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Location Determination of Logistics Warehouse facility using Fuzzy Multi Criteria Decision Making (FMCDM) Approach in Western Sea Sector of Indonesia

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Abstract

The design concept of state defense is influenced by developments of national, regional and global environment. The national and regional developments give an effect to process of the Indonesia Navy (TNI AL) strengthen development, one of which is the improvement of logistics capability. The strength of logistics distribution is needed to support the element of warships in maritime security operations where the condition today often experience delays. The aim of this paper is planning the construction of logistics warehouse in assisting supplies distribution in the western waters territory of Indonesia using Fuzzy Multi Criteria Decision Making (MCDM). The criteria of location election logistic warehouse consists of security, transportation access and facility of warehouse support. The quantitative criteria consists of distance to operation sector, distance to the settlement, and earthquake factor. The result of paper gives five alternative selected locations, such as Naval Base I (LW), Naval Base II (DG), Naval Base III (KT), Naval Base IV (PG), and Naval Base XII (TK). Based on data analyzed by Fuzzy MCDM method, the best location for logistics warehouse is Naval Base III (KT) with value 0,218. Secondly, Naval Base IV (PG) with value 0,216. Third, Naval Base II (DG) with value 0,192. Based on the calculation, the best alternative location for logistics warehouse is Naval Base III (KT).

Keywords: Logistics Warehouse, Naval Base, Fuzzy MCDM.

INTRODUCTION

Design concept of state defense is influenced by developments of national, regional and global environment (1). The national and regional developments give an effect to process of the Indonesia Navy (TNI AL) strengthen development , one of which is the improvement of logistics capability (2), (3).

The strength of logistics distribution is needed to support the elements of warship (4) in the maritime security operations where the condition today often experience delays. Logistics support has an important role as the key to success and victory in military operations (5).

Logistics in military doctrine is the art and science, preparation, and execution of troop movements including equipment and business on the battlefield (6). Military logistics warehouse is one of supporting in the task of operation (7). It should pay attention to the layout by considering the terms of certain conditions that are different with other logistics warehouse.

The aim of this paper is planning the construction of logistics warehouse in assisting supplies distribution in the western waters territory of Indonesia using Fuzzy Multi Criteria Decision Making (MCDM). The criteria of location election logistic warehouse consists of security, transportation access and facility of warehouse support. The quantitative criteria consists of distance to the enemy, distance to the settlement, and earthquake factor.

Fuzzy is the study of structures associated with obscurity like a mathematical structure that at one time supersedes two classical truths (8). The representation of fuzzy logic is found in an uncertainty. Uncertainty arises from ambiguity, accident or incomplete acknowledgement (9). The fuzzy set theory and its operations have played an important role in various fields, likely computers, management science, Banking and Finance, Social Sciences and many other (10). Fuzzy techniques in the form of reasoning estimate provide decision support and expert systems with strong reasoning (11).

The decision making process is a systematic way of solving problems for any scientific research (12). MCDM method is able to combine historical data and expert opinions by quantifying subjective judgement (13). Decision-making in uncertainty and decision support systems is a prominent decision-making technique (14). The general purpose of MCDM is to evaluate and select several alternatives based on criteria using systematic analysis in overcoming the limitations of unstructured decision making (15).

To support the research, this paper has many literatures, such as: Application of the Multi Criteria Decision Making Methods for Project Selection (16). Comparison of Multi Criteria Decision Making Methods From The Maintenance Alternative Selection Perspective (17). MCDM Methods in Practice: Determining Importance of PESTEL Analysis Criteria (18). Establishing the Location of Naval Base Using Fuzzy MCDM and Covering Technique Methods : A Case Study (19).

The paper is organized as follows: Section 2 justifies the multi-criteria for Naval Base determination. Section 3 provides an MCDM application, reviews the applications of MCDM for Naval Base Warehouse. Finally, Section 4 concludes the paper and discusses some possible future research directions on the implementation of MCDM for

logistics Warehouse determination.

MATERIAL / METHODOLOGY.

Logistics Warehouse.

