Hybrid framework of decision making in military: case study of railway planning

Achmad Farid Wadjdi¹,², Suhirwan², Yeyep Firdaus³

¹ R&D Agency, Ministry of Defense, Jakarta Selatan, Indonesia
² Indonesia Defense University, Sentul-Bogor, Indonesia
³ R&D Agency, Ministry of Defense, Jakarta Selatan, Indonesia

farid.wajedi@kemhan.go.id

Abstract. This paper focuses on exploring decision-making methods related to alternative decision choices, and how to derive its achievement strategy formulation. Albeit we found some combination of decision-making methods in the literature, we have to prove that such combination is a relevant framework for use in the context of military perceptions. We show in this case study that a structured combination of focus group discussions, Fuzzy AHP, Fuzzy TOPSIS, and SWOT is a straightforward framework to be used as a tool of decision making in the military environment.

1. Introduction

One of important development in the border areas is the development of transportation infrastructure. There are many border areas in Indonesia that need their infrastructure to be constructed or improved. One of the border areas is Kalimantan that needs railway network. The construction of the railway network will be a solution to address social and economic problems, including defense and security. Accelerating the development of pioneer railways requires support from local governments, especially in areas where rail infrastructure is not yet available. Also, the selection of infrastructure and facilities by local carrying capacity should be considered in the planning. The upgrading of this lane is directed to the development of rail and tonnage of bridges by the standards applicable to vulnerable areas. This suggestion is to support the achievement of substantial transport on safety and security and disaster anticipation [1]. Also, its presence can provide support for the security and control of border areas from various threats and vulnerabilities.

Studies that provide an overview of the welfare aspect have been widely practiced and have provided railway masterplans in Kalimantan [2]. In the meantime, this paper will provide an insight into improving the plan from the aspects of defense and security. Of course, to make essential recommendations in making decisions about details of railway network planning, the review will be based on a data-driven decision pattern.
How the railway network will be built and developed in Kalimantan based on military perceptions is an attracted case of decision making and strategy formulation to be studied. Such case is not a decision virtually in real time. It needs an assessment of many factors, while there are many methods related to the decision making of priorities and the selection of strategies. The fact that military perceptions are always related to the complexity of the problems then decision-making by a single method is generally considered insufficient. In practice, a combination of these methods should be performed to obtain the desired result.

Thus, this paper will raise the framework in incorporating the available single methods in the case of how to optimize railway utilization to support national defense interests in the border areas of Kalimantan. The hope is that the framework used in this study can contribute as a benchmark in the integration of various decision-making methods.

2. Literature Review

2.1. The rail networks in the border areas
Currently, the integration of transportation modes is universal. The choice of the railway mode is considered to be appropriate at a medium distance compared to the superior mode of the airline mode which is more suitable for the long-distance applications [1]. Moreover, the railway is exceeding the ordinary road in the aspect of carrying capacity [2]. Of course, discussing the disadvantages and advantages of modes of transport is debatable. However, it is certain that railway mode is still an essential alternative in the development of the economy [3]. Furthermore, many countries emphasize the importance of their border areas as their priority in national defense areas due to access to and from other countries. Such cross-country access may trigger the presumption of the nature of threats that cause regional tensions [4].

2.2. Rail networks planning and related issues
Good transport infrastructure and services are essential prerequisites for increasing trade, and for managing sustainable economic development [5]. Studies related to standardization of critical infrastructure has been widely investigated. Some of which are related to the construction of the railway network, such as [6]–[10]. Rinaldi [11] has proposed a model of interdependencies among critical infrastructures related to threats and national security interest. Burdett & Kozan [12] proposed the method of calculating the rail transport capacity. Hilmola & Henttu [13] shows border-crossing constraints of railways. Gathon & Pestieau [14] investigated the link between the effectiveness of regulatory and railway management. Şahin & Yüceoğlu [15] proposed crew capacity planning in railways involve finding the minimum number of crews to operate a predetermined set of train duties. Reddy et al. [16] proposed the model of rail maintenance cost, and Peterson & Church [17] reviewed rail vulnerabilities. De Bruijn & Veeneman [18] discussed decision making of a light rail option, and there are many other kinds of literature related to railway issues.

