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Research Article

Hierarchizing the Product Characteristics of Industrial Plain Sewing Machine for Making Best Purchase Decision

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Thousands of readymade garment industries are available in Bangladesh, where thousands of sewing machines are being used. The productivity of these sewing machines mostly depends on workers but more or less depends on the machine too. Suitable machines should be sourced to increase worker efficiency and production. Purchasing these machines needs some information or criteria ranking for choosing the best or most suitable machine. This study focuses on identifying and prioritizing those characteristics that fulfil the workers' (users') requirements and benefit the industry's overall income. This study intends to investigate the application of the fuzzy Kano model and AHP (analytical hierarchy process) to translate consumer expectations and design into quality products. Customer needs and technical attributes are assessed and prioritized using the AHP. Then, the optional attributes were prioritized by using the Kano model. RMG industries and their purchasing departments can use these prioritized qualities charts to help them choose a sewing machine. Manufacturers of sewing machines can utilize this information to improve their sewing machine qualities, such as if they need to add or remove any attributes that the consumer requires or does not require.

1. Introduction

A sewing machine is a mechanical device that uses thread to sew cloth and other soft materials together. During the first industrial revolution, sewing machines were developed to decrease the amount of manual sewing work done in the apparel industry. Since then, the apparel industry has seen a significant increase in efficiency and output. Bangladesh's readymade garment (RMG) industry contributes significantly to the country's overall economic growth. This industry employs approximately two million people, with women accounting for 80% of those employed [1]. It is also important to keep in mind that the earnings from this industry account for more than 80% of Bangladesh's total foreign exchange earnings [2]. A good sewing machine makes the work easier, safer, and comfortable and is therefore more productive for the workers. A good sewing machine also mitigates the chances of musculoskeletal disorders (MSDs) among workers [3]. Then, how could we choose the "best sewing machine" among all the brands and features? That depends on the industry labors' skill level and budget. Before purchasing a sewing machine, the industry must evaluate its demand and skills, considering how people might use the machine in the future as their abilities or technology improves. Day by day, fast-changing technology in this field and diversified and rapidly growing competition among marketers drive businesses to seek simple, long-term solutions. As a result, optimizing product characteristics within the context of different pricing has become the company's only means towards becoming profitable. That is why industry purchasers need proper guidelines and identification criteria for selecting sewing machines that will be both productive and beneficial to garment workers.

From the perspective of the sewing machine manufacturers, in this competitive market environment, end users require products with lower prices, high quality, and on-time services. In addition, companies should operate based on consumer needs and attitudes. Therefore, they have to reduce their manufacturing costs. To reduce cost, they need to optimize product characteristics by focusing on consumer demands and their level of satisfaction. Prioritization enables a business to concentrate its people and financial resources to provide its customers with the highest quality products. Instead of aimless improvements, targeted efforts are much more aligned to serve maximum value to the customers. For finding the priority of attributes, the question is "how can we then determine what is most important to the customer?" In this case, a multi-criteria decision-making (MCDM) model will help rank the criteria and assist customers in precisely understanding their priorities.

There are several multi-criteria decision-making methods, including AHP (analytic hierarchy process), TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) [4], ELECTRE (Elimination Et Choix Traduisant la Réalité) [5], BWM (Best-Worst Method) [6], DEMATEL (DEcision MAking Trial and Evaluation Laboratory) [7], MAUT (Multiple Attribute Utility Theory) [8], PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluation) [9, 10], GRA (Grey Relational Analysis) [11], and SWARA (Stepwise Weight Assessment Ratio Analysis) [12], which have been developed during the previous two decades and are being used practically in every area throughout the world to make decisions. The most recently developed MCDM method, Basic Uncertain Linguistic Information (IBULI), integrates consistent measures of decision experts that can effectively quantify subjective assessment information provided under uncertainty [13]. In terms of approach, BWM, DEMATEL, and MAUT preference ranking methods are similar to AHP, with a distinction in scale. From an application viewpoint, DEMATEL is ideal for assigning values to influential aspects based on supplied criteria [14]. MAUT employs the utility function, which tries to replace the value associated with a criterion for a decision maker's level of satisfaction. As TOPSIS is based on distance, it necessitates the definition of an ideal alternative, which may not be attainable in this scenario. Methods based primarily on statistical data, such as PROMETHEE and ELECTRE, are utilized for complex tasks. The key advantage of the most advanced AHP conceptualization is that it is easy to implement and allows for hierarchical problem modelling and the ability to make vocal judgments and validate consistency [15]. As a result, the authors are easily persuaded to choose the AHP method over others to achieve the research objectives.

To improve buying decisions' effectiveness, technical and non-technical data, such as customer requirements, must be examined. Rather than market concepts, focusing on potential customers is an excellent technique for identifying their demands. For this purpose, Dr. Kano's two-dimensional quality model is an excellent instrument. Dr. Kano classified quality elements by using functional and dysfunctional questionnaires in an assessment table. This is a fundamental tool for a two-dimensional quality model used in numerous research studies. The Kano model describes the relationship between user satisfaction and the quality of a product or service. Kano's major advantage is identifying customer needs that may be formed as a customer-specified quality. These inquiries will provide new ideas and a wonderful method to meet customer requirements. Kano models can be applied in every discipline of engineering, science, or social science where the perceptions of customers or users are more important for selecting criteria when designing a product. The Kano model is widely used for identifying customer requirements. No other method has been as effective as the Kano model in terms of serving its purpose.

