Artículo de investigación

Prioritization of kish airport projects using multi-criteria decision-making (weighting: shannon entropy)

Priorización de los proyectos del aeropuerto kish utilizando la toma de decisiones multicriterio (ponderación: entropía shannon)

Priorização dos projetos aeroportuários de kish usando a tomada de decisões multicritério (ponderação: entropia de shannon)

Recibido: 9 de abril de 2017. Aceptado: 30 de mayo de 2017

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Abstract

In many organizations, selection of the project and activities related to the management of selected projects throughout their lifecycle are considered among the important activities. In a multi-project environment, rare resources play an important limiting role and the allocation of resources is a crucial factor in success. In the situation studied in this research, some projects should be chosen and implemented from among several projects available in Kish Island airport so that the greatest profit is obtained with respect to the limited resources. This study was conducted using the multi-criteria decision-making approach (MCDM). The structure of the multi-criteria decision-making approach is of importance for solving different types of problems in the fields related to project management, including the time when the project manager is faced with decision problem-solving and often several contradictory views, as a result of which managers can enhance their performance in controlling the project activities, especially in a dynamic and variable environment.

Keywords: Prioritization, Multi-Criteria Decision-Making, Shannon Entropy, Kish Airport

Resumen

En muchas organizaciones, la selección del proyecto y las actividades relacionadas con la gestión de los proyectos seleccionados a lo largo de su ciclo de vida se consideran entre las actividades importantes. En un entorno de proyectos múltiples, los recursos raros desempeñan un papel importante de limitación y la asignación de recursos es un factor crucial para el éxito. En la situación estudiada en esta investigación, algunos proyectos deberían elegirse e implementarse entre varios proyectos disponibles en el aeropuerto de Kish Island para obtener el mayor beneficio con respecto a los recursos limitados. Este estudio se realizó utilizando el enfoque de toma de decisiones multicriterio (MCDM). La estructura del enfoque de toma de decisiones multicriterio es importante para resolver diferentes tipos de problemas en los campos relacionados con la gestión de proyectos, incluido el momento en que el gerente de proyectos se enfrenta con la resolución de problemas de decisión y, a menudo, con puntos de vista contradictorios, como resultado de lo cual los gerentes pueden mejorar su desempeño en el control de las actividades del proyecto, especialmente en un entorno dinámico y variable.

Palabras clave: priorización, toma de decisiones multicriterio, entropía de Shannon, aeropuerto de Kish

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Resumo

Em muitas organizações, a seleção do projeto e das atividades relacionadas ao gerenciamento de projetos selecionados em todo o seu ciclo de vida é considerada uma das atividades importantes. Em um ambiente multiprojeto, recursos raros desempenham um importante papel limitante e a alocação de recursos é um fator crucial para o sucesso. Na situação estudada nesta pesquisa, alguns projetos devem ser escolhidos e implementados dentre os vários projetos disponíveis no aeroporto de Kish Island para que o maior lucro seja obtido com relação aos recursos limitados. Este estudo foi conduzido usando a abordagem multi-critério de tomada de decisão (MCDM). A estrutura da abordagem multi-critério de tomada de decisão é importante para resolver diferentes tipos de problemas nos campos relacionados ao gerenciamento de projetos, incluindo o momento em que o gerente de projeto é confrontado com a resolução de problemas e muitas vezes várias visões contraditórias. resultado do qual os gerentes podem melhorar seu desempenho no controle das atividades do projeto, especialmente em um ambiente dinâmico e variável.

Palavras-chave: Priorização, tomada de decisões multicritério, Entropia de Shannon, Aeroporto de Kish.

