

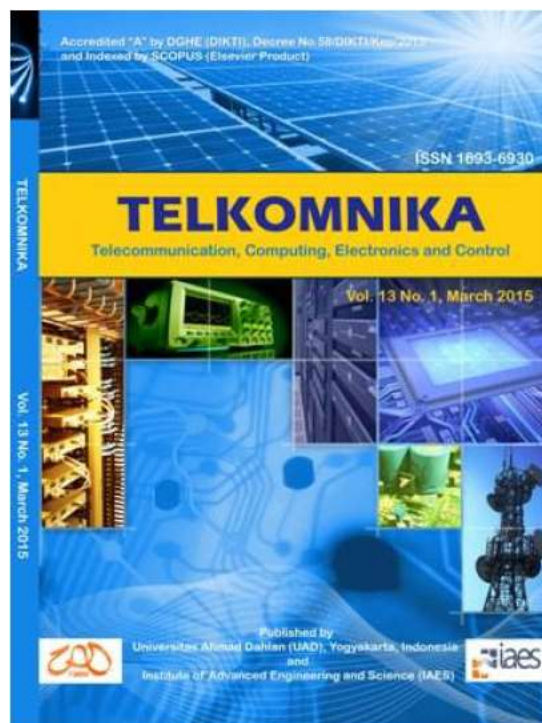
MCGDM with AHP based on Adaptive interval Value Fuzzy

Yeni Kustiyahningsih, Fatmawati, Herry Suprajitno

TELKOMNIKA, Vol.16, No.1

ISSN: 1693-6930

DOI: 10.12928/TELKOMNIKA.v16i1.7000



also developed by scimago:



SCIMAGO INSTITUTIONS RANKINGS

SJR

Scimago Journal & Country Rank

Enter Journal Title, ISSN or Publisher Name

[Home](#)[Journal Rankings](#)[Country Rankings](#)[Viz Tools](#)[Help](#)[About Us](#)

Telkomnika

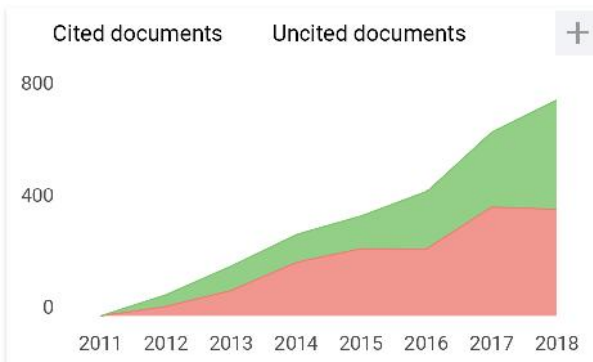
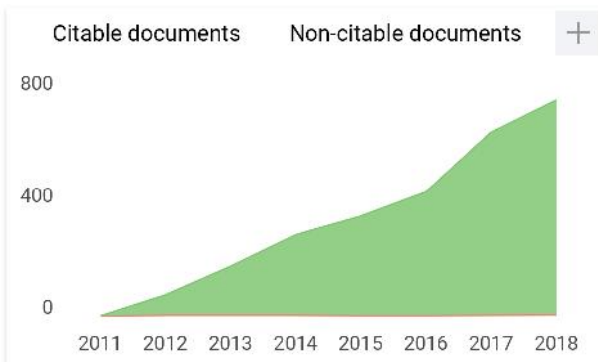
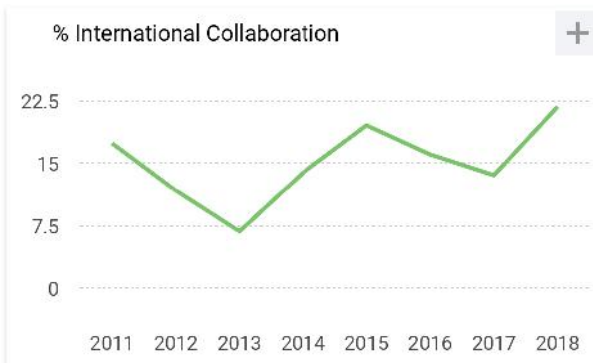
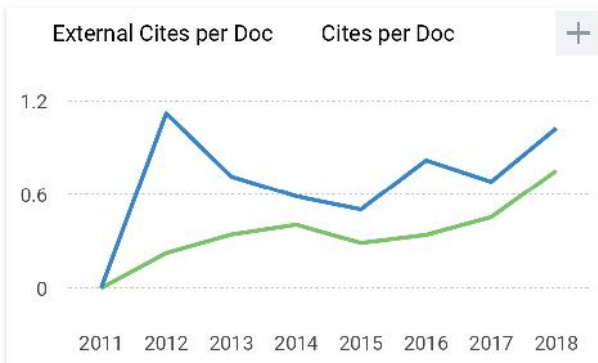
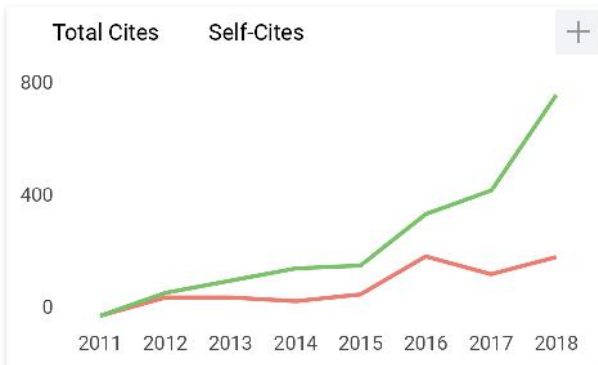
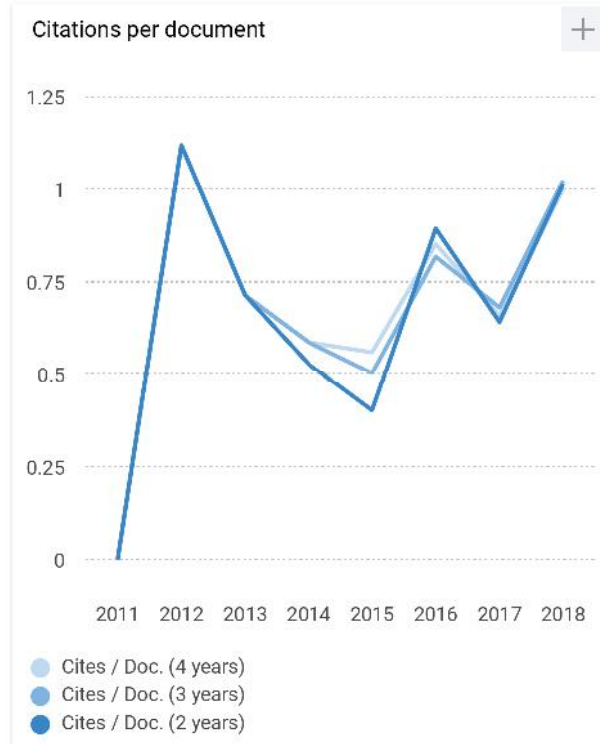
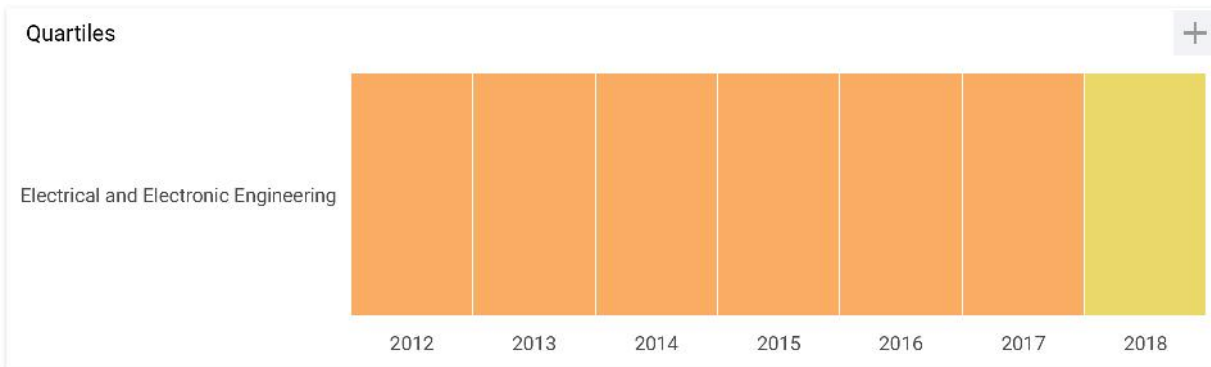
Country	Indonesia -  SJR Ranking of Indonesia
Subject Area and Category	Engineering Electrical and Electronic Engineering
Publisher	Institute of Advanced Engineering and Science (IAES)
Publication type	Journals
ISSN	16936930, 23029293
Coverage	2011-ongoing

