic accident prediction techniques have been continually developed. One of the most widely used methods is multivariate modeling. This model is the most common technique used in predicting building accidents. Accident prediction model currently constitutes the main tool for estimating the safety performance of road locations. Traditionally, the models are developed using the poisons-gamma hierarchy, which leads to the negative binomial regression model. The used regression model can be a linear regression model or non-linear regression model. The TRA is a chain of events which results in one or more road users causing damage or injury to oneself or others. While some recent studies present that the number of accidents on a given highway section during a certain period of time is probabilistic in nature and is a non-negative integer [9].

Statistical modeling is used to develop TRA prediction models in relation with the accident occurrence on road facilities to their various traffic and geometric characteristics. The model can be used to predict the accident potential of similar road facilities and also to conduct several safety studies, such as before-and- after studies to evaluate the effectiveness of safety improvement measures and those to identify and rank hazardous or accident-prone locations. Statistical models, moreover, are able to empirically link the accident situation and a mix of risk factors to explain these accidents, for example, road traffic and vehicle characteristics [10]. Furthermore, these statistical models are capable of incorporating a large number of variables and their interactions to explain changes in road accident involvement and severity. The development of statistical science encourages the development of other scientific

prediction methods. Statistical methods were commonly utilized in most previous studies, such as linear regression model, logistic regression model, poisons model, negative binomial model, zero-inflated negative binomial model and generalized linear regression model methods. These methods are subject to strong assumptions and limitations in application. In contrast, ANN has been proven efficient and effective in many fields [9].

The various scientific approaches to learn about TRA have been scientifically proven to provide suggestions for the improvement of safety values and the resolution of other safety issues. There are two main engineering approaches for dealing with traffic safety problems, namely the reactive approach and the proactive approach. The reactive approach or retrofit approach entails the necessary improvements in the existing hazardous sites to reduce accident frequency and severity at these sites. Meanwhile, the proactive approach is an accident prevention approach that tries to prevent unsafe road conditions from occurring in the first place [11]. These various engineering approaches are expected to improve the quality of human life.

Artificial Intelligence

Interpretation and prediction data is one of the important things in a toll road safety management. Numerous sets of data or information will be meaningless without any interpretation and the precise and accurately prediction. In line with this issue, the development of a model that can provide a good approach to the process of prediction is required. DM is a widely used approach in the interpretation of data in various disciplines. Through an approach of artificial intelligence (AI), DM has a huge potential to assist the interpretation and prediction process [12]. The utilization of computer and the availability of data which can be utilized for increasing the traffic safety should be continually developed [13], including the utilization of AI to determine the character of the driver and the vehicle in relation with the safety level [14]. In accordance with the library research, the AI approach and DM techniques have not been developed to devise predictive modeling of TRA prediction model.

The artificial intelligence (AI) is the development of the computer ability in interpreting various algorithms language. Soft computing method is performed by imitating the processes that found in nature, such as brain and natural selection [15]. Soft computing techniques allow the processing of data with uncertainly, imprecise and ambiguous characteristics. In the early mid-1960s, a new branch of computer science began to attract the attention of many scientists. This new branch, known as AI, can be defined as the study of how to make computers support the quality of people better performance in working world. To achieve these objectives, the computer is developed by imitating human behavior. In 1970, the AI is more focused on the development of expert systems which is designed to support decision-making through computed opinions of experts. Subsequently, in the 1990s, there was a shift of AI development where various issues were studied directly from the data [16]. Until now, the AI continues to grow and includes several methods and solutions for many disciplines. The scientific approach to civil engineering is increasingly familiar with the utilization of AI, such as in the development of transportation science [17].

The development of the information technology industry is very fast as indicated by the rapid growth of scientific data collection. Large size databases are not a problem anymore due to the advantage of computer technology with a range of major applications and supporters. Currently, all data are collected and stored in the database that can be a very valuable knowledge to support making decision and optimization of an action. Classical statistics have limitations to do the data analysis on a large number of data or when there is a complex relationship between the data variables. To overcome such limitations, the development of computer-based data analysis tools with greater capabilities and automaticity is required [18]. This effort is commonly defined as knowledge discovery in databases (KDD). Wang [19] mentioned the development of this tool is increasingly recognized with the term KDD DM.

