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Assessment of techno-entrepreneurship projects by using Analytical Hierarchy Process (AHP)

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Funding of techno-entrepreneurship projects has gained ground for the societies. Today, many governments support techno-entrepreneurship projects by using several policy tools such as incentives. Evaluating such projects is a very difficult task while a future perspective needs to be provided. In this paper, Analytical Hierarchy Process (AHP) has been used to determine to factors that should be used in evaluating the techno-entrepreneurship projects. AHP model was set up based on the experts' opinions. The model was tested with real data that contains attributes and outcomes (success/failure) of ten techno-entrepreneurship projects. Subsequently, projects were ranked. It has been seen that three already failed projects were ranked at the end of the list. Thus, the proposed AHP model was verified with these findings. We have seen that target marketing strategy in business technology markets is key to success. The proposed AHP framework in this study is expected to be useful to other societies as well.

1. Introduction

An entrepreneur is a person who at some point in time is self-employed, and who creates a completely new business [1]. In capitalist economies, entrepreneurs have played, and continue to play, a catalytic role in bringing technological innovations to market [2,3]. New jobs and new markets are created with values provided to the whole economy [4]. Therefore, entrepreneurship has been an important phenome of modern economies [5–7] and many economists claim that entrepreneurship is an important determinant of economic growth and development [8]. Nowadays, entrepreneurship has shifted to a new concept of “techno-entrepreneurship”. Startups are predominantly stated as techno-entrepreneurship in official records [9]. Techno-entrepreneurship is broadly defined as the entrepreneurial and intrapreneurial activities of both existing and nascent companies operating in technology-intensive environments [10].

In this regard, several countries like Turkey ([5] [11] [12]) have initialized some policies to support techno-entrepreneurship mostly based on the level of novelty. Entrepreneurship incentives and support mechanisms lay at the center of these policies [13]. These incentives can be either direct (full or partial payment) or indirect (such as tax reduction). Direct incentive decisions are mostly taken upon the application of entrepreneurs with a business plan. The promising projects are shortlisted based on some criteria such as market targeting, budget, experience, staff, and etc. Due to the financial constraints, certain projects can be either completely or partially rejected [14]. While those projects are governmentally supported, it is critical to find the projects that will create real values for the societies.

While techno-entrepreneurship projects start with an initial plan or prototype for seeking further project's improvement [15], support decisions are made upon some factors given in those initial plans. The decision of support has not been an easy task while a method supporting the selection of projects should not only provide a fair evaluation by decreasing the subjectivity of decision making but also should shorten the time required for evaluation [16]. Analytical Hierarchy Process (AHP) has been one of the most popular and powerful methods for group decision making used in project selection for evaluating complex multiple criteria alternatives involving subjective judgment [17]. Many studies used the AHP to select R&D projects in the private sector; however, the selection process of government-sponsored R&D projects is discussed less [17]. This paper presents an AHP model for government-sponsored techno-entrepreneurship project selection. To the best of our knowledge, use of AHP for techno-entrepreneurship project selection has not been performed before.

A group of experts was employed to determine some important factors that should be considered during techno-entrepreneurship

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project selection. Experts also compared factors with each other to create the hierarchical decision model. A real data set containing ten projects has been used to test the model. Experts have also compared the projects with each other and a total score has been obtained for each of the projects. The scores were used to rank the projects. Since the database indicates the actual status of the projects as success and failure (still being operated or closed), the ranking was compared with these actual results. It was seen that the projects that failed were ranked at the end of the list provided by AHP.

This paper is organized as follows. Section 2 presents the literature on project selection and the use of AHP in the stated selection process. Section 3 describes the methodology used. The data collection process and the information regarding the project alternatives are given in Section 4. Results are presented in Section 5. Section 6 concludes the paper with the discussion section.