16

H Index

Scope TELKOMNIKA (Telecommunication Computing Electronics and Control) is a peer reviewed International Journal in English published four issues per year (March, June, September and December). The aim of TELKOMNIKA is to publish high-quality articles dedicated to all aspects of the latest outstanding developments in the field of electrical engineering. Its scope encompasses the engineering of signal processing, electrical (power), electronics, instrumentation & control, telecommunication, computing and informatics which covers, but not limited to, the following scope: Signal Processing[...] Electronics[...] Electrical[...] Telecommunication[...] Instrumentation & Control[...] Computing and Informatics[...]

[Homepage](#)[How to publish in this journal](#)[Contact](#)[Join the conversation about this journal](#)



Telkomnika [Show this widget in your](#)



← own website

Just copy the code below and paste within your html code:

```
<a href="https://www.scimagojr.com/journalsearch.php?q=21100256101&tip=s...">
```



Melanie Ortiz 3 months ago

Dear user,
thank you for contacting us.
Sorry to tell you that SCImago Journal & Country Rank is not a journal. SJR is a portal with scientometric indicators of journals indexed in Elsevier/Scopus.
Unfortunately, we cannot help you with your request, we suggest you to visit the journal's homepage or contact the journal's editorial staff , so they could inform you more deeply. You can see the updated journal's information just above .
Best Regards, SCImago Team

M

mulyadi rusli 3 months ago

pardon me, can I know how long the reviewing process?

reply



Melanie Ortiz 3 months ago

Dear user,
thank you for contacting us.
Sorry to tell you that SCImago Journal & Country Rank is not a journal. SJR is a portal with scientometric indicators of journals indexed in Elsevier/Scopus.
Unfortunately, we cannot help you with your request, we suggest you to visit the journal's homepage or contact the journal's editorial staff , so they could inform you more deeply.
Best Regards, SCImago Team

M

Muthna 11 months ago

I want answer, why Journal website appear error? how can check my research status? please inform?

reply

M

muthna 11 months ago

why journal website close? appear error page 404.

reply

R **Rajni Bhalla** 1 year ago

Hello sir,
My paper suppose to publish in October. But still full text is not coming for this paper.As i have sent word file through mail also and uploaded on website also.Kindly let me know to whom should i contact.I have already sent mail to editor number of times.Kindly do the needful.
Thanking you
Regards
Rajni

reply

M **Mohammed Al-obaidi** 1 year ago

Hi, can I know how long the reviewing process?



Elena Corera 1 year ago

Dear Rajni,

thank you very much for your comment. Unfortunately, we cannot help you with your request, we suggest you contact journal's editorial staff so they could inform you more deeply. You can find contact information in SJR website <https://www.scimagojr.com>

Anyway, if there is any user who has already published in the journal, maybe could help us with your request.

Best Regards,
SCImago Team

S **shahd** 1 year ago

I want to Know how I can get the Impact Factor of any Journal

reply



Elena Corera 1 year ago

Dear Ahahd,

thank you very much for your request. You can consult that information in SJR website.

Best Regards,
SCImago Team

Leave a comment

Name

Email

(will not be published)

 I'm not a robot reCAPTCHA
Privacy - Terms**Submit**

The users of Scimago Journal & Country Rank have the possibility to dialogue through comments linked to a specific journal. The purpose is to have a forum in which general doubts about the processes of publication in the journal, experiences and other issues derived from the publication of papers are resolved. For topics on particular articles, maintain the dialogue through the usual channels with your editor.

Developed by:



Powered by:



Follow us on @ScimagoJR

Scimago Lab, Copyright 2007-2019. Data Source: Scopus®

EST MODUS IN REBUS
Horatio (Satire 1, 1, 106)



USER

Username

Password

Remember me

[Login](#)

SJR 2018 : 0.283 (Q2)
 CiteScore 2018 : 1.09
 SNIP 2018 : 0.730

TELKOMNIKA is the best journal in Indonesia 2017

Telkomnika

Q2 Electrical and Electronic Engineering
bes: quartile

SJR 2018
0.28

powered by scimagojr.com



- QUICK LINKS**
- Author Guideline
 - Editorial Boards
 - Reviewers
 - Online Submissions
 - Abstracting and Indexing
 - Scopus: Add missing document
 - Publication Ethics
 - Visitor Statistics
 - Contact Us

JOURNAL HARDCOPY

Order journal prints (hardcopy)

<<click in here>>

ICW-TELKOMNIKA

2019 ICW-TELKOMNIKA
 International Conference

JOURNAL CONTENT

Search

Search Scope

All

[Search](#)

Browse

- By Issue
- By Author
- By Title
- Other Journals

Home > About the Journal > **Editorial Team**

Editorial Team

Editor-in-Chief

[Dr. Tole Sutikno](#), Universitas Ahmad Dahlan, Indonesia

Editor-in-Chief for Power Engineering

[Dr. Ahmet Teke](#), Cukurova University, Turkey

Editor-in-Chief for Electronics Engineering

[Prof. Dr. Faycal Djeflal](#), University of Batna, Batna, Algeria

Editor-in-Chief for Power Electronics and Drives

[Assoc. Prof. Dr. Nik Rumzi Nik Idris](#), Universiti Teknologi Malaysia, Malaysia

Editor-in-Chief for Control Engineering

[Dr. Auzani Jidin](#), Universiti Teknikal Malaysia Melaka (UTeM), Malaysia

Editor-in-Chief for Signal Processing

[Assoc. Prof. Dr. Nidhal Bouaynaya](#), Rowan University, Glassboro, NJ, United States

Editor-in-Chief for Telecommunication Engineering

[Prof. Dr. Leo P. Ligthart](#), Delft University of Technology, Netherlands

Editor-in-Chief for Machine Learning, AI and Soft Computing

[Prof. Dr. Luis Paulo Reis](#), University of Minho, Portugal

Editor-in-Chief for Computer Science, Informatics and Information System

[Assoc. Prof. Dr. Wanquan Liu](#), Curtin University of Technology, Australia

Associate Editors

[Prof. Dr. Ahmad Saudi Samosir](#), Lampung University, Indonesia

[Prof. Dr. Francis C.M. Lau](#), The University of Hong Kong, Hong Kong

[Prof. Franco Frattolillo, Ph.D.](#), University of Sannio, Italy

[Prof. Dr. G. A. Papakostas](#), Eastern Macedonia and Thrace Institute of Technology, Greece