2.3. The factors influencing rail networks in Kalimantan
Railway transport planning for military purposes is mainly still referring to the general planning approach of the railway network. It relates to the policy direction and railway role in the whole mode of transportation [19]. The other factors are coping with forecasts of the movement of people and goods [20], cost analysis [21], and an urban, provincial or national spatial plan [22], [23]. It also related to military mobility, especially in isolated border areas, such as proximity [24], [25], threats [26], and difficulty level of access to the railway station [27].
The plan to build railway tracks in Kalimantan is to transport various commodities and natural resources such as coal, palm oil, and industrial timber products, but now, the government has developed the plan as a means of public transportation. Also, the plan is expected to facilitate the delivery of military weapon system, facilitate the dispatch of troops with sufficient numbers, facilitate the deployment of troop logistics, and for the approach point in the implementation of border area security patrols.

2.4. The hybrid framework of Multiple Criteria Decision Making in site selection
In this paper, we define hybrid decision-making frameworks as a framework for incorporating several single decision-making methods that aim to simplify data collection, subsequent analysis process, accuracy, and aim to solve a specific case. Therefore, in the incorporation of several methods in this paper referred to as a hybrid framework.

A variety of location determination methods are used, including Analytic Hierarchy Process (AHP), Višekriterijumska Optimizacija I Kompromisno Resenje (VIKOR), Decision-Making Trial and Evaluation Laboratory (DEMATEL), Technique For Others Reference by Similarity to Ideal Solution (TOPSIS), Preference Ranking Organization Method for Enrichment Evaluations (PROMETHEE), and Dominance-based Rough Set Approach (DRSA) [28]. Also, researchers often combine two or more of the methods, such as AHP and TOPSIS [29], [30]. The incorporation of such methods is intended to obtain the accuracy of the results. They often combine it with qualitative methods [31]. However, the most popular method of site selection is the combine of Fuzzy AHP and Fuzzy TOPSIS [32]. In this study, we use the combination of Fuzzy AHP and Fuzzy TOPSIS to relate with the criteria of fuzziness in the military research.

3. Methodology

3.1. Research Questions
The central question of the paper is how we conduct a hybrid framework when we have some methods related to the case study. We face two significant research questions as a case study based on military preferences “to accommodate the needs of military transportation in the railway plan in Kalimantan.” First is to find out the most significant criteria in the planning of the railway. We will then should examine the location alternatives based on the criteria. The last, we should formulate a strategy as a recommendation, and that should show the apparent framework.

3.2. Data Collecting and the Methods
Exploration of criteria in military decision-making usually uses the SWOT approach (Strength, Weaknesses, Opportunity, Threats) which discussed through Focus Group Discussion (FGD) or interview session during the FGD. The SWOT approach was used by interviewing field commanders, local officials, and transportation experts. Also, to explore their perceptions, we held six focus group discussions. The selected experts for the FGD are representations of institutions that are part of the border area management, namely Indonesia military (TNI), Police (Polri), National Border Management Agency (BNPP), Ministry of Public Works (KemenPUPR), Ministry of Communication & Information (Kominfo), Indonesian railroad company (PT. KAI), Ministry of Politics, Law and Security (Polhukam), Indonesia Institute of Science (LIPI), academics and persons who directly involved in carrying out border area management activities in Kalimantan. Furthermore, the Fuzzy AHP method combined with Fuzzy TOPSIS is used in weighting criteria on the SWOT for alternative railway lines.
The general procedure for decision making usually consists of the following steps [32]:

- Decide on the criteria that will be used to evaluate location alternatives
- Identify criteria that are important
- Develop location alternatives
- Evaluate the alternatives and select

Regarding the military environment, the criteria that will be used to evaluate location alternatives that offered through FGD are:

- proximity to existing or planned military facilities,
- the tonnage of military equipment,
- frequency threat estimates,
- contour areas, and
- proximity to logistics centers.

