



Interval type-2 hesitant fuzzy set method for improving the service quality of domestic airlines in Turkey

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ABSTRACT

This study investigates the level of service quality of domestic airlines in Turkey travelling between Istanbul and London and compares those airline companies according to a set of pre-determined criteria. A practical multi-criteria decision making approach combining hesitant and interval type 2 fuzzy sets is adopted and proposed for assessing the service quality of airline companies. The main finding of this study is that passengers care for service prioritization and personalization for a better flight experience and important differences occur in the service quality among the airline companies. Hence, handling of customer complaints, flight problems and individual attention could provide better insights for improving the service quality.

1. Introduction

As air transportation has begun to be used by large masses and as more companies have begun to provide services, this has brought about serious competition (Okumuş and Asil, 2007). Given the intense competitiveness of their industry, airlines need to develop a better understanding of passengers' needs. Passengers' expectations are essential to achieving the desired service quality. Thus, efforts to measure service quality within the sector have become increasingly important for facilitating consumer satisfaction (and, therefore, achieving and maintaining a competitive advantage) (Basfirinci and Mitra, 2015). Price and service quality criteria are initially used as the primary competitive items. Airlines have noticed that competition in price alone is insufficient in the long term. This implies that basing an airline's competitive advantage on price alone is not sustainable. An airline's competitive advantage also lies in its service quality as customers perceive it (Chen et al., 2011). Therefore, service quality has become a significant concern for those in the airline industry (Kazancoglu and Kazancoglu, 2013).

Along with the increase in flight numbers and aviation companies in recent years, competition within the aviation sector in Turkey has intensified. It is likely that the sector will grow even further with the increase in number of airports opening all over the country. The service quality offered by the companies as well as the resulting level of customer satisfaction will be a determinant in the competition. Companies

that wish to maintain their competitiveness must be able to accurately identify customer expectations, and perform the necessary work to not only meet these expectations, but also to exceed them (Cirpin and Kurt, 2016).

With the increasing development of civil aviation within the country, Ataturk and Sabiha Gokcen Airports in Istanbul have become insufficient in terms of capacity and operations, and a third airport is now being constructed on the European Side by the General Directorate of State Airports Authority (DHMI) in Istanbul. The new airport project consists of 4 phases and 6 Runway. The first phase of the new airport which is to have a total capacity of 150 million passengers, is expected to start commercial flights in 2018. Once all phases of the third airport have been completed, it is expected that it will be the world's highest passenger-capacity airport. The aim is that Turkey will have a very serious advantage in strategic terms and will meet the increasing number of international passengers. In particular, this new airport is expected to be one of the most important transfer hubs between Asia and Europe (Deveci et al., 2017).

Many service quality problems studies have been published. Abrahams (1983) presented a service quality model of air travel demand. Service quality is shown to be an important determinate of airline industry. Kazancoglu and Kazancoglu (2013) determined service quality factors of Turkish domestic airlines as well as ranking and benchmarking firms according to these factors using a fuzzy Multi Criteria Decision Making (MCDM) model. Kuo and Jou (2014) proposed

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a framework to investigate service quality asymmetrically. An empirical study in cross-strait direct flights (Taiwan–Shanghai) by [Lerrthairakul and Panjakajornsak \(2014\)](#) examined the relationship between five dimensions of service quality of low cost airlines and consumers' post purchase behavioural intentions. Most of the real-world strategic decisions require consideration of many conflicting factors. Multi-criteria Decision Making (MCDM) techniques provide the means to solve such problems supporting decision makers with the best option from a set of alternatives with respect to those factors ([Deveci et al., 2015](#); [Demirel et al., 2018](#); [Demirel et al., 2016](#); [Belbag et al., 2013](#); [Uludag and Deveci, 2013](#)).

Service quality dimensions were used to measure expectations and perceptions. The questionnaire included questions pertaining to dimensions on tangibles, responsiveness, reliability, empathy, flight pattern and, booking and ticketing services. The information obtained from the questionnaires were analysed and commented upon using the fuzzy MCDM method. The survey is composed of 6 main categories of service quality criteria and 26 related questions. For each category, the questions are shown in the following [Table 10](#) and the responses are given as 9-point Likert-type scale.

This study uses interval type-2 fuzzy set theory to evaluate the service quality of domestic airlines by passenger surveys. In this study, we propose a decision making model by utilizing the combination of hesitant fuzzy sets and interval type 2 fuzzy sets. This combination is named as interval type 2 hesitant fuzzy sets (IT2HFSs) as shown in [Hu et al. \(2015\)](#)'s study. [Rodríguez et al. \(2013\)](#)'s dominance and non-dominance rule procedure is merged to this methodology to evaluate the outrival degree of each criterion on other criteria when type 2 based hesitant decision making is adapted. A survey is conducted of 116 passengers for comparison of airline companies with respect to diversified variables (Tangibles, Responsiveness (Responsibility), Reliability and Assurance, Empathy, Flight pattern and Booking and ticketing service) extracted from the literature review. After that, the passengers' opinions are grouped into several linguistic evaluation categories according to similar answers. Then, using the joint judgments of the passengers, the priorities of the main and sub-criteria and ranking of three airline companies are calculated considering the hierarchical model. This enables the justification of [Hu et al. \(2015\)](#)'s study by real life example with a correct analysis of the usefulness of proposed methodology from a practical point of view. Finally, the results gathered from IT2HFS based decision making approach are compared with the methodology discussed in [Rodríguez et al. \(2013\)](#)'s study for testing the validity. The comparison of proposed study approves the improvement of [Rodríguez et al. \(2013\)](#)'s study which is not applicable when three or more criteria are available and could not ensure the accurate order of weights. Additionally, one at a time sensitivity analysis is conducted for representing the criteria sensitivity and airlines are compared their performance to decide the best alternative.