[Prof. Dr. Hussain Al-Ahmad](#), Khalifa University, United Arab Emirates

[Prof. Longquan Yong](#), Shaanxi University of Technology, China

[Prof. Ing. Mario Versaci](#), Mediterranea University of Reggio Calabria, Italy

[Prof. Dr. Mirosław Swiercz](#), Politechnika Białostocka, Poland

[Prof. Dr. Omar Lengerke](#), Universidad Autónoma de Bucaramanga, Colombia

[Prof. Dr. Srinivasan Alavandar](#), CK College of Engineering and Technology, India

[Prof. Dr. Tarek Bouktir](#), Ferhat Abbas University, Setif, Algeria

[Prof. Dr. Zahriadha Zakaria](#), Universiti Teknikal Malaysia Melaka, Malaysia

[Assoc. Prof. Jumril Yunas](#), Universiti Kebangsaan Malaysia, Malaysia

[Assoc. Prof. Dr. Lunchakorn Wuttisittikulki](#), Chulalongkorn University, Thailand

[Assoc. Prof. Dr. Mochammad Facta](#), Diponegoro University, Indonesia

[Assoc. Prof. Dr. Mohamed Arezki Mellal](#), M'Hamed Bougara University, Algeria

[Asst. Prof. Dr. Supavadee Aramvith](#), Chulalongkorn University, Thailand

[Asst. Prof. Dr. Andrea Francesco Morabito](#), University of Reggio Calabria, Italy

[Dr. Achmad Widodo](#), Universitas Diponegoro, Indonesia

[Dr. Arianna Mencattini](#), University of Rome "Tor Vergata", Italy

[Dr. Deris Stiawan](#), Universitas Sriwijaya, Indonesia

[Dr. Haruna Chiroma](#), Federal College of Education (Technical), Gombe,, Nigeria

[Dr. Huchang Liao](#), Sichuan University, China

[Dr. Jacek Stando](#), Technical University of Lodz, Poland

[D. Jude Hemanth](#), Karunya University, India

[Mark S. Hooper](#), Analog/RF IC Design Engineer (Consultant) at Microsemi, United States

[Dr. Munawar A Riyadi](#), Universitas Diponegoro, Indonesia

[Dr. Shahrin Md Ayob](#), Universiti Teknologi Malaysia, Malaysia

[Dr. Surinder Singh](#), SLIET Longowal, India

[Dr. Tutut Herawan](#), Universiti Malaya, Malaysia

[Dr. Yang Han](#), University of Electronic Science and Technology of China, China

[Dr. Yin Liu](#), Symantec Research Labs' Core Research group, United States

[Dr. Youssef Said](#), Tunisie Telecom Sys'Com Lab, National Engineering School of Tunis (ENIT), Tunisia

[Dr. Yutthapong Tuppadung](#), Provincial Electricity Authority (PEA), Thailand

[Dr. Zhixiong Li](#), China University of Mining and Technology, China

TELKOMNIKA Telecommunication, Computing, Electronics and Control

ISSN: 1693-6930, e-ISSN: 2302-9293

Universitas Ahmad Dahlan, 4th Campus, 9th Floor, LPPI Room

Jl. Ringroad Selatan, Kragilan, Tamanan, Banguntapan, Bantul, Yogyakarta, Indonesia 55191

Phone: +62 (274) 563515, 511830, 379418, 371120 ext. 4902, Fax: +62 274 564604

01945812

[View TELKOMNIKA Stats](#)

USER

Username

Password

Remember me

[Login](#)

SJR 2018 : 0.283
(Q2)
CiteScore 2018 : 1.09
SNIP 2018 : 0.730

TELKOMNIKA is the best
journal in Indonesia
2017

Telkomnika

Q2

Electrical and
Electronic
Engineering

bes: quartile

SJR 2018

0.28



powered by scimagojr.com

TEMPLATE**QUICK LINKS**

- Author Guideline
- Editorial Boards
- Reviewers
- Online Submissions
- Abstracting and Indexing
- Scopus: Add missing document
- Publication Ethics
- Visitor Statistics
- Contact Us

**JOURNAL
HARDCOPY**

Order journal prints
(hardcopy)

<<click in here>>

ICW-TELKOMNIKA

2019 ICW-TELKOMNIKA
International Conference

JOURNAL CONTENT

Search

Search Scope

All

[Search](#)

Browse

- By Issue
- By Author
- By Title
- Other Journals

HOME ABOUT LOGIN REGISTER SEARCH CURRENT ARCHIVES
ANNOUNCEMENTS

[Home](#) > [Archives](#) > **Vol 16, No 1**

Vol 16, No 1

February 2018

DOI: <http://dx.doi.org/10.12928/telkomnika.v16i1>

Table of Contents

A Dual-band Microstrip Slotted Antenna for UHF and Microwave RFID Readers	PDF
<i>Ahmed El Hamraoui, El Hassane Abdelmounim, Jamal Zbitou, Laarbi Elabdellaoui, Hamid Bennis, Mohamed Latrach</i>	94-101
A New Compact CPW-Fed Dual-Band Uniplanar Antenna for RFID Applications	PDF
<i>Ahmed El Hamraoui, El Hassane Abdelmounim, Jamal Zbitou, Laarbi Elabdellaoui, Hamid Bennis, Mohamed Latrach</i>	102-109
A New Compact and Wide-band Band-stop Filter Using Rectangular SRR	PDF
<i>B. Nasiri, A. Errkik, J. Zbitou, A. Tajmouati, L. El Abdellaoui, M. Latrach</i>	110-117
Comparative Study of Indoor Navigation Systems for Autonomous Flight	PDF
<i>Muhammad Ayaz</i>	118-128
Wireless Sensor Network over High Altitude Platform	PDF
<i>Veronica Windha Mahyastuty, Iskandar Iskandar, Hendrawan Hendrawan, M. Sigit Arifianto</i>	129-133
Macro-Bending Loss of Single-Mode Fiber Beyond Its Operating Wavelength	PDF
<i>Dwi Bayuwati, Tomi Budi Waluyo</i>	142-150
Reduction of Mutual Coupling between Closely Spaced Microstrip Antennas Arrays Using Electromagnetic Band-gap (2D-EBG) Structures	PDF
<i>Ahmed Ghaloua, Jamal Zbitou, Larbi El Abdellaoui, Mohamed Latrach, Abdelali Tajmouati, Ahmed Errkik</i>	151-158
A Multiband Printed Antenna Suitable for Wireless Applications	PDF
<i>S. El Kilani, L. El Abdellaoui, J. Zbitou, J. Terhzaz, A. Errkik, M. Latrach</i>	159-165
Pm-EEMRP: Postural Movement Based Energy Efficient Multi-hop Routing Protocol for Intra Wireless Body Sensor Network (Intra-WBSN)	PDF
<i>Tariq Rashid, Sunil Kumar, Akshay Verma, Prateek Raj Gautam, Arvind Kumar</i>	166-173
A Novel Design of a Miniature Metamaterial Antenna for RFID Reader Applications	PDF
<i>A. Ennajih, J. Zbitou, M. Latrach, A. Errkik, L. EL Abdellaoui, A. Tajmouati</i>	174-181
Low Complexity Multi-User MIMO Detection for Uplink SCMA System Using Expectation Propagation Algorithm	PDF
<i>Alva Kosasih, Onny Setyawati, Rahmadwati Rahmadwati</i>	182-188
System Performance Analysis of Half-Duplex Relay Network over Rician Fading Channel	PDF
<i>Phu Tran Tin, Tran Hoang Quang Minh, Tan N. Nguyen, Miroslav Voznak</i>	189-199
Capacity Improvement and Protection of LTE Network on Ethernet Based Technique	PDF
<i>Fadli Sirait, Akhmad Wahyu Dani, Triyanto Pangaribowo</i>	200-209
Development and Performance Enhancement of MEMS Helix Antenna for THz Applications using 3D HFSS-based Efficient Electromagnetic Optimization	PDF
<i>Abdelhakim Boudkhil, Mohammed Chetloul, Nadia Benabdellah, Nasreddine Benahmed</i>	210-216
Exponential Tapered Balun with Different Sizes for UWB Elliptical Dipole Antenna	PDF
<i>M A Zakwan, S A Hamzah, S M Shah, K N Ramli, M S Zainal, L Audah, N Abdullah, A Ubin, F C Seman, A K Anuar, Adeeb Salh, M Esa, N N N Abd Malik</i>	217-223
A Novel Configuration of a Microstrip Microwave Wideband Power Amplifier for Wireless Application	PDF

