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Evaluation of retail service quality – a fuzzy AHP approach

Rema Gopalan
School of Management, Indian Institute for Production Management, Rourkela, India
Sreekumar
Rourkela Institute of Management Studies, Rourkela, India, and
Biswajit Satpathy
Department of Business Administration, Sambalpur University, Sambalpur, India

Abstract

Purpose – With the growing importance of service quality in Indian retail, it becomes critical for the retailers to identify the appropriate dimensions for their retail stores. In the process of evaluating service quality the decision maker is often faced with ambiguities due to the imprecise information gained from the respondents. The purpose of this paper is to present an integrated fuzzy (fuzzy analytic hierarchy process (FAHP) approach to help the decision makers/retailers in practicing and judging the priorities of service quality strategies and accordingly benchmarking retail stores in Indian retail environment.

Design/methodology/approach – The study incorporated the five basic dimensions of Retail Service Quality Scale proposed by Dabholkar *et al.* (1996) and the FAHP approach to three leading apparel retail stores of a major city (Rourkela) of Orissa (an Indian state located in eastern part of the country) to determine the weights of criteria and sub-criteria of retail service quality.

Findings – The study identified that the dimensions, namely, personal interaction, physical aspects, reliability and policy are perceived as important by the Indian consumers. Merchandise and the store's willingness to handle returns and exchanges emerge as the most influencing variable affecting the overall service quality of the store.

Research limitations/implications – The study was restricted to a major city of Orissa and to three apparel stores. The results obtained may not be extrapolated to the country as a whole. The authors believe that the integrated approach of FAHP could be used by a variety of service industries to evaluate the service quality. The study did not investigate switching behavior among the respondents as they had been visiting all the three apparel stores during the preceding months.

Practical implications – The integrated approach of FAHP makes an empirical contribution to the service quality and retail marketing literature by overcoming the uncertainty of concepts those are associated with human beings' subjective judgments.

Social implications – The retailer can improve the quality of service provided by them based on the parameters important in Indian context, which will lead to higher customer satisfaction.

Originality/value – This paper can help the retail service providers to identify which of the retail service quality dimensions requires much attention to create sustainable competitive advantage.

Keywords Benchmarking, Service quality, Quality

Paper type Research paper

Global retail industry has seen drastic change in the recent time and India is no exception. The Indian retail market is one of the fastest growing retail markets in the world and is experiencing strong competition recently due to growing customer awareness of service quality. As per AT Kearney's (2012) report, India is a high-potential market with accelerated retail market growth of 15-20 percent expected over the next five

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years, supported by GDP growth of 6-7 percent. Retailing comprises of sales of goods or services to the end-user and as such, it is a service sector, which connotes a service function in terms of distributing goods and services to end-user. Jain and Ninan (2010) suggest that retail trade is the main activity, which has highly contributed to the growth of Indian service sector.

The Indian Retail Report (2013) has identified clothing and accessories in the overall retail pie as the largest category followed by food and grocery. India is witnessing entrance of global retailers in the apparel market, which has increased the competition level among local brands. Considering the competitive environment, there is a need for a retailing strategy that differentiates one clothing store from another. Today, the changing market trends demand the retail industry to expand its reach to the more customer touch points so as to drive them to the retail points. Consumers are very aware of and well informed about new retailing formats that venture to satisfy their needs. The retailers are highly expected to provide avenues that would give maximum value for the money and time spent by the customers. The retail arena today is very different – the opportunities are incredible but exploiting them is extremely tough (Parikh, 2006). Retailers need to continuously focus on areas under their control; this may give them an edge over their competitors and to survive in the economic crisis. An area that receives foremost attention in this regard is delivering high levels of service quality. Today's customers do not make purchase decisions merely on the basis of product characteristics, brand name or price; rather it is made mostly on customer's perception of quality attached to a product. Fashion consumers today are perceptive, better informed, more sophisticated and discriminating (Leung and To, 2001) that they expect service quality (e.g. helpful and courteous salespeople, convenient store layout, etc.) apart from the quality of merchandise purchased.

With the market crowded with many similar brands, retailers are coming around to the view that service is the true differentiator. As service quality can be the cornerstone to retailing success, retailers need to constantly evaluate their service quality through the use of a reliable measuring instrument. Such an evaluation can serve as an indicative tool that helps the company monitor, detect any imperfections and to continuously improve their service (Ramayah and Jasmine, 2003). According to Finn and Lamb (1991), "by satisfying customers through high quality service, business firms can not only retain their current customers, but also increase their market share" (p. 483).

Many studies on service quality have relied upon service quality construct and the popular scale SERVQUAL developed by Parasuraman *et al.* (1988). However, the applicability and reliability of SERVQUAL scale to the retailing industry has been found to be incongruous for service quality in retailing industry seems to be different from other services (Kaul, 2007; Dabholkar *et al.*, 1996). Review of studies on the applicability of SERVQUAL in retail settings reveal that as retail stores (such as discount stores and apparel stores) offer a mix of products and services, retailers are likely to have impact on service quality more than on product quality (Dabholkar *et al.*, 1996). As retailers can create such effects, service quality plays a significant strategic role in creating quality perceptions (Nhat and Hau, 2007). Therefore, providing high-quality customer service is essential for success and survival in the current competitive retail environment.

Service quality not only comprises tangible attributes but also intangible/subjective attributes such as empathy and reliability which are difficult to measure specifically. According to Tsai *et al.* (2008), "5-point Likert Scales are the main methods of evaluating service quality which allows respondents answer a questionnaire using a checklist form, selecting just one best answer for each item." But the Likert scale is

subjected to many limitations as the data are quantified using equal value integers and the data involves the fuzzy feelings of the subject. Under many conditions, "crisp data are inadequate for modeling real-life situations" (Lee *et al.*, 2012). In practicing and judging the priorities of service quality strategies the decision maker is often faced with doubts, problems and uncertainties. This ambiguity in a lot of human judgments has drawn the attention of many quality theorists and researchers to develop tools against ambiguity and imprecise. Zadeh (1965) introduced the fuzzy set theory as a tool in this regard, which quantifies human subjective knowledge, and proposed that the key elements in human thinking are not numbers, but linguistic terms or fuzzy set labels. AHP involves decomposing a complex and unstructured problem into a set of variables that are organized into a hierarchy (Chow and Luk, 2005). Based on the pair-wise comparisons of attributes and alternatives, the AHP derives relative preference measures for decision makers. Three advantageous features of the differentiated AHP from other decision-making approaches are: its ability to handle both tangible and intangible attributes; its ability to structure the problems in a hierarchical manner to gain insights into the decision-making process; and its ability to monitor the consistency with which a decision maker makes a judgment (Vargas, 1990; Wedley, 1990). According to Golden *et al.* (1989), the characteristics of AHP include simplicity, ease of use, flexibility and the ability to handle complex and ill-structured problems; its principles have been applied successfully on many complex real-life decision-making problems. With above cited benefits of AHP methodology over other approaches, the present study uses it to assess the weights of retail service quality dimensions and the relative weights of the criteria.

In spite of its popularity and simplicity of AHP concept, this method is often criticized for its inability to adequately handle the inherent uncertainty and imprecision associated with the mapping of the decision-maker's perception to exact numbers. Since some of the evaluation criteria are subjective and qualitative in nature, it is very difficult for the decision maker to express the preferences using exact numerical values and to provide exact pair-wise comparison judgments. The traditional AHP cannot straightforwardly be applied to solving uncertain decision-making problems. In order to eliminate this limitation, we consider the fuzzy approach, which is capable for tackling the uncertainty and imprecision of service evaluation process. It is more desirable for decision makers to use interval or fuzzy evaluations to handle the vagueness of the data involved in multi-criterion decision-making problems. The present study uses the fuzzy concept to reduce the vagueness attached with the data collected in assessing the retail service quality attributes.

With the growing significance of service quality in retail it has become inevitable to measure the importance of attributes without ambiguity and rank them. It is in the above stated context that the present paper adopts the fuzzy linguistic approach and the modified AHP to enhance the comprehensiveness and reasonableness of strategy development in Indian retail environment. The AHP methodology is used to assess the weights of retail service quality dimensions and the weights of criteria. The FAHP method is a constructive approach for benchmarking retail stores and it facilitates the retailers to set strategies to improve the overall service quality of the store. In the paper we are processing the data obtained as a result of the questionnaire implemented to the retail customers while assessing the applicability of the Retail Service Quality Scale (RSQS) developed by Dabholkar *et al.* (1996) in Indian retail setting. The combined approach of FAHP is applied as a benchmarking framework in assessing retail service quality in Indian retail industry.