The objective of this study was to determine the hierarchy of plain sewing machine attributes (both core and optional) to make the machine purchase decision optimal. The authors conducted direct interviews, investigations, and analytical techniques to discover customer needs and product requirements. The following section contains a literature review of certain studies undertaken to determine the viability of using AHP and Kano for attribute selection, ranking, and best decision making. To the best of the authors' knowledge, there is no literature that addresses the use of AHP and Kano models for finding, hierarchizing, or developing sewing machine attributes. The authors sought to solve a fairly typical problem (best sewing machine selection) in RMGs using AHP, which the decision maker accepted and appreciated. The AHP method was implemented to hierarchize the core attributes and find their respective weights. The fuzzy Kano model was used to determine and hierarchize the optional sewing machine attributes. Sewing machines are used for the same purpose all over the world. As a result, the findings of this study will be a valuable source of information for both industrialists and manufacturers worldwide. When purchasing sewing machines, the purchaser can observe the hierarchy of product characteristics and customer needs. In contrast, the manufacturer can observe the optional attributes they should focus on or develop machine characteristics for their sewing machines. Following the literature review, the remainder of this paper is organized as follows. The methodology section explains how AHP and the fuzzy Kano model were implemented step by step. The results of using the AHP and fuzzy Kano models to determine the best sewing machine were shown in the results and discussion section, and the implications of the findings were thoroughly discussed. The conclusion section summarizes and explains how the model was completed in light of our achieved goal. Lastly, the authors speculated on the study's limitations and future scopes of research.

2. Literature Review

2.1. Literature Review on AHP Model. The analytic hierarchy process (AHP), a sophisticated computational approach pioneered by Saaty, has been viewed as a major and adaptable modelling tool and has been utilized to solve a wide range of research difficulties [16]. The most significant impact of the AHP method has been in resolving supply chain issues. Over the last four decades, researchers working on a variety of AHP techniques have identified and addressed various complex supply chain problems. The researchers' common interest was solving supplier ranking and selection problems, which led to positive implications.

Tahriri et al. (2008) implemented AHP for best supplier selection in a steel manufacturing company, deciding how to allocate business and determining where development effort should be applied[17]. Marufuzzaman et al. (2009) implemented AHP to solve the supplier selection in an apparel manufacturing farm in Bangladesh [18]. Wang (2009) implemented AHP to select the right supplier of maintenance and repair parts in the industry [19]. Chan and Chan (2010) implemented AHP to solve the supplier selection problem in the apparel industry with a case example [6]. Özkan et al. (2011) implemented AHP for the best supplier selection for computer and printer purchasing for the General Directorate of Land Registry [20]. Rouyendegh and Ekran (2012) implemented AHP for supplier evaluation and a selection for a university procurement department [21]. Agarwal et al. (2014) implemented AHP for supplier evaluation and selection in the baby toy manufacturing industry [22]. Azadi et al. (2014) implemented AHP in a car glass company in Turkey to solve the supplier selection problem [23]. Sharma and Rawani (2016) implemented AHP for the selection of the best supplier in the cement industry in India, considering the relevant Green Corporate Social Responsibility (CSR) and Safety criteria [24]. Yadav and Sharma (2016) implemented AHP with a weight cum rating method for selecting the best supplier in a leading car and truck manufacturer company [25]. Environmental challenges have risen in recent decades, and maintaining environmental sustainability has been a primary priority. Researchers have also looked into this field to uncover the most important ideas that might lead any supply chain system to go "Green." For instance, Govindan et al. (2014) applied AHP to identify barriers to the implementation of green supply chain management (Green SCM) based on procurement effectiveness [26]. Wang et al. (2016) implemented AHP to investigate the pressures for Green Supply Chain Management (GSCM) adoption and to rank the pressures in the mining and mineral industry context [27]. Luthra et al. (2016) implemented AHP to identify and evaluate barriers in implementing a sustainable supply chain with a case example of the Indian plastic industry [28]. Luthra et al. (2013) implemented AHP for ranking of strategies to implement green supply chain management (GSCM) in the Indian manufacturing industry [10]. AHP can also select a third-party logistics (3PL) provider in a coordinated supply chain [29].

In the AHP method, the output is ranked using simple scales developed from pairwise comparisons [30–32]. Therefore, priorities for some complex models can be simply determined by studying their ranks [33], making it the simplest ranking method to apply in all the possible sectors. AHP is a methodologically sound and user-friendly strategy for single choice decision making [34] to multiple choice decision making [35], for performing resource allocation [36], benchmarking [36–38], and quality management [39–41]. The AHP method has been used in various applications to handle the problem of hierarchizing attributes to pick the best service. Many researchers have introduced fuzzy logic into the comparison for this purpose, which provides fuzzy numbers as a pairwise comparison scale. Thousands of studies have been conducted in which a fuzzy model of AHP has been established, inferred, and claimed to be more valid. However, Saaty (2006), the architect of AHP, claimed that the pairwise judgments are sufficiently fuzzy and that the fuzzy technique does not outperform the old one [42]. The 1–9 scale adopted in traditional AHP is not obsolete; each number represents the judgment as important, moderately important, or more important, making the fuzzy approach superfluous [43]. As a result, the authors approached this study by adhering to the traditional AHP method, inspired by its simplicity and wide range of application records in decision making. Table 1 summarizes notable studies from the previous 15 years. These studies have used AHP (without fuzzification) as the primary methodology for determining the optimal solution by hierarchizing key attributes.

