Applied Soft Computing 11 (2011) 2990–2998

Contents lists available at ScienceDirect

Applied Soft Computing

journal homepage: www.elsevier.com/locate/asoc

An integrated decision framework for evaluating and selecting e-learning products

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ARTICLE INFO

Article history:
Received 13 October 2009
Received in revised form 4 October 2010
Accepted 23 November 2010
Available online 4 December 2010

Keywords:
Quality function deployment
E-learning
Fuzzy regression
House of quality

ABSTRACT

A sound decision methodology for evaluating and selecting e-learning products should consider multiple and conflicting criteria and the interactions among them. In this paper, a decision framework which employs quality function deployment (QFD), fuzzy linear regression and optimization is presented for e-learning product selection. First, a methodology for determining the target values for e-learning product characteristics that maximize overall customer satisfaction is presented. The QFD framework is employed to allocate resources and to coordinate skills and functions based on customer needs. Differing from earlier QFD applications, the proposed methodology employs fuzzy regression to determine the parameters of functional relationships between customer needs and e-learning product characteristics, and among e-learning product characteristics themselves. Finally, the e-learning product alternatives are evaluated and ranked with respect to deviations from the target product characteristic values. The potential use of the proposed decision framework is illustrated through an application on e-learning products provided by the universities in Turkey.

1. Introduction

In recent years, advances in information technology transformed the way of learning and teaching towards a learner-centered education [1,2]. E-learning can be defined as an effective learning process created by combining digitally delivered content with learning support services. Worldwide, the e-learning market has a growth rate of 35.6% [3]. In particular, educational institutions pursue the potential education and financial benefits that the e-learning products promise. In contrast to campus based learning, a learner is able to customize the e-learning products to a certain extent, since the products do not have any time and space constraint. However, each user has different expectations in terms of technical and social attributes of a product. Hence, it is a challenging task to select the most satisfying e-learning product in such an environment.

Moreover combined with the globalization of the economies, which drastically changed the relationship between the customers and the product or service providers, the providers can no longer impose on the customers the products or services they are to use. Rather, the customer chooses the products or services that he/she requires. This trend can also be observed in the e-learning market. As a result, e-learning service providers have intended to introduce their own new product/service development and improvement mechanisms to assure the quality of their products and services. This outcome was unavoidable since they are part of a globally competitive market and they have to survive and maintain their market shares. One of the well-known strategic quality management tools that can provide a competitive advantage throughout this process is the quality function deployment (QFD), which simply intends to design products and services considering customers' needs (CNs) to guarantee satisfaction.

In this work, our main objective is to propose a mechanism to improve the e-learning products so that the customers' satisfaction is ensured. We apply the proposed decision methodology to evaluate several e-learning applications in Turkey. We initially explore the essential criteria for a successful e-learning environment. These criteria establish the basis for a comprehensive model for measuring e-learner satisfaction. Then, the QFD framework to allocate resources and to coordinate skills and functions based on CNs are introduced. This methodology enables us to easily develop the appropriate services for the customers. It ignores aspects with little or no meaning to customer; giving more importance to aspects meaning a lot. The main contribution of this study over previous QFD applications in education is that the proposed methodology employs fuzzy regression analysis to determine the parameters of functional relationships between customer needs and product characteristics, and among product characteristics themselves. Fuzzy regression analysis used in this research addresses the prob-

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doi:10.1016/j.asoc.2010.11.023

lem of subjectivity and vagueness in determining the relationships between customer needs and product characteristics, and the dependencies among product characteristics. Since fuzzy regression is a viable alternative approach for finding the values for these relationships, it improves the applicability of QFD as a decision support tool for determining the target values for product characteristics to be considered while designing an e-learning program, and thus, providing a roadmap for e-learning product developers. Finally, a weighted distance-based measure is introduced for ranking e-learning product alternatives.

The decision framework presented in this paper has advantages in comparison to the previously proposed analytical approaches for evaluation of educational products/programs such as statistical methods or analytic hierarchy process (AHP). Statistical techniques such as ordinary least squares are based on determining a meaningful statistical relationship between product characteristics that is difficult to obtain when the number of alternatives taken into consideration are relatively few. The AHP, which is a widely-used multi-attribute decision making technique, assumes that preferential independence of the product characteristics hold; however, this assumption generally does not hold in real-world applications. Data envelopment analysis (DEA) which is a nonparametric approach does not require the preferential independence assumption, while it is based on the assumption that every characteristic defined as output is related to every input.