1. Literature review

1.1 Overview of Indian retail sector

Retailing is the interface between the producer and the individual consumer buying for personal consumption and this excludes direct interface between the manufacturer and institutional buyers such as the government and other bulk customers. Retailing is the last link that connects the individual consumer with the manufacturing and distribution chain. The Indian retail industry is divided into organized and unorganized sectors. According to AT Kearney report for the year 2012, organized retail, which constitutes 8 percent of the total retail market, will grow much faster than traditional retail. It is expected to gain a higher share in the growing pie of the retail market in India. Various estimates put the share of organized retail as 20 percent by 2020. Within the organized retail sector, apparel is the largest segment followed by food and grocery. Trade or retailing is the single largest component of the services sector in terms of contribution to GDP. Many researchers have identified and highlighted the emergence of organized retailing in India and view the catalytic effects of retail on Indian economy. They have identified employment generation, growth of real estate, increase in disposable income and development of retail ancillary market as the various catalytic effects on Indian economy. According to Halepete *et al.* (2008), India is expanding internationally due to saturation of markets and challenges faced by international retailers. The modern retail formats provide wide variety to customers and offer an ideal shopping experience with an amalgamation of product, entertainment and service, all under a single roof. The modern Indian consumer is seeking more value in terms of improved availability and quality, pleasant shopping environment, financing option, trial rooms for clothing products, return and exchange policies and competitive prices (Jhamb and Kiran, 2012). Arshad and Hisam (2008) and Ghosh *et al.* (2010) highlighting the prospects of retailing in India opined that 47 percent of India's population is under the age of 20 and this will further increase to 55 percent by 2015 and this young population will immensely contribute to the growth of the retail sector in the country. According to a survey conducted by Tata Consultancy Services and Retail Association of India (2013) observed customer service, inventory management, people management, marketing, space management and expense management are the few areas of evolution and focus for Indian retailers. In 2013, the industry is moving toward an efficient growth model, built around sustainable operational efficiencies and exemplary customer service.

1.2 Importance of retail service quality

Service quality in retail has been considered as a critical aspect to achieve differential advantage. Researchers have found that one of the most important factors that affect the consumer's choice of store is service quality (Swoboda *et al.*, 2007); for this reason it is important to understand retail service quality. Zeithaml *et al.* (2009) observed, "cases in which customer service or services are offered in combination with a physical product, service quality may also be very critical in determining customer satisfaction." Therefore, it is important to maintain high standards when interacting with customers and delivering the service-product to customers (Varley and Rafiq, 2004).

1.3 Service quality and its measurement

Review of literature on service quality reveal that it is meaning may vary in different contexts (Ghobadian *et al.*, 1994). The concept of service quality is linked to the concepts of perceptions and expectations (Vázquez *et al.*, 2001). "Measuring and

evaluating service are not considered as add-ons to the overall delivery of service quality and there is already a well-established wealth of extant literature on measuring service quality, particularly in relation to customer expectations" (Abdolvand and Taghipouryan, 2011).

The popular scale SERVQUAL was the first pioneering work toward the measure of service quality undertaken by Parasuraman *et al.* (1985, 1988, 1991). The scale included five dimensions – tangibles, reliability, responsiveness, assurance and empathy and it evaluated service quality by comparing customer's expectations and perceptions. Since the development of SERVQUAL, it has been widely applied in different types of service industry involving "pure" service settings, namely, banking, securities brokerage, credit card services, long-distance telephone to name few. The scale has been tested and/or adapted in a great number of studies conducted in various service settings, cultural contexts and geographic locations. In spite of its wide applicability the universality of the SERVQUAL scale and its dimensions have been subjected to criticisms and "it is suggested that they require customization to the specific service sector in which they are applied" (Vázquez *et al.*, 2001, p. 1).

1.4 Service quality attributes in retail

The criteria used by the consumers for evaluating competing goods retailers (who sell a mix of goods and services) are different from criteria used to evaluate retailers that are primarily or exclusively service firms. According to Finn and Lamb (1991), "the service categories that were used in the development of SERVQUAL are very different to the retailing of goods," (p. 491). To overcome the failure of SERVQUAL to be fully adapted and validated in a retail store that offers a mixture of services and merchandise, Dabholkar *et al.* (1996) developed the RSQS. According to Kaul (2007), "RSQS is a performance-based measure of service quality but specific to the retail context" (p. 17). The weak theoretical support for a factor structure provided by retail literature and the failure of adaptation of SERVQUAL to retailing, Dabholkar *et al.* (1996) used a triangulation of research techniques to determine the factor structure of service quality. They conducted phenomenological interviews with three retail customers, exploratory in-depth interviews with six customers and a qualitative study tracking the thought processes of three customers during an actual shopping experience at a store. The findings of these qualitative investigations were combined with the existing literature and SERVQUAL, to form a basis for developing RSQS. In their opinion five basic dimensions of:

(1) physical aspects – retail store appearance and store layout;

(2) reliability – retailers keep to their promises and do the right things;

(3) personal interaction – retail store personnel are courteous, helpful and inspire confidence in others;

(4) problem solving – retail store personnel are capable to handle returns and exchanges, customer's problem and complaints; and

(5) policy – store's policy on merchandise quality, parking, operation hours and credit cards, were central to service quality.

The reliability of the scale for the five basic dimensions has been tested widely across the globe and in the contexts of different retail settings. In India the applicability of RSQS was tested by Kaul (2007) in context of apparel stores. She concluded that

the RSQS dimensions were not valid in India. Parikh (2006) studied the applicability of RSQS in Indian retail and found that the five dimensions are still useful and the overall reliability of the instrument is quite acceptable. He also suggested that once the factors are appropriately modified, the instrument can very well be utilized under the Indian conditions as well.

1.5 AHP

The AHP technique, first developed by Saaty (1980), is a powerful and reputable tool generally used for multiple criteria decision-making purposes (Vaidya and Kumar, 2006; Chow and Luk, 2005). The AHP technique involves the process of pair-wise comparisons to determine the relative importance and the precedence of alternatives in a multi-criteria decision-making problem (Karpuzcu and Ramanathan, 2011). According to Tsai *et al.* (2008), "AHP integrates expert opinion and assessment and moulds the complex decision making system into a simple element hierarchy system which can be used to clearly and accurately represent complex estimation criteria" (p. 307).

The utilization of AHP technique for service quality measurement purposes has gained interest in the last decade (Karpuzcu and Ramanathan, 2011). Competitive benchmarking as an important service improvement tool and the use of AHP for obtaining customer opinions about the importance of various service attributes and comparing different service provider's performances was proposed by Min and Min (1996, 1997). Chow and Luk (2005) exercise measuring service quality in fast-food industry and develop an AHP approach that would help managers identify which service dimensions (reliability, assurance, tangibles, empathy, responsiveness) require attention to create a sustainable competitive advantage, and also act as a comparative service improvement technique. Karpuzcu and Ramanathan (2011) used AHP to measure service quality of a single firm and it was of its first kind to be used in the physical distribution industry. Due to its simplicity, ease of use and great flexibility the AHP is combined with other techniques. It has been applied to the finance sector (Steuer and Na, 2003), education, engineering, government, industry, management, manufacturing, personal, political social and sports (Vaidya and Kumar, 2006).

Despite its popularity, some shortcomings of AHP have been reported in the literature, which have limited its applicability. One of the two prominent limitations of AHP is about the fact that the number of pair-wise comparisons to be judged increases rapidly as the number of alternatives and criteria increases. Rank reversal is another criticism about AHP, as pointed out first by Belton and Gear (1983).

Salem (2010) applied the AHP methodology in the benchmarking process within three Libyan manufacturing organizations to determine its benchmarking criteria. Chan *et al.* (2006) used AHP approach in benchmarking logistics performance of the postal industry in Hong Kong. Gilleard and Yat-lung (2004) presented the theoretical framework of applying the AHP method in benchmarking facility management service provider performance.

1.6 Fuzzy set theory

Some terms of expressing opinions, such as "neither agree nor disagree" and "somewhat important," can be heard very often in daily life, and their commonality is that they are more or less tainted with uncertainty. With different daily decision-making problems of diverse intensity, the results can be misleading if the fuzziness of human decision making is not taken into account (Lee *et al.*, 2010). Bellman and Zadeh (1970) have described the decision-making method in fuzzy environments, and an increasing number of

studies have dealt with uncertain fuzzy problems by applying fuzzy set theory. A major contribution of fuzzy set theory is its capability of representing vague data and also it allows mathematical operators and programming to apply to the fuzzy domain (Tsai *et al.*, 2008).

Apart from its application in various industrial areas and several management problems involving uncertainty this theory has been applied to support decision making (Prascevic and Petrovic-Lazarevic, 1996, 1997, 1998). Andrea (1997) concluded that fuzzy methodology can effectively address the numerous limitations in practicing and judging the priorities of service quality strategies by permitting the definition of metrics which can assess intangible factors and deal with heterogeneous measures. A fuzzy linguistic framework that linked organizational effectiveness, KSFs and performance measures has been described by Andrea (1997). Kaufmann and Gupta (1988) report that over 7,000 research papers, reports, monographs and books on fuzzy set theory and applications have been published since 1965. Literature review points many applications of fuzzy set theory on quality control (Roger *et al.*, 1999; Wang, 2002; Chen and Weng, 2002; Ufek and Ahmet, 2002; Chang and Yeh, 2002), quality measurement (Zhou *et al.*, 2001; Tsaur *et al.*, 2002), performance assessment (Chan *et al.*, 2002; Kahraman *et al.*, 2003; Shee *et al.*, 2003; Lin *et al.*, 2005), product design (Hsiao, 1994a, b, 1998), health care industry (Wong and Petrovic, 2000; Wu *et al.*, 2004), production management (Karwowski and Evans, 1986; Guiffrida and Nagi, 1998). Maravelakis *et al.* (2006) applied a three-dimensional fuzzy logic approach for measuring and benchmarking the innovativeness of SMEs. Kale and Karaman (2011) applied the fuzzy set theory for benchmarking the knowledge management performance of construction firms.