Introduction

Decision-making is part of the individuals' personal and occupational life (Akyurek & Guney, 2018). However, we are all kind of a decision-maker and are able to benefit from the study of scientific methods and techniques of decision-making. In today's world, criteria and parameters are needed for use in scientific models and methods to prepare, develop and control the programs and also make decisions for managers and make important organizational decisions (Valipour Zare'ei, 2016, Eris et al., 2017, Mazurova, 2017). Immediate and timely provision of services in different parts of an organization is a serious need. It is absolutely clear that if projects are carried out inconsistently and discretely and based on individual criteria and tastes, they lead to the wasting of resources including time and cost. In the shadow of such a method, particularly if the project is implemented by the people who are specialized in that field, one can hope that a system to prioritize designed projects is provided which is not only related to the researcher's interests but also can prepare the ground for applied research with objective results (Bahador, Keshtkar, 2017). Project prioritization can be a solution to this problem. In this context, it is possible to allocate the organization's capital to more important options by preventing the implementation of lower priority projects for the organization. Organizations should focus on determining their priorities. Prioritization of projects in organizations can help them in providing optimal executive services of projects and also saving resources including the implementation costs and time. Selection and prioritization are implemented in a decision-making environment with multiple criteria, which allow for the use of MCDM method comprising the analytical hierarchy process for measurement (Keshtkar, and Ghazanfari, 2017). Several examples of prioritization methods have been applied in organizations and industries. These methods are weighting matrix and hierarchical analysis methods with regard to the existing decision-making criteria and the attempt to choose the best option/options for the existing decision-making. Amir Afzali (2001) and 'Alikhani (2000) have used hierarchical analysis respectively for the prioritization of water and wastewater projects and power sector investment projects. Foroughi (2010) has applied it in planning and selecting the right marketing strategy in Mashhad Carton Company. Mousa Kazemi et al. (2012) have presented a model for prioritizing EFQM improvement projects using hierarchical analysis and effort-success matrix. Allahyari (2010) has used a combination of analytical hierarchy process (AHP) and Hoshin planning technique for prioritizing strategic quality projects in Saipa Company. In a study, Keshtkar (2013) has employed evaluation matrix (weighting matrix) to assess road construction projects in different US states while analyzing the project prioritization methods. In a similar study, Lambert (2007) has applied the cost-benefit analysis methodology to evaluate and prioritize the projects in Virginia transportation bureau. Given the importance of service quality at the airport, it is important to provide any solution to improve the performance of this organization. In this research, weighting of the factors was addressed using the opinion of experts and managers after data collection through questionnaires and then, the project prioritization was considered from a set of multi-criteria decision-making methods through TOPSIS method and simple weighting.

Research theoretical literature

- *Definition and importance of prioritization.* Prioritization is a necessary skill to use individual and team efforts and capabilities. This is especially important when time/resources are limited and demands are apparently unlimited. In this state, prioritization can help in allocating the time/resources to important projects, releasing the resources/time allocated to lower priority projects and even omitting some projects. Organizations often select the projects with a lower cost or projects that are more capable of running for implementation through traditional methods, regardless of the strategic goals of the organization and business environment conditions. This type of project appraisal is not reliable for achieving the intended objectives of the organization (Keshtkar, 2013).

In a simple state, prioritization can be done based on time constraints, potential profitability and project benefits or the pressure applied to complete the project. Prioritization based on the value or profitability of projects is probably the most common and most logical basis for prioritizing, whether this prioritization is based on conjectures and subjective opinions or an advanced financial evaluation. Time constraints are usually important when objectives, processes or other projects are dependent on the mentioned project to complete themselves.

Project prioritization methods are multi-criteria decision-making models that evaluate the options (projects) based on decision-making criteria (organizational goals). Multi-criteria decision-making methods attempt to consider different quantitative and qualitative criteria that cannot be converted to each other and begin to rank the available options. This category of decision-making methods can be divided into two types: with and without weighting, which have been briefly described in Table 1 (Rezaei Arjroudi et al., 2010).

Table 1: Classification of weighting methods on criteria

A) Standard level methods	B) Qualitative weighting methods	C) Quantitative weighting methods
1. Comprehensive satisfaction method	1. Dictionary method	1. Simple additive weighting method
2. Single satisfaction method	2. Semi-dictionary method	2. Electre method
	3. Removal method	3. TOPSIS method
	4. Permutation method	4. LINAMP method
		5. ANP and AHP

By examining the problem limitations and assessing the prioritization methods in the table, it was decided that to prioritize the projects, Shannon entropy weighting method, simple additive weighting method and TOPSIS method be used.