The remaining part of the paper is structured as follows: Section 2 presents the e-learning concept and a brief literature review on related works, and concludes with the development of evaluation criteria. Section 3 summarizes the main steps of the QFD along with related research. Section 4 provides the essentials for fuzzy linear regression. In Section 5, the decision methodology that combines QFD, fuzzy linear regression, optimization, and a distance-based measure is presented. In Section 6, the proposed framework is illustrated through an e-learning program evaluation study in Turkey. The last section presents concluding remarks driven from the case study.

2. E-learning

The European Commission defines e-learning as the use of new multimedia technologies and the Internet to improve the quality of learning by providing access to resources and services as well as enabling remote exchanges and collaboration.

One of the initial steps in bringing the educational material on the electronic media is the foundation of Virtual University, when the World Wide Web consisted of just 500 sites. The site is still providing web-based learning resources for subjects as diverse as basic HTML to the teaching of memoir writing [4]. After the first wave of only virtual universities (e.g. the British Open University, the Globewide Network Academy in Denmark), Stanford, Princeton, Yale and Oxford Universities came together in 2000 to build a non-profit alliance aimed at creating e-learning programs. At the end of April 2001, the MIT promoted a 10 year program available for free to everybody [1]. Another remarkable issue to state is the comparison of the USA and Europe; compared to the USA, in Europe there is greater government involvement, more emphasis on creative approaches to learning, more blending of e-learning with other forms, a greater use of learning communities and a strong emphasis on simulation and mobile [1]. The initiatives in Turkey are far behind Europe and the USA. Although there are several higher education institutions providing pre-bachelor degree, master's degree and certification programs, they are relatively new and the limited availability of broadband connections across Turkey inhibits their spread and development.

The current motto of e-learning is "any time, any place, any pace". These attributes are seen as the advantages, or strong points of e-learning. E-learning gives the learning initiative to the learner. Consequently, the learners can take the session when they want, even late in the night. They can follow their courses from virtually anywhere, i.e. from their work, home or from a café, only with the restriction of connectivity to the e-learning provider. These kinds of programs usually facilitate the learner whether to take, repeat or skip a session, a total pace control tailored to the learners' capabilities leading to a faster learning curve, compared to instructor-led training. The delivery of content in smaller units may contribute further to a more lasting learning effect [1]. Online chat reaching across borders can bring learners of different nationalities to discuss together, hence providing a platform to discuss and share experiences with other people from different cultural, socio-economical, and political backgrounds. Another advantage of e-learning environments is the round the clock accessibility to references when needed [5].

On the other hand, literature suggests that students attending e-learning courses dropout at a substantially higher rate than their counterparts in on-campus courses. Levy [6] reveals that the dropout rates from e-learning courses are 25–40% and more dramatically, the dropouts from online training centers exceed 50%, compared to 10–20% in on-campus courses and 10% in standard on-site training. Multimedia extensions of e-learning materials, such as video, audio, chat rooms, discussion boards, instant messaging and e-mail, all offering effective interaction for e-learners are used as a precaution to draw and keep their attention live [1]. The preparation of these materials usually requires substantial effort because traditional course materials should be initially processed to be suitable to put on-line, which not only includes the digitalization of contents, but also making use of the new multimedia tools. Consequently, it may cost more to develop, and it requires new skills in content producers. Nevertheless, technology must not be considered a goal in itself, but rather a means towards better and easier learning. It is becoming common ground that a good e-learning course does not solely rely on technical aspects but also on pedagogical aspects [7]. In this paper, we use the QFD methodology to consider the pedagogical aspects (customer needs) and technical aspects (product characteristics) together.

In recent studies, authors have analyzed the e-learning procedure and proposed several essential criteria. Huang et al. [8] proposed a methodology to overcome the problem in web-based educational systems where the structure of the domain and the content are usually presented in a static way, without taking into account the learners' goals, their experiences, their existing knowledge and their abilities. Wang [2] measured the e-learner satisfaction with a questionnaire considering evidence of reliability, content validity, criterion related validity, convergent validity, discriminant validity, and nomological validity. Hwanga et al. [9] divided the evolution criteria into three categories: (1) criteria for evaluating the design of student interface, (2) criteria for the quality of instructional contents, and (3) criteria for evaluating the assessment functions. Mahdizadeh et al. [10] designed a questionnaire for teachers to identify factors shaping their opinions about e-learning environment. Selim [11] specified e-learning critical success factors (CSFs) as perceived by university students. The author surveyed e-learning critical success factors and grouped them into four categories namely, instructor, student, information technology, and university support. Each category included several measures. Confirmatory factor modeling approach is used to assess the criticality of the measures included in each CSF category. Sun et al. [3] developed an integrated model with six dimensions: learners, instructors, courses, technology, design, and environment. They conducted a survey to investigate the critical factors affecting learners' satisfaction in e-learning. Kwok et al. [12] proposed