Tavana *et al.* (2009) used multi-criterion benchmarking system of fuzzy logic along with base realignment and closure decisions for US defence department. Tavana *et al.* (2011) proposed a framework combining excellence model developed by the European Foundation for Quality Management with Rembrandt method, the entropy concept, the weighted-sum approach and the theory of the displaced ideal to evaluate a set of business units (BUs). The literature review indicates the scope for using fuzzy approach for evaluating the BUs. The fuzzy approach takes care of certain demerits of crisp approach and can also be very helpful in identifying best performing units from a set of units.

1.7 Applications of FAHP

In this section we will focus on the joint applications of fuzzy analytic hierarchy process (FAHP) method in different sectors. When the fuzziness of the decision makers is considered the synthetic extension of classical AHP method leads to FAHP (Özdağoğlu and Özdağoğlu, 2007). The earliest work in the FAHP appeared in Laarhoven and Pedrycz (1983), which utilized triangular fuzzy numbers (TFNs) to model the pair-wise comparisons made in order to elicit weights of preference of the decision alternatives considered. Many other researchers (Boender *et al.*, 1989; Buckley, 1985a, b; Chang, 1996; Lootsma, 1997; Ribeiro, 1996) have studied the FAHP which is the extension of Saaty's theory; have provided evidence that FAHP shows relatively more sufficient description of this kind of decision-making FAHP. Bottani and Rizzi (2008) used the fuzzy logic to deal with vagueness of human thought and AHP to make a selection of the most suitable dyad supplier/purchased item. Lee *et al.* (2010) applied the fuzzy set theory along with the AHP and TOPSIS method to evaluate the service quality of online auction. Lee *et al.* (2008) studied the performance of IT department in the manufacturing industry in Taiwan. Buyukozkan *et al.* (2008) proposed FAHP method

to evaluate e-logistics-based strategic alliance partners. Pan (2008) used FAHP for selecting the suitable bridge construction method. Chang and Wang (2008) proposed consistent fuzzy preference relation in a comparison matrix. Chen *et al.* (2008) proposed combination of FAHP with multi-dimensional scaling to identify the preference similarity of alternatives. Kong and Liu (2005) evaluated the key factors that affect success in e-commerce with the use of FAHP.

The literature review on application of FAHP approach in Indian context has shown many applications in varied sectors. Majazi (2011) used FAHP in sequence selection in a single machine shop. Chatterjee and Mukherjee (2010) applied FAHP to study the performance measurement indicators in the process of selecting best technical institutions. Hota *et al.* (2013) applied FAHP in assessing the quality of teachers in Indian educational institutions. Ganguly and Guin (2013) used the FAHP approach for assessing and prioritizing the supply related risk for a product category and its impact on the buyer organization. Qureshi *et al.* (2009) use the FAHP approach to support a generic logistics benchmarking process. Augustine *et al.* (2010) presented a comprehensive FAHP-based framework using Chang's extent analysis method for prioritizing benchmarks in the service sector. Kabir and Hasin (2012) used the FAHP approach to support a generic online retail benchmarking process.

The service quality is a composite of various criteria and they are difficult to measure as they are linguistic expressions employed by the people and fuzzy numbers allow us to model those linguistic expressions. FAHP has been widely used in the evaluation of service quality of many sectors like banking (Chatterjee *et al.*, 2010), physical distribution (Karpuzcu, 2006), fast-food industry (Chow and Luk, 2005) and hotel industry (Ban and Bugnar, 2007). Tsai *et al.* (2008) used FAHP for market positioning and developing strategy in order to improve service quality in department stores.

The above review of literature has shown not many applications of FAHP-integrated approach in evaluating the retail sector in Indian context.

2. Fundamentals of fuzzy set theory and AHP

This section deals with the fundamental understanding of fuzzy and AHP method.

2.1 Fuzzy set theory

Since the introduction of the fuzzy set theory (Zadeh, 1965), an increasing number of studies have dealt with uncertain fuzzy problems by applying it. The basic concept of fuzzy set theory is that an element can partly belong to a fuzzy set which is a collection of elements with smooth boundaries, in which transmission from membership to non-membership is gradual rather than abrupt (Wu *et al.*, 2004).

(a) Fuzzy numbers and TFNs. According to the definition of Dubois and Prade (1978), the fuzzy number $\tilde{A}$ is a fuzzy set, and its membership function is $u_{\tilde{A}}(X)$: $R \rightarrow [0, 1]$. It is common to use TFNs $u_{\tilde{A}}(X) = (a_1, a_2, a_3)$ or $u_{\tilde{A}}(X) = (L_1, M_2, U_3)$ as shown in the following equation:

$$\mu_A(x) = \begin{cases} \frac{x-a_1}{a_2-a_1} \, a_1 \leqslant x \leqslant a_2 \\ \frac{a_3-x}{a_3-a_2} \, a_2 \leqslant x \leqslant a_3 \\ 0 \text{ otherwise} \end{cases} \quad (1)$$

where a_1 and a_3 stand for the lower and upper bounds of the fuzzy number $\tilde{A}$, respectively; and a_2, stands for the modal value. The operational laws of two TFNs $\tilde{A} = (a_1,\ a_2,\ a_3)$ and $\tilde{B} = (b_1,\ b_2,\ b_3)$ are as follows.

Addition of two fuzzy numbers $\oplus$:

$$(a_1,\ a_2,\ a_3) \oplus (b_1,\ b_2,\ b_3) = (a_1+b_1,\ a_2+b_2,\ a_3+b_3) \tag{2}$$

Subtraction of two fuzzy numbers Θ:

$$(a_1,\ a_2,\ a_3)\Theta(b_1,\ b_2,\ b_3) = (a_1-b_1,\ a_2-b_2,\ a_3-b_3) \tag{3}$$

Multiplication of two fuzzy numbers $\otimes$:

$$(a_1,\ a_2,\ a_3) \otimes (b_1,\ b_2,\ b_3) = (a_1 \times b_1,\ a_2 \times b_2,\ a_3 \times b_3) \tag{4}$$

Division of two fuzzy numbers ∇:

$$(a_1,\ a_2,\ a_3)\nabla(b_1,\ b_2,\ b_3) = \left(\frac{a_1}{b_1},\ \frac{a_2}{b_2},\ \frac{a_3}{b_3}\right) \tag{5}$$

(b) Linguistic value. The concept of linguistic variable is useful in describing situations that are complex or poorly defined by quantitative expressions (Zadeh, 1975). A linguistic value S is characterized by the term set, namely the set of the linguistic values of S, where each value is a fuzzy set. The linguistic values for set $S = \{\text{SD}, D, M, A, \text{SA}\}$, where strongly disagree (SD), disagree (D), neither agree nor disagree (M), agree (A), strongly agree (SA). The evaluators/experts are asked to conduct their judgments, and each linguistic variable can be indicated by a TFNs $u_{\tilde{A}}(X) = (L,\ M,\ U)$ within the scale range of 0-100, the evaluators can also subjectively assume their personal range of linguistic variable $u_{\tilde{A}}(\text{neitheragreenordisagree}) = (20,\ 50,\ 80)$ as shown in Figure 1.

(c) Defuzzification. Defuzzification is a technique to convert the fuzzy number into crisp real numbers. There are many methods available for this purpose – mean of maximum, center of gravity and A-cut method. The present study utilizes the center of gravity method due to its simplicity and does not require analyst's personal judgment (Tsaur *et al.*, 2002). The defuzzified value of fuzzy number can be obtained from the following equation.

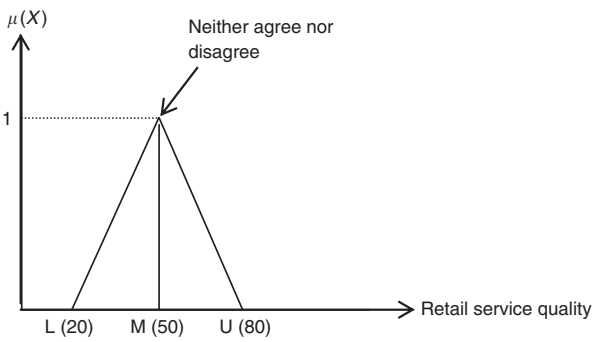

Figure 1.
Triangular membership function of fuzzy number

If $\tilde{A} = (a_1, a_2, a_3)$ then its expected value (EV) is calculated as:

$$\mathrm{EV(T)} = \frac{(a_1 + 2 \times a_2 + a_3)}{4} \quad (6)$$

2.2 Fundamentals of AHP

The AHP method consists of three basic principles, namely the decomposition, comparative judgment and synthesis of priorities (Saaty, 1994). In the first step, the decision makers need to break down the complex multiple criteria decision problems into its component parts and then every possible attributes are arranged into multiple hierarchical levels. The top level of the hierarchy represents the ultimate goal, while the lowest level is composed of all possible alternatives and one or more intermediate levels contain the evaluation criteria and sub-criteria. In the second step, the decision makers have to construct a set of pair-wise comparison matrices for each level of the hierarchy and make all the pair-wise comparisons. To obtain such matrices, Saaty (1980) proposed a nine-point pair-wise comparison scale. Since the comparisons are carried out through personal or subjective judgments, some degree of inconsistency may occur. Finally in the third step the operation called the consistency verification which provides guarantee that the judgments are consistent is regarded as one of the important advantages of the AHP (Ho, 2008). It is incorporated in order to measure the degree of consistency among the pair-wise comparisons by computing the consistency ratio. If it is found that the consistency ratio exceeds the limit, the decision makers should review and revise the pair-wise comparisons. Once all pair-wise comparisons are carried out at every level, and are proved to be consistent, the judgment can then be synthesized to find out the priority ranking of each criterion and its attributes.