Warehouse is one of the important components in the supply chain (20). Warehouse is a facility in the supply chain that serves to consolidate products, reduce transportation costs, provide value-added processes and shorten response time (21). The warehouse has several major roles: as a buff for material flow, as well as locations to provide value-added service likely as stamping, labeling and knitting (22). The decision on the selection of warehouse locations is a strategic decision affecting the distribution of logistics. There are various types of warehouse, such as: production warehouse and distribution centers (23); in the supply chain, it can be classified as raw material warehouses, warehouse work, distribution warehouses (24). The type of warehouse operations includes: putting away, order picking, receiving, internal replenishment, accumulating and sorting, packing, cross docking, and shipping (25).

Fuzzy Technique.

Fuzzification is a process of changing the actual scalar value into a fuzzy value. This is achieved with different types of fuzzifiers (8). In general, the fuzzy logic system consists of 5 steps (26), such as:

1. Fuzzification.
   Change the sharp input to the membership function according to the intuitive perception of the system statue.
2. Rule processing.
   Calculating the response from system status input according to the predefined rules matrix.
3. Inference.
   It gives evaluating each case for all fuzzy rules.
4. Composition.
   It combines information from rules.
5. Defuzzification.
   Converting the result to crisp values.

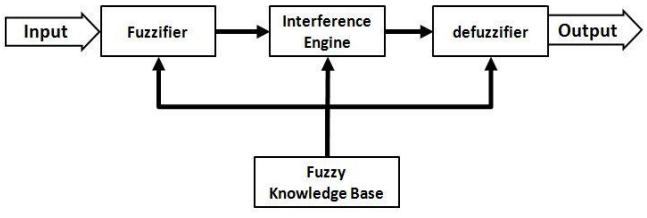

Figure 1: Fuzzy System

Steps.

1. Location alternative of logistics warehouse.
   a) Naval Base I (LW).
   b) Naval Base II (DG).
   c) Naval Base III (KT).
   d) Naval Base IV (PG).
   e) Naval Base XII (TK).
2. Quantitative and qualitative criteria.

The qualitative criteria of location election logistic warehouse consists of:

a) Security,
b) Transportation access and facility of warehouse support.

The quantitative criteria consists of:

a. Distance to operation sector.

An alternative distance to the field of operation sector is an important point for warship. It needs to support logistics with short time in every operation.

Table 1: Distance to Operation Sector

ALTERNATIVE	Sub Criteria	
	Distance (ASL) I	Distance (SCS)
Naval Base I (LW)	99 NM	702 NM
Naval Base II (DG)	1108 NM	1670 NM
Naval Base III (KT)	872 NM	535 NM
Naval Base IV (PG)	350 NM	398 NM
Naval Base XII (TK)	700 NM	140 NM

- Archipelagic Sea Lanes (ASL)
- South China Sea (SCS)

b. Distance to settlement.

Table 2: Distance to Settlement

ALTERNATIVE	Sub Criteria	
	Distance to City Center	Distance to Settlement
Naval Base I (LW)	1,2 KM	290 M
Naval Base II (DG)	13 KM	210 M
Naval Base III (KT)	5,5 KM	135 M
Naval Base IV (PG)	5,6 KM	250 M
Naval Base XII (TK)	4,8 KM	205 M

c. Earthquake factor.

Table. 3: Value of Earthquake factor

Alternative	VoAG
Naval Base I (LW)	0,25
Naval Base II (DG)	0,50
Naval Base III (KT)	0,25
Naval Base IV (PG)	0,15
Naval Base XII (TK)	0,05

- Value of Acceleration Gravity (VoAG)

3. Expert choices.
   a) Head of Base Facility Service, Indonesia Navy.
   b) Assistant of Commander of Western Fleet Command for Operations.
   c) Assistant of Commander of Western Fleet Command for Logistics.

RESULT AND DISCUSSION.

1. The weighting result for criteria stage assessment.

The result of weighting using numerical scale and lingusitics scale. Numerical scale using 1-10.