Data Mining

The Data Mining (DM) as the extraction of useful knowledge from raw data has been received a lot of attention from both the research community and industry. Indeed, many case studies suggest that companies are increasingly investigating the potential of DM technology to deliver competitive advantage. DM in R-Tools uses an object-oriented language, so r-miner can present a collection of important functions that can be applied to various problems. The r-miner is equipped with various functions, including fit, predict, mining, mgraph, metric and mmetric. Regression is one of the main tasks of DM. This task consists of mapping several inputs as independent variables to a given numeric output as the dependent variable [6]. Several regression approaches of DM are used including LR, ANNs, and SVM.

In the present research, DM was implemented in the R software (http://www.r-project.org/) under the r-miner library [6, 15, 17]. R is an open-source computational environment and high-level language that integrates powerful

statistical and graphical features for databases. R adopts a very flexible and objective-oriented design. The r-miner library consists of several regression techniques, each of them has its own advantages. MR is relatively easy to interpret due to its additive nature while the ANNs and SVM require more computational resources but are capable of modeling more complex data.

METHODOLOGY

In this study, the purpose of the methodology was to provide a framework for the TRA prediction model. Key components of the model were introduced and their relevance to the model was discussed. The discussion focused on the accident involvement and severity models and their integration. Model form, error distribution, concerns, and uncertainty were also discussed. The purpose of the TRA prediction model is to predict the number of vehicle accident involvements on road sections and their resulted injury profiles. Developing a TRA prediction model involves several problems, the first was regarding with imbalance data. Imbalance data means within the data, there is a considerable difference between the observed sizes of one data set. The second problem involves data processing to create a training data set. The training data set has a set of multiple features that can affect the prediction result. The research aimed to solve these two problems and performed efficiently prediction processing using the DM algorithm. In this paper, a novel method to determine each step for classification model analysis of TRA prediction from large data is explained in detail.

Model Approach

One of the basic issues in safety management system is the development of TRA prediction models. Several accident prediction models have been proposed over the years, some of which are simple and others more complex. The success of safety management process in safety toll road depends on the TRA prediction which is executed by the system. To enhance the performance of safety toll road, successful prediction of TRA is considered importance. The researcher conducted the TRA prediction models based on SVM and ANN, which are empirical (data-driven) methods with the occurrence based on the non-linier programming. SVM and ANN are popular method approaches in DM. DM aims at the extraction of useful knowledge from raw data and has been received a lot of attention from both the research community and industry.

The DM in R-Project for statistical computing (R-tools) is an open-source computational environment and high-level language that integrates powerful statistical and graphical features for data. R-Tools adopt a very flexible and object-oriented design [6]. The tool can be easily extended by the creation of packages. TRA prediction model was developed from the r-miner library with the inclusion of several variables. This research developed DM methodology for TRA prediction without any restrictive assumption by considering data input showed in Table 1 as input variables. TRA prediction was devised by following several processes. The *first* was the cleaning and examination of data that might be used in the TRA prediction model. When the data were “cleaned”, the incorrect and irrelevant data were removed from the dataset. This process included correcting typos, ensuring the consistency of data formats and removing records with incomplete data.

Second, the examination of data. Initially, histograms or bar charts of the variables should be created to determine their frequency. Subsequently, the correlation between variables should be found. Knowing the distributions and correlations between variables would help the modeler to choose an appropriate form for the data, and to evaluate the model more effectively once it had been created. As the data were examined, the inconsistencies and inaccuracies might be found signifying that further cleaning of the data was required. Correlation refers to the relationship between two variables. A high correlation means that the two variables are closely related – as one variable changes, the other changes proportionally. If they are continuous variables, they form a line when plotted against each other. A very low correlation means that the two variables change randomly and are not associated. Most data fit somewhere between the two extremes. Correlation test is showed by matrix correlation.

Third, the selection of model type. After considering each model type that had been investigated previously (linier, dynamic, and artificial intelligence), the most appropriate type of model was selected. Creating the best TRA prediction model is usually an iterative process where the modeler may change various aspects of the model form to create the best model using the available data. The aspects of the model form that can be changed vary, ranging from model type to the software used to develop the model. In the case of TRA prediction model types, some factors that affect the model form include the base equation, the variables used in the model, and how those variables are grouped.

