ANALYZING SERVICE QUALITY OF SUPERMARKETS USING FUZZY AHP

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ABSTRACT

To effectively compete, supermarkets need to know what factors affect customers' loyalty and work to improve these factors. This paper proposes a method that addresses uncertainty to identify key factors affecting customer satisfaction in the supermarket industry. Using Fuzzy Analytical Hierarchy Process (FAHP) method, we develop a set of benchmarks that help supermarkets enhance their service delivery. Our findings support previous research that product quality is considered most important to the supermarket customers followed by the cleanliness of the store. This paper reveals the Key Success Factors (KSF's) with regards to customer satisfaction enhancement and retention for the supermarket industry in the United States.

Keywords: FAHP, fuzzy, retail, supermarket, U.S.A.

INTRODUCTION

The retail grocery industry in the United States is a 500 billion dollar industry, and many scholars have focused their research on this industry [1]. Retail industry research reveals that an average consumer visits a grocery store at least once a week; this shows the close and constant interaction between the consumers and grocery stores. According to U.S. Bureau of Labor Statistics, an average consumer in the United States spends $3,921 per year on food prepared at home; that is roughly $9,800 per year per household. These expenditures are mainly in the supermarket industry to purchase cereals and bakery products, meat, poultry, fish and eggs, dairy products, fruits, vegetables and other food items [2]. We know that there is intense competition among supermarkets; grocery retail, on or offline has one of the smallest operating margins in the retail sector: with 2 to 3 percent pretax margin [3]. Because the margins are not very attractive in supermarket sector, grocery retailers generally compete to earn customers' loyalty and consequently benefit from Cusomters Lifetime Value (CLV). CLV defined as the projected positive impact of the customer on the retailer's profits over their entire relationship with the retailer [4]. A report from Food Marketing Institute and Nielsen in 2016 predicts the online grocery sales will have considerably more market share, within the next ten years from the bricks-and-mortar stores [5]. Nevertheless, the in-store experience of the customers is expected to remain an important topic in the retail industry for now. We also know that customer loyalty creates various benefits for a brand and has become the emphasis on increasing number of marketing strategies [6]. In fact, customer loyalty is a goal for many retailers because the customers switch quite effortlessly in the retail industry and the competition is very intensive [7]. Customer loyalty is associated with reduced costs; generally, customer retention is easier and more cost-effective than customer development. In the brick-and-mortar retail industry, the product is essentially the in-store experience that retailer provides to the consumer. The quality of shopping experience, similar to the quality of a tangible good, has different dimensions. It includes the location of the retailer, cleanliness, checkout speed, the courteousness of the staff, the variety of the product assortments offered and the availability of auxiliary services such as parking and packing/bagging [8]. It is critical that retailers identify the most important factors that affect customers' in-store experiences and determine the critical success factors in this industry. One way to do this is through ranking the supermarkets based on data collected from the customers. Ranking the top supermarkets provides us with information regarding strategies and tactics to win customers' positive perception as well as industry's Critical Success Factors. In 2008, Min analyzed the attributes of several supermarkets in the United States using the Analytic Hierarchy Process (AHP) analysis and presented a set of overall priority scores that ranked the importance of supermarket attributes. In his work, Min addressed five main research questions: 1) which elements comprise customer service attributes that influence the supermarket customer's perception of service quality? 2) Which service attributes are most important for customer satisfaction? 3) Which supermarket is perceived to be the industry leader? 4) How do we compare the supermarket's service performance with that of the industry leader using competitive gap analysis? 5) How do we develop a strategic action plan for continuous service improvement of the supermarket? [9]. Analytic Hierarchy Process (AHP) is a valuable method for solving complex decision-making problems involving expert judgment [10]. In the AHP method, the multi-attribute weight measurement is calculated by pair-wise comparison of the relative importance of two factors. However, traditional methods of the AHP cannot process imprecise or vague knowledge. Fishburn, a famous pioneer in the field of the decision-making process, expresses uncertainty in terms of probabilities for contingencies whose occurrence cannot be influenced by the specific act that is implemented but which determine the consequence that results under each available act [11]. The non-fuzzy AHP method requires certain judgments; alternatively, as a result of the complexity and uncertainty involved in real-world decision problems, decision makers feel more confident to provide their responses in the form of uncertain judgments (fuzzy judgments) rather than solid comparisons [12]. Uncertainty is important because "environmental effects on organizations are mediated by uncertainty surrounding decisions" [13]. Also, when a model or method is derived from vague information, the decisions made as a result may be subject to error. Therefore, in this study uncertainty is accounted for and considered. To address this vagueness, Zadeh presented the fuzzy sets theory to account for uncertainty associated with vagueness [14]. Wind and Saaty investigated and presented the applications of Fuzzy concept in marketing as well [15]. Fuzzy set theory very well bears a resemblance to human reasoning in its use of imprecise data and uncertainty associated with decision making; and many researchers have used fuzzy theory in conjunction with AHP. To name a few, Deb used Fuzzy AHP to evaluate customer's mall preferences in India because this scholar believes the theoretical validity, discrete numerical value and rank reversal problems in the AHP have been questioned recently; and more importantly, AHP is unable to accommodate uncertainty in the decision-making process [16]. In their research, Atef-Yekta et al. argue that using AHP enables decision makers to solve problems in which personal judgment of a decision maker plays an important part in the decision-making process. They also argue that using fuzzy set theory can lessen vagueness and uncertainties that are inherent in the experts' judgments [17]. In addition, Jenab and Sarfaraz conducted an analysis and compared AHP and FAHP; their study demonstrated that although both methods are useful, FAHP is more robust because it eliminates discrepancies caused by participants' personal emotional states. [18]. Van Laarhoven and Pedrycz found that by offering experts/decision makers the opportunity to express their fuzzy opinions in fuzzy numbers, the FAHP method provides more realistic results than the original non-fuzzy method [19]. Since the FAHP method takes into account uncertainty, in an age of big data, it can address problems involved with correlation implying causation. In their study, Jenab, Khouri and Sarfaraz, constructed a Fuzzy Analytic Hierarchy Process (FAHP) model to evaluate process complexity for decision making because FAHP takes into account uncertain situations [20]. Also, in developing supplier selection model, Jitrawichawet, Sarfaraz and Jenab, used Fuzzy