2. Literature review

In consequence of the complexity of the business environment, the available resource constraints, and the diversity of entrepreneurship project alternatives, funding correct project is important and time-consuming. The evaluation and selection of projects before an investment decision is customarily done using, technical information [18]. The main purpose of the project selection process is to analyze project viability and to approve/reject project proposals based on established criteria, following a set of structured steps and checkpoints [18]. A project selection framework should be flexible enough so that stakeholders can choose in advance the particular techniques or methodologies with which they are comfortable, in analyzing relevant data and making choices of the type of projects at hand [19]. Project selection and evaluation among several alternatives by considering several criteria have been investigated in several studies [14], [20–27]. There are certain difficulties in project selection. First of all a number of options are encountered to select the most appropriate projects [28]. The sheer volume of submission creates a significant challenge for project selection due to difficulties of assigning the most suitable reviewers to the most relevant project proposals [29]. The results are sensitive to reviewers while understanding the proposed project from the aspect of several stakeholder groups and analysis of alternatives in relation to a number of criteria, may end with different results [30]. Therefore, the most of these studies demonstrate a case study to validate the proposed selection approach.

Multi-criteria decision-making (MCDM) methods use a structured and logical approach to model complex decision-making problems [31]. Since its development, AHP has been one of the most widely used MCDM [32] because of its simplicity and flexibility [16]. AHP models are based on a comparative judgment of the alternatives and criteria [33]. Therefore, AHP is a useful approach for evaluating complex multiple criteria alternatives involving subjective judgment [17]. Since project selection problems mostly include several hierarchical criteria with several alternatives and a group of experts with different judgments, AHP models have been used effectively to optimize project selection in the research and development settings [33].

In 1987, [34] explored the applicability of an extension of the Analytic Hierarchy Process (AHP) for priority setting and resource allocation in the industrial R&D environment. An AHP modeling framework for the R&D project selection decision was presented and was linked to a spreadsheet model to rank a large number of projects.

[35] developed an AHP model for selecting a "new product development" policy, which is a specific R&D strategy. The AHP model was expanded to include a series of performance ratings for each criterion. The performance ratings and weights for each criterion were transferred to a spreadsheet program which produces the final project rankings. The resulting project priorities or scores were included in an integer programming model to support project funding decisions.

AHP was also used for information system project selection by Ref. [36]. The proposed AHP methodology adopted a multi-criteria approach to information system project selection which is dissimilar to the single criteria approach.

In 1991, [37] presented an improved Information System (IS) project selection methodology that combined the existing IS project selection methodologies of the AHP within a goal programming (GP) model framework.

[38] presented a fuzzy extension of the AHP for project selection. In their paper, they focused on the constraints that have to be considered within fuzzy AHP to take into account all the available information. They have demonstrated that considering all the information deriving from the constraints yields better results in terms of certainty and reliability.

[39] presented a framework for ERP system selection. The framework systematically constructed the objectives of ERP selection to support the business goals and strategies of an enterprise. It also identified the appropriate attributes and set up a consistent evaluation standard for facilitating a group decision process. Moreover, AHP method was applied in order to deal with the ambiguities involved in the assessment of ERP alternatives and relative importance weightings of attributes.

In one other study [40], AHP was employed to assist decision makers to select a proper project delivery.

[18] proposed a new methodology for project selection for oil fields development. The proposed methodology was comprised of both AHP and fuzzy TOPSIS. The structure of the project selection problem was analyzed and weights of criteria determined by employing AHP. However, final ranking was obtained by employing fuzzy TOPSIS. [41] constructed AHP-BP neural network model based on the traditional BP neural network that reduced the input dimensions of traditional BP neural network, significantly raised its learning speed, and improves the prediction accuracy.

3. Methodology

In an AHP hierarchy for choosing a techno-entrepreneurship project, the goal would be to choose the projects that can really be successful by creating value. Individual characteristics and project related factors are the two main criteria that are used in the selected database for selecting an entrepreneurship project. These criteria are often subdivided into several sub-criteria. In this study, the individual characteristics criterion is subdivided into gender, age, experience, and education. Experience grades are based on the previous workplaces and experiences. Education grading is performed based on the level of diploma that was attached to the project proposal. The project related factors criterion is subdivided into partnership, market, location, staff, and budget/requested capital. "Partnership" evaluation is performed according to the perceived power of partnership structure. "Market" sub-criteria are evaluated according to the availability in the targeted market. Barriers and competitors are both considered. "Location" criteria indicate the how business idea matches the location proposed for that business. Staff factor is evaluated according to organization chart and the job descriptions are given in the application file. Budget/requested capital factor covers the realism of the requested