The remaining data will be used to evaluate the model. From the library research, this research chose the log regression as a comparator and DM as a proposed model.

R Tools

The R is a unit of software that integrates multiple facilities with the manipulation, calculation, and reliable graphics performance. R is a free version of the language S of software (free) that is similar with S-PLUS and has been widely used by researchers and academics in scientific activities. The R environment is an open source and high-level matrix programming language, and broadly used for statistical and data analysis. The R community is very active, and the new packages are continuously being developed, hence, in this perspective, the R is an open tool for worldwide sharing of RDCT, 2009. One of such packages is the r-miner [6], which is available in http://www3.dsi.uminho.pt/pcortez/ rminer.html. The purpose of this package is to facilitate the usage of data mining algorithms in both classification and regression tasks. Considering that R uses an object-oriented language, the r-miner presents a series of important functions than can be applied on these objects, such as fit – create and adjust a given DM model using a dataset; predict – returns the predictions for new data; mining – a powerful function that trains and tests a model under several runs and a given validation method; mgraph, metric and mmetric – which return several mining graphs or metrics.

EXPERIMENT AND DISCUSSION

As the case study, the JORR Toll Road was selected. The road network in JORR has a complete characteristic. The outer ring road in metropolitan area is characterized by the presence of the urban and non-urban area that serves as the main transportation lines and this corridor is passed by all types of vehicles. JORR toll road connects the port city of Jakarta with other cities in the west, south and east region of Jakarta.

Toll Road Accident Data

The models were verified using the data from *Jalan Lingkar Jakarta (JLJ)* Toll Road Company and Indonesia Toll Road Authority. The dataset from the JORR toll road included 1,725 results derived from 45 toll road segments and 10 input parameters, which are referred to as the influential parameters in empirical studies of TRA. Those parameters were given an order code as input as presented in Table 1 below.

TABLE 1. Input Code

No	Code	Measurement	Description
Input 1	TRA	Accident/1.000.000 vehicles km	Number of accident
Input 2	ADT	Number	Daily Traffic Average
Input 3	TD	Vehicles/km	Traffic Density
Input 4	V	Km/hours	Traffic Speed
Input 5	L	Number	Number of lines
Input 6	STA	Station-segment	Position of accident
Input 7	IRI	Meter/kilometer (m/km)	International Roughness Index
Input 8	G	%	Gradient
Input 9	Ramp	Number	Number of Ramps
Input 10	Skid	Mm	Skid resistance

Accident data were firstly recorded by the police and the JLJ officers. The day and location of each accident was also recorded in the data. In addition, the death in toll, the number of casualties, and the information about those related to each accident were also recorded in the data. The weather condition and shapes of lines were also provided in the data in the form of ID categories.

The TRA data were collected from the history of accident reports. Roughness and geometric data were collected every year using the NAASRA roughness meter and then compiled in the database program. The NAASRA roughness meter measures the relative movement between the axle and the vehicle body at a given speed. ADT data were obtained

from the annual traffic data. The data chosen for this research were the data from 2010 until 2016. The statistics of the parameters used in this paper are presented in Table 2.

TABLE 2. Statistics of the database values

	TRA	ADT	TD	V	L	STA	IRI	G	Ramp	Skid
Min	0.00	344,302	0.76	30.15	3	0	1.83	-0.80	0	0.33
Max	10.00	439,859	0.89	98.46	3	45	3.75	0.90	1	0.67
Average	1.59	398,406	0.80	67.65	3	-	2.86	0.20	0.25	0.54
Dev.	1.62	34,903	0.03	17.78	0	-	0.32	0.01	0.02	0.12

Toll Road Accident Prediction Model

Using DM with SVM and ANNs model will result in predictive TRA that can be used for each toll road segment on the JORR. In this study, we used the r-miner package of the R tool to test the SVM and ANNs model. DM process used 75% of the whole data in the training process and predicted 25% of the result with the fit model. The quality of the prediction obtained by applying DM model as presented in Figure 1, which shows the results of TRA prediction model. This performance was confirmed by the values of R^2, Mean Absolute Deviation (MAD), and Root Mean Squared Error (RMSE). Among the 20 runs performed, the SVM hyper-parameters that best fit the data are $\epsilon = 0.08 \pm 0.02$ and $\gamma = 0.04 \pm 0.00$. The ANN hyper-parameters that best fit the data are $H = 4 \pm 1$.