- *Shannon entropy technique.*Shannon entropy (Shannon, 1948) is one of the very important concepts in information theory and is applicable in many branches of science such as physics, social sciences and so on. This formula is used to determine the importance rate of evaluation criteria and consists of four stages which will be described in the following (Soleimani Daamane et al., 2011).

Step 1: Normalization

$P_{ij} = I_{ij} / \sum_{i=1}^{m} Iij \quad i=1, 2,\dots, m; \; j=1,2,\dots,n$

In this equation, $C_1, C_2,\dots,C_m$ are the criteria, $A_1, A_2,\dots,A_N$ are substitutes and a_{ij} is the allocated proportion for the i^{th} criterion.

Step 2: Entropy calculation

$e_j = -e_0 \sum_{i=1}^{m} pij \, In \, pij \quad j= 1, 2, \dots, n$

In the above equation, e_0 is the constant entropy and is obtained from the equation below:

$$e_0 = (\ln m)^{-1}$$

Step 3: Degree of deviation set

$$d_j = 1 - e_0 \quad j= 1,2, \dots, n$$

Step 4: Calculating the relative weight of criteria

$$W_j = d_j / \sum_{j=1}^{n} dj \quad j=1, 2, \dots, n$$

The importance degree of the substitute A_j is determined using equation 5.

-Simple additive weighting method. It is one of the oldest and simplest methods used in MADM and is also the first subgroup of compensation models in the subgroup of scoring and rating, which needs similar scales or "unscaled" measurements that can be compared with each other. In this method, after positivizing and unscaling the decision matrix and forming D matrix, the following formula is used to calculate the utility of each project:

$$E(A)=D.W=\begin{bmatrix} E(A_{1)} \\ E(A_2) \\ \vdots \\ E(A_m) \end{bmatrix}$$

- Multi-Criteria Decision-Making (MCDM). It is applied to making decisions despite the existence of multiple and generally contradictory criteria and the solution to such problems is MCDM or designing the best option from among predetermined numeric options. How to find the best solution is the discussion topic of decision-making methods with multiple criteria. These methods are divided into two categories: Multi-objective decision-making model and multiple-attribute decision-making. The steps include designing or searching for an option that will be the most attractive and interesting option by considering all the existing criteria (Aleksandrovna Maximova and Aleksandrovich Belyaev, 2017 and Asgharpour, 1998). Issues of the outside world do not always necessarily have a decisive or unique solution. One of the simplest multiple-attribute decision-making methods is the simple weighting method. In this method, only the decision-making matrix and the weight vector of evaluation indicators are required (Pacheco et al., 2017 and Shirouyezad & Tavakkoli, 2014).

Another algorithm of multiple-attribute decision-making model is TOPSIS algorithm. The logic of this method is such that maximum criteria, profit criteria, and minimum criteria are the cost criterion. Thus, the ideal solution makes profit criteria maximum and cost criteria minimum (Shirouyezad & Tavakkoli, 2014). In cases where evaluation indicators are incompatible and in conflict with one another, another multiple-attribute decision-making method called VIKOR can be used. The logic of this approach is based on the distance from the ideal option and this method is applied when the decision-maker cannot state option preferences at the beginning of the problem design (Shirouyezad & Tavakkoli, 2014; 'Ataei, 2010).

Multi-criteria decision-making methods in ranking often produce different results. In most of the problems, decision-makers employ different methods to rank the options and then make their final decision using integration methods. Among the integration methods in multi-criteria decision-making, we can refer to the copeland method. On the whole, it can be said that in this method, the results of other methods are summed up and the final and integrated result of the problem decision-making is determined after the relevant calculations (Shirouyezad & Tavakkoli, 2014).

- Case study. In 1970, Kish Island was visited by the Iranian and American expert bodies due to the appropriate geographic and strategic location. In this year, a delegation from Iranian and American advisers visited Kish Island which was selected as an international tourist center because of natural features, beautiful coral beaches and clear waters of the surrounding area. The international airport of Kish Island was built in 1968. In 1994, night flights to Kish were established by equipping Kish runway with the lights for night flights. Considering that Kish Island lacks land route, all traffic is done by air and sea; the share of Kish airport is about 90% to 95% of total traffic and this has led to the strategic importance of Kish Island. Currently, an average of 70 inbound and outbound flights are daily made with the transfer of about 8,000 passengers. Further, commercial helicopter flights are also made from Kish airport to oil platforms or the islands near Kish, which have a significant share in the economy of the region and the country.