3. Research methodology

3.1 Survey

The aim of this section is presentation of a way for evaluating retail service quality by using fuzzy numbers as well using the AHP methodology as a comparative evaluation model that will assist the service providers to satisfy customers and in turn help them in outperforming their competitors. Over the years, the Indian state of Orissa has witnessed a chain of retail stores that have been well recognized for providing quality and value-priced fashion apparel and have emerged into successful retailers today. The present study is based on two set of questionnaire. The first set of the questionnaire was administered to determine the dimensions of the apparel stores and their relationships with the overall service quality, during the first quarter of 2011 in three multiple apparel stores located in different areas of the state of Orissa, India. We are processing the data thus obtained as a result of the questionnaire administered to 237 retail customers visiting the stores. The questionnaire was designed using five-point Likert scale where 1 meant "strongly disagree" and 5 meant "strongly agree" in the context of measuring the relative importance of five dimensions of retail service quality proposed by Dabholkar *et al.* (1996).

The second set of the questionnaire was administered to 100 respondents visiting the three leading apparel stores, to evaluate the relative importance of criteria of 28 items by using AHP method.

3.2 Evaluation of criteria using AHP method

In the present study to overcome the above mentioned limitations of AHP theory, it was decided to replace the pair-wise comparison matrix with a direct rating question which requests the respondents to give points to the five dimensions of retail service quality

proposed by Dabholkar *et al.* (1996). The direct rating scale was administered between a minimum of 0 and a maximum of 100 according to their importance in their service quality evaluation. As the points over 100 are obtained from customers, they were converted to weights that correspond to each dimension. All the weights then add up to one to represent the retail service quality evaluation process as a whole.

3.3 Determination of linguistic variables

For gaining each of the linguistic variables, expert opinions of 15 individuals were used, so each expert were asked to determine the variables in a spectrum of 0-100. Once we determine the linguistic variables we can determine the TFNs of each linguistic variable.

3.4 The overall valuation of fuzzy judgment

Every respondent perceives differently toward every criterion and hence the subsequent valuation of the linguistic variable varies. The extended algebraic operations on TFNs and the extension principle of Zadeh (1965) are used into the framework of the study as follows:

$$E_{ij} = \left(\frac{1}{m}\right) \otimes (E_{ij}^{1} \oplus E_{ij}^{2} \oplus, \ \ldots, \ \oplus E_{ij}^{m}), \tag{7}$$

where $\otimes$ is the multiplication of fuzzy numbers, $\oplus$ the addition of fuzzy number, E_{ij} is the overall average performance valuation of retail store i under criterion j over m respondents.

E_{ij} as a fuzzy number can be represented by triangular membership function as the following equation:

$$E_{ij} = (LE_{ij}, \ ME_{ij}, \ UE_{ij}) \tag{8}$$

According to Buckley (1985b) the three end points can be calculated as:

$$LE_{ij} = \frac{\left(\sum_{k=1}^{m} LE_{ij}^{k}\right)}{m}$$

$$ME_{ij} = \frac{\left(\sum_{k=1}^{m} ME_{ij}^{k}\right)}{m}$$

$$UE_{ij} = \frac{\left(\sum_{k=1}^{m} UE_{ij}^{k}\right)}{m}$$

3.5 Defuzzification

It is needed to convert a TFN into a crisp real number, which means to locate the best non-fuzzy value to the initial value.

4. Data analysis and results

4.1 Determination of fuzzy numbers for each of the linguistic variables

In the study, "strongly disagree" and "strongly agree" five spectrums are used that have been shown as the following:

Strongly disagree (SD), disagree (*D*), neither agree nor disagree (*M*), agree (*A*), strongly agree (SA).

For gaining each of the linguistic variables, expert opinions of 15 individuals were used, so each expert were asked to determine the variables in a spectrum of 0-100. The sample of these opinions is shown in Table I. Once we have achieved the opinion of 15 experts on linguistic variable scale, we can determine the TFNs of each linguistic variable. An example showing the determination of TFN SD linguistic variable is given in Table II.

As mentioned above, we obtained the TFN for SD linguistic variables by expert opinion and hence the other linguistic variables are also obtained in similar manner. The numbers with their membership function are as the following:

SD = (0, 7.66, 20) D = (10, 23.21, 40) M = (20, 40, 60) A = (40, 58.33, 80) SA = (60, 84.33, 100)

4.2 Degree of importance of criteria

Table III represents the number of respondents visiting each stores answering to the degree of importance of the criteria on the Likert scale.

4.3 Relative weights of criteria

The second section of the questionnaire was used to evaluate the relative importance of criteria of 28 items. The relative weights of the criteria are obtained by using AHP method (Figure 2).

(a) Evaluation criteria framework for retail service quality. Figure 2 shows the relative weights of the five dimensions of service quality, which are obtained by applying the modified AHP method. The weights for each of the dimensions are: physical aspect was 0.204, reliability was 0.182, personal interaction was 0.339, problem solving was 0.127 and policy was 0.148. The weights describe that the consumers place more importance to personal interaction, followed by physical aspects and least importance to problem solving. Ranked by weights, the criteria which are of concern to the customers are: store offering high-quality merchandise 0.045 and store willingness to handle returns and exchanges 0.044. The customers place equal importance (0.042) to the stores' ability to handle customers' complaints directly and immediately, interest of the store employees

Table I. Sample of opinions of experts on the scale of linguistic variables

SD	D	M	A	SA	
0-20	20-40	40-60	60-80	80-100	Expert 1
0-10	10-30	30-50	50-70	70-100	Expert 2
⋮	⋮	⋮	⋮	⋮	⋮
0-10	10-20	20-40	40-60	60-100	Expert 15

Table II. Example showing the determination of TFN SD linguistic variable

	L	$M = (L + U)/2$	U
Expert 1	0	10	20
Expert 2	0	5	10
Expert 3	0	10	20
⋮	⋮	⋮	⋮
Expert 15	0	5	10
TFN(SD)	0	7.66	20
	Min.	Average	Max.

Variables	Strongly agree (5)			Agree (4)			Neither agree nor disagree (3)			Disagree (2)			Strongly disagree (1)		
	B	BF	I	B	BF	I	B	BF	I	B	BF	I	B	BF	I
*Q*1	5	18	3	12	11	30	10	5	6	3	0	2	3	3	0
*Q*2	3	7	8	18	23	22	8	2	9	3	5	2	3	0	0
*Q*3	5	6	3	15	20	16	8	5	17	4	3	4	4	4	2
*Q*4	12	13	13	14	15	17	3	4	9	3	4	2	3	2	0
*Q*5	6	9	5	23	22	23	3	4	10	0	2	3	0	0	0
*Q*6	8	10	13	16	19	18	5	4	8	3	4	2	2	0	0
*Q*7	2	3	5	11	14	18	14	19	10	5	0	5	2	0	4
*Q*8	2	7	5	12	13	13	15	16	14	3	0	7	2	0	3
*Q*9	3	5	3	12	14	17	12	13	14	6	4	6	2	2	2
*Q*10	2	6	4	16	13	13	11	10	17	3	6	7	2	3	0
*Q*11	11	8	9	16	16	16	5	11	8	0	2	8	0	0	0
*Q*12	9	12	4	16	15	18	5	7	11	2	2	8	2	2	0
*Q*13	8	10	3	14	17	18	8	7	16	3	3	4	0	0	0
*Q*14	12	11	6	15	16	23	4	9	8	2	0	4	0	0	0
*Q*15	5	8	3	15	17	17	9	9	13	4	3	8	0	0	0
*Q*16	2	4	2	15	13	13	11	15	16	3	5	9	3	0	2
*Q*17	4	4	3	15	14	13	8	15	15	6	4	9	0	0	2
*Q*18	0	4	2	10	12	8	12	13	15	8	7	14	4	2	3
*Q*19	6	4	2	18	20	22	6	10	9	3	3	7	0	0	2
*Q*20	2	3	2	9	11	12	19	15	22	2	5	3	2	4	3
*Q*21	6	7	2	12	14	14	6	10	14	6	3	8	4	4	4
*Q*22	3	3	3	12	19	15	13	12	14	5	2	7	0	2	3
*Q*23	3	5	2	13	12	15	10	16	14	6	2	8	2	3	3
*Q*24	3	5	5	8	11	17	13	12	10	8	7	7	3	3	3
*Q*25	2	13	7	17	13	8	8	7	9	3	3	11	2	2	7
*Q*26	4	11	4	18	21	26	3	2	3	2	3	5	2	0	4
*Q*27	9	16	8	16	16	22	4	6	9	2	0	2	0	0	0
*Q*28	3	6	2	2	4	8	15	16	14	7	5	10	7	7	8

Table III.
Number of respondents on degree of importance of the criteria on the Likert scale

Notes: B, Bothra, Rourkela (30 respondents); BF, Bombay Fashions, Rourkela (33 respondents), I, Indera Textiles, Rourkela (37 respondents)

to solve customer problems and availability of desired merchandise in the store. Hence it is reflected from the weights that though the overall weight of problem solving is least among the five dimensions but the weights of criteria constituting it are quite higher than the rest of the criteria.