Analytical hierarchy process (AHP) because it introduces ‘fuzzy logic’ that provides advantages over AHP dealing with alternative comparisons for uncertainty and complexity problem [21]. Moreover, in their work, Sarfaraz, Mukerjee and Jenab argue that using FAHP, as opposed to AHP, increases the accuracy of the final judgment because FAHP takes into account imperfect precision of humans in decision making.

In the analytical hierarchy approach adopted by Min [9], the decision makers (survey participants) were asked to rate on a five-point Likert scale the service performance of the seven supermarkets in relation to 11 attributes. In fact, that the preference model of the participant could be very well uncertain and it could be quite difficult for her or him to select a precise numerical value for the comparison ratios [22]. Lack of information, knowledge, and complexity of the decisions could cause the decision maker become uncertain about her or his own level of preference. One of the best ways to deal with uncertain judgments is to express the comparison ratio as an interval or fuzzy set [23]. Using fuzzy sets enable us to incorporate the prioritization procedure to develop priorities, closely satisfying the uncertain decision. In recent years, scholars have begun to apply Fuzzy AHP (Fuzzy Analytic Hierarchy Process) to minimize uncertainty associated with expressions by study participants [24]. In the method we have proposed, to determine imprecision and uncertainty, all the assessment data are specified into triangular fuzzy numbers (TFNs) [25]. There is no prior research that analyzes supermarket attributes using Fuzzy AHP. Our approach uses the extended Fuzzy AHP model that was presented by Chang in 1996 to calculate priority numbers. He used triangular fuzzy numbers for a pairwise comparison scale of fuzzy AHP. Then, using the extent analysis method, he introduced the synthetic extent value of the pairwise comparison. By applying the principle of the comparison of fuzzy numbers, he represented the weight vectors concerning each element under a certain criterion. [26]. The application section of this paper will present a multi-criteria Fuzzy AHP problem, calculating a Fuzzy AHP model with seven alternatives and 11 criteria. We then calculate the priority scores for all the alternatives to find the factors most important to supermarket customers in the United States.