Identified projects at Kish airport which have been considered in this study are shown in Table 2. Additionally, because of the obvious difference in cost and the need to examine homogeneous projects together, projects are divided into two sections of macro projects (cost over 25 billion tomans) and micro projects (cost up to 25 billion tomans).

Table 2: Classification of identified projects at Kish airport

No.	Project name	Description	Predicted cost (toman)	Macro/micro
1	Passenger terminal	Manufacturing, equipping and operating the passenger terminal hall of domestic and international flights at Kish airport with an area of 43,000 square meters	135 billion	Macro
2	Hendorabi airport	Runway, airplane parking, passenger lounge, watchtower, ground safety station, office building, airport fencing, runway lighting system	65 billion	Macro
3	Southern runway	Lengthening, widening and covering the southern runway (27R/09L) with dimensions of 4,000 meters long and 75 meters wide	43 billion	Macro
4	Heliport	Construction and operation of infrastructure including helicopter band, helipad, water, electricity, sewage and lighting system	11 billion	Micro
5	Watchtower	Purchase, installation and commissioning of the switching system of flight watchtower and infrastructure phase	10 billion	Micro
6	Fueling	Construction and operation of fueling facilities by with a capacity of 400 creating daily fuel storage tanks thousand liters	2 billion	Micro
7	Securing flight areas	Completion project of the fence surrounding the airport and departure of deers from the flight area and their transfer to the deer park	1.2 billion	Micro
8	CAT II runway lighting	Purchase, installation and operation of the CAT II runway lighting system for the southern runway (27R/09L) with the aim of helping inbound flights at the time of landing in low visibility	17 billion	Micro
9	ILS	Purchase, installation and operation of the ILS system to help the inbound flights at the time of accurate landing	8 billion	Micro
10	DVOR / DME	Purchase, installation and operation of the DVOR/DME system to help flight navigation	2 billion	Micro
11	RVR	Purchase, installation and operation of the RVR system to provide accurate and real visibility for flights and help the flights in low visibility	1 billion	Micro
12	Radar automation	Purchase, installation and operation of the radar automation system for giving precise flight guidance and providing the highest level of flight care service	25 billion	Micro
13	CCTV surveillance and security cameras	Purchase, installation and operation of the CCTV system for full security coverage and monitoring of all airport points	3 billion	Micro

Research method

Initially, projects identified at Kish airport were divided into two macro and micro groups according to cost estimates. Afterwards, indicators of the variables effective in the mentioned projects were identified through the interview with four airport experts, and weight was assigned to each indicator using the opinion of 15 experts.

Table 3: Determining the importance of each indicator in (macro and micro) projects of Kish airport with regard to different decision-making indicators

Micro/macro	Project name	Acceptability	Capability of running the project	Alignment with the strategy	Job creation	Increased safety	Project time	Dependency of other projects
Micro	Heliport construction							
	Watchtower							
	Fueling							
	Securing flight areas							
	Runway lighting							
	ILS							
	DVOR/DME							
	RVR							
	Radar automation							
	CCTV							
Macro	Passenger terminal							
	Hendorabi airport							
	Southern runway							

Table 4: Determining the importance of each criterion

Very high	High	Medium	Low	Very low
9	7-8	5-6	3-4	1-2

Besides, airport management opinions about the weight of each indicator were obtained independently through questionnaire in order to be used in weighting calculations. The management opinion in calculations is displayed as λ coefficient. It should be noted that considering the researcher's experience and the importance of management opinion in all stages of the country's airport projects, these weights have been separately presented in calculations while we could make the calculations without them.