Table 4: Data from Expert Value

	Criteria	Sub Criteria	EXPERT 1	EXPERT 2	EXPERT 3	EXPERT 4
			N	N	N	N
Qualitative						
1	SECURITY	Clear from Enemy	9	10	10	10
		Clear from Conflict	9	8	8	8
2	TRANSPO-RTATION ACCESS	The Military Harbour	10	10	10	10
		The Civillian Harbour	7	5	5	8
		Airport	8	5	5	8
3	SUPPORTING FACILITIES	Communication Facilities	8	8	10	9
		Electrical Facilities	7	8	8	7
		Water Facilities	8	8	8	8
		Container Facilities	9	9	10	9
		Facilities of Maintenance and Repair	9	9	8	8
Quantitative						
1	Distance to Operation Sectors	Distance to ACL	9	8	8	10
		Distance to SCS	10	8	8	10
2	Distance from City Center	Distance from City Center	9	9	7	10
		Distance from Settlement	10	9	9	10
3	Earthquake Factor		10	10	10	10

2. The result of alternative assessment rate.

Result of alternative assessment rate using a numerical scale with value 1-10.

Table 5: Criteria Value of Alternative Location

	Criteria	Sub Criteria	ALTERNATIVE	EXPERT 1	EXPERT 2	EXPERT 3	EXPERT 4
				N	N	N	N
1.	SECURITY	Clear from Enemy	Naval Base I (LW)	8	6	6	7
			Naval Base II (DG)	9	8	6	6
			Naval Base III (KT)	8	10	8	8
			Naval Base IV (PG)	5	4	6	7
			Naval Base XII (TK)	8	6	7	7
		Clear from Conflict	Naval Base I (LW)	7	6	6	6
			Naval Base II (DG)	8	8	6	7
			Naval Base III (KT)	6	6	8	6
			Naval Base IV (PG)	7	8	5	5
			Naval Base XII (TK)	8	8	5	6
2.	TRANSPORTATION ACCESS	The Military Harbour	Naval Base I (LW)	9	8	7	9
			Naval Base II (DG)	6	10	6	7
			Naval Base III (KT)	7	10	7	6
			Naval Base IV (PG)	8	10	6	7
			Naval Base XII (TK)	9	6	6	7
		The Civillian Harbour	Naval Base I (LW)	9	8	6	8
			Naval Base II (DG)	9	6	6	8
			Naval Base III (KT)	9	8	7	9
			Naval Base IV (PG)	8	8	5	8
			Naval Base XII (TK)	8	8	5	8
		Airport	Naval Base I (LW)	9	6	5	7
			Naval Base II (DG)	8	6	5	7
			Naval Base III (KT)	9	8	6	8
			Naval Base IV (PG)	8	6	5	8
			Naval Base XII (TK)	8	6	5	7
3.	SUPPORTING FACILITIES	Communication Facilities	Naval Base I (LW)	7	8	6	6
			Naval Base II (DG)	7	8	6	6
			Naval Base III (KT)	7	8	8	8
			Naval Base IV (PG)	7	8	6	6
			Naval Base XII (TK)	7	8	6	6
		Electrical Facilities	Naval Base I (LW)	8	6	6	7
			Naval Base II (DG)	8	6	6	7
			Naval Base III (KT)	8	8	7	8
			Naval Base IV (PG)	8	6	6	8
			Naval Base XII (TK)	8	4	6	8
		Water Facilities	Naval Base I (LW)	6	8	6	7
			Naval Base II (DG)	7	8	6	7
			Naval Base III (KT)	7	8	6	6
			Naval Base IV (PG)	8	8	6	7
			Naval Base XII (TK)	8	8	6	7
		Container Facilities	Naval Base I (LW)	6	8	6	8
			Naval Base II (DG)	7	8	6	9
			Naval Base III (KT)	8	8	7	6
			Naval Base IV (PG)	8	8	6	6
			Naval Base XII (TK)	8	8	6	6
		Facilities of Maintenance and Repair	Naval Base I (LW)	6	8	7	7
			Naval Base II (DG)	6	4	5	6
			Naval Base III (KT)	7	8	7	9
			Naval Base IV (PG)	6	8	7	9
			Naval Base XII (TK)	7	4	5	6

3. Determining the middle value of fuzzy numbers.

Table. 6: Triangulation Fuzzy Number (TFN) for Criteria Location

	Linguistics	EXPERT 1			EXPERT 2			EXPERT 2			EXPERT 4		
	Level	Ct	At	Bt	Ct	At	Bt	Ct	At	Bt	Ct	At	Bt
1	Very Low												
2	Low												
3	Medium	1,00	6,00	7,50	1,00	5,00	7,83	1,00	5,00	6,86	1,00	6,00	7,60
4	High	6,00	7,50	9,10	5,75	7,83	9,43	5,00	6,86	9,83	6,00	7,60	9,78
5	Very High	7,60	9,10	10,00	7,83	9,43	10,00	6,96	9,83	10,00	7,80	9,78	10,00

Table 6 as a Value function table from expert choices for in each alternative assessment. In this table, each expert showed the value of lower limit (Ct), middle (At) and upper limit (Bt).