Table 1. Criteria and Sub-Criteria Affecting Railway Lines Plan

| Criteria          | Sub-criteria                  | Description of decision |
|-------------------|-------------------------------|-------------------------|
| Economic Aspects  | Average Economic Growth       | gain                    |
|                   | Population                    | gain                    |
|                   | Track                         | cost                    |
| Plan              | Local                         | gain                    |
|                   | National                      | gain                    |
| Military Aspects  | Number of Facilities          | gain                    |
|                   | Level of Infrastructures      | gain                    |
|                   | Proximity to the mission area | gain                    |
| Threats           | Threats to the natural resources | gain                 |
|                   | Threats of the disputed border | gain                   |
|                   | Threats of trans-national crime | gain                |

From the various references mentioned above and after being confirmed through FGD, we obtain criteria in the context of the interests of national defense, see Table 1. In multi-criteria decision making, Table 1 shows the criteria and sub-criteria used to guide FGD participants in the judgment. In the description of the decision, "gain" means the greater the value of a criterion, the higher the level of its preference, while the "cost" is the opposite.

In this study, we adopted the Fuzzy AHP and Fuzzy TOPSIS framework proposed by İrfan Ertuğrul and Nilsen Karakaşoğlu [33]. We will focus more on the research recommendations to discuss in detail. Therefore, we do not provide a detailed description of fuzzy sets, fuzzy numbers, linguistic variables, and mathematical formulas of Fuzzy AHP or Fuzzy TOPSIS.

Table 2. Alternative Railway Routes

| Code | Routes   |
|------|----------|
| A-1  | P, M, N, S, E |
There are several proposed railway lines in Kalimantan, see Table 2. We provide data in Table 3 that are tailored to the criteria that we inference from various secondary sources, geographic information system and the results of discussions on FGDs to assist participants in their judgment. Participants may use the data, but the decision should prioritize their knowledge and expertise. It should be noted that the determination of the criteria and sub-criteria is the result of the pairwise comparison in the Fuzzy AHP approach. The resulting weights will be used in the Fuzzy TOPSIS approach to rank alternative railway lines. For purposes of military research ethics, we use the code without specifying more clearly. Whereas common code like H means high, M is Medium, L is Low, and VL is Very Low; Y/N is Yes or Not. Figure 1 shows the structure of criteria, alternatives, and the goal.

Table 3. Data for Decision Maker of Railway Plan

| Code | Plan | Economic Aspects | Military Aspects | Threat |
|------|------|------------------|------------------|--------|
|      |      | Local EGrowt h | Trac k (Km) | Populatio n (Million) | NofFa c | Infrast . level | Prox | Nat Res . | Borde r Disp . | TN C |
| A-1  | N    | Y                | L                | 287 | 1.30 | H | H | Nea r | H | H | H |
| A-2  | Y    | Y                | L                | 144 | 1.05 | H | H | Mod   | M | M | M |
| A-3  | Y    | Y                | M                | 269 | 1.83 | H | H | Nea r | H | H | H |
| A-4  | Y    | Y                | VL               | 303 | 1.28 | L | M | Nea r | H | H | H |

Figure 1. The Hierarchy structure of the research
4. Results and Discussion
Data analysis with Fuzzy AHP gives the criteria and sub-criteria weight, see Table 4, 5 and 6. Meanwhile, the weighting results are used on Fuzzy TOPSIS to rank alternatives. The sub-criteria and criteria weighting results are also used in the SWOT analysis to assist in the formulation of other recommendation strategies emerging from the discussion.

Table 4. Mean of pairwise comparison with respect to the goal

|                  | Threat | MilAsp | Splan | Ecopot | Geometric mean |
|------------------|--------|--------|-------|--------|----------------|
| Threat           | (1,1,1)| (4.308,5.62,6.372) | (0.874,2.28,3.824) | (2.328,3.824,5.431) | (1.721,2.646,3.392) |
| MilAsp           | (0.157,0.178,0.232) | (1,1,1) | (0.191,0.271,0.481) | (0.229,0.41,1.144) | (0.288,0.373,0.598) |
| Splan            | (0.262,0.439,1.144) | (2.08,3.688,5.244) | (1,1,1) | (0.958,2.607,4.497) | (0.85,1.433,2.279) |
| Ecopot           | (0.184,0.262,0.43) | (0.874,2.498,4.372) | (0.222,0.384,1.043) | (1,1,1) | (0.435,0.708,1.183) |
| Sum              |        |        |        |        | (3.293,5.159,7.451) |