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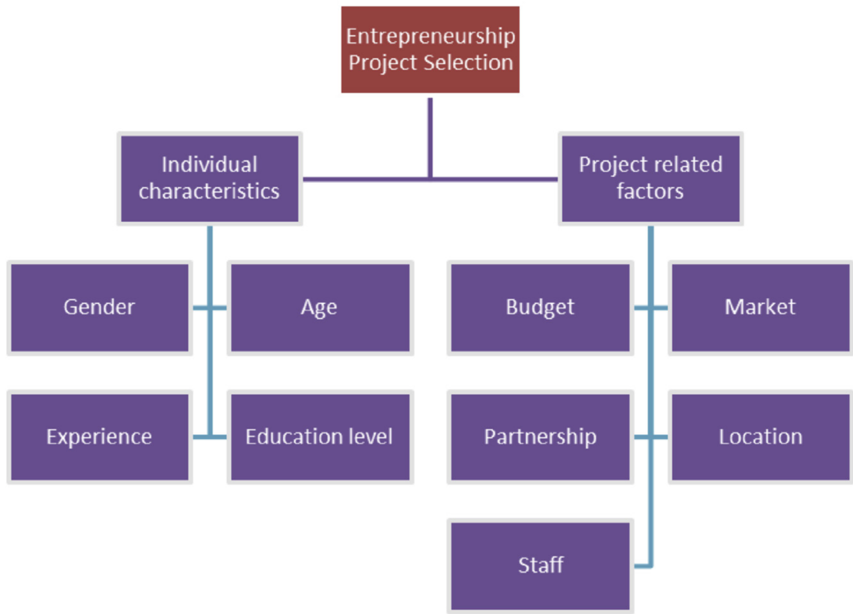

Fig. 1. The hierarchical structure of the decision problem.

amount by comparing the owner's equity and the requested fund. Corresponding hierarchy is as demonstrated in Fig. 1.

As the next step, sub-criteria under each main criterion are compared two by two by three experts by using PriEst software [42]. These experts have first seen the project information and as the application files were given to them. The priorities of main factors (Fig. 2) and the sub-criteria under each main criterion (Fig. 3 and Fig. 4) are as presented in Figs. 2, 3 and 4 respectively. At this point, the comparison of main factors has been performed, and the AHP method has yielded the local priorities for these criterions.

Sum of local weights is always equal to 1, where the priorities are calculated just for one main criterion. Overall/global weights indicate the weight for the whole decision problem. Table 1 indicates both the local/global weights for all criteria. Ranks column shows the importance of the criteria among nine criteria. The most important criterion has been found as the "market". The least important criterion is "gender". Project related factors are dominant when compared to individual characteristics. "Experience" is the most important criterion among the "individual characteristics".

4. Project alternatives and evaluation

Ten project alternatives were also compared with each other for each of criteria. Project rankings have been found as demonstrated in Fig. 5. Evaluation scores of the projects were as given Table 2.

The database in our hand provides the outputs of these projects as success/failure. The funded project owners declare that they will not close their business next for three years. The businesses that were closed immediately after three years are accepted as failed. The ones that are still operated are accepted as successful. The Project 8, 9, 10 was listed as failed projects. They are also ranked at the end of the ranking list obtained with the proposed AHP model. This can be accepted as the validation of the proposed model.

5. Results

Government sponsored techno-entrepreneurship projects should be rigorously examined before taking a support decision. In this regard, it is important to define the structure of objectives that make a techno-entrepreneurship project successful. In this study, a decision hierarchy has been provided with the help of three experts and a database has been used to test the validity of the model. The proposed methodology indicated that the least satisfying projects have been Project 8, 9 and 10. These projects have also been realized and project owners started up a business however their businesses have not survived more than three years. In this regard, proposed methodology appeared to be producing appropriate results.

The results have shown that the most important factors in entrepreneurship project selection are the project related factors: "Market", "Budget", "Location" and "Staff". The values of the individual factors (gender, education, education, experience) do not significantly affect overall score of the alternatives. The higher values of these factors increase the project proposal's probability of being successful. "Market" factor, the leading factor, is evaluated according to availability in the targeted market. Barriers and competitors are both considered in the evaluation. In this regard, it can be stated that the "market" that the project targets are the most important factor that should be considered. A well-designed market analysis can be very influential on the decision of reviewers. The match between the proposed technology and the market requires expertise.