<i>Amine Rachakh, El Abdellaoui Larbi, Zbitou Jamal, Ahmed Errkik, Abdelali Tajmouati, Latrach Mohamed</i>	224-231
A Solution to Partial Observability in Extended Kalman Filter Mobile Robot Navigation	PDF
<i>Hamzah Ahmad, Nur Aqilah Othman, Mohd Syakirin Ramli</i>	134-141
	PDF
Long-term Robust Tracking whith on Failure Recovery	302-313
<i>Khaled Hammemi, Mohamed Atri</i>	
	PDF
MCGDM with AHP based on Adaptive Interval Value Fuzzy	314-322
<i>Yeni Kustiyahningsih, Fatmawati Fatmawati, Herry Suprijanto</i>	
	PDF
Comparison of Secret Splitting, Secret Sharing and Recursive Threshold Visual Cryptography for Security of Handwritten Images	323-333
<i>Sugianto Sugianto, Suharjito Suharjito, Nico Surantha</i>	
	PDF
Analysis of S2 (Spherical) Geometry Library Algorithm for GIS Geocoding Engineering	334-342
<i>Risma Ekawati, Untung Suprihadi</i>	
	PDF
Measuring Enterprise Resource Planning (ERP) Systems Effectiveness in Indonesia	343-351
<i>Adhi Wibowo, Marti Widya Sari</i>	
	PDF
Efficiency of 128-bit Encryption and Decryption Process in Elgamal Method Using Elliptic Curve Cryptography (ECC)	352-360
<i>Dicky Nofriansyah, Afzalur Syaref, Widiarti R Maya, Ganefri Ganefri, Ridwan Ridwan</i>	
	PDF
File Encryption and Hiding Application Based on AES and Append Insertion Steganography	361-367
<i>G. C. Prasetyadi, R. Refianti, A. B. Mutiara</i>	
	PDF
Frontalis Muscle Strength Calculation Based On 3D Image Using Gray Level Co-occurrence Matrix (GLCM) and Confidence Interval	368-375
<i>Hardianto Wibowo, Eko Mulyanto Yuniarno, Aris Widayati, Mauridhi Hery Purnomo</i>	
	PDF
Temporal Exploration in 2D Visualization of Emotions on Twitter Stream	376-384
<i>Mochamad Nizar Palefi Ma'ady, Chuan-Kai Yang, Renny Pradina Kusumawardani, Hatma Suryotrisongko</i>	
	PDF
Design of Cloud-based and IPTV Digital Signage System	385-389
<i>Algifanri Maulana, Asfiyan Asfiyan</i>	
	PDF
The Locator Framework for Detecting Movement Indoors	390-401
<i>Kevin Curran</i>	
	PDF
The Quality of the New Generator Sequence Improvent to Spread the Color System's Image Transmission	402-414
<i>Mohamed Krim, Adda Ali Pacha, Naima Hadj Said</i>	
	PDF
Similarities of Antimalarial Resistance Genes in Plasmodium Falciparum Based on Ontology	415-423
<i>Dinar Munggaran Akhmad, Yeni Herdiyeni, Etih Sudarnika</i>	
	PDF
Modified Discrete Firefly Algorithm Combining Genetic Algorithm for Traveling Salesman Problem	424-431
<i>Ling Teng, Hang Li</i>	
	PDF
Enhanced User-driven Ranking System with Splay Tree	432-444
<i>R. Jayashree, A. Christy</i>	
	PDF
Assessment of Early Hypertensive Retinopathy using Fractal Analysis of Retinal Fundus Image	445-454
<i>Wiharto Wiharto, Esti Suryani, Muhammad Y. Kipti</i>	
	PDF
Designing an Agent for Information Extraction from Persian E-shops	455-462
<i>Nasrin Rasouli, Leila Abedi, Sara Ghaei</i>	
	PDF
A Radial Line Slot Array (RLSA) Antenna with the Specifications of 16 dBi Outdoor patch Antenna	46-52
<i>Teddy Purnamirza, Safrizal Hasbi, Imran M. Bin Ibrahim, Mulyono Mulyono, Fitri Amillia, Depriwana Rahmi</i>	
	PDF
Embedded System Practicum Module for Increase Student Comprehension of Microcontroller	53-60
<i>Indrianto Indrianto, Meilia Nur Indah Susanti, Rakhmat Arianto, Riki Ruli A. Siregar</i>	

Structural and Optical properties of Multiwalled Carbon Nanotubes Modified by DBD Plasma at Atmospheric Pressure	PDF	
<i>Norain Sahari, Zolkafle Buntat, Zulkifli Azman, Zainuddin Nawawi, Muhammad Abu Bakar Sidik, Muhammad Irfan Jambak</i>		61-68
NO2 Gas Sensing Properties of Carbon Films Fabricated by Arc Discharge Methane Decomposition Technique	PDF	
<i>Elnaz Akbari, Zolkafle Buntat, Syed Muhammad Zafar Iqbal, Zulkifli Azman, Norain Sahari, Zainuddin Nawawi, Muhammad Irfan Jambak, Muhammad Abu Bakar Sidik</i>		69-76
OFET Preparation by Lithography and Thin Film Depositions Process	PDF	
<i>Sujarwata Sujarwata, Fianti Fianti, Langlang Handayani, Aji Purwinarko, Susilo Susilo</i>		77-83
High-precision Ultrasonic Flowmeter for Mining Applications based on Velocity-area	PDF	
<i>Lili Zhang, Lenian Xu, Laxmisha Rai</i>		84-93
Simulation and Hardware Implementation of Shunt Active Power Filter Based on Synchronous Reference Frame Theory	PDF	
<i>Karthikrjan Senthilnathan, Iyswarya Annapoorani, S. Ravi</i>		1-9
Optimal Expenditure and Benefit Cost Based Location, Size and Type of DGs in Microgrids Systems Using Adaptive Real Coded Genetic Algorithm	PDF	
<i>Umar Umar, Firdaus Firdaus, Adi Soeprijanto, Ontoseno Penangsang</i>		10-17
A Numerical Modeling for Study Marine Current in the Manado Bay, North Sulawesi	PDF	
<i>Parabelem Tinno Rompas Dolf, Jenly Dyliep Manongko Isria</i>		18-24
Influence Types of Startup on Hydrothermal Scheduling	PDF	
<i>Ignatius Riyadi Mardiyanto, Hermagasantos Zein, Adi Soeprijanto</i>		25-37
Asymmetrical Nine-Level Inverter Topology with Reduce Power Semiconductor Devices	PDF	
<i>M. S. Arif, S.M. Ayob, Z. Salam</i>		38-45
Low-cost and Portable Process Control Laboratory Kit	PDF	
<i>Ade Gafar Abdullah, Dadang Lukman Hakim, Muhammad Afif Auliya, Asep Bayu Dani Nandiyanto, Lala Septem Riza</i>		232-240
Estimating Parameter of Nonlinear Bias Correction Method Using NSGA-II in Daily Precipitation Data	PDF	
<i>Angga Wahyu Pratama, Agus Buono, Rahmat Hidayat, Hastuadi Harsa</i>		241-249
Probabilistic Self-Organizing Maps for Text-Independent Speaker Identification	PDF	
<i>Ayoub Bouziane, Jamal Kharroubi, Arsalane Zarghili</i>		250-258
A Survey on Knowledge Transfer between Knowledge-based Systems	PDF	
<i>Nyoman Karno, Iping Supriana, Nur Maulidevi</i>		265-273
Rank Computation Model for Distribution Product in Fuzzy Multiple Attribute Decision Making	PDF	
<i>Syafariani R. Fenny, A. Nursikuwagus, Tono Hartono</i>		274-281
An Automatic Approach for Bilingual Tuberculosis Ontology Based on Ontology Design Patterns (ODPs)	PDF	
<i>Bambang Harjito, Denis Eka Cahyani, Afrizal Doewes</i>		282-289
Detection of Ship Using Image Processing and Neural Network	PDF	
<i>Sutikno Sutikno, Helmie Arif Wibawa, Priyo Sidik Sasongko</i>		259-264
Current State of Personal Data Protection in Electronic Voting: Criteria and Indicator for Effective Implementation	PDF	
<i>Muharman Lubis, Mira Kartiwi, Sonny Zuhuda</i>		290-301

