MAPPING THE USE OF MULTICRITERIA METHODS APPLIED TO PUBLIC SECURITY

Marcio Pereira Basilio (UFF)
marciopbasilio@gmail.com
Helder Gomes Costa (UFF)
hgc@vm.uff.br
Valdecy Pereira (UFF)
valdecypereira@yahoo.com.br

Public security is a topic with increasing relevance over the years. In this context, the growing demand requires decisions that consider multiple points of view, some of them subjective. This work is based on the assumption that few studies have been conducted in the public security sector employing multiple criteria techniques to support the decision making procedure. In this context, this research had the objective of mapping the application of MCDA methods within the scope of public security. A literature review in the journals of the Scopus and ISI Web of Science databases was carried out in October 2016, accessed through Capes portal, integrating the following themes: public security and multicriteria decision aid. A systematic search was conducted by applying the Webibliomining method. After applying specific keywords and filters 965 records were returned from Scopus and 788 records from the ISI Web of Science. The review of findings summary resulted in a set of 19 articles validated as compliant for inclusion in the revision, where 19 were from Scopus and 6 were shared with the Web of Science base. The analysis of the articles showed that there is no predominant multicriteria method in the context of the search. The recurrent applications refer to the resolution of the policing distribution problem, and classification of crime rate by region. The key contribution of this work is to provide the reader with a map of public safety problems already addressed in the context of MCDAs approaches and to highlight aspects of this problem that have not yet explored in the context of the MCDA.

Palavras-chave: Webibliomining, public security, multicriteria analysis

1. Introduction

Decision within public safety is part of a peculiar context that involves analyzing the problem in the light of multiple perspectives or multiple evaluation criteria. However, despite the successes already achieved in *the Multiple Criteria Decision Aid* (MCDA) matter, there is a perception that there are few decision making related works in the public safety sphere whose modeling is supported by the concepts of this matter (MCDA).

In this context, the following question arises: how has the application of MCDA methods in the public security sector evolved over the years?

This work is based on the assumption that few studies have been conducted in the public security sector employing multiple criteria techniques to support the decision making procedure. Thus, it aims to map the intellectual production as published in scientific journals found in Scopus and Web of Science bases, accessed through the CAPES portal, which considers the use of the MCDA to model decisions in public security, identifying mainly, the methods employed, the contexts in which such modeling was done, the criteria used and the findings reached in such previous works.

2. Methodology

The methodology applied in this work is based on *the* Webibliomining works proposed by Costa (2010), and also explored by *Barros et al* (2015) and Pereira and Costa (2015). More specifically, six steps are performed:

1. Defining the research sample;
2. Research in the sample, with keywords;
3. Identification of journals having the highest number of published articles on the topic;
4. Identification of those authors with the highest number of publications;
5. Chronological production survey, determining the cycles with highest production;
6. Selection of articles for bibliographic research, which should consider:
   a. The most relevant articles;

b. Identification of the first and last authors writing on the topic;
c. Identification of the most relevant texts in each major production cycle.

These steps were performed and the results thereof are detailed in the next section.

3. Search Results

3.1 Sample definition

The sample searched corresponds to such articles indexed in the Web of Science and Scopus Bases, which indexes a vast and recognized collection of scientific journals. Access to the bases was through Capes Portal. Such bases were chosen because to it was available via the Capes newspaper's portal and, mainly, due to its representativeness and comprehensiveness. These databases index the contents of journals, covering all areas of knowledge. As for the time frame, the survey was conducted in October 2016, covering all years available in the database.

3.2 Search in the sample

The search was performed by using public safety and multi-criteria related words. In relation to public security, there is a divergence in the meaning of the terms, for example, the word "*Security*" is related to property security, personal security, at a military level, or even national sovereignty/stability. While "*Safety*," also reflects security but is rather related to health, physical integrity, hazard protection, or absence of risk caused by unsafe conditions. Thus, both keywords were used for the sake of comprehensiveness. For selecting the articles, an advanced search was performed employing Boolean expressions ("AND" and "OR"), which allows the combination of keywords in the search for a better approach to the specific term. The search process was based on the use of the most common expressions associated with the term "multicriteria decision aid" and also based on such public safety inherent terms, such as safety and security. In this way, the following keywords were used: (secur* OR safe*) AND (multicriteria OR "multicriteria" OR "multi-criteria" OR "multiplecriteria" OR mcda OR mcdm)) then Scopus returned 965 records, while Web of Science database returned 788 records; regarding the types of documents, the search was filtered for article, review, and, as for the type of outlet, for journals. At each base, filters were applied to these collections of

records in order to identify articles addressing the use of multi-criteria methods in the context of public safety, as illustrated in Figure 1.