The number of attributes used to conform to the criteria comparison matrix in all of this literature (Table 1) was no more than ten (except in 3 out of 27 cases). It should be noted that consistency is determined primarily by the selection of appropriate attributes rather than the number of attributes used (independent of their quantity). The criteria comparison matrix in AHP comprises expert opinions and choices rated on Saaty's scale, which ranges from 1 to 9. All of these viewpoints can be distilled into a single choice based on the ratings of all experts, or the mean of all expert ratings can be used to create a pairwise comparison matrix [18]. Among all the references shown in Table 1, researchers involved experts for criteria comparison from various fields. In 25 out of 27 studies, the number of experts who participated in decision making is less than 20. So, the recommended number of experts for an appropriate outcome should be no more than 20 [57]. Involving more experienced and knowledgeable people in that field could yield impressive results. The comparison matrix should include input from professionals in several sectors, such as purchase, maintenance, academic, research and development professionals, and also other people involved in purchasing.

2.2. Literature Review on Kano Model. There are numerous instances where the Kano model has been successfully implemented. It was used to develop product features by obtaining new ideas from consumers, finding ergonomic standards, finding the best attributes of community cultural products, finding product quality attributes, and so on (Table 2). The Kano model was effectively applied to these engineering options. Surprisingly, the Kano model has also been employed in non-engineering applications to determine user satisfaction. Education, healthcare, and tourism may all be good examples (Table 2). The nature of the users/consumers and the area of use of that specific product or service determine Kano questionnaire sampling. There is no established sampling direction that can ensure the validity of the sample use in the Kano model.

The Kano model with fuzzy approaches has also been widely used to solve different issues. In terms of how the attributes deal with the fuzziness of human ideas, Lee and Huang nicely illustrated the distinctions between the two

Table 1: Literature review on AHP application.

References	Method/tools adapted	Number of criteria compared	Large group scale? (>20)
Chen and Huang [44]	AHP integrated with bi-negotiation agents	4	No
Sevkli et al. [45]	Data envelopment analytic hierarchy process (DEAHP)	6	No
Hsu and Chen [35]	Integrated AHP with modified Delphi method	5	No
Haldar et al. [46]	Integrated AHP with simulated annealing (SA) algorithm and Taguchi robust design method	6	No
[47]	AHP	13	No
[17]	AHP	7	No
[18]	AHP	5	No
[19]	AHP-enhanced GP (goal programming) method	7	No
[20]	AHP	4	No
[21]	AHP	6	No
[22]	AHP	5	No
[26]	AHP	5	No
[23]	AHP combination with structural equation modelling (SEM)	10	Yes
[27]	AHP	4	No
[24]	AHP	5	No
[25]	AHP	6	No
[28]	Combination of AHP and quality function deployment (QFD)	3	No
[48]	AHP	4	No
[29]	Integrated AHP and modified Delphi method	10	No
[49]	AHP	26	Yes
[50]	AHP	3	No
[51]	Integrated AHP and evidential reasoning (ER)	8	No
[52]	AHP	4	No
[53]	AHP	6	Yes
[54]	AHP integrated with weight cum rating method	6	No
[55]	AHP	15	No
[56]	Combined AHP and multi-expression programming method	5	No

types of surveys [72]. The fuzzy domain is concerned with mathematical and statistical approaches, making it more effective in the research. The traditional Kano survey requires individuals to make a single decision about a certain feature, ignoring the individual's uniqueness and uncertainty. When it comes to product design when gaining customer satisfaction is the major goal, a single point of view does not produce the best results. The fuzzy Kano concept encourages people to express themselves in five distinct ways and with five alternative options. For example, survey respondents may select one of five options [72], which include "I like it that way," "It must be that way," "I am neutral," "I can live with it that way," and "I dislike it that way." The survey becomes more reflective of respondents' opinions than the traditional one. Many researchers have addressed the differences between the classical and fuzzy Kano theories, produced new fuzzy concepts, and emphasized the need to incorporate the fuzzy concept into implementation.

Fuzzy Kano approaches were accepted and implemented by researchers in product development [73–75], the manufacturing industry [76], the renewable industry [77], and the supply chain [78], and all researchers agreed that the results of their implementations were more acceptable than those of traditional Kano models. For instance, Jain et al. implemented the fuzzy Kano method to identify customer attributes in an Indian iron and steel plant industry and then incorporated the SWARA method to assign weight and rank them with the Complex Proportional Assessment of Alternatives (COPRAS) method for supplier selection [79]. Jain and Singh used the fuzzy Kano method to identify the "must-be" attributes among 36 criteria and then performed supplier selection using the SWARA and Range of Values (ROV) methods [80]. Kilaparthi and Sambana integrated the Kano model with the VIKOR analysis, where the Kano model provided weightage for the supplier selection attributes, and the VIKOR resolved the uncertainty while selecting the best supplier of a forging firm in India [81]. Kuo et al. developed a supplier hierarchy in the Indonesian palm oil industry by combining the fuzzy AHP and Kano approaches. The Kano model was used to find the most important sustainability criteria, and the AHP model was used to find the weight of each criterion and create a ranking [82]. The Kano model, particularly its fuzzy approach, can also provide an effective solution for managing customer service logistics [83]. Referring these examples, introducing the fuzzy Kano approach to determining optional sewing machine attributes would serve to achieve half of our research's goal.

Customer needs may vary across categories, and today's "must-be" features will become core elements in the future. The Kano model is used for more than just identifying customer needs. It also implies the significance of the characteristics in five distinct categories. The first priority should be to deliver what is expected (must-be needs); the

Table 2: Literature review on Kano model application.