4.4 Replacement of scores by linguistic values

The scores obtained from the respondents for the first section of the questionnaire are replaced by the linguistic scales to illustrate the use of TFNs to reduce the level of undetermination of scores. Each retail store has been evaluated from the point of view of criteria k, $k \in \{1, 2, \ldots, 28\}$, from the list of those 28 considered, calculating the arithmetic average of the fuzzy numbers obtained as answers provided by the respondents visiting the stores, that is using for criterion k the formula (formula (1) with the weights considered equal with $1/n$).

$1/n \otimes (n_1 \cdot u_1 \oplus n_1 \cdot u_2 \oplus n_3 \cdot u_3 \oplus n_4 \cdot u_4 \oplus n_5 \cdot u_5)$, where $n_i, i \in \{1, 2, 3, 4, 5\}$ represents the number of respondents providing an answer corresponding the TFN u_i to the question regarding the k quality criteria, and $n = n_1 + n_2 + n_3 + n_4 + n_5$.

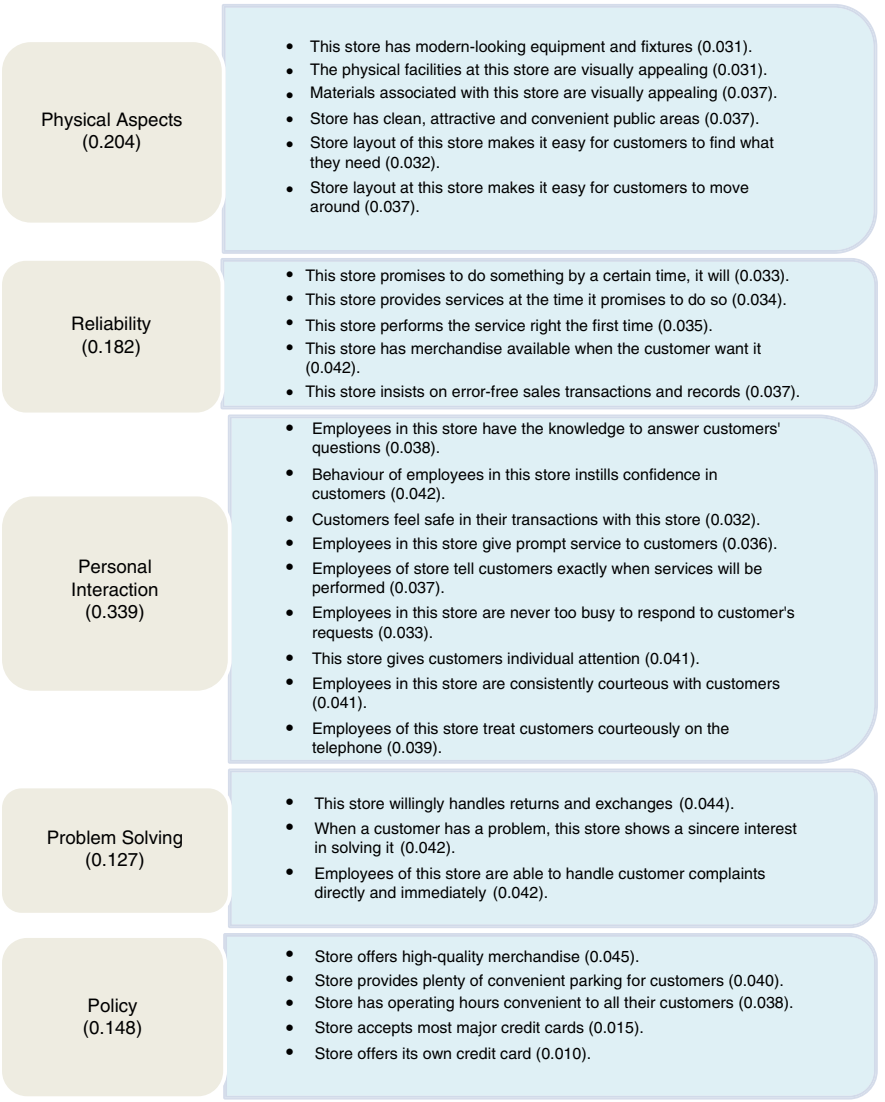

Figure 2.
Weights of the 28 criteria

For example, the evaluation of the Big Bazaar store from the point of view of modern looking equipments and fixtures of the store criterion is calculated as follows:

$$\frac{1}{30}(5.u_5 \oplus 12.u_4 \oplus 10.u_3 \oplus 3.u_2 \oplus 3.u_1)$$

$$= \frac{1}{30}((0,\ 38.3, 100) \oplus (120,\ 278.52,\ 480) \oplus (200,\ 400,\ 600) \oplus (120,\ 174.99,\ 240)$$

$$\oplus (180,\ 252.99,\ 300))$$

$$= \frac{1}{30}(620,\ 1{,}144.8,\ 1{,}720) = (20.67,\ 38.16,\ 57.33).$$

Similarly the evaluation of the Bombay Fashions by the respondents is calculated from the point of availability of merchandise when the customers want it is calculated as follows:

$$\frac{1}{33}(6.u_5 \oplus 13.u_4 \oplus 10.u_3 \oplus 6.u_2 \oplus 3.u_1)$$

$$= \frac{1}{33}((0,\ 45.96,\ 120) \oplus (130,\ 301.73,\ 520) \oplus (200,\ 400,\ 600) \oplus (240,\ 349.98,\ 480) \oplus (180,\ 252.99,\ 300))$$

$$= \frac{1}{33}(750,\ 1{,}350.66,\ 2{,}020)$$

$$= (22.73,\ 40.93,\ 61.21)$$

Similarly, the other data obtained from the respondents for each criterion considered and for each of the retail stores are synthesized. The results are presented in Table IV.

Criteria and their importance		B				BF				I			
		Fuzzy			Real	Fuzzy			Real	Fuzzy			Real
1	0.031	20.66	38.16	57.33	38.58	11.82	25.64	42.42	26.38	13.51	29.08	48.11	29.95
2	0.031	21.33	36.95	60	38.81	14.24	29.06	47.88	30.06	12.97	28.34	47.03	29.17
3	0.037	23.67	42.57	63.33	43.03	20	37.04	56.36	37.61	21.08	39.9	60.54	40.36
4	0.037	25.33	32.16	50.67	35.08	15.45	30.6	49.09	31.44	11.62	26.24	44.32	27.11
5	0.032	9.67	23.33	40.67	24.25	13.94	25.95	49.09	28.73	14.86	31	50.27	31.79
6	0.037	16.67	32.54	51.33	33.27	13.03	27.6	46.06	28.57	11.35	25.78	43.78	26.68
7	0.033	23.67	43.03	64	43.43	15.76	33.57	53.33	34.06	22.16	40.14	60	40.61
8	0.034	22	39.92	62	40.96	13.64	30.16	49.09	30.76	23.51	42.2	62.7	42.65
9	0.035	24	43.34	64.67	43.84	20.61	38.95	59.39	39.47	21.89	40.44	61.08	40.96
10	0.042	20.67	39.01	59.33	39.51	22.73	40.93	61.21	41.45	20.27	38.4	58.92	39
11	0.037	8.67	21.85	38.67	22.76	13.94	29.98	49.09	30.75	17.3	33.16	52.43	34.01
12	0.038	15.33	30.85	49.33	31.59	14.85	30.47	49.09	31.22	19.46	36.62	56.76	37.37
13	0.042	14	29.37	48	30.19	13.03	28.07	46.67	28.96	17.84	35.52	55.68	36.14
14	0.032	10.33	23.89	41.33	24.86	10.3	24.72	42.42	25.54	14.86	30.62	49.73	31.46
15	0.036	16.33	32.66	52	33.41	14.24	30.03	49.09	30.85	20.27	37.95	58.38	38.64
16	0.037	22.33	41.05	61.33	41.44	19.09	37.09	57.58	37.71	25.14	44.61	65.95	45.08
17	0.033	24.59	43.74	64.86	35.73	18.18	36.03	56.36	36.65	18.33	34.96	54.67	44.23
18	0.041	30	50.54	72	50.77	23.64	42.61	63.64	43.12	19.46	50.56	61.62	45.55
19	0.041	21.62	39.54	60	30.15	15.76	32.42	52.12	33.18	14	29.29	48	40.17
20	0.039	22.33	42.32	63.33	42.58	25.76	45.67	66.67	45.94	23.24	43.29	64.32	43.54
21	0.044	24	41.73	61.33	42.2	21.21	39.12	58.79	39.56	26.49	46.06	67.03	46.41
22	0.042	19.33	37.11	57.33	37.72	19.09	37.25	57.58	37.79	24.05	43.04	63.78	43.48
23	0.042	23	41.45	62	41.97	21.21	40.2	60.61	40.55	25.14	44.41	65.41	44.84
24	0.045	25.33	48.28	70	47.97	24.55	43.48	64.24	43.94	22.43	40.38	60.54	40.93
25	0.04	19	35.78	54.67	36.31	15.45	31.06	49.7	31.82	32.97	49.49	69.73	50.42
26	0.038	14.67	28.46	44.67	29.06	11.21	25.05	43.03	26.09	20.54	37.38	56.76	38.01
27	0.015	10.67	23.9	40.67	24.78	8.48	22.24	40	23.24	12.97	28.34	47.03	29.17
28	0.01	34	55.6	76.67	55.47	29.7	50.33	70.91	50.31	33.51	54.57	75.68	54.58

Table IV.
Synthesis of answers under the form of triangular fuzzy numbers and classical form

4.5 Defuzzification

To compare and evaluate the situations of the retail stores relatively to a certain criterion, the fuzzy numbers obtained are defuzzified using the expectance value formula (Equation (6)). In the above mentioned example of criterion modern looking equipments and fixtures of the store for the Big Bazaar we obtain:

$$\frac{(20.66+2\times 38.16+57.33)}{4}=38.58$$

Similarly in the case of Bombay Fashions for the criteria availability of merchandise when the customers want it we obtain the real value as:

$$\frac{(22.73+2\times 40.93+61.21)}{4}=41.45$$

The other real numbers so obtained are also presented in Table IV.