The application of keywords and search filter allowed reducing the collection of entries to those potentially matching the search theme. At a later time, the summary of such records was analyzed, which resulted in a collection of 19 papers validated as matching for inclusion in the review, where 19 were from Scopus database and 6 were from the Web of Science database (6 were common to both datases), as shown in Figure 2.

It should be noted that the search phrase and the filters were used as decision aids so as to provide a starting point for the papers for further refinement. According to Neves et al (2015), this is a usual strategy employed in researches involving a systematic literature review, and is employed to eliminate homonymy-related noise. Neves et al (2015) illustrated this when quoted ANP term. It is the acronym both for the multicriteria method "AnalyticNeworkProcesss", and for the National Agency of Petroleum (the Brazilian Agency that deal whith the regulation of realatonship between Petroleun industry and Market), which justifies refining from the initial base of articles potentially matching the search.

Figure 1 summarizes the main results from the initial search. The second column records the initial search terms, including the results from Scopus and Web of Science database. Scopus returned 965 records for papers published in Journals, while the Web of Science recorded 788 papers in the database. In the second phase 23 filters associated with multicriteria methods were applied, as shown in Figure 1. All 19 selected papers potentially matching the public safety theme that will become the starting point for literature review are shown in Figure 3.

Following is an analysis of the data in this Figure, and also a summary of each of the papers listed there in Figure 3.

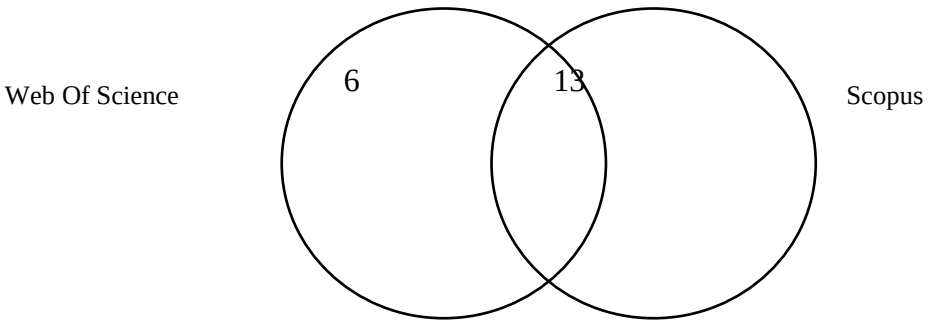
Figure 1 - Filter by multi-criteria method.

	Search terms	**Results**	
		Scopus	**Web Of Science**
Initial search phrase, restricting the search to paper, Review and Journals only	((secur* OR safe*) AND (multicriteria OR "multi criteria" OR "multi-criteria" OR "multiple criteria" OR mcda OR mcdm))	965	788
	"Aggregated Indices Randomization Method" OR AIRM	0	0
	"Analytic Hierarchy Process" OR AHP	360	174

Filters associated to the term multicriteria	"Analytic Network Process" OR ANP	102	30
	Borda	4	0
	Condorcet	0	0
	"Disaggregation - Aggregation Approaches" UTA OR OR OR UTAII UTADIS	7	2
	"Dominance-based Rough Set Approach" OR DRSA	5	4
	"Elimination et Choix Traduisant it Realité" OR ELECTRE	67	13
	"EvidentialReasoning Approach"	19	10
	"Geometrical Analysis for Interactive Aid" OR GAIA	15	2
	"Grey Relational Analysis" OR GRA	23	2
	"Measuring Attractiveness by a Categorical Based Evaluation Technique" OR MACBETH	8	1
	"Multi-attribute Global Inference of Quality" OR MAGIQ	0	0
	"Multi-attribute Utility Theory" OR MAUT	12	3
	"Multi-attribute Value Theory" OR MAVT	1	0
	"New Approach toAppraisal"	0	0
	"Potentially all pairwise rankings of all possible alternatives" OR PAPRIKA	0	0
	"Preference Ranking Organization Method for Enrichment Evaluations of" OR PROMETHEE	65	20
	THOR	1	0
	TODIM	3	0
	TOPSIS	151	53
	"Weighted Product Model" OR WPM	0	0
	"Weighted Sum Model" OR WSM	1	1