Sector	Reference	Purpose	Fuzziness?	Sample population
Engineering (product design)	Shahin and Shahiverdi [58]	Estimating customer lifetime value for new product development	No	20
	Bilgili et al. [59]	Developed jewelry with tile design and calculated customer satisfaction for new product development	No	102
	Gangurde and Patil [60]	Identifying customer satisfaction through the integrated Kano model and QFD method for new product development for mobile phones	No	225
	Hashim and Dawal [61]	Improving the ergonomics and user needs of adolescent workstation design in a school workshop using an integrated Kano and QFD approach	No	255
	Hwang et al. [62]	Identifying the relationship between user emotional experiences and satisfaction with community culture products, by using the Kano model and Kano's regression method	No	62
	Salahuddin and Lee [63]	Identifying the key quality features of wearable technology embedded products that have the most influence on consumer satisfaction	No	471
Education	Madzík et al. [64]	Identifying student needs and preferences in the field of higher education	No	102
	Arefi et al. [65]	Identifying student requirements for the quality of Master's programs at Tehran's state universities	No	136
	Venkateswarlu et al. [66]	Identifying student's level of satisfaction studying at private Indian private universities	No	193
Healthcare	Gustavsson et al. [67]	Identification of a wide range of patients' needs within a Swedish hospital's children's and women's healthcare department, based on a view of multiple patient roles, as a means to support this new patient perspective	No	113
	Matı´as-Guiu et al. [68]	The Kano methodology was used to assess the expectations of patients receiving symptomatic migraine treatment and the neurologists treating them	No	204
	Huang [69]	Improving mobile healthcare service quality by implementing the Kano model and the IPA (importance performance analysis) method by confirming service quality attributes for priority improvement	No	300
Tourism industry	Yang et al. [70]	Proposes a strategic pricing model for a 5-star hotel in Taiwan that can provide customers with increased value by charging less while maintaining reasonable features	No	115
	Zobnina and Rozhkov [71]	Identifying the factors that influence tourist satisfaction in the context of a Russian hotel	No	1238

second priority should be to deliver what is specified (one-dimensional needs), and the last priority should be to provide attractive needs [84]. Identification of the sewing machine optional attributes using the Kano model will also result in a hierarchy of those identifying attributes, which should be the primary consideration for product developers to seek and focus on.

Every sewing machine has some features in common that are widely used all over the world. However, by adding some optional criteria to these globally launched products, they may be able to satisfy their customers more than before. The Kano model was used in this study to determine which extra or optional features customers expect in current sewing machines and to what extent they do not. To identify optional features, consumers of sewing machines must be interviewed, which cannot be represented through simple yes/no responses. For this purpose, collecting, recording, and calculating information using fuzzy logic should be more feasible.

3. Methodology

3.1. Defining Key Consumers. The relationship between product and service capabilities and consumer or user needs must be examined during the optimization phase. To make these judgments valid, it is critical to define clear and consistent definitions as well as the most important underlying principles addressing the consumer or user. The first step in identifying the key consumer is identifying the sets of all potential customers. Following the identification of many client segments, the second step focuses on the primary clients. Once the user groups have been determined, selecting the consumers could be easier. Sewing machines are available as both home and industrial appliances. However, our priority was on sewing machine industry appliances, where thousands of sewing machines are used in the garment industry. Sewing machine operators and purchasers are the consumers here. For this reason, our primary goal was to interview consumers (workers and supervisors) and purchasers in the RMG industry.

3.2. Identifying Core and Optional Attributes of the Sewing Machine. Weber et al. examined 74 articles on supplier selection from 1966 to 1990 and identified 23 common attributes used as vendor selection criteria in those studies [85]. Quality, delivery, performance, warranty, capacity, and price were the most important selection criteria among all 23 attributes. In this study, the sewing machine characteristics were separated into two categories. These are (i) core attributes and (ii) optional attributes. The core characteristics are common among sewing machines of all brands and types. The core attribute data mainly consisted of technical information such as motor speed, warranty period, expenses, noise level, efficiency, and so on. An industrial visit was undertaken to a reputed readymade garment industry in Gazipur, Bangladesh. It is a woven cloth manufacturing industry that produces both tops and bottoms. The purpose of the industrial visit was to learn about the core and optional attributes of sewing machines and their use and expectations in the industry. The best way to obtain this information is to interview technical personnel involved with these machines, such as those in maintenance, industrial engineering, and procurement team, who directly purchase or assist in purchasing and preserving technical data. A team of eight industrial engineers, one procurement officer, and two maintenance managers was formed to collect core attribute data and get comparable information to establish a pairwise comparison matrix. The authors discovered some core attributes from discussion with the experts by analyzing machine designs, drawings, and functioning. Some attributes were added that are not connected to machine performance but are crucial variables to consider when purchasing, such as warranty period, pricing, and durability. Ten sewing machine core qualities were identified in five categories, as indicated in Figure 1. Almost all articles analyzed consider "delivery" as one of the most crucial selection criteria. This paper solely discusses hierarchizing machine attributes, not vendor selection. When it comes to supplier selection, "delivery" could be a critical consideration.

The optional attributes are those that people wish to have to help them with their current machines. Another discussion with experts was conducted to evaluate which unique characteristics of sewing machines they desired to have in order to increase user satisfaction. As the Kano method implies, sewing machine users (operators and supervisors) were surveyed to determine the optimal strategy for collecting optional attributes. Before conducting the survey, verbal consent was obtained from the factory's operations head. To collect the satisfaction level of users, 150 sewing machine operators and 30 supervisors were randomly selected for the survey from a total of approximately 4000 workers and 78 supervisors in that industry.