The results show that for different criteria we obtain different hierarchies and therefore we cannot classify the three retail stores globally.

For example, for the criterion 3, materials available in the store are visually appealing the order (descending) is Bothra, Indera and Bombay Fashions, for criterion 8, the store provides services at the time it promises to do so the order is Indera, Bothra and Bombay Fashions, for criterion 20, employees of the store treat customers courteously on the telephone is Bombay Fashions, Indera and Bothra.

In addition to this for a correct hierarchy we should take into account the importance given by the respondents to different criteria, which are the weights of the criteria presented in the second column in Table IV. To measure the quality of services in each of the three retail stores, from customers' perspective, we will calculate the fuzzy weighted arithmetic average of the result obtained for each retail store.

S_B, S_{BF} and S_I are indicators of service quality of retail stores Big Bazar, Bombay Fashions and Indera, respectively.

For Bothra retail store we obtain:

$$S_B = 0.031\times(20.66,\ 38.16,\ 57.33)\oplus 0.031\times(21.33,\ 36.95,\ 60)$$

$$\oplus,\ \ldots,\ \oplus 0.010\times(34,\ 55.60,\ 76.67)=(19.55,\ 36.41,\ 55.93)$$

Similarly for Bombay Fashions and Indera the service quality index is calculated as follows:

$$S_{BF}=(17.27,\ 33.91,\ 46.77) \text{ and } S_I=(20.58,\ 38.73,\ 58.42)$$

To compare the results the expectancy values are calculated using the formula (Equation (6)). We obtain:

$$EV(S_B)=148.30$$

$$EV(S_{BF})=131.86$$

and:

$$EV(S_I)=156.45$$

Hence the order (descending) of complying with the quality criteria Indera Textiles, Bothra, Bombay Fashions. The final ranking is shown in Table V.

5. Conclusion and managerial implications

Indian retail industry is expected to grow at a rate of 15-20 percent over next five years. This indicates opportunities lying before the local and global retail players. The Indian retail sector shall gear up for the opportunities and one of the important dimensions requiring attention is service quality. The service quality can be the cornerstone to retailing success; retailers need to constantly evaluate their service quality through the use of a reliable measuring instrument and improve upon them. In practicing and judging the priorities of service quality strategies the decision maker is often faced with doubts, problems and uncertainties. In order to overcome the uncertainty of concepts those are associated with human beings' subjective judgments, the paper uses fuzzy numbers and membership functions. The modified AHP methodology is used to assess the weights of retail service quality dimensions and the weights of criteria. The combined FAHP method is a constructive approach for benchmarking the retailers to set strategies to improve the overall service quality of the store.

The five dimensions crucial for retail service quality are physical aspect, reliability, personal interaction, problem solving and store policy. The relative weights of the five dimensions of retail service quality are calculated using modified AHP method. The relative weights of five dimensions are found to be physical aspect, reliability, personal interaction, problem solving and store policy score is found to be 0.204, 0.182, 0.339, 0.127 and 0.148, respectively. The weights describe that the consumers place more importance to personal interaction, followed by physical aspects and least importance to problem solving. The weight of each dimension is obtained through the weights of individual variables under the each dimension. Ranked by weights, the sub-criteria which are of concern to the customers are: store offering high-quality merchandise 0.045 and store willingness to handle returns and exchanges 0.044. The customers place equal importance (0.042) to the stores' ability to handle customers' complaints directly and immediately, interest of the store employees to solve customer problems and availability of desired merchandise in the store. Hence it is reflected from the weights that though the overall weight of problem solving is least among the five dimensions but the weights of criteria constituting it are quite higher than the rest of the criteria. Every respondent perceives differently toward every criterion and hence the subsequent valuation of the linguistic variable varies. At the next level fuzzy approach is used to capture the perception of the respondents toward a particular store. The weights calculated for each variable is integrated with the fuzzy scale to find the score. Finally the defuzzification is done to get the expectancy value. The stores are ranked based on their expectancy score. The findings reveal that store S_I is ranked one as the best performing retail store followed by stores S_B and S_{BF}. The stores S_B and S_{BF} can improve their overall service quality performance and can achieve better results. The model can be replicated for multiple no. of stores. The best store or a combination can be taken as the benchmark and other stores can follow for improvement.

Table V. Final ranking

Name of the store	Expectancy values	Ranking
Indera	156.45	1
Bothra	148.30	2
Bombay fashions	131.86	3

This study makes an empirical contribution to the benchmarking framework and particularly to the retail marketing literature. The paper also contributes to service quality concept and especially in the way the retail service quality can be upgraded. The paper identifies the important dimensions of the retail service quality and calculates the weights of the dimensions. This can be important to understand the relative importance of the retail service quality dimension. The paper also calculates the weights of individual variables under each dimension. This can be very useful for retail organization. They can compare their performance *vis-à-vis* the better performing organization and improve on the dimensions and variables in which their performance is not up to mark.

6. Limitations and scope for future research

Although the findings of the study can provide insight and understanding for retailers to develop appropriate retail service strategies, also it shall be considered in lights of some of its limitations which may be of worth investigation for future researches. The study was restricted to a major city of Orissa and to three apparel stores. The results obtained may not be extrapolated to the country as a whole. The authors believe that the integrated approach of fuzzy and AHP could be used by a variety of service industries to evaluate the service quality.

The study did not investigate switching behavior among the respondents as they had been visiting all the three apparel stores during the preceding months. Future research could address this limitation. The small sample size of 237 respondents for the first section and 15 experts for the second section of the questionnaire, respectively, may also be error prone. Future research in retail service quality evaluation should examine a larger sample size which would enable more reliable analysis across different demography of respondents. Also, the instrument used for the study included all the 28 variables proposed by Dabholkar *et al.* (1996); this limits the inclusion of other variables which may be of importance in the measurement of retail service quality in Indian context.

References

Abdolvand, M.A. and Taghipouryan, M.J. (2011), "Evaluation of customs service quality by using Fuzzy SERVQUAL and Fuzzy MCDM", *American Journal of Scientific Research*, No. 35, pp. 89-103.

Andrea, R. (1997), "Linking organizational effectiveness, key success factors and performance measures: an analytical framework", *Management Accounting Research*, Vol. 8 No. 2, pp. 207-219.

Arshad, S.A. and Hisam, M.W. (2008), *Issues in Retailing, Research in Management and Technology*, Aneet and Ramanjeet Singh (Ed.), Deep and Deep Publications Pvt Ltd, Rajouri Garden, Delhi, pp. 109-118.

Augustine, M., Jain, R. and Yadav, O.P. (2010), "A fuzzy-AHP-based framework for prioritizing benchmarks in the service sector", *International Journal of Productivity and Quality Management*, Vol. 5 No. 4, pp. 452-472.

Ban, L.O. and Bugnar, N. (2007), "Using triangular fuzzy numbers for measuring quality of service from the client's perspective in the hotel industry", *Fascicle of Management and Technological Engineering, ANNALS of the ORADEA UNIVERSITY*, Vol. 4 No. 16, pp. 2468-2475.

Bellman, R.E. and Zadeh, L.A. (1970), "Decision making in a fuzzy environment", *Management Science*, Vol. 17 No. 4, pp. 141-164.

Belton, V. and Gear, T. (1983), "On a short-coming of Saaty's method of analytic hierarchies", *Omega*, Vol. 11 No. 3, pp. 228-230.

Boender, C.G.E., de Graan, J.G. and Lootsma, F.A. (1989), "Multi-criteria decision analysis with fuzzy pairwise comparisons", *Fuzzy Sets and Systems*, Vol. 29 No. 2, pp. 133-143.

Bottani, E. and Rizzi, A. (2008), "An adapted multi-criteria approach to suppliers and products selection- an application oriented to lead-time reduction", *Int. J. Production Economics*, Vol. 111 No. 2, pp. 763-781.

Buckley, J.J. (1985a), "Ranking alternatives using fuzzy members", *Fuzzy Sets and Systems*, Vol. 15 No. 1, pp. 21-31.

Buckley, J.J. (1985b), "Fuzzy hierarchical analysis", *Fuzzy Sets and Systems*, Vol. 17 No. 3, pp. 233-247.

Buyukozkan, G., Feyzioglu, O. and Nebol, E. (2008), "Selection of the strategic alliance partner in logistics value chain", *Int. J. Production Economics*, Vol. 113 No. 1, pp. 148-158.

Chan, D.C.K., Yung, K.L. and Andrew, W.H.L.P. (2002), "An application of fuzzy sets to performance evaluation", *Integrated Manufacturing Systems* , Vol. 13 No. 4, pp. 237-246.