Source: Prepared by the authors.

Figure 2 - Representation of Starting Research Core



Source: Prepared by the authors.

Figure 3 - List of articles adhering to the theme selected.

Authors	**Title**	**Source**	
Figueiredo, C.J.J.D. *et al* (2016)	A classification model to evaluate the security level in a city based on GIS-MCDA	Scopus	Web Of Science
Liberatore, F., et al (2016)	A Comparison of Local Search Methods for the Multicriteria Police Districting Problem on Graph	Scopus	Web Of Science

Chen, F., et al (2015)	Road safety risk evaluation by means of improved entropy TOPSIS-RSR	Scopus	Web Of Science
Paula Silva, CJ, et al (2015)	Maxillofacial injuries the markers of interpersonal violence in Belo Horizonte, Brazil: Analysis of the socio-spatial vulnerability of the location of victim's residences	Scopus	Web Of Science
Camacho-Collados, M., et al (2015)	The Decision Support System for predictive police patrolling	Scopus	
Bouranta, N., et al (2015)	Measuring police officer and citizen satisfaction: comparative analysis	Scopus	Web Of Science
Özdemir, Ü., Et al (2015)	Strategic model approach for the investigating causes of maritime accidents [Stratejikbir model yaklaşimiiledenizkazasebeplerininaraştirilmasi]	Scopus	
Camacho-Collados, M., et al (2015)	The multi-criteria Police districting problem for the efficient and effective design of patrol sector	Scopus	Web Of Science
di Bella, E., et al (2014)	Multi-indicator Approach for Smart Security Policy Making	Scopus	
Gupta, M., et al (2014)	The framework of intelligent decision support system for Indian police	Scopus	
Adler, N., et al (2014)	The Traffic Police Location and Schedule Assignment Problem	Scopus	
Mignelli, C., et al (2013)	Use of multi-criteria model to compare devices for the protection of roads against Rockfall	Scopus	
Manning, M., et al (2013)	Overview of: "Valuing developmental crime prevention"	Scopus	
Chen, C.-W., et al (2013)	Application of GIS for the determination of hazard hotspots after direct transportation linkages between Taiwan and China	Scopus	
Gurgel, A. M. (2013)	the multicriteria prioritization model to support public safety planning	Scopus	
Amendola, K.L., et al (2011)	An experimental study of compressed work schedules in policing: Advantages and Disadvantages of various shift lengths	Scopus	
Karvetski, CW, et al (2011)	Scenario and multiple criteria decision analysis for energy and environmental security of military and industrial installations	Scopus	
Lau, H.C.W., et al (2010)	Optimizing patrol force deployment using a genetic algorithm	Scopus	
Nutt, D.J., et al (2010)	Drug harms in the UK: A multicriteria decision analysis	Scopus	

Source: Prepared by the authors.

3.3 Identification of outlets with the highest number of papers published

Regarding the identification of the outlets matching the specific theme of the research, 18 outlets were identified, 17 out of which would contain one paper per outlet, and only one, MathematicalProblems In Engineering, published two papers, as shown in Table 1. This note shows a diversity of outlets, with no authors' preference as for any specific outlet.