Table 5: Effective indicators in prioritization of different projects of Kish international airport

Effective factors	Weight
The importance of the project cost	
Project acceptability	
Capability of running the project operationally	
Alignment of the project with the strategy (airport development plan)	
Job creation when implementing a project	
Increased safety level after completion of the project	
Time of project implementation in short-term projects (less than two years)	
Time of project implementation in mid- and long-term projects (more than two years)	
Dependency of other projects on a project	

To determine the importance rate of each indicator, various methods such as the review of expert opinions or mathematical ranking methods can be used. In this research, Shannon entropy method has been employed.

Data analysis

- Calculating the weight of micro projects using the Shannon entropy method

Table 6: Geometric mean allocated to micro projects using the Shannon entropy method

Project name	Acceptability	Capability of running the project	Alignment with the strategy	Job creation	Increased safety	Project time (year)	Dependency of other projects
Heliport construction	6.192	7.238	7.348	5.315	7.483	2	1.414
Watchtower	5.150	8.485	7.021	5.623	8.485	1	1.861
Fueling	4.356	6.055	2.449	3.500	3.936	1	1.414
Securing flight areas	6.506	4.527	3.761	1.861	8.485	0.5	1.189
Runway lighting	5.030	6.817	5.477	3.936	7.483	0.5	5.180
ILS	4.494	8.239	6.620	2.449	7.667	0.5	4.401
DVOR/DME	3.409	6.928	6.880	2.449	6.928	0.5	1.414
RVR	2.711	7.737	7.445	2.449	8.000	0.5	2.060
Radar automation	4.120	5.233	6.817	2.378	8.739	1.5	1.189
CCTV	4.162	7.200	7.696	2.632	2.213	1	1
Entropy of each indicator	0.988	0.993	0.981	0.971	0.977	0.958	0.922
Amount of deviation	0.012	0.007	0.019	0.029	0.023	0.042	0.079
Weight of the criteria	0.032	0.018	0.048	0.076	0.059	0.109	0.2
Weight of each criterion in management opinion λ	7	8	9	3	8	8	9
Adjusted weights	0.0306	0.0194	0.0588	0.0308	0.0640	0.1183	0.2441

With respect to the obtained coefficients, it can be concluded that for micro projects, cost index has the highest importance and impact among the indicators and the index of dependency of other projects which had the greatest effect for macro projects is in the second place and the index of project time is put in the third place. The rest of the indicators are placed in the next levels at low intervals.

- Calculating the weight of macro projects using the Shannon entropy method

Table 7: Geometric mean allocated to macro projects using the Shannon entropy method

Project name	Acceptability	Capability of running the project	Alignment with the strategy	Job creation	Increased safety	Project time (year)	Dependency of other projects
Passenger terminal	7.707	5.180	7.448	7.483	3.464	5	1.861
Hendorabi airport	7.416	5.144	2.340	8.132	4.229	4	1.189
Southern runway	5.958	6.402	7.969	7.969	8.485	4	7.238
Entropy of each indicator	0.994	0.995	0.902	0.999	0.928	0.995	0.734
Amount of deviation	0.006	0.005	0.098	0.001	0.072	0.005	0.266
Weight of the criteria	0.010	0.009	0.182	0.001	0.135	0.009	0.496
Weight of each criterion in management opinion λ	7	8	9	3	8	5	9
Adjusted weights	0.0098	0.0100	0.2270	0.006	0.1929	0.099	1

Given the obtained coefficients, it can be concluded that for macro projects, the index of dependency of other projects has the highest importance and impact among the indicators and the index of alignment with relatively significant difference is in the second place and the rest of the indicators are placed in the next levels at low intervals.

- Calculating the prioritization of macro projects using the simple additive weighting (SAW) method

Table 8: Ranking of micro projects using the simple additive weighting method

Project name	Rank	Final priority rank
Heliport construction	0.16	9
Watchtower	0.187	7
Fueling	0.25	4
Securing flight areas	0.38	2
Runway lighting	0.29	3
ILS	0.283	6
DVOR/DME	0.29	5
RVR	0.46	1
Radar automation	0.13	10
CCTV	0.20	8