3.3. Implementing AHP for Ranking the Core Attributes. The authors employed the extraction method to determine the maximal eigenvalue/eigenvector and judgment matrix in AHP. Applying AHP for ranking core attributes, the following steps and equations were followed.

(i) The first step in implementing AHP is to create the numerical pairwise comparison matrix. Saaty proposed evaluating or comparing the various criteria on a scale of 1–9 [16] (Table 3).

The scales were used to rate the comparative importance. Construct a pairwise comparison matrix where weights are given based on comparative importance of the given criteria. In this matrix,

$$aij = \frac{1}{a_{ji}}, \tag{1}$$

where a_{ij} is the element of i^{th} row and j^{th} column of the comparison matrix.

(ii) After getting the comparison matrix to calculate the n^{th} root $\overline{Wi}$ of the products of elements for each row of the comparison matrix,

$$\overline{Wi} = \sqrt[n]{\prod_{i=1}^{n} aij\,(\text{where}, i = 1, 2, 3, \ldots\ldots, n;\ j = 1, 2, 3, \ldots\ldots m)}. \tag{2}$$

(iii) Calculate the eigenvector for each row:

$$wi = \frac{\overline{Wi}}{\sum_{i=1}^{n} \overline{Wi}}. \tag{3}$$

It is also the weight vector for the AHP priority matrix evaluation.

We now have the proper attribute hierarchy. However, another important aspect of developing AHP is guaranteeing its consistency. The following steps should be followed to verify that the decisions in the pairwise comparison are consistent:

(i) Multiply the complete comparison matrix [Aij] by the eigenvector column to get the Row matrix:

$$\text{Row matrix} = [Aij] \otimes [Wij]]. \tag{4}$$

(ii) Calculate the lambda value (λ) for each row by diving the Row matrix value by diving its respective eigenvector:

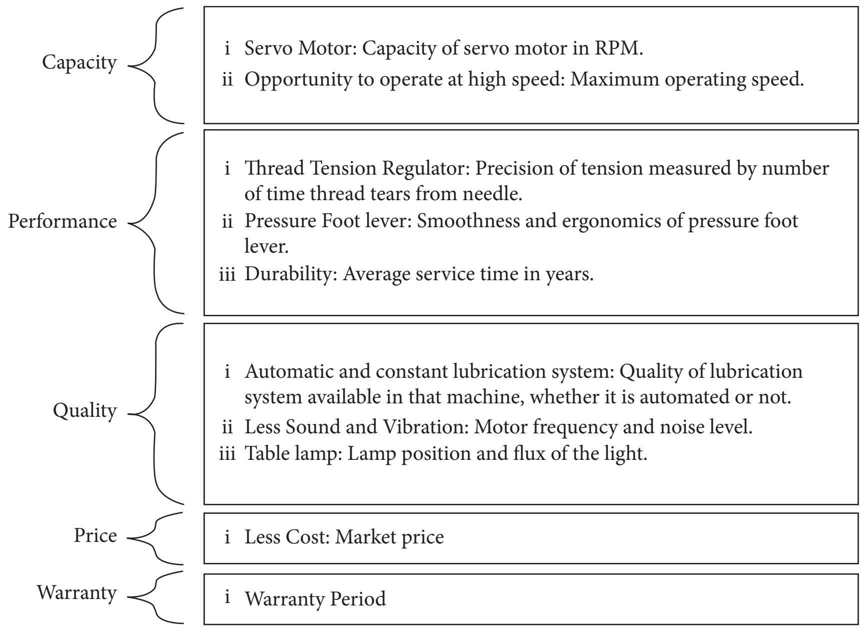

Figure 1: Criteria and subcriteria of core attributes.

Table 3: Scale of relative importance.

Numerical value	Level of importance
1	Equal importance
2	Less importance
3	Moderate importance
4	Higher importance than moderate
5	Strong importance
6	More strong importance
7	Very strong importance
8	Very, very strong importance
9	Extreme importance

$$\lambda = \frac{\text{Row matrix value of a row}}{Wi}. \tag{5}$$

(iii) Now calculate the maximal eigenvalue of the comparison matrix by

$$\lambda_{\max} = \frac{\sum_{i=1}^{n}(\lambda)}{n}. \tag{6}$$

(iv) Then, the following equation can be used to get the Consistency Ratio (CR):

$$\text{CR} = \frac{\text{CI}}{\text{RI}}. \tag{7}$$

Here, CI denotes Consistency Index= $\lambda\,\max - n/n - 1$, where $n =$ no. of criteria; and RI stands for the Random Index, and it can be found in Table 4.

If the calculated Consistency Ratio (CR) ≤ 0.1, then the criteria matrix is within the consistency limit.

3.4. Using the Kano Model to Optimize the Optional Attributes. On the x-axis, Figure 2 shows the Kano model's quality element. The quality element is offered more to the right as the arrow moves to the right, and the quality element is offered less to the left as the arrow moves to the left. The y-axis shows the consumer's level of product satisfaction. Customers are satisfied when the arrow is pointing upward; when it is pointing downward, customers are dissatisfied. As a result, the following quality attributes can be classified as "Kano customer need attributes." The Kano model segregates the attributes of a product or service into five separate categories. The five categories of Kano's quality attributes are as follows:

(i) Attractive quality feature (A): customers are satisfied if this feature is available in sufficient quantity. Even if there are not enough of them, it is still acceptable.