The motivation of the adaptation of interval type-2 hesitant fuzzy set is mainly depending on the following theoretical issues:

- Better representation of uncertainty (when compared to type 1 and type 2 fuzzy sets) and also simplification of computing process when compared with type 2 fuzzy sets are shown in [Hu et al. \(2015\)](#)'s study. In addition to that, hesitant fuzzy sets assist the improvement of MCDM problems. The combination of these fuzzy extensions can provide better representation of uncertainty with simplified calculations.
- Compared with hesitant fuzzy sets, interval type-2 hesitant fuzzy set can reflect uncertainty of inaccurate information by primary and secondary memberships, more efficiently ([Hu et al., 2015](#)).

Specifically for service quality case study, interval type-2 hesitant fuzzy set based decision making provides the following solutions:

- *Establishing the membership degree when there is a set of possible values.*

Survey results indicate various interpretation of service improvement indicators which obstruct the appearance of the definition of membership degree of an element clearly. Exact membership degrees cause the failure of the reflection of real life decision making problems especially when there are considerable amount of respondents and criteria. Compared with hesitant fuzzy sets, interval type-2 hesitant fuzzy set can reflect uncertainty of inaccurate information by primary and secondary memberships, more efficiently ([Onar et al., 2014](#)).

- *Adaptation of decision making process using certain linguistic variables.* In some cases, hesitant fuzzy set based formed data cannot be directly processed as we faced in our survey results. For instance, "criterion 1 is slightly stronger than criterion 2" can be easily represented via Type-2 fuzzy sets as [Onar et al. \(2014\)](#) mentioned in their paper. In this regard, interval type 2 formed hesitant representation facilitates better revealing of linguistic expressions by involving all necessary linguistic expressions considering optimistic and pessimistic point of view as appeared in our survey.

The remainder of this paper is organized as follows. The literature regarding this subject is reviewed in Section 2. Airline service quality evaluation criteria problem is introduced in Section 3. In Section 4, basic hesitant fuzzy set concepts, definitions, interval type-2 fuzzy and an interval type 2 fuzzy hesitant sets are proposed. The steps of proposed methodology are given in Section 5. In Section 6, an illustrative empirical case, applying the proposed interval type 2 hesitant fuzzy MCDM method to evaluate service quality of passenger airlines, is presented. In addition, sensitivity analysis and comparative analysis are given to demonstrate the feasibility of the proposed method. Finally, conclusion and discussion are presented in Section 7.

2. Literature review

The service quality problem in airlines is applied to the interval type 2 hesitant fuzzy set method for solving problems such as the MCDM problem. Regarding type-1 fuzzy MCDM, many papers have been published in recent years. These papers are reviewed and classified according to the types of methods used. The methods in question are Fuzzy TOPSIS, VIKOR, Servqual, GRA (Grey relational analysis), ANP/AHP, MA (Multi-criteria Analysis), integral, DEMATEL, etc. The general fuzzy MCDM service quality problems are summarized in [Table 1](#) and [Table 2](#).

Many of those previous studies propose fuzzy multi-criteria decision making (MCDM) techniques as a solution method. But there has not been much research work using interval type-2 fuzzy MCDM publish. [Chang and Yeh \(2002\)](#) proposed an effective fuzzy multi-criteria model for evaluating service quality of domestic airlines by customer surveys. [Chen et al. \(2011\)](#) evaluated customer perceptions on in-flight service quality. This study applies fuzzy-grey approach and main purpose of this study is to deal with domestic airline in-flight service quality where uncertainty arises. [Chou et al. \(2011\)](#) presented an evaluation of airline service quality using the fuzzy weighted SERVQUAL method. This study is applied to the case of Taiwanese airline. As a result, some interesting conclusions and useful suggestions are given to airlines to improve the service quality. [Demir \(2012\)](#) focused on evaluation of service quality of airway companies giving domestic services in Turkey with Fuzzy TOPSIS method. This study tested the service quality of four airways companies with domestic flights in Turkey. [Kuo \(2011\)](#) proposed a novel interval-valued fuzzy multi criteria decision making approach for improving airlines' service quality of Chinese cross-strait. [Nejati et al. \(2009\)](#) proposed a ranking of airlines service quality factors using a Fuzzy TOPSIS approach. [Toosi and Kohanali \(2011\)](#) applied fuzzy set theory for evaluating service quality of three airlines are active in Qeshm free zone in Iran via customer survey. [Tsaour et al. \(2002\)](#) proposed an application of the Fuzzy MCDM to determine service quality of an airline. By applying AHP in obtaining criteria weight and TOPSIS in

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