Table. 7: TFN Value of Qualitative

	Linguistics	EXPERT 1			EXPERT 2			EXPERT 2			EXPERT 4		
	Level	Qit	Oit	Pit	Qit	Oit	Pit	Qit	Oit	Pit	Qit	Oit	Pit
1	Very Low												
2	Low				1,00	4,00	6,00						
3	Medium	1,00	5,90	7,59	4,00	6,00	8,00	1,00	5,74	7,25	1,00	5,94	7,41
4	High	5,90	7,59	9,00	6,00	8,00	8,00	5,74	7,25	10,00	5,94	7,41	9,00
5	Very High	7,59	9,00	10,00	8,00	8,00	10,00	0,00	0,00	0,00	7,41	9,00	10,00

In table 7, it showed that the value of lower limit (Qt), Middle (Ot), and upper limit (Pt).

4. Determining of aggregate weighting for each criteria.

Table 8: Agregate Weight of Qualitative Criteria

	Sub Criteria	Weight Average		
		c_t	a_t	b_t
1	Clear from Enemy	7,448	9,535	10
2	Clear from Conflict	6,063	7,848	9,76
3	The Military Harbour	7,448	9,535	10
4	The Civillian Harbour	3,5	6,275	8,392
5	Airport	3,5	6,275	8,392
6	Communication Facilities	6,552	8,736	9,632
7	Electrical Facilities	5,688	7,448	9,535
8	Water Facilities	3,188	6,673	8,59
9	Container Facilities	7,448	9,535	10
10	Facilities of Maintenance and Repair	6,583	8,246	9,903

The respondents evaluate each criteria selection using linguistic scale to take a weight of the criteria.

5. Calculate the preference value for each alternative.

Table 9: Value of Alternative Preferences

	Sub Criteria	ALTERNATIVE	Average		
			Qit	Oit	Pit
1	Clear from Enemy	Naval Base I (LW)	4,209	6,686	8,313
		Naval Base II (DG)	3,898	7,169	8,166
		Naval Base III (KT)	6,394	7,564	9,5
		Naval Base IV (PG)	2,234	5,763	7,461
		Naval Base XII (TK)	5,394	7,064	9
2	Clear from Conflict	Naval Base I (LW)	2,975	6,317	7,916
		Naval Base II (DG)	4,709	7,186	8,313
		Naval Base III (KT)	2,934	6,272	8,252
		Naval Base IV (PG)	3,475	6,817	7,916
		Naval Base XII (TK)	3,475	6,817	7,916
3	The Military Harbour	Naval Base I (LW)	6,686	8,313	9,5
		Naval Base II (DG)	2,75	6,394	8,064
		Naval Base III (KT)	5,159	7,195	9,103
		Naval Base IV (PG)	3,984	6,763	8,461
		Naval Base XII (TK)	4,633	7,038	8,563
4	The Civillian Harbour	Naval Base I (LW)	5,133	7,538	8,563
		Naval Base II (DG)	4,633	7,038	8,563
		Naval Base III (KT)	5,502	7,934	8,813
		Naval Base IV (PG)	3,484	6,763	7,961
		Naval Base XII (TK)	4,709	7,186	8,313
5	Airport	Naval Base I (LW)	4,633	7,038	8,563
		Naval Base II (DG)	4,209	6,686	8,313
		Naval Base III (KT)	5,133	7,538	8,563
		Naval Base IV (PG)	4,209	6,686	8,313
		Naval Base XII (TK)	4,209	6,686	8,313
6	Communication Facilities	Naval Base I (LW)	3,475	6,817	7,916
		Naval Base II (DG)	3,475	6,817	7,916
		Naval Base III (KT)	5,894	7,564	9
		Naval Base IV (PG)	3,475	6,817	7,916
		Naval Base XII (TK)	3,475	6,817	7,916
7	Electrical Facilities	Naval Base I (LW)	4,209	6,686	8,313
		Naval Base II (DG)	4,209	6,686	8,313
		Naval Base III (KT)	5,894	7,564	9
		Naval Base IV (PG)	5,894	7,564	9
		Naval Base XII (TK)	3,459	6,186	7,813
8	Water Facilities	Naval Base I (LW)	3,484	6,763	7,961
		Naval Base II (DG)	4,709	7,186	8,313
		Naval Base III (KT)	3,475	6,817	7,916
		Naval Base IV (PG)	4,709	7,186	8,313
		Naval Base XII (TK)	4,709	7,186	8,313
9	Container Facilities	Naval Base I (LW)	3,484	6,763	7,961
		Naval Base II (DG)	5,078	7,583	8,563
		Naval Base III (KT)	4,659	7,195	8,603
		Naval Base IV (PG)	3,475	6,817	7,916
		Naval Base XII (TK)	3,475	6,817	7,916
10	Facilities of Maintenance and Repair	Naval Base I (LW)	4,669	7,141	8,648
		Naval Base II (DG)	1	5,394	7,064
		Naval Base III (KT)	6,263	7,961	9,25
		Naval Base IV (PG)	5,038	7,538	8,898
		Naval Base XII (TK)	2,225	5,817	7,416