Table 1- Identification of outlets with the highest number of papers published

SOURCE TITLE	PUBLICATIONS
In MathematicalProblems Engineering	2
CriminologyAndPublicPolicy	1
DecisionSupport Systems	1
Environmental AndEngineeringGeoscience	1
European Journal Of Operational Research	1
Expert Systems WithApplications	1
Integrated Environmental Assessment And Management	1
Journal Of Enterprise Information Management	1
JournalOf Experimental Criminology	1
Journal Of Multi Criteria Decision Analysis	1
Lancet	1
Natural Hazards	1
PlosOne	1
Policing	1
PrometTrafficTraffico	1
Safety Science	1
Sobrapo	1
Social IndicatorsResearch	1

Source: Prepared by the authors.

3.4 Identification of authors with the highest number of publications

As regards the identification of those authors with the most publications, this research made no difference between authors and co-authors. Thus, 58 researchers were identified, but only Camacho-Collados, M. and Liberatore, F. outstood with three publications each, as shown in Table 2. The remaining 56 authors had only one publication each, which allows inferring that the topic in question is a matter of concern for many researchers, which reinforces the relevance of the topic.

Table 2 - Identification of authors with the highest number of publications

AUTHOR NAME	PUBLICATIONS	AUTHOR NAME	PUBLICATIONS
Camacho-Collados, M.	3	Lau, H.C.W.	1
Liberatore, F.	3	Lee, C.C.	1
Adler, N.	1	Leporatti, L.	1
Amendola, K.L.	1	Linkovz, I.	1
Angulo, J.M.	1	Manning, M.	1
Bouranta, N.	1	Mignelli, C.	1
Chandra, B.	1	Mota, C.M.D.M.	1

Chen, C.H.	1	Moura, A.C.M.	1
Chen, C.W.	1	Naves, M.D.	1
Chen, F.	1	Nutt, D.J.	1
Corsi, M.	1	Paiva, P.C.P.	1
De Paula Silva, C.J.	1	Peila, D.	1
De Paula, L.P.P.	1	Phillips, L.D.	1
Deng, Y.	1	Pomarico, S.	1
Ferreira E Ferreira, E.	1	Raviv, T.	1
Ferreira, R.C.	1	Sher, M.	1
Figueiredo, C.J.J.D.	1	Silvestrini, R.A.	1
Gupta, M.	1	Siskos, Y.	1
Gupta, M.P.	1	Slipka, M.	1
Güneroğlu, A.	1	Smith, C.	1
Hakkert, A.S.	1	Tseng, C.P.	1
Hamilton, E.E.	1	Tsotsolas, N.	1
Ho, G.T.S.	1	Vargas, A.M.D.	1
Homel, R.	1	Wang, J.	1
Hon, W.T.	1	Weisburd, D.	1
Jones, G.	1	Zhao, Y.	1
Karvetski, C.W.	1	diBella, E.	1
King, L.A.	1	Özdemir, Ü.	1
Lambert, J.H.	1		

Source: Prepared by the authors.

3.5 Survey of bibliographic production

The publications chronology for the starting nucleus of the bibliographic review spanned the years from 2010 to 2016, where the years from 2013 to 2015 outstand, as shown in Table 3.

Table 3 - Bibliographic production chronology survey

YEAR	PUBLICATIONS
2016	2
2015	6
2014	3
2013	4
2012	0
2011	2
2010	2
TOTAL	19

Source: Prepared by the authors.

3.6 Topic included in the survey

This section provides a brief description of the 19 selected articles to be included in the survey, identifying authors, methods employed, countries, dimensions, and criteria used in each survey. As shown in Figure 4.

Figure 4 - Starting nucleus identified.

