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A multi-criteria approach for the group assessment of an academic course: A case study

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ABSTRACT

The present paper aims at proposing a structured methodology to evaluate the results of an academic training course addressed to postgraduate students. The evaluation process intends to identify the efficacy of an education course by means of a comparison between the general objectives and the results expected by the students. Since the evaluated aspects by the students, detected by means of questionnaires, are both quantitative and qualitative, the proposed methodology is based on the analytic hierarchy process (AHP). In order to facilitate the evaluation process, answers have been modelled by means of linguistic variables. In particular, different evaluation scales have been used and each one is characterized by different levels associated to different fuzzy numbers.

Introduction

The present paper aims to propose a methodological approach to evaluate the efficacy of an academic master course titled "Safety management systems in the workplace and risk analysis" supplied by the University of Palermo (Italy). In particular, the evaluation process intends to highlight the efficacy of the course by comparing the expected with the obtained results. Student opinions have been recorded by means of questionnaires that, as recently stressed by Blair and Inniss (2014), typically are used by Universities for student evaluation for gathering data for course improvement.

Each module of the master course is recorded to measure the satisfaction, the interest and the appreciation of the training course according to educational, organizational and social goals. The evaluation process has been carried out by means of a methodological support able to consider different qualitative and quantitative criteria. Such a type of assessment well fits with benefits provided by the multi-criteria decision methods. In particular, the proposed methodology is based on the analytic hierarchy process (AHP) (Saaty, 2000) and aimed to synthesize the feedback arising from the students about activities provided by lectures. Opinions are collected by questionnaires opportunely designed with the aim to assess the functionality and the offered competencies by academic lectures. The functionality aspect has been evaluated in terms of location chosen for lectures, compatibility with working time, and quality of provided educational materials, whereas the second one has been evaluated in terms of difficulty in acquiring the competencies and the skills offered by the training activities on the basis of clearness, availability to discussion and level of detail of lectures.

Literature review

AHP is a multi-criteria decision method widely used in several sectors including logistic (Opasanon & Lertsanti, 2013), industrial, government, engineering, management, etc. The AHP has been commonly applied in different areas of research such as alternatives evaluation, resource allocation, planning and development, priority and ranking, forecasting, and performance benchmarking. Recently, Shall (2014) proposed the use of the AHP to derive the partner importance score in a problem regarding the partner selection in a scientific collaboration environments.

With relation to the educational field recently, Lupo (2013a) proposed the AHP method as a tool to estimate the priorities of the strategic service attributes in a model able to assess the didactic service of the Management Engineering programme at the University of Palermo (Italy). Lukman, Krajnc, and Glavič (2010) suggest the AHP to determine weights of indicators to be used to compare and rank several universities in respect to educational, performance and environmental criteria. In order to collect the needed data, different experts of various countries have been involved by means of questionnaires wherein questions have been formulated by means of the classical pairwise comparisons of the

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AHP method. Feng, Lu, and Bi (2004) use the AHP, combined with the support offered by data envelopment analysis (DEA), for the assessment of the efficiency of research & development (R&D) management activities in universities. Authors propose this type of evaluation for motivating the management staff of universities to improve their work from a long strategic development view. In particular, they propose a measure to assess the efficiency of R&D management work of 29 research-oriented universities in China. Also de Figueiredo and Barrientos (2012) present a DEA with the aim to compare network schools among themselves and with out-of-network schools, providing a deeper understanding of school efficiency levels in the face of scarce resources, and allowing for sharing of best practices across the network.

Soares de Mello, Gonçalves Gomes, Angulo Meza, Soares de Mello, and Soares de Mello (2006) use the DEA models to evaluate the ability of the post-graduate engineering programmes to produce published scientific papers from master degrees and doctoral theses and to measure the scientific production of each programme relative to the resources put at disposal.

In order to rank a set of private universities, Wu, Chen, and Chen (2010) adopt the VIKOR method combined with the AHP method. Furthermore, Wu, Chen, and Chen (2012) propose a combined method based on fuzzy analytic hierarchy process (FAHP) and VIKOR that involve different experts to investigate and rank a set of alternatives constituted by diverse typologies of universities (research intensive university, teaching intensive university and professional intensive university).

In other fields of research like transport (Berrittella, Certa, Enea, & Zito, 2008), water management (Srdjevic, 2007), software selection (Lai, Wong, & Cheung, 2002) and maintenance (Certa, Enea, Galante, & Lupo, 2013a), the AHP method is proposed as a tool to make group decisions when diverse stakeholders with conflicting interests are involved.