(ii) One-dimensional quality attribute (O): customers are satisfied if it is in sufficient quantities. However, an insufficient aspect reduces its acceptability.

(iii) Must-have quality attribute (M): consumers are satisfied when this attribute is fully present. Inadequate offerings will result in increased dissatisfaction.

(iv) Indifferent quality attribute (I): regardless of whether it is sufficient or insufficient, this element will not result in contentment.

(v) Reverse quality attribute (R): dissatisfaction occurs when lacking, while Satisfaction is reversed when enough.

As part of the initial phase, the actual users of this machine were surveyed. The survey generated a few optional attributes. The objective and purpose of this research were communicated to the participants before the commencement of the survey so that they could relate to the research purpose and confidently deliver their responses. A Kano

Table 4: Value of RI for given no. of criteria [86].

n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0.00	0.00	0.58	0.9	1.12	1.24	1.32	1.41	1.46	1.49	1.51	1.53	1.55	1.57	1.58

Note: If the calculated Critical Ratio (CR) ≤ 0.1, then the criteria matrix is within the consistency limit.

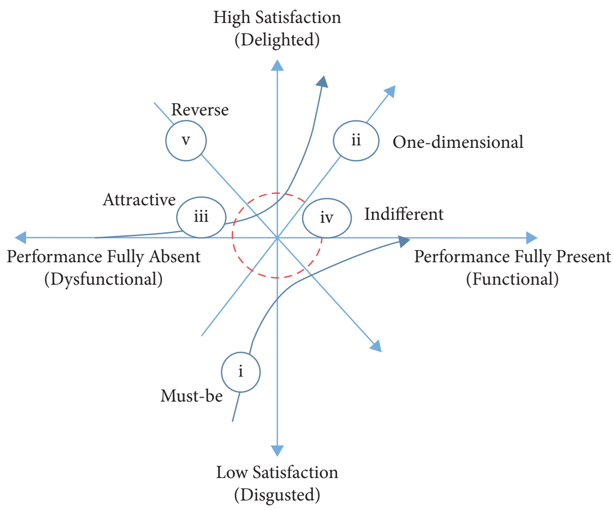

Figure 2: Customer satisfaction and product attribute relationship (adapted from Ullah and Tamaki [87]).

questionnaire (Table5) was prepared and provided to the participants for data collection. The authors prepared a training session to help workers understand the terms, writing, and form-filling method. The entire document was translated into Bengali for the workers' benefit. In collaboration with the industrial engineering team, the authors directed all participants to provide ratings based on their experiences and perceptions. A total of 180 employees (150 machine operators and 30 supervisors) were randomly chosen for data collection and were provided a data collection form (Table 5). A total of 102 forms were received from respondents (response rate of 68%), all of which were fully completed and readable. After getting all of the data forms from the participants, the authors used the method developed by Lee and Huang [72], which is explained below.

Let us define two universal set of positive and negative responses U and V. $P = \{P1, P2, \ldots, Pp\}$ and $N = \{N1, N2, \ldots, Nn\}$ represents the sets of p and n linguistic variables on U and V, respectively, which together construct a $p \times n$ matrix of a two-dimensional quality model, and Fuzzy Sample {FSk, $k = 1, 2, \ldots, r$} is random fuzzy sample on U and V.

We assign linguistic variables P_i and $N_j$to normalized membership $m\ (P)_{ki}$ ($\sum_{i=1}^{p} m(P)_{ki} = 1$ and $m\ (N)_{kj}$ ($\sum_{j=1}^{n} m(N)_{kj} = 1$, and let $S_{ij} = \sum_{k=1}^{r} m(P)_{ki} \otimes m(N)_{kj}$ and T_h be the sum of S_{xy} which (x, y) cell corresponds to the h^{th} attribute in the evaluation matrix for each sample $FS_{k.}$

The fuzzy Kano's mode (FKM) of this quality element is the largest value of $\{T_h\}_{\alpha,}$ which is in the range of α significant classification level. The dataset is referred to as multi-fuzzy mode if more than two sets of Kano's fuzzy quality attribute categorization have the same value of T_h. A final score of equal indicates that $M > O > A > I$ which has the most impact on the product [72].

3.5. Implementation of AHP and Fuzzy Kano Model

3.5.1. Implementing AHP for Hierarchizing Core Attributes. An expert team, comprising eight industrial engineers, one procurement officer, and two maintenance managers, was formed to provide comparative information on the attributes when assessing for the creation of a pairwise comparison matrix. Table 3 shows the ratings based on the priority after the ranking. Table 6 shows the criteria comparison matrix for all of the attributes, along with their ratings. These ratings were determined by experts agreeing on a single judgment that one measure is more or less essential than another. For example, when comparing machine durability with cost, the attribute "machine durability" was given more importance and rated five since experts believe that cost should not be given higher priority at the expense of machine durability. The cost function was graded in inverse to that rating, which became 0.2 (1/5).

The first and most crucial stage was accomplished, and the next step was to determine the n^{th} root and related eigenvector weights, which will determine the importance hierarchy of these attributes. The n^{th} root value and eigenvector weights were determined using the formulae stated in the methodology section (Table 7).