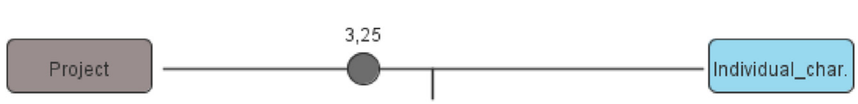

Fig. 2. Comparison of main criteria.

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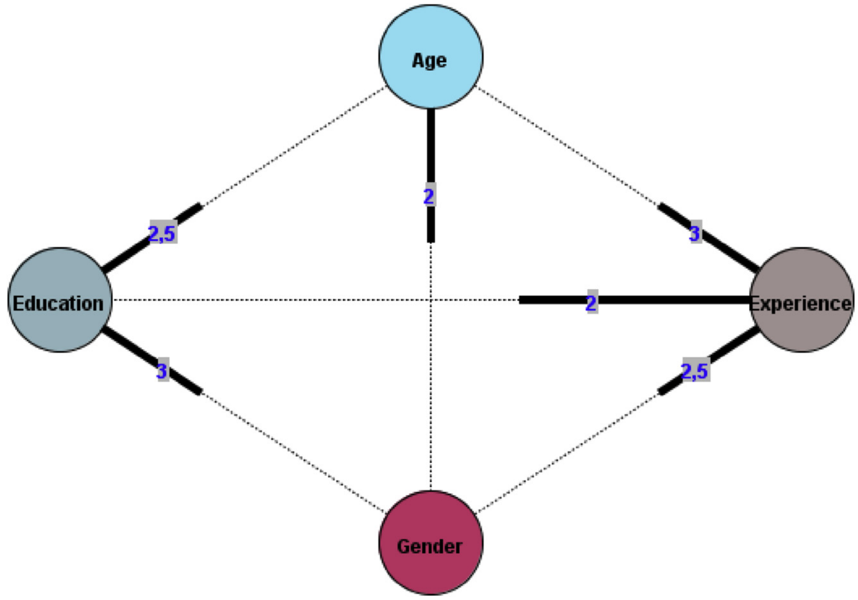

Fig. 3. Comparison of sub-criteria under individual characteristics.

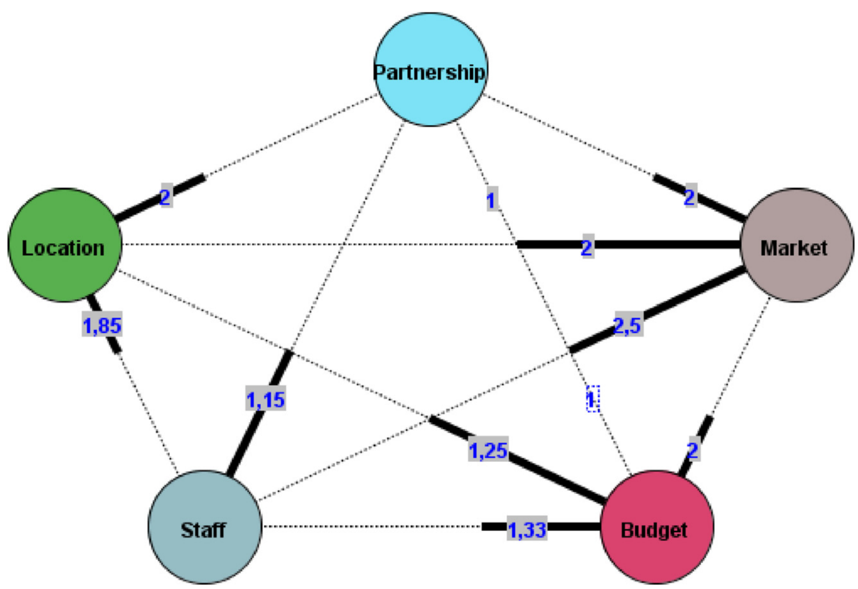

Fig. 4. Comparison of sub-criteria under project related factors.

Table 1
Criteria weights.