Table 9: Ranking of micro projects using the TOPSIS method

Project name	Positive Euclidean distances	Negative Euclidean distances	Relative proximity to the positive ideal	Relative proximity to the negative ideal	Project weight	Priority of each project
Heliport construction	0.28460	0.03061	0.097	0.90	0.97	9
Watchtower	0.27564	0.04198	0.132	0.87	0.132	8
Fueling	0.18553	0.13182	0.415	0.58	0.415	4
Securing flight areas	0.13187	0.22871	0.634	0.37	0.634	2
Runway lighting	0.26695	0.13443	0.335	0.67	0.335	5
ILS	0.24938	0.11460	0.315	0.69	0.315	6
DVOR/DME	0.18302	0.013725	0.429	0.57	0.429	3
RVR	0.09615	0.27732	0.743	0.26	0.743	1
Radar automation	0.30017	0.02356	0.073	0.93	0.073	10
CCTV	0.23034	0.08565	0.0271	0.73	0.271	7

Table 10: Ranking of macro projects using the simple additive weighting method

Project name	Rank	Final priority rank
Passenger terminal	0.51	2
Hendorabi airport	0.37	3
Southern runway	1.40	1

Table 11: Ranking of macro projects using the TOPSIS method

Project name	Positive Euclidean distances	Negative Euclidean distances	Relative proximity to the positive ideal	Relative proximity to the negative ideal	Project weight	Priority of each project
Passenger terminal	0.72061	0.13666	0.159	0.84	0.159	2
Hendorabi airport	0.81233	0.03900	0.046	0.95	0.046	3
Southern runway	0.00140	0.081631	0.998	0.002	0.998	1

Conclusion

Prioritization and selection of projects in organizations are one of the most important issues in decisions of managers and decision-makers. In the process of project prioritization, the applied method, approach and criteria are of crucial importance. Attention to sustainability indicators is currently expanding. Since the sustainability criteria and their importance are different in various industries, the use of expert opinion in organizations can be useful in determining effective criteria. Therefore, in this study, project prioritization took place using TOPSIS and simple additive weighting techniques.

As can be observed, the results obtained from both methods are very close to each other. First, second, seventh, eighth, ninth and tenth priorities are equal in both SAW and TOPSIS methods and third, fourth, fifth, and sixth priorities are ranked at very low numerical intervals in both methods. But with regard to the obtained rankings in the SAW method, the numbers have little difference for third to sixth priorities and it is better to use the TOPSIS method for this part of calculations, which is more accurate.

Give the current conditions of economic enterprises and limited financial resources and organizational capital, better use of existing resources is considered a value. By the same token, it is possible to allocate the organization's capital to more important options by preventing the implementation of lower priority projects for the organization. The projects in question, i.e. macro and micro projects, are related to mid-term and long-term horizons of Kish Island airport. Hence, the results of the calculations can be made available to the DM decision-maker as follows in order to appropriately engage in planning with the obtained order while having full knowledge of effective indicators.

1. RVR
2. Securing flight areas
3. DVOR/DME
4. Fueling
5. CAT II runway lighting
6. ILS
7. CCTV
8. Flight watchtower
9. Heliport construction
10. Radar automation

References

'Alikhani, M. (2000). Applying the fuzzy model of hierarchical analysis to prioritize investment projects and providing a model for improving incompatibility in it: A case study of the energy sector. Master's thesis, Iran University of Science and Technology, Faculty of Industry.

'Ataei, M. (2010). Multi-criteria decision-making. First Edition. Shahroud, Shahroud University of Technology Press.

Akyürek, S., Guney, S. (2018). Effects of Learning Styles and Locus of Control on the Decision-Making Styles of Leader Managers. Eurasia Journal of Mathematics, Science and Technology Education, 14(6), 2317-2328.

Aleksandrovna Maximova, O & V. Aleksandrovich Belyaev (2017). Generational Indigenation in a Multi-Ethnic and -Religious Society (Tatarstan, Russia). Opción, Año 33, No. 84 (2017): 38-64.

Allahyari, M. & Akbari Moqaddam, B. (2010). Prioritization and decision-making in selecting the strategic quality projects in Saipa Company based on the Hoshin planning technique with AHP method. 7th International Conference on Industrial Engineering, Isfahan University of Technology.