The attribute hierarchy is obtained. A step-by-step procedure detailed in the Methodology section was used to check the consistency. The decision matrix's consistency was tested by calculating the Consistency Ratio (CR) (Table 8). The Row matrix was first obtained by multiplying the comparison matrix by the eigenvector column. The Row matrix was computed using the Excel function "MMULT." The Lambda Value (λ) for each row was computed by dividing the Row matrix by the eigenvector for that row. By averaging all of the Lambda values, the Lambda Average (λ_{max}) was calculated to be 10.89. The Consistency Index (CI) was then obtained, and the Consistency Ratio (CR) was found by using the Random Index (RI) value of 1.49 from Table 4. Then, the Consistency Index (CI) was calculated:

$$CI = \frac{10.89 - 10}{10 - 1} = 0.0989; n = \text{no. of criteria} = 10. \quad (8)$$

For calculating the Consistency Ratio (CR), the value of Random Index (RI) was found to be 1.49 (Table 4).

$$\text{CR} = \frac{\text{CI}}{\text{RI}} = \frac{0.0989}{1.49} = 0.066. \quad (9)$$

According to Saaty if the calculated Consistency Ratio (CR) < 0.1, then the comparisons are valid in the consistent limit. We may now specify the hierarchy of a sewing machine's core attributes based on their weights (eigenvector) as our obtained CR is 0.066, less than 0.1 [16].

The hierarchy is shown below (top most attributes rank higher):

Table 5: The Kano questionnaire form.

Attributes		Type of answer				
		Like	Must-be	Neutral	Live-with	Dislike
Wiper facility	Functional answer					
	Dysfunctional answer					
Under thread trimmer facility	Functional answer					
	Dysfunctional answer					
Folder attachment	Functional answer					
	Dysfunctional answer					
Automatic needle feed	Functional answer					
	Dysfunctional answer					
Programmable	Functional answer					
	Dysfunctional answer					
Knee lever facility	Functional answer					
	Dysfunctional answer					
Button powering system	Functional answer					
	Dysfunctional answer					
Measuring scale along with the table	Functional answer					
	Dysfunctional answer					
Convenient drawer for storing sewing accessories	Functional answer					
	Dysfunctional answer					

Table 6: AHP criteria comparison matrix.

	Table lamp	Durability	Less cost	Less noise	Maximum speed	Warranty period	Automatic and constant lubrication system	Flexibility of pressure foot lever	Thread tension regulator	Separate servo motor
Table lamp	**1.00**	0.33	0.20	0.33	0.20	1.00	0.11	0.20	0.20	0.11
Durability	3.00	**1.00**	5.00	1.00	0.33	3.00	0.20	0.14	0.20	0.20
Less cost	5.00	0.20	**1.00**	1.00	0.11	1.00	0.20	0.14	0.20	0.14
Less noise	3.00	1.00	1.00	**1.00**	0.25	3.00	0.33	0.20	0.33	0.14
Maximum speed	5.00	3.00	9.00	4.00	**1.00**	7.00	1.00	0.33	0.20	0.20
Warranty period	1.00	0.33	1.00	0.33	0.14	**1.00**	0.14	0.11	0.14	0.11
Autonomous and constant lubrication system	5.00	5.00	5.00	3.00	1.00	7.00	**1.00**	1.00	1.00	0.33
Flexibility of pressure foot lever	5.00	7.00	7.00	5.00	3.00	9.00	1.00	**1.00**	1.00	1.00
Thread tension regulator	5.00	5.00	5.00	3.00	5.00	7.00	1.00	1.00	**1.00**	1.00
Separate servo motor	9.00	5.00	7.00	7.00	5.00	7.00	3.00	1.00	1.00	**1.00**
Column sum	**42.00**	**27.86**	**41.20**	**25.66**	**16.03**	**46.00**	**7.98**	**5.12**	**5.27**	**4.23**

(i) Separate servo motor
(ii) Flexibility of pressure foot lever
(iii) Thread tension regulator
(iv) Automatic and constant lubrication system
(v) Maximum speed
(vi) Durability
(vii) Less noise
(viii) Less cost
(ix) Table lamp and warranty period

3.5.2. Using the Fuzzy Kano Model to Hierarchize Optional Attributes. Following a thorough discussion and brainstorming session with the experts, 9 attributes were identified that could add value to working with the sewing machine by increasing its efficiency, making any task easier, eliminating extra time for searching or any unnecessary motion, or adding any ergonomic feature that is required for worker safety. The following are the nine optional attributes:

(i) Wiper facility
(ii) Under machine thread trimmer facility

Table 7: Hierarchy matrix with relative weight (eigenvector).

	Table lamp	Durability	Less cost	Less noise	Maximum speed	Warranty period	Automatic and constant lubrication system	Flexibility of pressure foot lever	Thread tension regulator	Separate servo motor	nth root value	Eigenvector
Table lamp	**1.00**	0.33	0.20	0.33	0.20	1.00	0.11	0.20	0.20	0.11	0.27	0.02
Durability	3.00	**1.00**	5.00	1.00	0.33	3.00	0.20	0.14	0.20	0.20	0.66	0.05
Less cost	5.00	0.20	**1.00**	1.00	0.11	1.00	0.20	0.14	0.20	0.14	0.39	0.03
Less noise	3.00	1.00	1.00	**1.00**	0.25	3.00	0.33	0.20	0.33	0.14	0.61	0.04
Maximum speed	5.00	3.00	9.00	4.00	**1.00**	7.00	1.00	0.33	0.20	0.20	1.48	0.10
Warranty period	1.00	0.33	1.00	0.33	0.14	**1.00**	0.14	0.11	0.14	0.11	0.29	0.02
Autonomous and constant lubrication system	5.00	5.00	5.00	3.00	1.00	7.00	**1.00**	1.00	1.00	0.33	1.97	0.14
Flexibility of pressure foot lever	5.00	7.00	7.00	5.00	3.00	9.00	1.00	**1.00**	1.00	1.00	2.83	0.20
Thread tension regulator	5.00	5.00	5.00	3.00	5.00	7.00	1.00	1.00	**1.00**	1.00	2.58	0.18
Separate servo motor	9.00	5.00	7.00	7.00	5.00	7.00	3.00	1.00	1.00	**1.00**	3.44	0.24
Column sum	**42.00**	**27.86**	**41.20**	**25.66**	**16.03**	**46.00**	**7.98**	**5.12**	**5.27**	**4.23**	**14.52**	