Authors	Country	Method	Subject	Criteria
Liberatore, F., et al (2016)	Spain	Graph Algorithms	Public Security	area, isolation, demand, anddiameter.
Figueiredo, C.J.J.D. *et al* (2016)	Brazil	Dominance-Based Rough Set Approach (DRSA)	Public Security	Income,R$∗ (by person); Gini índex; Infrastructure (bathroom and piped water%); Education (years); e Demographic density per km2.
Chen, F., et al (2015)	China	TOPSIS-RSR	Road Safety	Percentage of vehicle drivers holding his/her licence maximum three years; Percentage of heavy goods vehicles in total vehicle fleet; Road density; Percentage of motor ways/freeways in total road length; Percentage of urban population; Percentage of illiteracy population; Physician per 1,000 inhabitants; Life expectancy; Gross domestic product per capita; Percentage of national expenditure in health as GDP; Number of driving licenses delivered per vehicles; Fatalities per 100,000 inhabitants; Fatalities per road accidents; Fatalities per road accidents; and Fatalities per 10,000 vehicles.
Paula Silva, CJ, et al (2015)	Brazil	Multi-criteria analysis - MCA (not specified)	Crime Preventio n	Housing density; Per capita income; Income of the head of the family; Number of exclusive bathrooms; Record of electricity consumption; Suitability characteristics of the household; Lighting in the neighborhood; Sewage disposal in the neighborhood.
Camacho-Collados, M., et al (2015)	Spain	Linear Programming	Public Security	Notidentified
Bouranta, N., et al (2015)	Greece	MUSA system	Public Security	Amount of work; Type of work; Financial rewards; supervision; Co-workers; Company identification; Career facilitation; Physical conditions.
Camacho-Collados, M., et al (2015)	Spain	Linear Programming	Crime Preventio n	Area; Support received; demand; diameter; Area ratio; Isolation ratio; demand ratio; and Diameter ratio.
Özdemir, Ü., Et al (2015)	Turkey	DEMATEL / ANP	navigation safety	External influences and environment; Shore-side management; Ship factor;

				People factor; Organization on board; and Working and living conditions
di Bella, E., et al (2014)	Italy	POSAC analyzes / PCA / MDS	Crime Prevention	Not identified
Gupta, M., et al (2014)	India	Data Mining	Public Security	Not identified
Adler, N., et al (2014)	Israel	Multiple-objectiveprogramming	Public Security	Not identified
Mignelli, C., et al (2013)	Italy	AHP	Road Safety	Landscape impact; Impacts During the construction phases - dust; Impacts During the construction phases - noise, vibration; Impacts on water, air, soil, noise and vibration During the exercise; Direct construction cost; Management and maintenance costs, without rock block impact; Management and operation costs, with rock block impacts on the structure; Cost of safety During exercice; Indirect construction cost -disposal of excavated rock or soil; Indirect construction cost - recovery roadway and traffic diversion cost; project's complexity related with the skills of staff design; preliminary investigation; geo residual risks related to excavation and site job; excavated rock disposal and construction Supplying materials; Worksite complexity; improvement of the road layout; During construction traffic diversion; Increase of time travel During construction; social acceptance; Project not shared by the community; construction team.
Manning, M., et al (2013)	United States	MCDM	Crime Prevention	Not identified
Chen, C.-W., et al (2013)	Taiwan	Gathering and scattering model analysis	Public Security	Not identified
Gurgel, A. M. (2013)	Brazil	SMARTS multicriteriamethod	Crime Prevention	Demographic density; Population growth; living in bad conditions; Inequality; Income concentration; and Degree of Police occurences.
Amendola, K.L., et al (2011)	United States	AnalysisofCovariance (ANCOVA)	Public Security	Not identified
Karvetski, CW, et al (2011)	United States	AHP	Security ofMilitary	Energy continuity; Energy availability; Foreign input; Renewable sources and / or Environmental impacts; System vulnerability; and Innovation
Lau, H.C.W., et al (2010)	Hong Kong	Linear Programming	Public Security	Notidentified
Nutt, D.J., et al (2010)	United Kingdom	Multi-criteria analysis – MCA (not	Crime Prevention	Drug-specific mortality; Drug-related mortality; Drug-specific damage; Drug-related damage; dependence;

		specified)		Drug-specific impairment of mental functioning; Drug-related impairment of mental functioning; Loss of tangibles; Loss of relationships; Injury; Crime; Environmental damage; Family adversities; International damage; Economic cost; and Community.

Source: Prepared by the authors.