CIm = 0.026 and CIg = 0.012 (Consistent)

Table 5. The matrix of final weights (criteria) with respect to the goal

| Criteria | Final Fuzzy Weight | Final Normal Crisp Weight |
|----------|--------------------|--------------------------|
| Threat   | (0.231,0.513,1.03) | 0.4864                   |
| MilAsp   | (0.039,0.072,0.181) | 0.0774                   |
| Splan    | (0.114,0.278,0.692) | 0.2891                   |
| Ecopot   | (0.058,0.137,0.359) | 0.1471                   |

Table 6. The matrix of final weights (sub-criteria) with respect to the goal

| Sub-criteria | Final Fuzzy Weight | Final Normal Crisp Weight |
|--------------|--------------------|--------------------------|
| Bd           | (0.089,0.37,1.228) | 0.3463                   |
| Tnc          | (0.024,0.072,0.247) | 0.0703                   |
| Nr           | (0.024,0.072,0.247) | 0.0698                   |
| Prox         | (0.015,0.052,0.218) | 0.0551                   |
| NofFac       | (0.004,0.01,0.044)  | 0.0112                   |
| Infrastr Level | (0.004,0.01,0.044) | 0.0111                   |
| National Plan | (0.057,0.232,0.897) | 0.2359                   |
| Local Plan   | (0.014,0.046,0.213) | 0.0532                   |
| Egrowth      | (0.023,0.099,0.433) | 0.1056                   |
| Pop          | (0.006,0.019,0.085) | 0.0208                   |
| Track        | (0.006,0.019,0.085) | 0.0207                   |

Table 6 shows three main criteria which are significant preferences of experts with weight 0.3463 (the threat of border dispute), 0.2359 (National Railway Network Plan) and 0.1056 (average growth of the local economic). Nevertheless, all sub-criteria preferences remain agreed to be applied in the discussion in formulating strategies using SWOT analysis. While in the analysis using Fuzzy TOPSIS, we will use the fourth weight of the results criteria from the Fuzzy AHP. The result of Fuzzy TOPSIS is in Table 7.
To formulate a ranking achievement strategy generated through Fuzzy TOPSIS, we map the criteria and sub-criteria into the SWOT analysis as in Table 8.

**Table 7.** The priority ranking of alternatives

| Alternatives | Distance from positive ideal (D+) | Distance from negative ideal (D-) | Solution (D-/ (D++D-)) | Rank |
|--------------|----------------------------------|----------------------------------|------------------------|------|
| A1           | 3.329                            | 0.695                            | 0.173                  | 2    |
| A2           | 3.462                            | 0.567                            | 0.141                  | 3    |
| A3           | **3.204**                        | **0.817**                        | **0.203**              | **1**|
| A4           | 3.620                            | 0.415                            | 0.103                  | 4    |

**Table 8.** The mapping of criteria to SWOT components based on the local condition

| F-TOPSIS/F-AHP Component | SWOT Group       | The impact on the preferences |
|--------------------------|------------------|-------------------------------|
| Criteria Sub-criteria    |                  |                               |
| Economic Aspects         |                  |                               |
| Average Economic Growth  | Weakness         | Negative                      |
| Population               | Weakness         | Negative                      |
| Track                    | Weakness         | Negative                      |
| Spatial Plan             |                  |                               |
| Local                    | Opportunity      | Positive                      |
| National                 | Opportunity      | Positive                      |
| Military Aspects         |                  |                               |
| Number of military facilities | Strength | Positive                      |
| Infrastructure Level     | Strength         | Positive                      |
| Proximity to the mission area | Strength | Positive                      |
| Threat                   |                  |                               |
| Threat to natural resources | Threat        | Positive                      |
| Threat of the disputed border | Threat      | Positive                      |
| Threat of trans-national crime | Threat  | Positive                      |