Criteria	Local Weights	Global Weights	Rank
Individual	0,235	0235	
Project	0,765	0765	
SUM	***1***	***1***	
Age	0,157	0,036895	8
Gender	0,111	0,026085	9
Experience	0,429	0,100815	6
Education	0,303	0,071205	7
SUM	***1***	***0,235***	
Market	0,266	0,20349	1
Budget	0,245	0,187425	2
Partnership	0,142	0,10863	5
Staff	0,138	0,10557	4
Location	0,209	0,159885	3
SUM	***1***	***0,765***	

6. Discussion

Knowledge-based techno-entrepreneurship is essential for encouraging economic development in a society. Most countries foster the growth of new technology-based entrepreneurship by establishing incentive policies. These incentives cover resource supplement to augment skills and to support the project-to-commercialization process. The question of what influences the rate of success for a techno-entrepreneurship project, and how their success can be predicted, is one of the fundamental questions in societies where there are limited resources for funding them. Turkey has been one of the countries implementing direct techno-entrepreneurship incentives as a national policy. Decisions for supporting an entrepreneur are done based on some factors. Decisions show its validity by the time. Some supported projects fail

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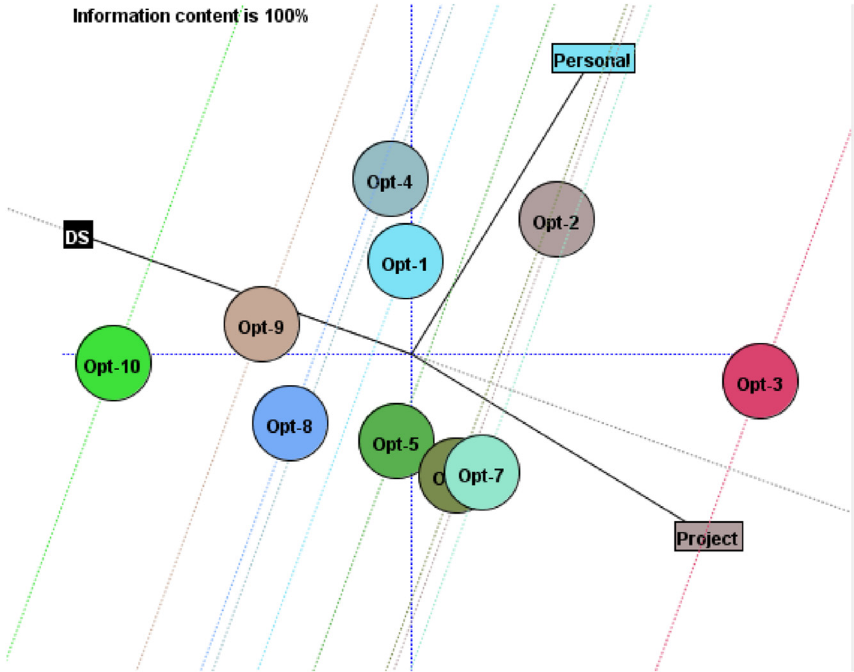

Fig. 5. Weighted option values.

Table 2
Preferability of the project options.

Project No	Preferability
Project 1	0.096
Project 2	0.118
Project 3	0.139
Project 4	0.093
Project 5	0.097
Project 6	0.111
Project 7	0.109
Project 8	0.087
Project 9	0.082
Project 10	0.069

and some other continue with success. This paper provided a decision hierarchy for presenting a robust and valid methodology. The presented case study has shown how the proposed hierarchy works as intended. The role of market focus appeared as the leading factor. We have seen that target marketing strategy in business technology markets is key to success. Market selection criteria have the potential to be a powerful determinant of success in entrepreneurship projects. Future research can add great insight into how entrepreneurs select and target technology markets and how the reviewers perceive these targets. The proposed AHP framework in this study is expected to be useful to other countries as well.