THE EXTENDED FUZZY AHP MODEL

The extended Fuzzy AHP model presented in this section is based on the applications of the extent analysis method on Fuzzy AHP by Da-Yong Chang [26]. The calculation process of the priority indexes using a Fuzzy AHP is shown here.

First, we define Fuzzy numbers and represent some basic calculations for these numbers; then we present the Fuzzy AHP and its application in this case. Generally speaking, the triangular fuzzy number is denoted as $(l\ ,\ m\ ,\ u)$. We define the Fuzzy number M on R to be a triangular Fuzzy number if its membership functions

$$\mu_M(X) \begin{cases} \frac{x}{m-l} - \frac{l}{m-l}, & x \in [l, m] \\ \frac{x}{m-u} - \frac{u}{m-u}, & x \in [m, u] \\ 0, & Otherwise \end{cases} \tag{1}$$

Assuming that $l \leq m \leq u$ thus we can denote a Fuzzy value by $(l\ ,\ m\ ,\ u)$. Also we define M such that: $\{x \in R \mid l < x < u\}$ and $l = m = u$ could be a non-Fuzzy number by definition.

Given that two Fuzzy numbers M_1 and M_2 are defined as $M_1 = (l_1, m_1, u_1)$ and $M_2 = (l_2, m_2, u_2)$ the normal operations of such Fuzzy numbers are defined as:

$$(l_1, m_1, u_1) + (l_2, m_2, u_2) = (l_1 + l_2,\ m_1 + m_2,\ u_1 + u_2) \text{ Addition} \tag{2}$$

$$(l_1, m_1, u_1) \,.\, (l_2, m_2, u_2) = (l_1 . l_2,\ m_1 . m_2,\ u_1 . u_2) \quad \text{Multiplication} \tag{3}$$
$$(\lambda, \lambda, \lambda) \,.\, (l_1, m_1, u_1) = (\lambda\, l_1, \lambda\, m_1, \lambda\, u_1) \text{ Multiplying a constant} \tag{4}$$
$$(l_1, m_1, u_1)^{-1} = \left(\frac{1}{l_1}, \frac{1}{m_1}, \frac{1}{u_1}\right) \text{ Inversion} \tag{5}$$

The value of the Fuzzy synthetic extent is calculated as follows:
An object set: $X = \{x_1, x_2, \dots, x_n\}$
Moreover, the goal set would be: $U = \{u_1, u_2, \dots, u_n\}$
We can get the m extent analysis values object with the following notation, and for each object, we have the following:
$M_{gi}^1, M_{gi}^2, M_{gi}^m$, $i=1,2,3,\ldots,n$
When all M_{gi}^j $(j=1,2,3,\ldots,m)$ are Fuzzy numbers. By definition, assuming that

$$M_{gi}^1, M_{gi}^1, M_{gi}^1, \dots, M_{gi}^m \tag{6}$$

are the values of extent analysis of i^{th} object for m goals, the value of the Fuzzy synthetic extent is defined as:

$$S_i = \left[\sum_{j=1}^{m} M_{gi}^1\right] . \left[1 / \left[\sum_{i=1}^{n} \sum_{j=1}^{m} M_{gi}^1\right]\right] \tag{7}$$