TELKOMNIKA Telecommunication, Computing, Electronics and Control

ISSN: 1693-6930, e-ISSN: 2302-9293

Universitas Ahmad Dahlan, 4th Campus, 9th Floor, LPPI Room

Jl. Ringroad Selatan, Kragilan, Tamanan, Banguntapan, Bantul, Yogyakarta, Indonesia 55191

Phone: +62 (274) 563515, 511830, 379418, 371120 ext. 4902, Fax: +62 274 564604

01945803[View TELKOMNIKA Stats](#)

MCGDM with AHP based on Adaptive interval Value Fuzzy

Yeni Kustiyahningsih^{*1}, Fatmawati², Herry Suprajitno³

¹Information System, Faculty of Engineering, Trunojoyo University, Madura, Indonesia

¹Information System, Department of Mathematics, FST, Airlangga University, Indonesia

^{2,3}Department of Mathematics, Faculty of Science and Technology, Airlangga University, Indonesia

Corresponding author, e-mail: ykustiyahningsih@trunojoyo.ac.id, fatmawati@fst.unair.ac.id,
herry-s@fst.unair.ac.id

Abstract

The purpose research is to develop the decision model of Multi-Criteria Group Decision Making (MCGDM) into Interval Value Fuzzy Multi-Criteria Group Decision Making (IV-FMCGDM), while the specific purpose is to construct decision-making model of Adaptive Interval Value Fuzzy Analytic Hierarchy Process (AIV-FAHP) uses Triangular Fuzzy Number (TFN) and group decision aggregation functions using Interval Value Geometric Means Aggregation (IV-GMA). The novelty research is to study the concept of group decision making by improving the middle point on the Interval Value Triangular Fuzzy Number (IV TFN). It provides more accurate modeling, and better rating performance, and more effective linguistic representation. This research produced a new decision-making model and algorithm based on AIV-FAHP used to measure the quality of e-learning.

Keywords: Group Decision Making, Adaptive Interval Fuzzy, AIV FAHP, IVGMA, E-learning.

Copyright © 2018 Universitas Ahmad Dahlan. All rights reserved.

1. Introduction

Multiple Criteria Group Decision Making (MCGDM) is a decision-making method to determine the best alternative from a set of alternatives with using alternative preferences as election criteria [1]. Some MCGDM methods include Simple Additive Weighting (SAW), Weighted Product (WP), Elimination and Choice Express Reality (ELECTRE), Technique for Order Preferences of Similarity Ideal Solution (TOPSIS), and Analytic Hierarchy Process (AHP) [2]. AHP is one of the most widely used MCGDM approaches. AHP is a structured multi-criteria technique for organizing and analyzing complex decisions based on many criteria. The AHP approach is able to elaborate complex multi-criteria problems into a hierarchical structure resulting in a flexible and easy-to-understand model. The AHP considers the value of logical consistency in the assessment, this logical concession is used to test the perception of the assessor and determine the optimal weighting in multi-criteria decision making [3-5].

The MCGDM method approach with AHP is not suitable for handling data that contains uncertainty. The issue of uncertainty can be attributed to incomplete information and unclear information [6]. The problems of measurements e-learning are imprecise data so that decision-makers can not provide appropriate numerical values for evaluation of criteria. The criteria in e-learning are subjective and qualitative, it is very difficult for decision makers to express appropriate preferences using numerical values. The weaknesses in the MCGDM method can be solved by using Fuzzy Multiple Criteria Group Decision Making (FMCGDM). The Fuzzy method in this study is used to accommodate the vague nature of decision-making for qualitative criteria. Fuzzy has excellent performance, more flexible decision-making processes, and capable of handling data that contains uncertainty and inaccuracy. Integration methods AHP with other methods can determine strategies more efficiently and give some contribution in decision making more optimal [7-10]. In group preferences, FMCGDM results in a higher consensus than non-Fuzzy decision makers, but the level of trust given to linguistic preference forms will overlap. Overlap on FMCGDM can be overcome by using Fuzzy Interval value.

Some previous researchers about interval value Fuzzy are decision-making model based on Interval Value Triangular Fuzzy Number by using extension Fuzzy TOPSIS for selection [11], Fuzzy analytic hierarchy process with Fuzzy type-2 interval sets [12], hybrid

FANP and IV FTOPSIS for network access selection [2], combine DEMATEL and TOPSIS based on interval Fuzzy [13, 14]. The study states that the Fuzzy Interval value is the expansion of Fuzzy, with the value of the Fuzzy membership function in the interval form. Fuzzy value intervals provide more accurate modeling and better rating performance. Intervals Fuzzy value have a more effective representation, have high flexibility, memory and time used for more efficient computation. This study has not modified interval point TFN with a different middle point, not yet used for implementation of e-learning measurement with group decision model. This study aims to construct Adaptive Adaptive Interval Value Fuzzy Analytic Hierarchy Process (AIV-FAHP) with improvement point on adaptive interval Fuzzy and aggregation of opinion with interval Value Geometric Means Aggregation (IV-GMA) to determine the weight of e-learning indicator. The measurement indicators are determined by Learning Technology System Architecture (LTSA) and ISO 9126 [15, 16]. The novelty research is to study the concept of group decision making with interval value Fuzzy to improve the point of the interval. At the interval value Fuzzy, each judge can determine the point of interval flexible and freely then developed into the concept of adaptive. Adaptive interval Fuzzy allows the appraiser to create its own set according to the required rules [17]. It can optimize the number and position of the Fuzzy set so using this method can improve the accuracy of recommendations [18]. Based on the description above, this research uses adaptive interval value Fuzzy approach for measurement e-learning with group decision-making model.

2. Research Method

2.1. Interval-Valued Fuzzy (IVF)

The interval-valued Fuzzy set A is defined as follows [11]:

$$A = \left\{ \left(x, \left[\mu_A^L(x), \mu_A^U(x) \right] \right) \right\}, \quad x \in X, \quad (1)$$

$$\begin{aligned} \mu_A^L, \mu_A^U: X &\rightarrow [0, 1]; \\ \forall x \in X, \mu_A^L(x) &\leq \mu_A^U(x). \end{aligned} \quad (2)$$

For Example,

$$\bar{\mu}_A(x) = \left[\mu_A^L(x), \mu_A^U(x) \right], \quad x \in X, \quad (3)$$

The interval value Fuzzy set A can be expressed as follows:

$$A = \left\{ \left(x, \bar{\mu}_A(x) \right) \right\}, \quad \bar{\mu}_A: X \rightarrow [0, 1]; \quad x \in X. \quad (4)$$

Based on these definitions, the interval value Fuzzy set A is represented by upper and lower limits.