References

[1] S. Markussen, K. Røed, The gender gap in entrepreneurship – the role of peer effects, J. Econ. Behav. Organ. 134 (Supplement C) (Feb. 2017) 356–373.
[2] D. Miller, E. Garnsey, Entrepreneurs and technology diffusion: how diffusion research can benefit from a greater understanding of entrepreneurship, Technol. Soc. 22 (4) (Nov. 2000) 445–465.
[3] D.L. Bodde, M. Greene, The art of the hypothetical: entrepreneurship as an empirical guide to policy, Technol. Soc. 21 (3) (Aug. 1999) 247–262.
[4] S. Aparicio, D. Urbano, D. Gómez, The role of innovative entrepreneurship within Colombian business cycle scenarios: a system dynamics approach, Futures 81 (Supplement C) (Aug. 2016) 130–147.
[5] M. Markatou, Incentives to promote entrepreneurship in Greece: results based on the 'new innovative entrepreneurship' program, Proc. Soc. Behav. Sci. 195 (Supplement C) (Jul. 2015) 1113–1122.
[6] M. Salehizadeh, Venture capital investments in emerging economies: an empirical analysis, J. Dev. Entrepreneurship 10 (03) (Dec. 2005) 253–269.
[7] C. Vlachou, O. Iakovidou, The evolution of studies on business location factors, J. Dev. Entrepreneurship 20 (04) (Dec. 2015) 1550023.
[8] J. Paul, A. Shrivatava, Do young managers in a developing country have stronger entrepreneurial intentions? Theory and debate, Int. Bus. Rev. 25 (6) (Dec. 2016) 1197–1210.
[9] A.S. Örnek, Y. Danyal, Increased importance of entrepreneurship from entrepreneurship to techno-entrepreneurship (startup): provided supports and conveniences to techno-entrepreneurs in Turkey, Proc. Soc. Behav. Sci. 195 (Supplement C) (Jul. 2015) 1146–1155.
[10] F. Thérin, Handbook of Research on Techno-entrepreneurship, Edward Elgar Publishing, 2007.
[11] C. Román, E. Congregado, J.M. Millán, Start-up incentives: entrepreneurship policy or active labour market programme? J. Bus. Ventur. 28 (1) (Jan. 2013) 151–175.
[12] T. Yigitcanlar, J. Sabatini-Marques, E.M. da-Costa, M. Kamruzzaman, G. Ioppolo, Stimulating technological innovation through incentives: perceptions of Australian and Brazilian firms, Technol. Forecast. Soc. Change (Jun. 2017). In press, https://doi.org/10.1016/j.techfore.2017.05.039.
[13] N. Dogan, The intersection of entrepreneurship and strategic management: strategic entrepreneurship, Proc. Soc. Behav. Sci. 195 (Supplement C) (Jul. 2015) 1288–1294.
[14] P.S. Roychaudhuri, V. Kazantzi, D.C.Y. Foo, R.R. Tan, S. Bandyopadhyay, Selection of energy conservation projects through financial pinch analysis, Energy 138 (Supplement C) (Nov. 2017) 602–615.
[15] D.C. Chou, Applying design thinking method to social entrepreneurship project, Comput. Stand. Interfac. 55 (May 2018) 73–79. https://doi.org/10.1016/j.csi.2017.05.001.
[16] E. Karasakal, P. Aker, A multicriteria sorting approach based on data envelopment analysis for R&D project selection problem, Omega 73 (Supplement C) (Dec. 2017) 79–92.
[17] C.-C. Huang, P.-Y. Chu, Y.-H. Chiang, A fuzzy AHP application in government-sponsored R&D project selection, Omega 36 (6) (Dec. 2008) 1038–1052.
[18] M.P. Amiri, Project selection for oil-fields development by using the AHP and fuzzy TOPSIS methods, Expert Syst. Appl. 37 (9) (Sep. 2010) 6218–6224.
[19] N.P. Archer, F. Ghasemzadeh, An integrated framework for project portfolio selection, Int. J. Proj. Manag. 17 (4) (Aug. 1999) 207–216.
[20] V. Atal, T. Bar, S. Gordon, Project selection: commitment and competition, Game. Econ. Behav. 96 (Supplement C) (Mar. 2016) 30–48.
[21] M.A. Jun, J.C.P. Cheng, Selection of target LEED credits based on project information and climatic factors using data mining techniques, Adv. Eng. Inf. 32 (Supplement C) (Apr. 2017) 224–236.
[22] M.G. Kaiser, F. El Arbi, F. Ahlemann, Successful project portfolio management beyond project selection techniques: understanding the role of structural alignment, Int. J. Proj. Manag. 33 (1) (Jan. 2015) 126–139.
[23] H. Minken, Project selection with sets of mutually exclusive alternatives, Econ.