Next, we have to decide the relative importance of each pair of factors in the same hierarchy. Using the Fuzzy pairwise comparison method, we come up with the evaluation *matrix*$A = (a_{ij})_{n\times m}$. For any Fuzzy number such as $a_{ij} = (l, m, u)$ the greater the distance between l and u (Or l-u) the fuzzier the number. When the difference comes down to zero, the number will become a non-Fuzzy number. If element j proves to be more important than I, the pairwise comparison will be: $a_{ij}^{-1} = (\frac{1}{u}, \frac{1}{m}, \frac{1}{l})$.
In order to make comparison among a set of Fuzzy numbers, we define the degree of possibility. The degree of possibility of $M_1 \geq M_2$ is defined as:

$$V(M_1 \geq M_2) = \sup_{x \geq y} \left[\min(\mu_{M_1}(x), \mu_{M_2}(y)\right] \tag{8}$$

For $M_1 = (l_1, m_1, u_1)$ *and* $M_2 = (l_2, m_2, u_2)$
To compare M_1 and M_2 as Fuzzy numbers, we have the values of:
$V(M_1 \geq M_2)$ and $V(M_2 \geq M_1)$
Hence we have:
$V(M_1 \geq M_2) = 1$; iff $m_1 \geq m_2$ and:

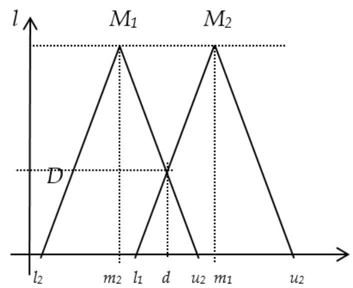
$$V(m_2 \geq m_1) = \text{height } (m_1 \cap m_2) = \mu_{m1}(d) \tag{9}$$

We define d as the ordinate of the highest intersection of point D between μ_{M1} and μ_{M2} as depicted in Figure 1.

Assuming that $M_1 = (l_1, m_1, u_1)$ and $M_2 = (l_2, m_2, u_2)$ we can calculate the ordinate of D using (10):

$$V(M_2 \geq M_1) = \frac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} \tag{10}$$

FIGURE I: THE FUZZY NUMBERS M1 AND M2 AND THEIR COMPARISON



The degree of possibility for a convex Fuzzy number is to be greater than k convex Fuzzy numbers $M_i (i = 1,2,3, \dots, k)$ can be defined as:

$$V(M \geq M_1, M_2, \dots, M_k) = \min V(M \geq M_i), i = 1,2,3, \dots, k \quad (11)$$

$$\text{Assuming that } d'(A_i) = \min V(S_i \geq S_k) \quad (12)$$

Then the weight of the vector will be:

$$W' = (d'(A_1), d'(A_2), d'(A_3), \dots, d'(A_n))^T \quad (13)$$

Where A_i $(i = 1,2, \dots, n)$ are n elements. After normalizing the weight of vectors we will have:

$$W = (d(A_1), d(A_2), d(A_3), \dots, d(A_n))^T \quad (14)$$

Where W is a non-Fuzzy number.
Now that we have illustrated the calculation process, we apply the model to the data on supermarkets in the United States.

APPLICATION

Before presenting the tables and calculation process, it is important to provide context about our measures and supermarkets in the United States. Research has shown that some service factors are considered to be more important to supermarket customers, and we use those factors in our analysis. These service attributes are derived from determinants of supermarket service quality identified by Banning and Weber [27]. Also, our calculations use factors from previous research on the main supermarket service factors. Min revealed 11 service attributes that were considered relevant to the supermarket industry service quality [28]. Some examples of these factors, useful for our research include product quality, product variety, and cleanliness of supermarket, supermarket location, price, price labeling, fast checkout, easy payment, employee courtesy, store operating hours and the availability of special departments (Table 1). Based on previous research [29], [30]; the overall satisfaction of the customers normally is closely correlated with these factors. The participants in the research by Min were 210 supermarket shoppers in the southeastern part of the United States who shopped at seven different supermarkets between 2003 and 2006 [9]. The supermarkets considered for the research were Kroger, Meijer, Winn Dixie, Wal-Mart, Pic-Pac, Aldi, and Save-A-Lot. The data was collected on these stores because these stores share some similarities, regarding scale, location and product offerings [9]. The participants were asked to provide their perception regarding the importance of different supermarket attributes and then provide their overall satisfaction regarding specific supermarkets on an individual basis. After running statistical tests in SPSS package, such as factor analysis, some factors were retained and considered to be more important to service quality. Myers found that the best and most reliable way to find out which factors are more important to customers is to ask them to rank the attributes by the way they affect overall satisfaction [31]. Therefore, the participants were asked to rank the supermarket attributes in the way they affect their overall satisfaction. We used the factors related to service quality of supermarkets identified by Min [9] and the approach presented by Chang [26] to construct a Fuzzy AHP for supermarket attributes. The process of conversion and calculation will be shown in the following steps:

Seven alternatives and eleven attributes were identified in the data.

In the first step, the expert rankings were converted to Fuzzy numbers; we used Table I for conversion. This provided us with one 11 x 11 and seven 7 x 7 matrices for alternatives and criteria. All the numbers in the mentioned matrices were Fuzzy numbers.

TABLE I: CONVERSION TO FUZZY NUMBERS

Linguistic scale for importance	Triangular Fuzzy scale	Triangular Fuzzy Reciprocal scale
Equally important (EI)	(1/2, 1, 3/2)	(2/3, 1, 2)
Weakly more important (WMI)	(1, 3/2, 2)	(1/2, 2/3, 1)
Strongly more important (SMI)	(3/2, 2, 5/2)	(2/5, 1/2, 2/3)
Very strongly more important (VSMI)	(2, 5/2, 3)	(1/3, 2/5, 1/2)
Absolutely more important (AMI)	(5/2, 3, 7/2)	(2/7, 1/3, 2/5)

In the next step, using formula (7) the value of Fuzzy synthetic extent with respect to the i^{th} object was calculated for the pairwise comparison of the alternatives as well as the pairwise comparison of attributes for each alternative. Using formulas (8), (9) and (10) the degree of possibility for each matrix was calculated. Moreover, priority weights were also calculated using formulas (12) and (13). The d′ values (d primes) provide us with weight (W′), and after normalizing the weights using formula (14), we find W for the alternatives and criteria which is a non-Fuzzy array. The arrays are then put into a matrix format and multiplied as depicted in Figure I that provides us with the priority scores for each attribute. As an example, the calculation of pairwise comparison of one of the seven attributes is shown Table II. Comparison the eleven alternatives are depicted in Table II, and final calculation of final scores is shown in Figure II.

TABLE II: PRODUCT QUALITY

	Meijer	Kroger	Winn Dixie	Wal-Mart	Aldi	PicPac	SaveALot
Meijer	1 1 1	1 1 1/2 2	1 1 1/2 2	1 1/2 2 2 1/2	2 2 1/2 3	2 2 1/2 3	2 1/2 3 3 1/2
Kroger	1/2 2/3 1	1 1 1	1/2 1 1 1/2	1 1 1/2 2	1 1/2 2 2 1/2	2 2 1/2 3	2 2 1/2 3
Winn Dixie	1/2 2/3 1	2/3 1 2	1 1 1	1/2 1 1 1/2	1 1 1/2 2	1 1/2 2 2 1/2	1 1/2 2 2 1/2
Wal-Mart	2/5 1/2 2/3	1/2 2/3 1	2/3 1 2	1 1 1	1 1 1/2 2	1 1/2 2 2 1/2	1 1/2 2 2 1/2
Aldi	1/3 2/5 1/2	2/5 1/2 2/3	1/2 2/3 1	1/2 2/3 1	1 1 1	1 1 1/2 2	1 1 1/2 2
PicPac	1/3 2/5 1/2	1/3 2/5 1/2	2/5 1/2 2/3	2/5 1/2 2/3	1/2 2/3 1	1 1 1	1/2 1 1 1/2
SaveA Lot	2/7 1/3 2/5	1/3 2/5 1/2	2/5 1/2 2/3	2/5 1/2 2/3	1/2 2/3 1	2/3 1 2	1 1 1