Chan, F.T.S., Chan, H.K., Lau, H.C.W. and Ralph, W.L. Ip (2006), "An AHP approach in benchmarking logistics performance of the postal industry", *Benchmarking: An International Journal*, Vol. 13 No. 6, pp. 636-660.

Chang, D.Y. (1996), "Applications of the extent analysis method on fuzzy-AHP", *European Journal of Operational Research*, Vol. 95 No. 3, pp. 649-655.

Chang, T.-H., Wang, T.-C. (2008), "Measuring the success possibility of implementing advanced manufacturing technology by utilizing the consistent fuzzy preference relations", *Expert Systems with Applications*, Vol. 36 No. 3, pp. 4313-4320.

Chang, Y.H. and Yeh, C.H. (2002), "A survey analysis of service quality for domestic airlines", *European Journal of Operational Research*, Vol. 139 No. 1, pp. 166-177.

Chaterjee, D. and Mukherjee, B. (2010), "Study of Fuzzy AHP model to search the criterion in the evaluation of the best technical institutions: a case study", *International Journal of Engineering Science and Technology*, Vol. 2 No. 7, pp. 2499-2510.

Chatterjee, D., Chowdhury, S. and Mukherjee, B. (2010), "Study of the application of Fuzzy analytical hierarchical process (FAHP) in the ranking of Indian Banks", *International Journal of Engineering Science and Technology*, Vol. 2 No. 7, pp. 2511-2520.

Chen, L.H. and Weng, M.C. (2002), "Using fuzzy approaches to evaluate quality improvement alternative based on quality costs", *The International Journal of Quality and Reliability Management*, Vol. 19 No. 2, pp. 122-136.

Chen, M.F., Tzeng, G.H. and Ding, C.G. (2008), "Combining Fuzzy AHP with MDS in identifying the preference similarity of alternatives", *Applied Soft Computing*, Vol. 8 No. 1, pp. 110-117.

Chow, C.C. and Luk, P. (2005), "A strategic service quality approach using analytic hierarchy process", *Managing Service Quality*, Vol. 15 No. 3, pp. 278-289.

Dabholkar, P.A., Thorpe, D.I. and Rentz, J.O. (1996), "A measure of service quality for retail stores: scale development and validation", *Journal of the Academy of Marketing Science*, Vol. 24 No. 1, pp. 3-16.

Dubois, D. and Prade, H. (1978), "Operations on fuzzy number", *International Journal of System Science*, Vol. 9 No. 6, pp. 13-626.

Finn, D.W. and Lamb, C. Jr (1991), "An evaluation of the SERVQUAL scales in a retailing setting", *Advances in Consumer Research*, Vol. 18 No. 1, pp. 483-490.

Ganguly, K.K. and Guin, K.K. (2013), "A Fuzzy AHP approach for inbound supply risk assessment", *Benchmarking: An International Journal*, Vol. 20 No. 1, pp. 129-146.

Ghobadian, A., Speller, S. and Jones, M. (1994), "Service quality: concepts and models", *International Journal of Quality & Reliability Management*, Vol. 1 No. 9, pp. 43-66.

Ghosh, P., Tripathi, V. and Kumar, A. (2010), "Customer expectations of store attributes: a study of organized retail outlets in India", *Journal of Retail & Leisure Property*, Vol. 9 No. 1, pp. 75-87.

Gilleard, J.D. and Yat-lung, P.W. (2004), "Benchmarking facility management: applying analytic hierarchy process", *Facilities*, Vol. 22 Nos 1/2, pp. 19-25.

Golden, B., Wasil, E. and Harker, P. (1989), *The Analytic Hierarchy Process: Applications and Studies*, Springer-Verlag, Berlin.

Guiffrida, A.L. and Nagi, R. (1998), "Fuzzy set theory applications in production management research: a literature survey", *Journal of Intelligent Manufacturing*, Vol. 9 No. 1, pp. 39-56.

Halepete, J., Seshadri, K.V. and Park, S.C. (2008), "Wal-Mart in India: a success or failure?", *International Journal of Retail and Distribution Management*, Vol. 36 No. 9, pp. 701-713.

Ho, W. (2008), "Integrated analytic hierarchy process and its applications – a literature review", *European Journal of Operational Research*, Vol. 186 No. 1, pp. 211-228.

Hota, H.S., Pavani, S. and Gangadhar, P.V.S.S. (2013), "Evaluating teachers ranking using Fuzzy AHP technique, *International Journal of Soft Computing and Engineering*, Vol. 2 No. 6, pp. 485-488.

Hsiao, S.W. (1994a), "Fuzzy set theory on car-color design", *Color Research and Application*, Vol. 19 No. 3, pp. 202-213.

Hsiao, S.W. (1994b), "Fuzzy set theory applied to car style design", *International Journal of Vehicle Design*, Vol. 15 Nos 3-5, pp. 255-278.

Hsiao, S.W. (1998), "Fuzzy logic based decision model for product design", *International Journal of Industrial Ergonomics*, Vol. 21 No. 2, pp. 103-116.

Indian Retail Report (2013), "Indian retail sector report", available at: www.michaelpage.co.in/websitepdf/IN_Retail_sector_report_2013.pdf (accessed February 2013).

Jain, S. and Ninan, T.N. (2010), "Servicing India's GDP growth", in Acharya, S. and Mohan, R. (Eds), *India's Economy Performance and Challenges, Essays in Honour of Montek Singh Ahluwalia*, Oxford University Press, New Delhi, pp. 328-365.

Jhamb, D. and Kiran, R. (2012), "Emerging retail formats and it's attributes: an insight to convenient shopping", *Global Journal of Management and Business Research*, Vol. 12 No. 2, pp. 63-71.

Kabir, G. and Hasin, M.A.A. (2012), "Framework for benchmarking online retailing performance using fuzzy AHP and TOPSIS method", *International Journal of Industrial Engineering Computations*, Vol. 3 No. 4, pp. 561-576.

Kahraman, C., Ufuk, C. and Ziya, U. (2003), "Multi-criteria supplier selection using fuzzy AHP", *Logistics Information Management*, Vol. 16 No. 6, pp. 382-394.

Kale, S. and Karaman, E.A. (2011), "A fuzzy logic model for benchmarking the knowledge management performance of construction firms", *Canadian Journal of Civil Engineering*, Vol. 38 No. 4, pp. 464-475.

Karpuzcu, H. (2006), "Measuring service quality in distribution logistics using SERVQUAL and AHP: a case study in a pharmaceutical wholesaler in Turkey", dissertation, University of Nottingham, Nottingham.

Karpuzcu, H. and Ramanathan, R. (2011), "Comparing perceived and expected service using an AHP model: an application to measure service quality of a company engaged in pharmaceutical distribution", *Journal of Operational Search Society of India*, Vol. 48 No. 2, pp. 136-152.

Karwowski, W. and Evans, G.W. (1986), "Fuzzy concepts in production management research: a review", *International Journal of Production Research*, Vol. 24 No. 1, pp. 129-147.

Kaufmann, A. and Gupta, M.M. (1988), *Fuzzy Mathematical Models in Engineering and Management Science*, Elsevier Science Inc., New York, NY.

Kaul, S. (2007), "Measuring retail service quality: examining applicability of international research perspectives in India", *Vikalpa*, Vol. 32 No. 1, pp. 15-26.

Kearney, A.T. (2012), "Global retail expansion: keeps on moving", available at: www.atkearney.com/documents/10192/4799f4e6-b20b-4605-9aa83ef451098f8a (accessed August 2012).

Kong, F. and Liu, H. (2005), "Applying Fuzzy analytic hierarchy process to evaluate success factors of e-commerce", *International Journal of Information and Systems Sciences*, Vol. 1 Nos 3-4, pp. 406-412.

Laarhoven, P.J.M. and Pedrycz, W. (1983), "A fuzzy extension of Saaty's priority theory", *Fuzzy Setsand Systems*, Vol. 11 Nos 1-3, pp. 229-241.

Lee, C.C., Chiang, C. and Chen, C.-T. (2012), "An evaluation model of e-service quality by applying hierarchical fuzzy TOPSIS method", *International Journal of Electronic Business Management*, Vol. 10 No. 1, pp. 38-49.

Lee, D., Lee, C. and Pietrucha, M. (2008), "Evaluation of driver satisfaction of travel information on variable message signs using fuzzy aggregation", *Journal of Advanced Transportation*, Vol. 42 No. 1, pp. 5-18.

Lee, W.H., Wang, C.H. and Pang, C.T. (2010), "Evaluating service quality of online auction by fuzzy MCDM", *World Academy of Science, Engineering and Technology*, Vol. 65, pp. 1070-1076.

Leung, C. and To, C.K. (2001), "Measuring perceived service quality of fashion stores: a test-retest reliability investigation", *Journal of Fashion Marketing and Management*, Vol. 5 No. 4, pp. 324-329.

Lin, S.C., Liang, G.S. and Ye, K.D. (2005), "A survey investigation of airports as distribution centers: a strategic advantage perspective", *International Journal of Management*, Vol. 22 No. 3, pp. 396-414.

Lootsman, F. (1997), *Fuzzy Logic for Planning and Decision Making*, Kluwer Academic Publishers, London.