Amir Afzali, M. (2001). Prioritization of sewage projects using the hierarchical analysis method. Master's Thesis, Mazandaran University.

Asgharpour, M. (1998). Decision-making and research on operations in management. First volume, Tehran, Tehran University Press.

Bahador M., Keshtkar, M. M., (2017). Reviewing and modeling the optimal output velocity of slot linear diffusers to reduce air contamination in the surgical site of operating rooms, INTERNATIONAL JOURNAL OF COMPUTER SCIENCE AND NETWORK SECURITY, 17 (8), 82-89.

Eris, H., Kayhan, H., Bastas, M., Gamar, C. (2017). Teacher and Administrative Staff Views on Teachers' Participation in Decision Making Process. Eurasia Journal of Mathematics, Science and Technology Education, 13(11), 7411-7420. https://doi.org/10.12973/ejmste/79794

Foroughi, F. (2010). Analytical hierarchy process of strategic market planning and selection of the right strategy using the hierarchical analysis technique in Mashhad Carton Company. Master's thesis, University of Tehran, Faculty of Management.

G Soleimani, M Amiri, SM Khatami, MJ Isfahani :Using S Technology, in the Automotive Industry, with the Approach of Its Implementation in Commercial Vehicles . Industrial Engineering & Management Systems.2016; 15(4): pp.290-297

Keshtkar M. M. (2013) Numerical Simulation of Radiative Heat Transfer in a Boiler Furnace Contained with a Non-Gray Gas, International Journal of Engineering & Technology, 1(3), 137-148.

Keshtkar M. M., Ghazanfari M. (2017). Numerical Investigation of Fluid Flow and Heat Transfer Inside a 2D Enclosure with Three Hot Obstacles on the Ramp under the Influence of a Magnetic Field, Engineering, Technology & Applied Science Research, 7 (3), 1647-1657.

Keshtkar, M. (2013) Research Article Simulation of Thermo-Hydraulic Behavior of a Lid-Driven Cavity Considering Gas Radiation Effect and a Heat Generation Zone, International Journal of Engineering & Technology, 1(1), 8-23

Mazurova, E. (2017). Exploratory Analysis of the Factors Affecting Consumer Choice in E-Commerce: Conjoint Analysis. Journal of Information Systems Engineering & Management, 2(2), 12. https://doi.org/10.20897/jisem.201712

Mousa Kazemi, S. J., Rokni, M. & Okhravi, A. H. (2012). Prioritization of EFQM improvement projects using the fuzzy AHP group and effort matrix. Production management and operations, 3 (1): 119-134. on a harmony search and artificial bee colony for solving a portfolio optimization problem using a mean-semi variance approach. J Central South University 23 (2016), No. 1,181–188.

Pacheco, M.M., Ramírez García, A., Martos Ruano, M.D & Anguita López, V (2017). El absentismo escolar en Andalucía (España): balance y propuestas de futuro en el marco de la Unión Europea. Opción, Año 33, No. 84 (2017): 65-90

Rad, 'A., Talebi, D. & Jalali, H. (2008). Providing a model for the prioritization of needs in software and information systems or the use of AHP method. Journal of Payame Modiriyat, No. 28.

Rezaei Arjroudi, R., Najafi, M. & Montazeri, M. (2010). A model for the prioritization of road construction projects in the country. 5th National Congress of Civil Engineering, Ferdowsi University of Mashhad.

S. M. Seyedhosseini, M. J. Esfahani, M. Ghaffari: A novel hybrid algorithm based

Salati, F. & Makouei, A. (2013). Providing value (desirability) function of the prioritization of research projects in research and development centers using the UTA method: A case study of Iran Water Resources Company. Industrial Management Studies, 11 (31): 19-33.

Shirouyezad, H. & Tavakkoli, M. M. (2014). Discussions on decision-making with multiple criteria. Publications of Danesh Pazhoohane Barin Press, Isfahan.

Valipour Zare'ei, N. (2016). Prioritization of research projects in research and development centers using the TOPSIS technique: A case study of cardiovascular research center of Tabriz University of Medical Sciences. Master's thesis, Al-Ghadir Institute of Higher Education, Faculty of Industrial Engineering.