11 14 17	0.1459 0.2410 0.3819	l1 m1 u1	S1
8 1/2 11 1/6 14	0.1127 0.1922 0.3145	l2 m2 u2	S2
6 2/3 9 1/6 12 1/2	0.0884 0.1578 0.2808	l3 m3 u3	S3
6 4/7 8 2/3 11 2/3	0.0871 0.1492 0.2621	l4 m4 u4	S4
4 3/4 6 1/4 8 1/6	0.0628 0.1073 0.1834	l5 m5 u5	S5
3 1/2 4 1/2 5 5/6	0.0460 0.0769 0.1310	l6 m6 u6	S6
3 3/5 4 2/5 6 1/4	0.0476 0.0757 0.1400	l7 m7 u7	S7

Sum of Weights	(W′)						
3.1721	d′(C1)	d′(C2)	d′(C3)	d′(C4)	d′(C5)	d′(C6)	d′(C7)
	1.0000	0.7756	0.6185	0.5586	0.2193	0.0000	0.0000
	Normalized Array (W)						
	0.3152	0.2445	0.1950	0.1761	0.0691	0.0000	0.0000

TABLE III: COMPARISON OF ALTERNATIVES

	Product Quality	Cleanliness of the Store	Competitive Price	Product Variety	Fast Checkout	Convenience of Store Location	Good Price Labeling	Easy Payment	Employee courtesy	Store Operating Hours	Availability of Special Departments
Product Quality	1 1 1	1/2 1 1 1/2	1/2 1 1 1/2	1 1 1/2 2	1 1 1/2 2	1 1 1/2 2	1 1/2 2 2 1/2	1 1/2 2 2 1/2	1 1/2 2 2 1/2	2 2 1/2 3	2 2 1/2 3
Cleanliness of the Store	2/3 1 2	1 1 1	1/2 1 1 1/2	1 1 1/2 2	1 1 1/2 2	1 1 1/2 2	1 1 1/2 2	1 1/2 2 2 1/2	1 1/2 2 2 1/2	1 1/2 2 2 1/2	2 2 1/2 3
Competitive Price	2/3 1 2	2/3 1 2	1 1 1	1/2 1 1 1/2	1 1 1/2 2	1 1 1/2 2	1 1 1/2 2	1 1/2 2 2 1/2	1 1/2 2 2 1/2	1 1/2 2 2 1/2	1 1/2 2 2 1/2
Product Variety	1/2 2/3 1	1/2 2/3 1	2/3 1 2	1 1 1	1/2 1 1 1/2	1 1 1/2 2	1 1 1/2 2	1 1 1/2 2	1 1 1/2 2	1 1 1/2 2	1 1/2 2 2 1/2
Fast Checkout	1/2 2/3 1	1/2 2/3 1	1/2 2/3 1	2/3 1 2	1 1 1	1/2 1 1 1/2	1 1 1/2 2	1 1 1/2 2	1 1 1/2 2	1 1 1/2 2	1 1/2 2 2 1/2
Convenience of Store Location	1/2 2/3 1	1/2 2/3 1	1/2 2/3 1	1/2 2/3 1	2/3 1 2	1 1 1	1/2 1 1 1/2	1/2 1 1 1/2	1 1 1/2 2	1 1 1/2 2	1 1 1/2 2
Good Price Labeling	2/5 1/2 2/3	1/2 2/3 1	1/2 2/3 1	1/2 2/3 1	1/2 2/3 1	2/3 1 2	1 1 1	1/2 1 1 1/2	1/2 1 1 1/2	1 1 1/2 2	1 1 1/2 2
Easy Payment	2/5 1/2 2/3	2/5 1/2 2/3	2/5 1/2 2/3	1/2 2/3 1	1/2 2/3 1	2/3 1 2	2/3 1 2	1 1 1	1/2 1 1 1/2	1 1 1/2 2	1 1 1/2 2
Employee Courtesy	2/5 1/2 2/3	2/5 1/2 2/3	2/5 1/2 2/3	1/2 2/3 1	1/2 2/3 1	1/2 2/3 1	2/3 1 2	2/3 1 2	1 1 1	1/2 1 1 1/2	1 1 1/2 2
Store Operating Hours	1/3 2/5 1/2	2/5 1/2 2/3	2/5 1/2 2/3	1/2 2/3 1	1/2 2/3 1	1/2 2/3 1	1/2 2/3 1	1/2 2/3 1	2/3 1 2	1 1 1	1/2 1 1 1/2
Availability of Special Departments	1/3 2/5 1/2	1/3 2/5 1/2	2/5 1/2 2/3	2/5 1/2 2/3	2/5 1/2 2/3	1/2 2/3 1	1/2 2/3 1	1/2 2/3 1	1/2 2/3 1	2/3 1 2	1 1 1