Herein the AHP is employed, in a preliminary phase, to translate the semantic judgement, associated to a specific degree of assessment scales, into a numerical value. Then AHP is proposed to make a group evaluation and to assign local weights to the considered evaluation criteria/objectives. If a dependence among criteria exists, or in general among the elements to compare, and if the analytic network process cannot be disregarded (Saaty, 2005), a method derived by the AHP can be employed to derive the relative priorities. Another typical issue in applying the AHP is to measure the consistency in individual decision and in group decisions. In fact, as stressed by Dong, Zhang, Hong, and Xu (2010), the consistency measure is a vital basis for consensus in group decision making.

A problem that frequently arises in designing a decision support tool, as in the proposed one, is the representation of the vagueness and of the uncertainty that typically affect the elicitation of information which cannot be handled by the traditional (crisp) approaches. For this aim, the fuzzy set theory (Zimmermann, 1993) represents a valid support. In literature, different approaches in which the multi-criteria methods are combined with the fuzzy theory are suggested. Kuo, Linag, and Huang (2006) state that the multi-criteria decision-making (MCDM) problems often involve complex decisional processes in which multiple requirements and fuzzy conditions have to be simultaneously taken into consideration. For example, with relation to the environmental impact assessment, Kaya and Kahraman (2011) propose a fuzzy AHP procedure to assign weights to criteria with relation to a context of urban industrial planning. Furthermore, a fuzzy outranking methodology, in detail a fuzzy ELECTRE (Roy, 1990), is proposed to assess the environmental impact. Wang and Chin (2008) supply a fuzzy AHP method which utilizes a linear goal programming (LGP) model to derive normalized fuzzy weights to be assigned to criteria. The proposed LGP priority method is tested by three numerical examples including an application of fuzzy AHP regarding a new product development (NPD). Wang and Parkan (2006) propose two approaches based on the collection of the fuzzy opinions to derive the weights to be considered in a group decision. Zheng, Jing, Huang, Shi, and Zhang (2010) suggest a methodology based on the fuzzy AHP for the assessment of the building energy conservation. A decision group is firstly established. Then judgments are provided for each evaluation sub-factor on the basis of experts' knowledge and expertise and are expressed by means of linguistic variables described by triangular fuzzy numbers. Lupo proposes a ServQual based model in which a proper fuzzy extension of the AHP is considered to perform reliable assessment of service attribute importance weights, considering judgments of both customers (2013b) and stakeholders (2013c).

Zhang and Zhang (2013) propose a multi-attribute approach based on trapezoidal fuzzy sets to make group decision.

Aiming at dealing with the uncertainty that can affect the judgement expression of each student, in the present paper alternative answers proposed for each question and successively translated into numerical values by means of the AHP method have been modelled by fuzzy numbers. Successively a fuzzy aggregation procedure of student evaluations is proposed to obtain an aggregated judgement of the master training course. This procedure takes into account the degree of attendance of each student.

The remainder of the paper is organized as follows: the proposed methodological approach is described in "Case study". In "Training course goals" section the training course goals are described. The AHP and the methodological support offered by the fuzzy theory for the proposed case study are illustrated and discussed in "Methodological approach" and "Criticality analysis by fuzzy modelling" respectively. Finally, conclusions are drawn in "Conclusions". The questionnaire administered to students and the related aggregated answers (across all the students) for each module, that represents the input data of the process evaluation of the training course, are reported in the Appendix.

Case study

The proposed methodology aims to evaluate the efficacy of an academic training course supplied to postgraduate students. The academic master course titled "safety management systems in the workplace and risk analysis" has been organized in different modules and offered by the University of Palermo. With relation to the training course goals, each module is characterized by the same importance, that is, the same weight is assigned to each one in global evaluation process. For each module, students' evaluations have been collected, by providing a questionnaire (shown in the Appendix), in order to measure the satisfaction, the interest and the appreciation of the training course according to educational, organizational and social goals. In particular, the hierarchy structure, representing the goals of the training course at different levels, is shown in Fig. 1.

The evaluation process needs to be supported by a methodological tool able to consider different criteria and to aggregate judgments expressed by the involved students. In particular, the evaluation criteria are the two aspects respect to carry out the evaluation of the different modules, that is the functionality and the treated topics. Thus, the questionnaire has been structured in two parts, each one constituted by questions formulated on the basis of related criterion.

Actually, the aim of the analysis is to investigate both the individual assessments of the postgraduate students and aggregate the assessments with relation to the different training course goals. The aggregation process is necessary and useful in order to obtain a synthetic measure of students' satisfaction.