4. Concluding Remarks

Revisiting the question that motivated the present research, which sought to learn the evolution of the application of MCDA methods in the scope public security, it can be stated that the target was reached and the hypothesis is few studies available in the scope of public security employing multicriteria techniques for decision support was confirmed. Upon the use of keywords specific to the topic and with the restrictions on the type of documents, such as article and review, and the type of publication outlets restricted to journals, the application to the databases returned 965 entries in Scopus and 788 entries in the ISI Web Of Science base. Filters were applied in each base to such collections of entries, aiming to identify such papers that contemplated the use of multicriteria methods in the context of the public security area. The application of keywords and search filter allowed reducing the collection of entries to those potentially matching the search theme. Reviewing the summary of such entries resulted in a collection of 19 papers validated as matching for inclusion in the review, 19 from the Scopus database and 6 shared with the Web of Science database. The papers were reviewed and reported in the body of work, but no predominant method was identified.

This study was limited to applying the methodology to the analysis of outlets indexed in two indexation bases available on the CAPES outlets portal. In general, it can be assumed that the main limitation for this research is associated with the fact that the sample includes only those papers indexed in the Scopus or in the ISI *Web of Science*; despite the quality of the indexers in both databases, important contributions, not yet indexed in them, may not have been considered in the search. Based on the study developed, on the preparation of the proposed methodology and on the expertise gained during its application, the following suggestions are proposed for future development: search other databases, for example, Scielo, and EBSCO.

This research also determined that the use of multicriteria methods is still little explored in such topics such as: patrolling optimization, identification of areas prone to crime, selection of

police officers, selection of public safety projects, police service performance evaluation, and crime indicators.

5. References

ADLER, N.; HAKKERT, A.S.; RAVIV, T.; and SHER, M.. The Traffic Police Location and Schedule Assignment Problem. **Journal of Multi-Criteria Decision Analysis**. V. 21, 05 / jun, p.315-333, 2014. https://dx.doi.org/10.1002/mcda.1522

AMENDOLA, K. L.; WEISBURD, D.; HAMILTON, E. E., JONES, G., and SLIPKA, M. An experimental study of compressed work schedules in policing: Advantages and Disadvantages of various shift lengths. **Journal of Experimental Criminology**.V. 7, no. 4, p. 407-442, 2011. https://dx.doi.org/10.1007/s11292-011-9135-7

BARROS, M.D.; Salles, CAL; Gomes, C.F.S.; SILVA, R.A.D.; and Costa, H. G.. Mapping of the Scientific Production on the ITIL Application Published in the National and International Literature. **Proceeding Computer Science**, vol. 55, p. 102-11, 2015.

BOURANTA, N.; SISKOS, Y.; and TSOTSOLAS, N. (2015). Measuring police officer and citizen satisfaction: **comparative analysis.Policing**. V. 38, n. 4, p. 705-721, 2015. https://dx.doi.org/10.1108/PIJPSM-01-2015-0008

CAMACHO-COLLADOS, M.; and LIBERATORE, F.. The Decision Support System for predictive police patrolling. **Decision Support Systems**. V. 75, p. 25-37, 2015. https://dx.doi.org/10.1016/j.dss.2015.04.012

CAMACHO-COLLADOS, M.; LIBERATORE, F.; and ANGULO, J.M.. The multi-criteria Police districting problem for the efficient and effective design of patrol sector. **European Journal of Operational Research**. V. 246, no. 2, p. 674-684, 2015. https://dx.doi.org/10.1016/j.ejor.2015.05.023

CHEN, F.; WANG, J.; and DENG, Y.. Road safety risk evaluation by means of improved entropy TOPSIS-RSR. **Safety Science**. V. 79, p. 39-54, 2015. https://dx.doi.org/10.1016/j.ssci.2015.05.006

CHEN, C. W.; LEE, C. C.; TSENG, C. P., and CHEN, C. H.. Application of GIS for the determination of hazard hotspots after direct transportation linkages between Taiwan and China**. Natural Hazards**. V. 66, n. 2, p. 191-228, 2013. https://dx.doi.org/10.1007/s11069-012-0402-3
COSTA, H.G.. Model for webibliomining: Proposal and application case. **Magazine FAE**, v. 13, no. 1, p. 115-126, 2010.