	Si		
13 1/2 18 1/2 23 1/2	0.0726 0.1379 0.2436	l1 m1 u1	S1
12 2/3 17 1/2 23	0.0681 0.1304 0.2384	l2 m2 u2	S2
11 5/6 16 1/2 22 1/2	0.0636 0.1230 0.2332	l3 m3 u3	S3
9 2/3 13 5/6 19	0.0520 0.1031 0.1970	l4 m4 u4	S4
9 1/6 13 18	0.0493 0.0969 0.1866	l5 m5 u5	S5
7 2/3 11 1/6 16	0.0412 0.0832 0.1659	l6 m6 u6	S6
7 10 1/6 14 2/3	0.0380 0.0758 0.1520	l7 m7 u7	S7
7 9 5/6 14 1/2	0.0378 0.0733 0.1503	l7 m7 u7	S8
6 1/2 9 13 1/2	0.0351 0.0671 0.1399	l7 m7 u7	S9
5 4/5 7 3/4 11 1/3	0.0312 0.0576 0.1175	l7 m7 u7	S10
5 1/2 7 10	0.0297 0.0519 0.1037	l7 m7 u7	S11

Sum of Weights	(W′)										
7.2394	d′(C1)	d′(C2)	d′(C3)	d′(C4)	d′(C5)	d′(C6)	d′(C7)	d′(C8)	d′(C9)	d′(C10)	d′(C11)
	1.0000	0.9570	0.9151	0.7815	0.7356	0.6306	0.5613	0.5462	0.4876	0.3589	0.2656
	Normalized Array (W)										
	0.1381	0.1322	0.1264	0.1080	0.1016	0.0871	0.0775	0.0754	0.0674	0.0496	0.0367

FIGURE II: PUTTING THE W'S FROM THE PREVIOUS CALCULATION TO MATRIX FORMAT AND CALCULATING THE FINAL SCORE

	Product Quality	Cleanliness	Competitive Price	Product Variety	Convenience of Location	Good Price Labeling	Fast Checkout	Easy Payment	Employee Courtesy	Availability of a Specific Department	Store Operating Hours
Meijer	0.3152	0.3119	0.2748	0.3646	0.2465	0.1976	0.2108	0.2051	0.2164	0.1844	0.2540
Kroger	0.2445	0.2903	0.2013	0.2631	0.1670	0.1664	0.1790	0.1900	0.1767	0.1638	0.2161
Winn Dixie	0.1950	0.2082	0.1935	0.2289	0.1712	0.1251	0.1638	0.1907	0.1610	0.1585	0.1982
Wal-Mart	0.1761	0.1687	0.1396	0.1434	0.1540	0.1251	0.1576	0.1315	0.1442	0.1598	0.1908
Aldi	0.0691	0.0000	0.0989	0.0000	0.1147	0.1251	0.1243	0.1208	0.1204	0.1191	0.0586
PicPac	0.0000	0.0210	0.0460	0.0000	0.0907	0.1303	0.0967	0.0883	0.0995	0.1138	0.0716
SaveALot	0.0000	0.0000	0.0460	0.0000	0.0559	0.1303	0.0678	0.0735	0.0819	0.1007	0.0107

x

0.1381
0.1322
0.1264
0.1080
0.1016
0.0871
0.0775
0.0754
0.0674
0.0496
0.0367

=

0.2660
0.2136
0.1850
0.1531
0.0795
0.0583
0.0445

RESULTS

After multiplying the arrays and sorting the priority scores, our findings are depicted on the right side of Table IV.