**Table 9.** The SWOT analysis of military perspective

| SWOT Group | Group weights | Factors    | Local weight | Global weight |
|------------|--------------|------------|--------------|---------------|
| S (Mil Aspects) | 0.0774       | Prox       | 0.7121       | 0.0551        |
|             |              | NofFac     | 0.1452       | 0.0112        |
|             |              | level      | 0.1427       | 0.0111        |
| W (EcoAspects)  | 0.1471       | EGrowth    | 0.7181       | 0.1056        |
|             |              | Population | 0.1411       | 0.0208        |
|             |              | Track      | 0.1408       | 0.0207        |
| O (Plan)    | 0.2891       | National   | 0.8160       | 0.2359        |
|             |              | Local      | 0.1840       | 0.0532        |
| T (Threat)  | 0.4864       | Bd         | 0.7120       | 0.3463        |
|             |              | Nat Res.   | 0.1435       | 0.0698        |
|             |              | TNC        | 0.1445       | 0.0703        |

Thus, from military preferences, Table 7 shows A-3 is the prioritized Railway Route. The next step to realize the priority choice of the railway route (A-3), we need a selection of strategies based on factors that are taken into consideration when ranking the choice of available railway lines. In addition to being implemented, the choice of strategies is also needed to provide detailed reasons for the ranking of the prioritized railway route. For that, we analyzed
data available with SWOT. Mapping criteria and sub-criteria are weighted into the SWOT as in Tables 8 and 9. Noteworthy is that the economic aspect of the border area is included as a weakness because the referenced will become an expense at the time of initial investment and the cost of railway operation in the short term.

The top dominant factors based on SWOT Group in decision making stated in Table 9 are (1) National plan, (2) Low eco growth, (3) Proximity to mission area, and (4) Border dispute. The existence of a national railway network plan, where the context is to integrate its development with economic and political aspects, has been recognized as a major factor in the construction of the railroad network in the border area [34]. Even in the context of military perceptions as shown by this study, the national plan factor is the top choice. The results of this study also show that the availability of railroads will soon overcome low economic growth in the border area. The military perception shows that the aspect of the local economy is a more important option to be overcome immediately than that of military aspects and threats. We have confirmed the result during the last FGD that the option is real when the border security condition is stable. After that, the perceived military aspects become an important option to consider in choosing the location of the railroad network. The first is proximity to the operational mission area and the second option to be considered is the disputed area. This perception has shown that the military needs infrastructure to support troop mobility to the operational mission area. Also, they also view that the construction of railroad infrastructure approaching the disputed area is important for the implementation of their operational mission.

There are four strategy options recommended to realize the priority choice of the railway line (A-3) as shown in Table 9, namely: Maxi-Maxi (Proximity to Mission Area and National Plan), Maxi-Mini (Proximity to Mission Area and Border Dispute), Mini-Maxi (Low Economic Growth and National Plans), and Mini-Mini (Low Economic Growth and Border Dispute). So, all strategic priority options refer to the railway network development (A-3) that addresses economic, security and state sovereignty issues through the implementation of the national railway program.

Noteworthy in the framework is that SWOT has been used at the beginning to brainstorm FGD and at the end, SWOT used with the weight of Fuzzy AHP results to determine the best recommendations. Albeit the method such as Fuzzy AHP or Fuzzy TOPSIS, each also allows for a recommendation based on the weighting values of criteria and subcriteria, the combined method as the framework notice in this paper shows the results that are easier to interpret, more robust, and straightforward to formulate the best strategy.

5. Conclusions, Limitations, and Recommendations
We have shown the framework of a combination of several research methods such as FGD-SWOT-FAHPTOPSIS-SWOT that is useful for the study.

Research questions on essential criteria and alternative recommendations are answered. There are some limitations that we are hard to avoid that is the detailed exploration of criteria, sub-criteria, and the exact actual formulation of the strategy recommended. We do not elaborate on this paper for reasons of ethical research in the military environment.