2.2. Membership Function

The membership function is a curve showing the mapping of data input points into their membership values (often called membership degrees) that have intervals between 0 and 1. One way to use is the triangular membership function approach (Triangular Fuzzy Number). The function used in this study is Interval Value Triangular Fuzzy Number. Interval Value Triangular Fuzzy Number (IV-TFN) is given in Figure 1.

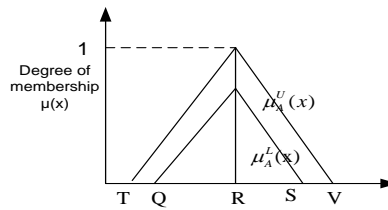


Figure 1. Interval value Fuzzy set [19]

The membership function of IVF-TFN is defined as follows [19]:

$$\mu_A^L(x) = \begin{cases} (x-q)/(r-q); & q \leq x \leq r \\ (s-x)/(s-r); & r \leq x \leq s \\ 0; & \text{otherwise,} \end{cases} \tag{5}$$

With $A^L = (q, r, s), q \leq r \leq s$.

$$\mu_A^U(x) = \begin{cases} (x-t)/(r-t); & t \leq x \leq r \\ (v-x)/(v-r); & r \leq x \leq v \\ 0; & \text{otherwise,} \end{cases} \tag{6}$$

With $A^U = (t, r, v), t \leq r \leq v$.

2.3. Construct Interval Value Fuzzy Analytic Hierarchy Process (IV-FAHP)

This research uses Interval Value Triangular Fuzzy Number (IV-TFN) with improvement at the same middle point, different middle points, and aggregation of opinion with Interval Value Geometric Means Aggregation (IV-GMA). The steps in constructing IV-FAHP methods are as follows:

1. Construction of pairwise comparison matrix D for criteria.

$$D = \begin{bmatrix} 1 & d_{12} & d_{13} & \dots & d_{1n} \\ d_{21} & 1 & d_{23} & \dots & d_{2n} \\ d_{31} & d_{32} & 1 & \dots & d_{3n} \\ \dots & \dots & \dots & \dots & \dots \\ d_{n1} & d_{n2} & d_{n3} & \dots & 1 \end{bmatrix} \tag{7}$$

Where $i, j = 1, 2, \dots, n$.

2. Normalization of pairwise comparison matrices. Each column is summed, then each element in the matrix is divided by the total value of the column. Next, determine the average row or vector that contains the set of numbers n weight w_1, w_2, \dots, w_n and consistency analysis.

3. Representing the model of decision making in the Interval Fuzzy Triangular Number with the same middle point as in Figure 2.

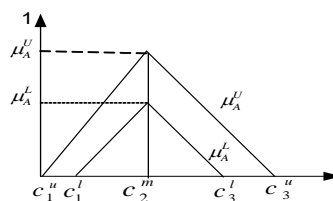


Figure 2. IV TFN with same middle point

Based on Figure 2. The matrix C can be expressed as follows:

$$C = \begin{bmatrix} 1 & c_{12} & c_{13} & K & c_{1n} \\ c_{21} & 1 & c_{23} & K & c_{2n} \\ c_{31} & c_{32} & 1 & K & c_{3n} \\ M & M & MO & M & \\ c_{n1} & c_{n2} & c_{n3} & K & 1 \end{bmatrix} \tag{8}$$

Where,

$$\mu_A^l \leq \mu_A^u, c_{2ij}^{ml} = c_{2ij}^{mu}, \quad c_{ij1}^l \leq c_{ij2}^m \leq c_{ij3}^l, \quad c_{ij1}^u \leq c_{ij2}^m \leq c_{ij3}^u$$

$$i, j = 1, 2, \dots, n.$$

4. Represents a model of decision making in a Fuzzy Triangular Number Interval with a different middle point at which point $g_2^{ml} < g_2^{mu}$ as shown in Figure 3.

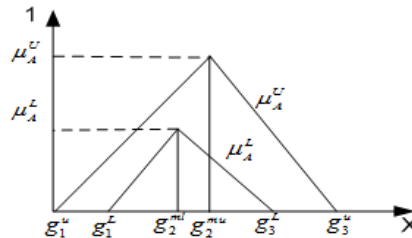


Figure 3. IV TFN different middle point

Based on Figure 3. The matrix G can be expressed as follows:

$$G = \begin{bmatrix} 1 & g_{12} & g_{13} & K & g_{1n} \\ g_{21} & 1 & g_{23} & K & g_{2n} \\ g_{31} & g_{32} & 1 & K & g_{3n} \\ M & M & MO & M & \\ g_{n1} & g_{n2} & g_{n3} & K & 1 \end{bmatrix} \tag{9}$$

Where,

$$g_{ij} = (g_{ij}^u, g_{ij}^l, g_{2ij}^{ml}, g_{2ij}^{mu}, g_{3ij}^l, g_{3ij}^u),$$

$$g_{ij}^{-1} = \left(\frac{1}{g_{3ij}^u}, \frac{1}{g_{3ij}^l}, \frac{1}{g_{2ij}^{ml}}, \frac{1}{g_{2ij}^{mu}}, \frac{1}{g_{ij}^l}, \frac{1}{g_{ij}^u} \right), \quad \mu_A^l \leq \mu_A^u, \quad g_{ij2}^{ml} < g_{ij2}^{mu}, \quad g_{ij1}^l \leq g_{ij2}^{ml} \leq g_{ij3}^l,$$

$$g_{ij1}^u \leq g_{ij2}^{mu} \leq g_{ij3}^u, \quad i, j = 1, 2, \dots, n.$$

Based on the pairwise comparison matrix that has been defined in Steps 3 and 4, then the matrix will be converted into Fuzzy interval number scale. The result of the respondent's assessment (group decision) on the pairwise comparison preference in the Fuzzy scale using the Interval Value Geometric Means Aggregation (IV-GMA). IV-GMA in the Interval Value Triangular Fuzzy Number (IV-TFN) with the same middle point is denoted by the Z matrix expressed as follows:

$$Z = \begin{bmatrix} z_{11} & z_{12} & z_{13} & \mathbf{K} & z_{1n} \\ z_{21} & z_{22} & z_{23} & \mathbf{K} & z_{2n} \\ z_{31} & z_{32} & z_{33} & \mathbf{K} & z_{3n} \\ \mathbf{M} & \mathbf{M} & \mathbf{MO} & \mathbf{M} & \\ z_{n1} & z_{n2} & z_{n3} & \mathbf{K} & z_{nm} \end{bmatrix} \tag{10}$$

Where

$$z_{ij} = \left(\left(\prod_{k=1}^n c_{ijk}^u \right)^{1/n}, \left(\prod_{k=1}^n c_{ijk}^l \right)^{1/n}, \left(\prod_{k=1}^n c_{ijk}^m \right)^{1/n}, \left(\prod_{k=1}^n c_{ijk}^l \right)^{1/n}, \left(\prod_{k=1}^n c_{ijk}^u \right)^{1/n} \right) \quad i, j = 1, 2, \dots, n.$$

5. Calculate the criterion weight of the matrix S with the same middle point. The weighted result of the S matrix criteria is denoted by U^* . The weight criteria for a Triangular Fuzzy Number (TFN) can be expressed as follows:

$$U^* = \begin{bmatrix} u_1 \\ u_2 \\ u_3 \\ \mathbf{M} \\ u_n \end{bmatrix}, \tag{11}$$