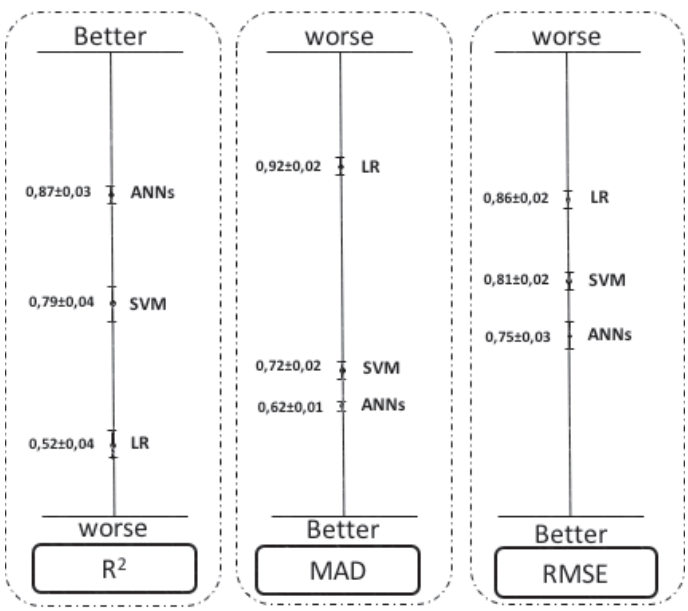


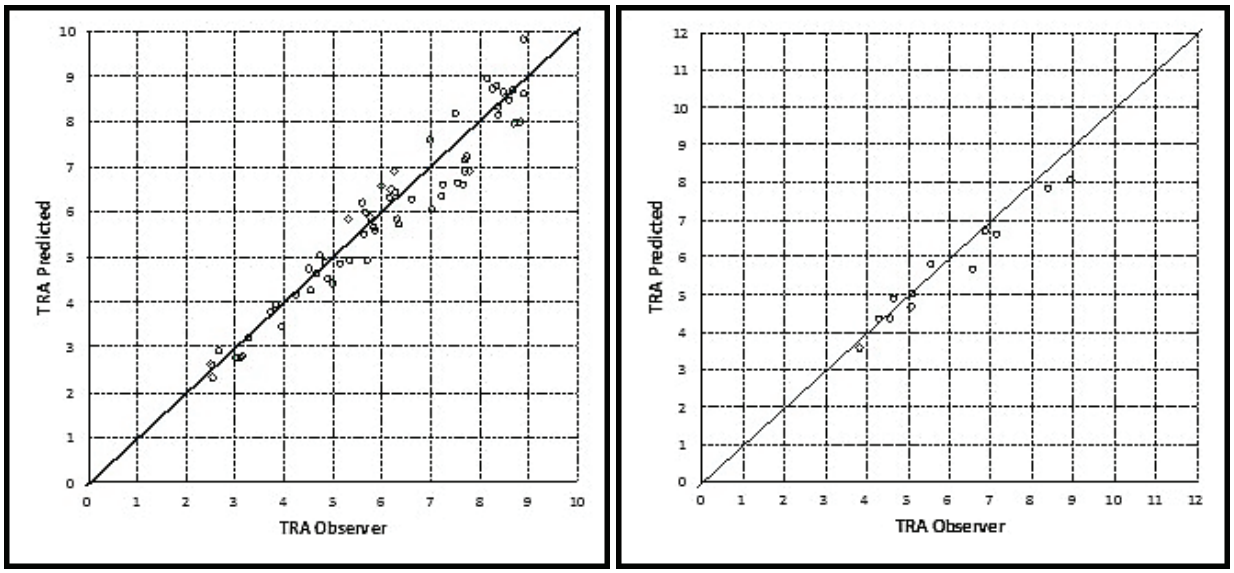
FIGURE 1. The measurement of performances.