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Transport. 6 (Supplement C) (Jun. 2016) 11–17.
[24] L.N. Nassif, J.C.S. Filho, J.M. Nogueira, Project portfolio selection in public administration using fuzzy logic, Proc. Soc. Behav. Sci. 74 (Supplement C) (Mar. 2013) 41–50.
[25] A. Novoselov, I. Potravny, I. Novoselova, V. Gassiy, Selection of priority investment projects for the development of the Russian Arctic, Polar Science 14 (December 2017) 68–77. https://doi.org/10.1016/j.polar.2017.10.003.
[26] H. Park, J. (Jay) Lee, B.-C. Kim, Project selection in NIH: a natural experiment from ARRA, Res. Pol. 44 (6) (Jul. 2015) 1145–1159.
[27] X. Xu, A. Chen, S.C. Wong, L. Cheng, Selection bias in build-operate-transfer transportation project appraisals, Transport. Res. Pol. Pract. 75 (Supplement C) (May 2015) 245–251.
[28] R. Bhattacharyya, P. Kumar, S. Kar, Fuzzy R&D portfolio selection of interdependent projects, Comput. Math. Appl. 62 (10) (Nov. 2011) 3857–3870.
[29] T. Silva, Z. Guo, J. Ma, H. Jiang, H. Chen, A social network-empowered research analytics framework for project selection, Decis. Support Syst. 55 (4) (Nov. 2013) 957–968.
[30] I. Ivanović, D. Grujičić, D. Macura, J. Jović, N. Bojović, One approach for road transport project selection, Transport Pol. 25 (Supplement C) (Jan. 2013) 22–29.
[31] P.P. Kalbar, S. Karmakar, S.R. Asolekar, Technology assessment for wastewater treatment using multiple-attribute decision-making, Technol. Soc. 34 (4) (Nov. 2012) 295–302.
[32] H. Martin, T.U. Daim, Technology roadmap development process (TRDP) for the service sector: a conceptual framework, Technol. Soc. 34 (1) (Feb. 2012) 94–105.
[33] C.A. Grady, X. He, S. Peeta, Integrating social network analysis with analytic network process for international development project selection, Expert Syst. Appl. 42 (12) (Jul. 2015) 5128–5138.
[34] M.J. Liberatore, An extension of the analytic hierarchy process for industrial R #x0026;D project selection and resource allocation, IEEE Trans. Eng. Manag. EM-34 (1) (Feb. 1987) 12–18.
[35] M.J. Liberatore, A decision support approach for R&D project selection, in: The Analytic Hierarchy Process, Springer, Berlin, Heidelberg, 1989, pp. 82–100.
[36] K. Muralidhar, R. Santhanam, R.L. Wilson, Using the analytic hierarchy process for information system project selection, Inf. Manag. 18 (2) (Feb. 1990) 87–95.
[37] M.J. Schniederjans, R.L. Wilson, Using the analytic hierarchy process and goal programming for information system project selection, Inf. Manag. 20 (5) (May 1991) 333–342.
[38] M. Enea, T. Piazza, Project selection by constrained fuzzy AHP, Fuzzy Optim. Decis. Making 3 (1) (Mar. 2004) 39–62.
[39] C.-C. Wei, C.-F. Chien, M.-J.J. Wang, An AHP-based approach to ERP system selection, Int. J. Prod. Econ. 96 (1) (Apr. 2005) 47–62.
[40] I.M. Mahdi, K. Alreshaid, Decision support system for selecting the proper project delivery method using analytical hierarchy process (AHP), Int. J. Proj. Manag. 23 (7) (Oct. 2005) 564–572.
[41] K. Wu, X. Li, The establishment and application of AHP-BP neural network model for entrepreneurial project selection, in: Proceedings of the Eleventh International Conference on Management Science and Engineering Management, 2017, pp. 634–643.
[42] S. Siraj, L. Mikhailov, J.A. Keane, PriEsT: an interactive decision support tool to estimate priorities from pairwise comparison judgments, Int. Trans. Oper. Res. 22 (2) (Mar. 2015) 217–235.

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