Where,

$$u_i = \left(\frac{\prod_{j=1}^n (z_{1ij}^u)^{1/n}}{\sum_{i=1}^n z_{3ij}^u}, \frac{\prod_{j=1}^n (z_{1ij}^l)^{1/n}}{\sum_{i=1}^n z_{3ij}^l}, \frac{\prod_{j=1}^n (z_{2ij}^m)^{1/n}}{\sum_{i=1}^n z_{2ij}^m}, \frac{\prod_{j=1}^n (z_{3ij}^l)^{1/n}}{\sum_{i=1}^n z_{1ij}^l}, \frac{\prod_{j=1}^n (z_{3ij}^u)^{1/n}}{\sum_{i=1}^n z_{1ij}^u} \right), \quad i, j = 1, 2, \dots, n.$$

6. Compute deFuzzyfication from u_i . DeFuzzyfication used to convert the Fuzzy output to a crisp value by the Best Non-Interval Fuzzy Performance (BNIP) method. BNIP can be stated as follows:

$$BNIP_i = \frac{a+b}{2},$$

$$a = \alpha_1 \left[\frac{(u_{3i}^u - u_{1i}^u) + (u_{2i}^{mu} - u_{1i}^u)}{3} + u_{1i}^u \right] \tag{12}$$

$$b = \alpha_2 \left[\frac{(u_{3i}^l - u_{1i}^l) + (u_{2i}^{ml} - u_{1i}^l)}{3} + u_{1i}^l \right]$$

Where $i = 1, 2, \dots, n.$

3. Results and Analysis

3.1. System Description

These steps are Modeling Stage, Modeling is the stage of identification of MCGDM problems by determining the number of variables to be used in the study (criteria, alternatives, appraisers, and respondents) as shown in Figure 4. The measurement indicators of e-learning in this study are determined based on Learning Technology System Architecture (LTSA) with adaptive design personalize and ISO 9126 [15-16].

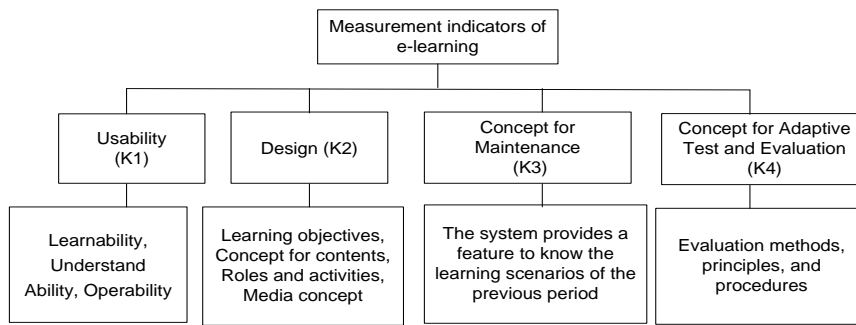


Figure 4. Indicator of e-learning

The next step, weighting using the concept of Adaptive Interval Value Triangular Fuzzy Number (AIV-TFN) with different interval points as shown in Figure 2. and 3. The last step is to construct AIV-FAHP methods such as at section 2.3. All research phases can be seen in Figure 5. AHP IVF Framework In this picture is described complete step Fuzzy adaptive interval framework.

3.2. Simulation and Analysis

After obtaining the mathematical model of the Interval Triangular Fuzzy Number with the same middle point and the different middle point, the simulation and analysis of the model have been made based on existing indicators in e-learning. This is done to determine the optimal solution in decision making based on the interval point and the smallest threshold value to determine the recommendation of e-learning system, e-learning mapping, and clustering/grouping e-learning.

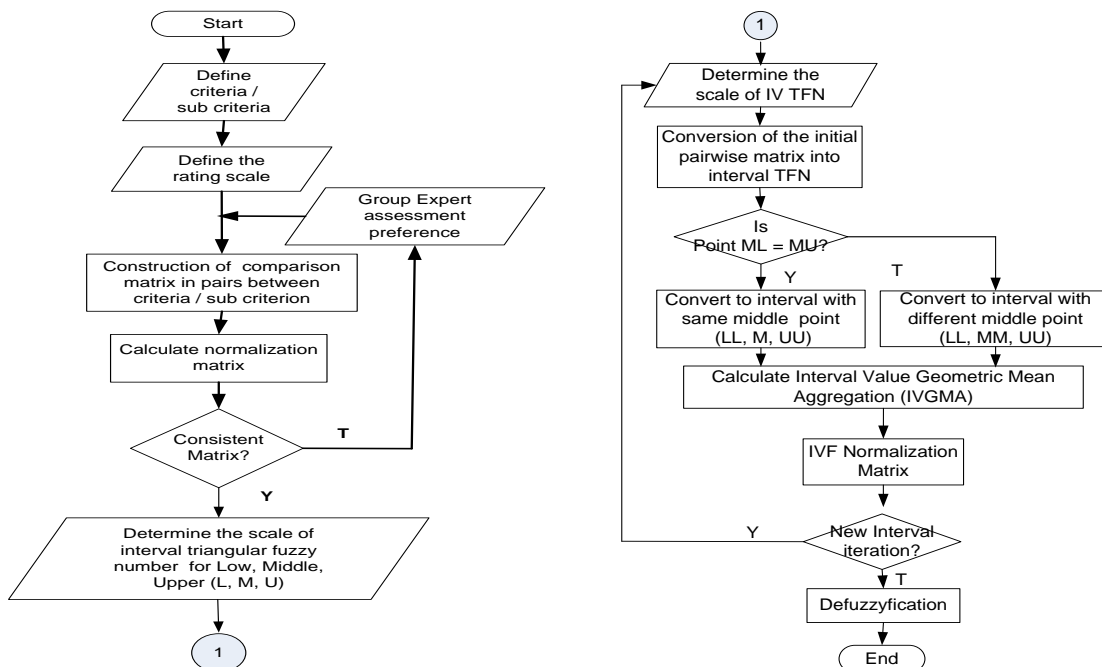


Figure 5. Framework AIV-FAHP

The stages of the simulation of this research program is:

1. Doing questioners to some expert people to determine the comparative matrix assessment.
2. Calculating the consistency matrix of pairwise matrices, if the consistency ratio (threshold) is less than 0.1 then the matrix is considered consistent.
3. Determining the linguistic scale by using two different middle points on IVF TFN. The Next is determined the linguistic scale for each interval point. Table 1 shows the linguistic scale with the same middle point. Table 2 shows the linguistic scale with different midpoints. Each point is made dynamic, in accordance with existing rules.

Table 1. Linguistic Scale with the Same Middle Point

Numerical Scale	IV-TFN scale	Definition of Linguistic Variables
1	[(1,1), 1,(1,1)]	Equally Important
3	[(1, 1.5) 3 (3.5, 4)]	Slightly More Important
5	[(3, 3.5) 5 (5.5, 6)]	More important
7	[(5, 5.5) 7 (8, 8.5)]	Very Important
9	[(7, 7.5) 9 (9.5, 10)]	The most important

Table 2. Linguistic Scale with the Different Middle Point

Numerical Scale	IV-TFN scale	Definition of Linguistic Variables
1	[(1,1), (1,1), (1,1)]	Equally Important
3	[(1, 1.5) (3, 3.3) (3.5, 4)]	Slightly More Important
5	[(3, 3.5) (5, 5.3) (5.5, 6)]	More important
7	[(5, 5.5) (7,7.3) (8, 8.5)]	Very Important
9	[(7, 7.5) (9, 9.3) (9.5, 10)]	The most important

4. Conversion of pairwise matrix matched into interval value, then normalize Weight in intervals with same middle point and Normalize Weight in intervals with different middle points.