Of that, in a complete analysis, the results of the quantitative analysis can be combined with the qualitative analysis based on social theories. We encourage other researchers to do so given the results of quantitative mapping on SWOT as we point out would be more meaningful if there is a reason based on social theories that strengthen it, for example, with the theory of expectancy[35], push-pull policy theory [36], and other related social theories.
References

[1] M. Givoni and D. Banister, “Role of the railways in the future of air transport,” Transp. Plan. Technol., vol. 30, no. 1, pp. 95–112, 2007.

[2] G. Pirie, “Railways and labour migration to the rand mines: Constraints and significance,” J. South. Afr. Stud., vol. 19, no. 4, pp. 713–730, 1993.

[3] L. Affuso, J. Masson, and D. Newbery, “Comparing Investments in New Transport Infrastructure: Roads versus Railways?,” Fisc. Stud., vol. 24, no. 3, pp. 275–315, 2003.

[4] J. Holslag, “The Persistent Military Security Dilemma between China and India,” J. Strateg. Stud., vol. 32, no. 6, pp. 811–840, Dec. 2009.

[5] T. R. Lakshmanan, “The broader economic consequences of transport infrastructure investments,” J. Transp. Geogr., vol. 19, no. 1, pp. 1–12, 2011.

[6] D. J. Puffert, “Path Dependence in Spatial Networks: The Standardization of Railway Track Gauge,” Explor. Econ. Hist., vol. 39, no. 3, pp. 282–314, 2002.

[7] K. Woods, “Ceasefire capitalism: Military-private partnerships, resource concessions and military-state building in the Burma-China borderlands,” J. Peasant Stud., vol. 38, no. 4, pp. 747–770, 2011.

[8] S. Wang, X. Li, and Q. Zhang, “An evaluation model and empirical study on standardization of railway construction project,” Int. J. Digit. Content Technol. its Appl., vol. 6, no. 23, pp. 677–683, 2012.

[9] D. Li, “Railway development and military conflicts in prewar China,” in Eurasian Geography and Economics, 2013, vol. 54, no. 5–6, pp. 500–516.

[10] S. Burmaoglu and O. Sarıtas, “Changing characteristics of warfare and the future of Military R&D,” Technol. Forecast. Soc. Change, vol. 116, pp. 151–161, 2017.

[11] S. M. Rinaldi, “Modeling and simulating critical infrastructures and their interdependencies,” in 37th Annual Hawaii International Conference on System Sciences, 2004. Proceedings of the, 2004, p. 8 pp.

[12] R. L. Burdett and E. Kozan, “Techniques for absolute capacity determination in railways,” Transp. Res. Part B Methodol., vol. 40, no. 8, pp. 616–632, 2006.

[13] O. P. Hilmola and V. Henttu, “Border-crossing constraints, railways and transit transports in Estonia,” Res. Transp. Bus. Manag., vol. 14, pp. 72–79, 2015.

[14] H. J. Gathon and P. Pestieau, “Decomposing efficiency into its managerial and its regulatory components: The case of European railways,” Eur. J. Oper. Res., vol. 80, no. 3, pp. 500–507, 1995.

[15] G. Şahin and B. Yüceoğlu, “Tactical crew planning in railways,” Transp. Res. Part E Logist. Transp. Rev., vol. 47, no. 6, pp. 1221–1243, 2011.

[16] V. Reddy, G. Chattopadhyay, P. O. Larsson-Kråik, and D. J. Hargreaves, “Modelling and analysis of rail maintenance cost,” Int. J. Prod. Econ., vol. 105, no. 2, pp. 475–482, 2007.

[17] S. K. Peterson and R. L. Church, “A framework for modeling rail transport vulnerability,” Growth Change, vol. 39, no. 4, pp. 617–641, 2008.

[18] H. De Bruijin and W. Veeneman, “Decision-making for light rail,” Transp. Res. Part A Policy Pract., vol. 43, no. 4, pp. 349–359, 2009.

[19] M. M. Dessouky and R. C. Leachman, “A simulation modelling methodology for analyzing large complex rail networks,” Simulation, vol. 65, no. 2, pp. 131–142, 1995.