PAULA SILVA, C.J.; MOURA, A.C.M.; PAIVA, P.C.P.; FERREIRA, R.C.; SILVESTRINI, R.A.; VARGAS, A.M.D.; PAULA, L.P.P.; NAVES, M.D.; and FERREIRA AND FERREIRA, E.. Maxillofacial injuries the markers of interpersonal violence in Belo Horizonte, Brazil: Analysis of the socio-spatial vulnerability of the location of victim's residences. **PLOS ONE** V. 10, n. 8. Art. N. e0134577, 2015. https://dx.doi.org/10.1371/journal.pone.0134577

DI BELLA, E.; CORSI, M.; and LEPORATTI, L.. Multi-indicator Approach for Smart Security Policy Making. **Social Indicators Research**. V. 122, no. 3, p. 653-675, 2014. https://dx.doi.org/10.1007/s11205-014-0714-7

FIGUEIREDO, C.J.J.D.; and MOTA, C. M. D. M.. The classification model to evaluate the security level in the city based on GIS-MCDA. **Mathematical Problems in Engineering**. V.2016, Art. No. 3,534,824, 2016. https://dx.doi.org/10.1155/2016/3534824.

Gupta, M. Chandra, B., Gupta, MP (2014).The framework of intelligent decision support system for Indian police.Journal of Enterprise Information Management. V.27, No. 5, p.512-540.https://dx.doi.org/10.1108/JEIM-10-2012-0073

GURGEL, André Morais; and MOTA, Caroline Maria de Miranda.. The multicriteria prioritization model to support public safety planning. **Operational Research**, *33*(2), 251-267, 2013. https://dx.doi.org/10.1590/S0101-74382013000200007

KARVETSKI, C.W.; LAMBERT H.; and LINKOVZ, I.. Scenario and multiple criteria decision analysis for energy and environmental security of military and industrial installations. **Integrated Environmental Assessment and Management**. V. 7, n. 2, p. 228-236, 2011. https://dx.doi.org/10.1002/ieam.137

LAU, H. C. W.; HO, G.T.S; ZHAO, Y.; and HON, W.T.. Optimizing patrol force deployment using the genetic algorithm. **Expert Systems with Applications**. V. 37, n. 12, p. 8148-8154, 2010. https://dx.doi.org/10.1016/j.eswa.2010.05.073

LIBERATORE, F.; and CAMACHO-COLLADOS, M.. A Comparison of Methods Local Search for the MultiCriteria Police districting problem on Graph. **Mathematical Problems in Engineering**. V.2016, Art. No. 3,690,474, 2016. https://dx.doi.org/10.1155/2016/3690474.

MANNING, M.; SMITH, C.; and HOMEL, R.. Overview of: "Valuing developmental crime prevention". **Criminology and Public Policy**. V. 12, n. 2, 2013. https://dx.doi.org/10.1111/1745-9133.12023

MIGNELLi, C.; POMARICO, S.; and PEILA, D.. Use of multi-criteria model to compare devices for the protection of roads against Rockfall. **Environmental and Engineering Geoscience**. V. 19, n. 3, p. 289-302, 2013. https://dx.doi.org/10.2113/gseegeosci.19.3.289

NEVES, Roberta Braga; PEREIRA, Valdecy; and COSTA, Helder Gomes.. Aid multicriteria decision applied to the planning and management in the oil and gas industry. **production,** *25*(1), 43-53. Epub September 03, 2013. https://dx.doi.org/10.1590/S0103-65132013005000060

NUTT, D.J.; KING, L.A.; and PHILLIPS, L.D.. Drug harms in the UK: The multicriteria decision analysis. **The Lancet**. V. 376, no. 9752, p. 1558-1565, 2010. https://dx.doi.org/10.1016/S0140-6736(10)61462-6

ÖZDEMIR, Ü.; and GÜNEROĞLU, A.. Strategic approach model for investigating the causes of maritime accidents [Stratejikbir model yaklaşimiiledenizkazasebeplerininaraştirilmasi]. **Promet - Traffic - Traffico**. V. 27, n. 2, p. 113-123, 2015. https://dx.doi.org/10.7307/ptt.v27i2.1461

PEREIRA, V.; and COSTA, Helder Gomes. The literature review on lot size with quantity discounts: 1995-2013. **Journal of Modelling in Management**, vol. 10, p. 341-359, 2015. http://dx.doi.org/10.1108/JM2-07-2013-0029