5. The next step is to determine the weight of the indicator assessment by performing DeFuzzyfication, in Table 3. It is DeFuzzyfication of the matrix with the same interval point, and Table 4. shows DeFuzzyfication of the matrix with different interval points.

Table 3. DeFuzzyfication With The Same Middle Point

Criteria	Lower limit	Upper limit	Defuzzification
K1	0,179	0,241	0,211
K2	0,288	0,383	0,336
K3	0,509	0,671	0,590
k4	0,957	1,247	1,102

Table 4. DeFuzzyfication With Different Middle Point

Criteria	Lower limit	Upper limit	Defuzzification
K1	0,097	0,079	0,088
K2	0,164	0,131	0,147
K3	0,313	0,243	0,278
k4	0,605	0,452	0,528

Based on the DeFuzzyfication results from each interval point at Table 3 and Table 4. It shows that with two-point interval yield a smaller value range between criterion one with another criterion. Therefore the authors conclude that the interval between two points has better accuracy than at one point. The result of weighting criteria also shows the same order ie Concept for Adaptive Test and Evaluation (K4), Concept for Maintenance (K3), Design (K2),

Usability (K1). The result of comparison of criteria can be seen in Figure 6. Comparison of weight indicator. Fuzzy's adaptive interval concept can determine the optimal value by testing different interval points according to existing data. The methods discussed in this study can be applied in different domain problems, where the perceptions of decision-makers have an important role in the final outcome.

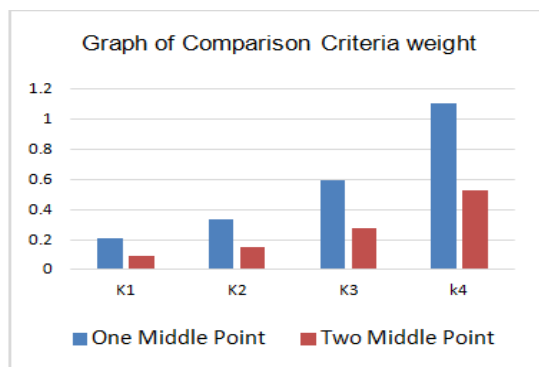


Figure 6. The Comparison of Criteria Weight

4. Conclusion

The interval value Fuzzy is an expansion of Fuzzy, with the value of the Fuzzy membership function in the interval form. Interval Value Fuzzy provide more accurate modeling, better rating performance, effective representation, and efficient computing. In the interval, the value Fuzzy is adaptive so that each judge can determine the point of interval flexible. FAHP is developed based on adaptive interval value by modifying the interval point on the Triangular Fuzzy Number with same middle point and different middle point. Decisions are taken in this study based on a smaller threshold, Improvements were also made at Interval Fuzzy points and opinion aggregation by Interval Value Geometric Means Aggregation (IV-GMA) method. Based on the simulation it is found that the range of values between the criteria generated with different TFN middle points is smaller than the same middle point. The methods in this study can be applied in different domain issues, where the perceptions of decision-makers have an important role in the final outcome.

The Further research can be developed using adaptive interval values FANP, ELECTRE, VIKOR, and DEMATEL with triangular Fuzzy or trapezoid Fuzzy number and aggregation of opinion with other methods.

References

- [1] Dursun M, Karsak E. A Fuzzy MCDM Approach for Personnel Selection. *Expert Systems with Applications*. 2010; 37(6): 4324-4330.
- [2] Skondras E, Sgora A. An ANP and Trapezoidal interval Value Fuzzy Technique for order preference by similarity to ideal solution Network access selection method. *Int. J. Commun. Syst.* 2014: 1-20.
- [3] Dagdeviren M, Yavuz S, Kilinc N. Weapon selection using the AHP and TOPSIS methods under Fuzzy environment. *Expert System with Applications*. 2009; 36: 8143-8151.
- [4] Aggarwal R, Sanjeet S. AHP and Extent Fuzzy AHP Approach for Prioritization of Performance Measurement Attributes. *International sciences index*. 2013; 7(1).
- [5] Kustiyahningsih Y, Rahmanita E, Purnama J. Integration Balanced Scorecard and Fuzzy Analytic Network Process (FANP) for Measuring Performance of Small Medium Enterprise (SME). *Journal of Theoretical and Applied Information Technology (JATIT)*. 2016; 94(2): 343-352.
- [6] Lazim A, Norsyahida Z. Integration of Fuzzy AHP and interval type-2 Fuzzy DEMATEL. *International Journal Expert Systems with Applications*. 2015; 42(9): 4397-4409.
- [7] Baohui J, Yuxin Z, Xiang L. Research on Zonal Inspection Intervals of Civil Aircraft Based on Improved FAHP. *Indonesian Journal of Electrical Engineering and Computer Science*. 2014; 12(1): 129-134.

- [8] Xie H, Duan W, Sun Y, Du Y. Dynamic DEMATEL Group Decision Approach Based on Intuitionistic Fuzzy Number. *TELKOMNIKA Telecommunication Computing Electronics and Control*. 2014; 12(4): 1064-1072.
- [9] Santoso I, Sa'adah M, Wijana S. QFD and Fuzzy AHP for Formulating Product Concept of Probiotic Beverages for Diabetic. *TELKOMNIKA Telecommunication Computing Electronics and Control*. 2017; 15(1): 391-398.
- [10] Diabagaté A, Azmani A, El Harzli M. Selection of the Best Proposal using FAHP: Case of Procurement of IT Master Plan's Realization. *International Journal of Electrical and Computer Engineering (IJECE)*. 2017; 7(1): 353-362.
- [11] Ashtiani B, Haghighirad F, Makui A, Ali Montazer G. Extension of FuzzyTOPSIS method based on interval-valued Fuzzy sets. *Applied Soft Computing*. 2009; 9(2): 457-461.
- [12] Kahraman C, Ucal Sar I, Ostaysi B, Turanoglu E. Fuzzy Analytic Hierarchy Process with interval type-2 Fuzzy sets. *Knowledge-Based Systems*. 2014; 59: 48-57.
- [13] Adil Baykasoglu A, Golcuk I. Development of an interval type-2 Fuzzy sets based hierarchical MADM model by combining DEMATEL and TOPSIS. *Expert Systems With Applications*. 2017; 70(15): 37-51.
- [14] Kumar P, Claudio D. Implications of estimating confidence intervals on group Fuzzy decision making scores. *Expert Systems With Applications*. 2016; 65: 152-163.
- [15] Cahyani A, Basuki, A, Malasari E, Kustiyahningsih Y. Design an Adaptive E-learning Application Architecture Based on IEEE LTSA Reference Model. *TELKOMNIKA Telecommunication Computing Electronics and Control*. 2015; 13(1): 284-289.
- [16] Djouab R, Bari M, An ISO 9126 Based Quality Model for the e-Learning Systems. *International Journal of Information and Education Technology*. 2016; 6(5): 370-375.
- [17] Sevarac Z, Devedzic V, Jovanovic J. Adaptive neuro-Fuzzy pedagogical recommender. *Expert Systems with Applications*. 2012; 39: 9797-9806.
- [18] Ghavipour M, Meybodi M R. An adaptive Fuzzy recommender system based on learning automata. *Electronic Commerce Research and Applications*. 2016; 20: 105-115.
- [19] Fuh CF, Jea R, Su JS. Fuzzy system reliability analysis based on level (k,1) interval-valued Fuzzy numbers. *Information Sciences*. 2014; 27(2): 185-197.