Majazi, V. (2011), "Using fuzzy multi-criteria assessment method (fuzzy AHP) in the best sequence selection in a single machine shop", *Indian Journal of Science & Technology*, Vol. 4 No. 5, pp. 502-508.

Maravelakis, E., Bilalis, N., Antoniadis, A., Jones, K.A. and Moustakis, V. (2006), "Measuring and benchmarking the innovativeness of SMEs: a three-dimensional fuzzy logic approach", *Production Planning & Control*, Vol. 17 No. 3, pp. 283-292.

Min, H. and Min, H. (1996), "Competitive benchmarking of Korean luxury hotels using the analytic hierarchy process and competitive gap analysis", *Journal of Services Marketing*, Vol. 10 No. 3, pp. 58-72.

Min, H. and Min, H. (1997), "Benchmarking the quality of hotel services: managerial perspectives", *International Journal of Quality & Reliability Management*, Vol. 14 No. 6, pp. 582-597.

Nhat, N.D.D. and Hau, L.N. (2007), "Determinants of retail service quality-a study of supermarkets in Vietnam", *Science & Technology Development*, Vol. 10 No. 8, pp. 15-23.

Özdağoğlu, A. and Özdağoğlu, G. (2007), "Comparison of AHP and fuzzy AHP for the multicriteria decision-making processes with linguistic evaluations", İstanbul TicaretÜniversitesi Fen BilimleriDergisiYıl: 6 Sayı:11Bahar 2007/1s, pp. 65-85.

Pan, N.F. (2008), "Fuzzy AHP approach for selecting the suitable bridge construction method", *Automation in Construction*, Vol. 17 No. 8, pp. 958-965.

Parasuraman, A., Zeithaml, V.A. and Berry, L.L. (1985), "A conceptual model of service quality and its implications for future research", *Journal of Marketing*, Vol. 49 No. 4, pp. 41-50.

Parasuraman, A., Zeithaml, V.A. and Berry, L.L. (1988), "SERVQUAL: a multiple-item scale for measuring consumer perceptions of service quality", *Journal of Retailing*, Vol. 64 No. 1, pp. 12-40.

Parasuraman, A., Zeithaml, V.A. and Berry, L.L. (1991), "Refinement and reassessment of the SERVQUAL scale", *Journal of Retailing*, Vol. 67 No. 4, pp. 420-450.

Parikh, D. (2006), "Measuring retail service quality: an empirical assessment of the instrument", *Vikalpa*, Vol. 31 No. 2, pp. 45-55.

Prascevic, Z. and Petrovic-Lazarevic, S. (1996), "Probabilistic-possibilistic approach to the optimal selection of a contractor", *Journal of Operational Research*, Vol. 6 No. 1, pp. 137-141.

Prascevic, Z. and Petrovic-Lazarevic, S. (1997), "Determination of optimal bidding profit rate by fuzzy set theory", *Cybernetics and Systems*, Vol. 28 No. 4, pp. 337-343.

Prascevic, Z. and Petrovic-Lazarevic, S. (1998), "Fuzzy multiple objective decision making in the construction industry", working paper, Department of Management, Monash University, pp. 90-98.

Qureshi, M.N., Kumar, P. and Kumar, D. (2009), "Framework for benchmarking logistics performance using fuzzy AHP", *Int. J. of Business Performance and Supply Chain Modelling*, Vol. 1 No. 1, pp. 82-98.

Ramayah, T. and Jasmine, Y.A.L. (2003), "What drives relationship quality? A study on two retail clothing stores", *Proceedings of the 5th Asian Academy of Management Conference, "Challenges of Globalized Business: The Asian Perspective", Kuantan, September 10-13*.

Ribeiro, R.A. (1996), "Fuzzy multiple criterion decision making: a review and new preference elicitation techniques", *Fuzzy Sets and Systems*, Vol. 78 No. 2, pp. 155-181.

Roger, F.B., Ian, N.L. and Martina, A.B. (1999), "Internal marketing and customer driven wave fronts", *The Service Industries Journal*, Vol. 19 No. 4, pp. 49-67.

Saaty, T.L. (1980), *The Analytic Hierarchy Process*, 9th ed., McGraw Hill, New York, NY.

Saaty, T.L. (1994), "How to make a decision: the analytic hierarchy process", *Interfaces*, Vol. 24 No. 6, pp. 19-43.

Salem, M.S.M. (2010), "An application of the analytic hierarchy process to determine benchmarking criteria for manufacturing organizations", *International Journal of Trade, Economics and Finance*, Vol. 1 No. 1, pp. 93-102.

Shee, D.Y., Tzeng, G.H. and Tang, T.I. (2003), "AHP, fuzzy measure and fuzzy integral approaches for the appraisal of information service providers in Taiwan", *Journal of Global Information Technology Management*, Vol. 6 No. 1, pp. 8-30.

Steuer, R.E. and Na, P. (2003), "Multiple criteria decision making combined with finance: a categorized bibliographic study", *European Journal of Operational Research*, Vol. 150 No. 3, pp. 496-515.

Swoboda, B., Haelsig, F., Morschett, D. and Schramm-Klein, H. (2007), "An inter-sector analysis of the relevance of service in building a strong retail brand", *Managing Service Quality*, Vol. 17 No. 4, pp. 428-448.

Tata Consultancy Services and Retail Association of India (2013), "Report, Indian retail operations benchmarking and excellence survey – a RAI-TCS study", available at: www.tcs.com/.../Retail-Operations-Benchmarking-Excellence-Survey-Me

Tavana, M., Bourgeois, B.S. and Sodenkamp, M.A. (2009), "Fuzzy multiple criteria base realignment and closure (BRAC) benchmarking system at the department of defense", Vol. 16 No. 2, pp. 192-221.

Tavana, M., Yazdi, A.K., Shiri, M. and Rappaport, J. (2011), "An EFQM-Rembrandt excellence model based on the theory of displaced ideal", *Benchmarking – An International Journal*, Vol. 18 No. 5, pp. 644-667.

Tsai, M.-T., Wu, H.-L. and Liang, W.-K. (2008), "Fuzzy decision making for market positioning and developing strategy for improving service quality in department stores", *Quality & Quantity*, Vol. 42 No. 3, pp. 303-319.

Tsaur, S.H., Chang, T.Y. and Yen, C.H. (2002), "The evaluation of airline service quality by fuzzy MCDM", *Tourism Management*, Vol. 23 No. 2, pp. 107-115.

Ufek, C. and Ahmet, B. (2002), "An approach to the evaluation of quality performance of the companies in Turkey", *Managerial Auditing Journal*, Vol. 17 Nos 1-2, pp. 92-100.

Vaidya, O.S. and Kumar, S. (2006), "Analytic hierarchy process: an overview of applications", *European Journal of Operational Research*, Vol. 169 No. 1, pp. 1-29.

Vargas, L.G. (1990), "An overview of the analytic hierarchy process and its application", *European Journal of Operational Research*, Vol. 48 No. 1, pp. 2-8.

Varley, R. and Rafiq, M. (2004), *Principles of Retail Management*, Palgrave Macmillan, New York, NY.

Vázquez, R., Ignacio, A.R.-D.B., Ana M.D. and Agustin, V.R. (2001), "Service quality in supermarket retailing: identifying critical service experiences", *Journal of Retailing and Consumer Services*, Vol. 8 No. 1, pp. 1-14.

Wang, E.J. (2002), "Outage costs and strategy for hi-tech industries: a fuzzy multiple goal approach", *The International Journal of Quality & Reliability Management*, Vol. 19 Nos 8-9, pp. 1068-1087.

Wedley, W.C. (1990), "Combining qualitative and quantitative factors – an analytic hierarchy process", *Socio-Economic Planning Sciences*, Vol. 24 No. 1, pp. 57-64.

Wong, A. and Petrovic, L. (2000), "Fuzzy control model in the hospitality industry", *International Journal of Agile Management Systems*, Vol. 2 No. 2, pp. 156-162.

Wu, W.Y., Hsiao, S.W. and Kuo, H.P. (2004), "Fuzzy set theory based decision model for determining market position and developing strategy for hospital service quality", *Total Quality Management*, Vol. 15 No. 4, pp. 439-456.

Zadeh, L.A. (1965), "Fuzzy sets", *Information and Control*, Vol. 8 No. 3, pp. 338-353.

Zadeh, L.A. (1975), "The concept of a linguistic variable and its application to approximate reasoning", *Information Sciences*, Vol. 8 No. 3, pp. 199-249.

Zeithaml, V., Bitner, M. and Gremler, D. (2009), *Service Marketing: Integrating Customer Focus Across the Firm*, 5th ed., McGraw International Edition, Boston, MA.

Zhou, D., Ma, J. and Efraim, T. (2001), "Journal quality assessment: an integrated subjective and objective approach", *IEEE Transactions on Engineering Management*, Vol. 48 No. 4, pp. 479-490.

Further reading

Chau, V.S. and Kao, Y.Y. (2009), "Bridge over troubled water or long and winding road? Gap-5 in airline service quality performance measures", *Managing Service Quality*, Vol. 19 No. 1, pp. 106-134.

Lapierre, J., Filiatrault, P. and Perrien, J. (1996), "Research on service quality evaluation: evolution and methodological issues", *Journal of Retailing and Consumer Services*, Vol. 3 No. 2, pp. 91-98.

Corresponding author

Dr Sreekumar can be contacted at: sreekumar42003@yahoo.com