TABLE IV: PRIORITY SCORES CALCULATED USING FUZZY AHP METHOD

Alternatives: Supermarkets	Priority Scores Obtained Using Fuzzy AHP
Meijer	0.2660
Kroger	0.2136
Winn Dixie	0.1850
Wal-Mart	0.1531
Aldi	0.0795
PicPac	0.0583
SaveALot	0.0445

Table IV shows the priority scores obtained using Fuzzy AHP approach; the analytical approach that Min adopted provides a pairwise comparison of alternatives and criteria using a scale to indicate the strength with which one element dominates over another with respect the higher level element. Obviously, assigning numerical values to the level of preference is difficult and uncertain [22]. In fact, we argue that Fuzzy sets incorporate the prioritization procedure that can be applied to derive priorities, approximately satisfying uncertain decision making. We argue that the Fuzzy AHP approach provides a more accurate ranking because it combines the uncertainty factor, using the Fuzzy approach that the AHP model fails to incorporate. Our approach will provide a more accurate basis to create a set of Key Success Factors for customer satisfaction in the supermarket industry that could be extremely useful when leaders in supermarket industry develop and revise their corporate and competitive strategic plans.

CONCLUSION / DISCUSSION / IMPLICATIONS

As Table IV shows, Meijer has the highest ranking in Fuzzy AHP analysis. Product quality, cleanliness, competitive price, product variety, the convenience of location, good price labeling, fast checkout, easy payment, employee courtesy, store operating hours, availability of special departments, ordered by importance to the customers, are the areas that are the most critical to customer satisfaction enhancement. Uncertainty in the retail environment is a given. Grocery stores, in particular, face a highly competitive industry and fight for consumer's loyalty. Using the Fuzzy AHP method, this study addresses this uncertainty and adds value to ranking techniques used by supermarkets to gauge the most important service factors that will earn them loyal customers. In other words, supermarkets need the most accurate method to analyze customer data and build their strategies upon. Fuzzy Analytical Hierarchy Process is the more accurate approach for supermarket managers to use because it takes the uncertainty associated with decision making into account when analyzing customer data. This is a significant improvement considering the increasing amount of data collected by supermarkets and aggregated with other consumer data resources available in the digital age. More data will require supermarkets to rely on the quality and accuracy of the information and the analytics utilized for decisions.

The calculations presented in this paper were re-calculated five times to ensure the accuracy of the analysis and the results. However, there are other ways to convert the expert rankings to sets of Fuzzy numbers. In this paper, we used a five-point conversion table to convert the crisp number to corresponding Fuzzy sets while one could also use the nine-point conversion table to increase the accuracy of results. Additionally, the findings may not necessarily represent the national population regarding race, age, gender, income level, etc. Future research could administer a survey on a nation-wide on a large population to ensure that all demographic groups are represented in the sample. In the extensions of this research, one could conduct statistical Goodness of Fit to ensure all subgroups in the population are represented in the sample thus increase the accuracy of findings for its nation-wide implications. Furthermore, the proliferation of interlinked tablets, smartphones, smartphone applications, computers and other information technological advances has led to a convergence of real and digital worlds [32]. This convergence requires retailers to have a more dynamic interaction with their customers in cyberspace as well as in brick and mortar retail settings.

We suggest future research focus on Key Success Factors in creating a more consistent customer experience both online and at physical retail locations. The senior management of supermarkets could use the top factors presented above to formulate competitive and operational strategies for supermarkets. We know retailers compete fiercely to create customer loyalty and repeat-purchase behavior to benefit from Customers' Lifetime Value eventually. Factors presented in this research could be used to create a robust differentiation strategy (competitive strategy), and management could put emphasis the same factors when they define or redefine their operational goals and objectives (Operational strategy).

References available upon request from the authors.