[20] Y. P. Wang and C. Q. Ma, “Influencing factors and development trends of urban rail transit passenger flow,” Chang. Daxue Xuebao (Ziran Kexue Ban)/Journal Chang. Univ. (Natural Sci. Ed.), vol. 33, no. 3, pp. 69–75, 2013.
[21] S. Samanta and M. Jha, “Model for Rail Transit Alignment Planning and Design,” *Transp. Res. Board 88th Annu.*, no. November 2008, 2009.

[22] H. Gerçek, B. Karpak, and T. Kiliçalaslan, “A multiple criteria approach for the evaluation of the rail transit networks in Istanbul,” *Transportation (Amst)*., vol. 31, no. 2, pp. 203–228, 2004.

[23] R. K. Shepherd and S. D. Pryke, “Regional rail planning; a study of the importance of ‘steering’ and ‘pragmatism’ in stakeholder networks,” *Eur. Manag. J.*, vol. 32, no. 4, pp. 616–624, 2014.

[24] F. S. Pearson, “Geographic Proximity and Foreign Military Intervention,” *J. Conflict Resolut.*, vol. 18, no. 3, pp. 432–460, 1974.

[25] J. Robst, S. Polachek, and Y. C. Chang, “Geographic proximity, trade, and international conflict/cooperation,” *Confl. Manag. Peace Sci.*, vol. 24, no. 1, pp. 1–24, 2007.

[26] P. Collier and A. Hoeffler, “Military Expenditure : Threats, Aid and Arms Races,” *World Bank Policy Res. Work. Pap.* 2927, pp. 1–23, 2002.

[27] L. Grenzeback, D. Hunt, and C. Systematics, “National Rail Freight Infrastructure Capacity and Investment Study,” *Cambridge ….*, no. September, 2007.

[28] A. Mardani, A. Jusoh, K. M. D. Nor, Z. Khalifah, N. Zakwan, and A. Valipour, “Multiple criteria decision-making techniques and their applications - A review of the literature from 2000 to 2014,” *Economic Research-Ekonomska Istrazivanja*, vol. 28, no. 1, pp. 516–571, 2015.

[29] S. Öznüt and S. Soner, “Transshipment site selection using the AHP and TOPSIS approaches under fuzzy environment,” *Waste Manag.*, vol. 28, no. 9, pp. 1552–1559, 2008.

[30] G. Kabir and R. S. Sumi, “Selection of Concrete Production Facility Location Integrating Fuzzy AHP with TOPSIS Method,” *Int. J. Product. Manag. Assess. Technol.*, vol. 1, no. 1, pp. 40–59, 2012.

[31] M. M. Fouladgar, A. Yazdani-Chamzini, and E. K. Zavadskas, “An integrated model for prioritizing strategies of the Iranian mining sector,” *Technol. Econ. Dev. Econ.*, vol. 17, no. 3, pp. 459–483, 2011.

[32] F. Torfi, R. Z. Farahani, and S. Rezapour, “Fuzzy AHP to determine the relative weights of evaluation criteria and Fuzzy TOPSIS to rank the alternatives,” *Appl. Soft Comput. J.*, vol. 10, no. 2, pp. 520–528, 2010.

[33] I. Ertugrul and N. Karakasoglu, “Comparison of fuzzy AHP and fuzzy TOPSIS methods for facility location selection,” *Int. J. Adv. Manuf. Technol.*, vol. 39, no. 7–8, pp. 783–795, 2008.

[34] K. Stanev, E. J. Alvarez-Palau, and J. Martí-Henneberg, “Railway Development and the Economic and Political Integration of the Balkans, c. 1850–2000,” *Eur. - Asia Stud.*, vol. 69, no. 10, pp. 1601–1625, 2017.

[35] University of Cambridge, “Vroom’s expectancy theory,” *IFM Management Technology Policy*, 2014.

[36] G. F. Nemet, “Demand-pull, technology-push, and government-led incentives for non-incremental technical change,” *Res. Policy*, vol. 38, no. 5, pp. 700–709, 2009.