Table 9 showed that a value of preferences from each alternative.

6. Calculate the fuzzy index value from assessment result for each alternative.

Table 10: Value of Evaluation Form

INDEX	ALTERNATIVE				
	1	2	3	4	5
Yi	24,79	21,51	30,02	22,5	22,49
Qi	56,19	54,59	58,92	54,8	54,16
Zi	78,82	76,75	83,05	77,4	76,71
Hi1	2,11	2,6	2,86	3,98	2,76
Ti1	5,98	5,11	4,14	4,34	4,62
Hi2	6,31	6,09	6,92	6,57	6,36
Ui1	1,95	1,98	1,88	1,86	1,92
Ti2	25,21	26,55	23,66	25,9	24,47
Ui2	-24,6	-24,2	-26	-24,4	-24,5

Table 10 showed a value of the fuzzy index from assessment result in each alternative for qualitative criteria.

7. Calculate the utility value for each alternative.

This step is the defuzzification process using centroid method.

Table 11: Weight of Defuzzification

	Criteria	Sub Criteria	Defuzzification Weight	ALTERNATIVE				
				1	2	3	4	5
1	SECURITY	Clear from Enemy	9,124	5,683	5,728	7,456	4,222	5,956
		Clear from Conflict	7,281	4,856	6,184	4,881	5,356	5,355
2	TRANSPORTATION ACCESS	The Military Harbour	8,569	7,784	4,956	6,621	5,769	6,061
		The Civillian Harbour	5,225	6,554	6,054	6,919	5,352	6,182
		Airport	5,225	6,054	5,683	6,554	5,683	5,682
3	SUPPORTING FACILITIES	Communication Facilities	7,743	5,356	5,356	7,068	5,356	5,355
		Electrical Facilities	6,938	5,683	5,683	7,068	7,068	5,05
		Water Facilities	5,169	5,353	6,183	5,356	6,184	6,182
		Container Facilities	8,569	5,353	6,538	6,217	5,356	5,355
		Facilities of Maintenance and Repair	7,707	6,217	3,403	7,415	8,01	4,225

Table 12: Value of Alternative Preferences

ALTERNATIVE	G_i
Naval Base I (LW)	42,14
Naval Base II (DG)	40,01
Naval Base III (KT)	46,48
Naval Base IV (PG)	40,39
Naval Base XII (TK)	39,98

Table 13: Utility Index Form

ALTERNATIVE	$U_t(G_i)$
Naval Base I (LW)	1,041
Naval Base II (DG)	0,883
Naval Base III (KT)	0,988
Naval Base IV (PG)	0,913
Naval Base XII (TK)	0,9

Table 12 showed a value of alternative performance from each alternative. From calculation result, it showed x_1 = 40,013 and x_2 = 46,478. Whereas, dimana x_1 as a G_i minimum and x_2 is G_i maximum.

8. Calculate the rank value for each alternative based on qualitative criteria.

Table 14: Alternative Rank

RANK	S_{ti}
Naval Base I (LW)	0,22
Naval Base II (DG)	0,187
Naval Base III (KT)	0,209
Naval Base IV (PG)	0,193
Naval Base XII (TK)	0,191

Table 14 showed that based on qualitative criteria, the first alternative for logistics warehouse is Naval base I (LW) with value 0,22.