For each model, a total of 1.000 runs of a 20-cross validation procedure were applied. Three DM techniques were tested by using the dataset that had been previously described to perform the predictions. Among the tested three DM algorithms, the best results were obtained by ANNs models. The lower the MAD and RMSE values, the better the predictive model, while a perfect model should have an R runs and with the respective 95% confidence intervals according with the t-student distribution. The computed regression error metrics, for ANNs in terms of the MAD of 0.62 ± 0.01, RMSE of 0.75 ± 0.03 and coefficient of determination (R^2) of 0.87 ± 0.03. The lower the MAD and RMSE values, the better the predictive model, while a perfect model should have an R^2 value close to 1.0.

The predictive results (measured unseen data) were shown in terms of observed versus predicted scatterplots. In such scatterplots, the better the predictions, the closer they are to the diagonal line (perfect model). Figure 2 shows the scatterplots of TRA predictive models with ANNs, which reveal a good fit. The scatterplots show the results of

the learning stage modelling with the total amount of 72-month data, and Figure 2 (b) demonstrates the iteration of validation stage.

Figure 2 (a) illustrates some scatterplots showing the results of the learning stage modelling with the total amount of 60-month data, and Figure 2 (b) demonstrates the iteration of validation stage. The computed regression error metrics, in terms of coefficient of determination (R^2) was 0.96 ± 0.02, while a perfect model should have an R^2 value close to 1.0. The results are presented in terms of the average of the runs and with the respective 95% confidence intervals according with the t-student distribution. Analyzing the results, a good fit is achieved by the ANNs model.



a. Learning Stage b. Validation stage

FIGURE 2. ANNs TRA outputs

In the validation stage, the features of the r-miner library were used to describe and obtain the relative contribution value of each input value. Figure 3 shows the importance attributed by ANNs to each input parameter that was obtained by applying sensitivity analysis.

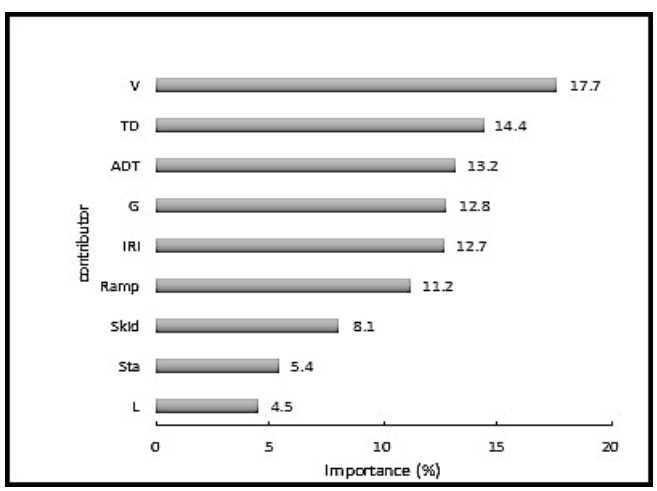


FIGURE 3. ANNs TRA outputs.

Based on the figure, it is concluded that the ranking of the variables is in the following order: speed, traffic density, traffic volume, gradient, roughness, ramp number, skid resistance, location, and line number. At the learning and validation stage, speed has the highest contribution level to the value of the TRA.

CONCLUSION

This study developed a TRA prediction model to generate an optimal model of safety management in the toll road. Both objectives were achieved simultaneously. The factors which allegedly because accidents have been investigated for providing road safety, and subsequently, the accident prediction models which include relations between these factors have been established. The TRA reports from 2010 to 2016 were used to form the database. By using DM techniques and the ANNs technique, a model with excellent predictive capacity for large data was obtained. It is also possible to predict the TRA for several different locations using the DM techniques. The proposed model also allows for the identification of the input parameters that control the behavior of the speed, traffic density, traffic volume, gradient, roughness, ramp number, skid resistance, location, and line number. Furthermore, the results showed that the DM techniques, namely ANNs and SVM, have a strong relationship ($R^2 \geq 0.75$) and should be considered in the model. This model can be used in the TRA prediction model.

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