9. Calculate the alternative rank value based on quantitative criteria.

Table 15: Agregate Weight of Quantitative Value

	CRITERIA	Weight Average		
		c_t	a_t	b_t
1	Distance to ACL	6,463	8,31	9,815
2	Distance to SCS	6,088	7,91	9,59
3	Distance from City Center	6,983	8,79	9,958
4	Distance from Settlement	7,448	9,53	10
5	Earthquake factor	7,448	9,53	10

Table 15 upon showed the defuzzification using centroid method.

Table 16: Defuzzification of Quantitative Criteria

	CRITERIA	Weight of Criteria	
1	Distance to ACL	7,62	0,19
2	Distance to SCS	7,27	0,182
3	Distance from City Center	8,055	0,201
4	Distance from Settlement	8,54	0,213
5	Earthquake factor	8,54	0,213

Next step, quantitative weight criteria multiped with the warehouse quantitative data.

Table 17: Data of Quantitative Criteria

	CRITERIA	ALTERNATIVE				
		1	2	3	4	5
1	Distance to ACL	99	1108	872	350	700
2	Distance to SCS	702	1670	535	398	140
3	Distance from City Center	1,2	13	6,5	2,9	4,8
4	Distance from Settlement	3	0,05	0,15	0,2	0,06
5	Earthquake factor	0,25	0,5	0,25	0,15	0,05
	Normalization					
1	Distance to ACL	0,242	0,161	0,18	0,222	0,194
2	Distance to SCS	0,199	0,129	0,211	0,221	0,24
3	Distance from City Center	0,042	0,458	0,229	0,102	0,169
4	Distance from Settlement	0,062	0,103	0,309	0,412	0,113
5	Earthquake factor	0,198	0,146	0,198	0,219	0,24

Table 18: Alternative Rank Based on Quantitave Criteria

ALTERNATIVE	Oti
Naval Base I (LW)	0,146
Naval Base II (DG)	0,199
Naval Base III (KT)	0,227
Naval Base IV (PG)	0,238
Naval Base XII (TK)	0,19

Based on table quantitative criteria upon, Naval base IV (PG) is the highest rank with value 0,238.

10. Calculate the total rank value for each alternative.

Table 19: Value Total of Logistics Warehouse Alternative Rank

ALTERNATIVE	F_{ti}	RANKING
Naval Base I (LW)	0,183	V
Naval Base II (DG)	0,193	III
Naval Base III (KT)	0,218	I
Naval Base IV (PG)	0,216	II
Naval Base XII (TK)	0,19	IV

Table 19 showed the calculation result from each alternative with qualitative and quantitative criteria. It gives results that Naval Base III (KT) is the highest rank for logistics warehouse with value 0,283.

CONCLUSION.

The result of paper gives five alternative selected locations, such as Naval Base I (LW), Naval Base II (DG), Naval Base III (KT), Naval Base IV (PG), and Naval Base XII (TK). Based on data analyzed by Fuzzy MCDM method, the best location for logistics warehouse is Naval Base III (KT) with value 0,218. Secondly, Naval Base IV (PG) with value 0,216. Third, Naval Base II (DG) with value 0,192. Based on the calculation, the best alternative location for logistics warehouse is Naval Base III (KT).

REFERENCES.

1. *Coping with Global Environmental Change, Disasters and Security.* Brauch, H. G. 2011, Hexagon Series on Human and Environmental Security and Peace.

2. Rahman, Chris. *Concepts of Maritime Security.* New Zealand : Victoria University of Wellington, 2009.

3. *The Effect of Strategic Environment Change toward Indonesia Maritime Security : Threat and Opportunity.* Putra, I. N., et al. 16, 2017, International Journal of Applied Engineering Research, Vol. 12, hal. 6037-6044.

4. *Defence Logistics Special Issue Editorial: An Important Research Field in Need of Research* . Keenan, D. Y., Rietjens, Sebastiaan dan Tatham, Peter. 2013, International Journal of Physical Distribution & Logistics Management.

5. Pagonis, G. *Moving Mountains: Lessons in Leadership and Logistics from the Gulf War*. Cambridge : Harvard Business School Press, 2012.

6. Thope, P. *The Theory of Action.* New York : Free Press, 2010.

7. *Factors Affecting Logistic Support in Military Operations: Case of the Kenya Defence Forces.* Ohndyl, O. G. dan Shale, N. I. 2014, International Academic Journal of Procurement and Supply Chain Management, hal. 1-11.

8. *Fuzzy Set Theory And Its Application for Interpretation of Damage Caused by Earthquakes Depending on The Magnitude And Epicentre Distance.* Sayal, Anu dan Singh, Satyajeet. 2013, International Journal of Emerging Technology and Advanced Engineering, hal. 343-347.

9. *Similarity relations and fuzzy orderings.* Zadeh, L. A. 1971, Information sciences, hal. 177-200.

10. *Some Fundamental Operations on Fuzzy Set Theory.* Khan, H. 2012, IJMS, hal. 161-166.

11. *Fuzzy Logic and Fuzzy Set Theory Based Edge Detection Algorithm.* Peric, N. 2015, Serbian Journal of Electrical Engineering, hal. 109-116.

12. *Applications of Multi-criteria Decision Making in Software Engineering.* Sehra, S. K., Brar, Y. S. dan Kaur, N. 2016, International Journal of Advanced Computer Science and Applications, hal. 472-477.

13. *Application of Multi-criteria Decision Making to Sustainable Energy Planning: A Review.* Pohekar, S. D. dan Ramachandran, M. 2004, Renewable & Sustainable Energy Review, hal. 365-381.

14. Gal, T. dan Hanne, T. *Multicriteria decision making: Advances in MCDM models, algorithms, theory, and*

applications. New York : Kluwer Academic Publishers, 1999.

15. *Application of Multi Criteria Decision Making to Urban Planning - A Review.* Afshari, A. R., Vatanparast, M. dan Cockalo, D. 2016, Journal of Engineering Management and Competitiveness, hal. 46-53.

16. *Application of the Multi Criteria Decision Making Methods for Project Selection.* Pangsri, Prapawan. 2015, Universal Journal of Management, hal. 15-20.

17. *Comparison of Multi Criteria Decision Making Methods From The Maintenance Alternative Selection Perspective.* Thor, Jureen, Ding, Siew-Hong dan Kamaruddin, Shahrul. 2013, The International Journal Of Engineering And Science, hal. 27-34.

18. *MCDM Methods in Practice: Determining Importance of PESTEL Analysis Criteria.* Dočkalíková, Iveta dan Kashi, Kateřina. 2014, The 8th International Days of Statistics and Economics, hal. 334-344.

19. *Establishing the Location of Naval Base Using Fuzzy MCDM and Covering Technique Methods : A Case Study.* Suharyo, Okol S., Manfaat, Djauhar and Armono, Haryo D. 1, s.l. : International Journal of Quantitative Management, March 2017, International Journal of Quantitative Management, Vol. 23.

20. *Research on Warehouse Operation: A Comprehensive Review.* Gu, J., Goetschalckx, M. dan McGinnis, L. F. 2007, European Journal of Operational Research, hal. 1-21.

21. Bartholdi, I. J dan T., Hackman S. *Warehouse and Distribution Science.* 2006.

22. *Analytical Model for Optimum Warehouse Dimensions.* Karakis, Ismail, Baskak, Murat dan Tanyaş, Mehmet. 2015, Research in Logistics & Production, hal. 255-240.

23. Ghiani, G, Laporte, G, dan Musmanno, R. *Introduction to Logistics System Planning and Control.* England : John Wiley & Sons., 2004.

24. Frazelle, E. *World-class Warehouseing and Material Handling.* New York : McGraw-Hill, 2001.

25. Tompkins, J. A, et al. *Facilities Planning.* NJ : John Wiley & Sons, 2003.

26. *Effect of Different Defuzzification Methods in a Fuzzy Based Load Balancing Application* . Naaz, S., Alam, A. dan Biswar, R. 2011, International Journal of Computer Science Issues, hal. 261-267.

27. *Optimal Fuzzy Model Construction with Statistical Information using Genetic Algorithm.* Hossain, Md. A., et al. 2011, International Journal of Computer Science & Information Technology, hal. 241-257.