Table 8: Consistency calculation.

	nth root value	Eigenvector	Row matrix	Lambda value (λ)	Consistency Index (CI)	Consistency Ratio (CR)
Table lamp	0.27	0.02	0.21	11.19		
Durability	0.66	0.05	0.51	11.12		
Less cost	0.39	0.03	0.33	12.04		
Less noise	0.61	0.04	0.43	10.29		
Maximum speed	1.48	0.10	1.16	11.42		
Warranty period	0.29	0.02	0.20	10.16		
Automatic and constant lubrication system	1.97	0.14	1.41	10.40	0.0989	0.066
Flexibility of pressure foot lever	2.83	0.20	2.04	10.46		
Thread tension regulator	2.58	0.18	1.97	11.11		
Separate servo motor	3.44	0.24	2.54	10.73		
Column sum	14.52	Lambda average (λmax) =		10.89		

(iii) Folder attachment

(iv) Automatic needle feed

(v) Programmable

(vi) Knee lever facility

(vii) Button powering system

(viii) Measuring scale along with the table

(ix) Convenient drawer for storing sewing accessories

All sewing machines do not share these attributes. Based on identifying all optional attributes, the next step was to determine the level of satisfaction the worker would feel while working with this machine. The questionnaire form (Table 5) was circulated and collected from participants, and the results were recorded on separate Excel sheets for each attribute. Each attribute was calculated separately. The calculation of identifying the degree of worker satisfaction for the attribute "wiper facility" is shown in this article as a sample calculation, and the detailed calculation of other attributes was not shown because the formula and calculations for each attribute are the same. Table 9 shows the aggregated data sheet comprising the percentage responses for the attribute "wiper facility" from 10 participants out of 102. The calculation for other attributes was the same. That is why the authors only showed the calculation for the first attribute, "wiper facility," instead of presenting the calculation for the other eight attributes in this article.

For participant 1, the sets of linguistic variables of positive and negative answers are

$mP = \{0.6,0,0.4,0,0\}$

$mN = \{0,0,1,0,0\}$

Multiplying m$P'\otimes$mN, we get a 5×5 two-dimensional fuzzy correlation matrix which is as follows:

$$S = \begin{bmatrix} 0 & 0 & 0.6 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0.4 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}. \quad (10)$$

After S is obtained, it contains a 5×5 matrix which is then compared with the two-dimensional attribute classification 5×5 table based on the Matzler and Hinterhuber [88] model, as shown in Table 10.

When matrix S and Table 10 are compared, it is possible to deduce that participant 1 has 0.60 of the attractive quality attributes and 0.4 of the indifferent quality attributes. The summary of the satisfaction level for all 102 respondents was calculated using the same approach. Table 11 shows the satisfaction percentages for the 10 participants out of 102.

The α-cut common consensus standard notion is utilized to obtain $\{T_h\}_\alpha$ to find a more accepting and suitable category. The cutoff value of $\alpha \geq 0.4$ was used. When the quality attribute level is equal to or greater than α, "1" will be displayed; when it is less than α, "0" will be displayed in their perspective values depicted in Table 12.

The "wiper facility" quality attribute for the first responder can be divided into two categories: attractive and indifferent (Table 12). In a bigger context, the sum of responses for each column (attribute) can be identified as the highest level of satisfaction that the consumer seeks. Table 12 shows that while the attribute wiper facility was classified as attractive 22 times, the majority (frequency 38) of the responses were in favour of its optional use. The requirement for all quality attributes will be obtained by repeating the above processes for estimating the satisfaction level, as indicated in Table 13.

4. Discussion

Two of the most critical components of an AHP application are a clearly stated purpose and a set of criteria and alternatives [20]. According to Cheng and li, AHP has two key applications: first, it is used to create a decision-making matrix by weighting and comparing a set of traits to the alternatives; second, it is used to decide from several options [33]. The generation of comparison matrices is critical in AHP applications. Managers from different departments have different perspectives on the same issue based on the focus of their areas. When the whole weight of their decisions is added together, it is not easy to anticipate when the overall weight will stabilize. In this instance, decision makers

Table 9: Answers for fuzzy Kano questionnaire for the attribute "wiper facility."

Participant number	Two-dimensional answers	Fuzzy Kano questionnaire categories				
		Like (%)	Must-be (%)	Neutral (%)	Live-with (%)	Dislike (%)
1	Functional	60		40		
	Dysfunctional			100		
2	Functional		100			
	Dysfunctional					100
3	Functional	50	50			
	Dysfunctional					100
4	Functional	50		50		
	Dysfunctional	33.33		33.33	33.33	
5	Functional	80	20			
	Dysfunctional			50		50
6	Functional	100				
	Dysfunctional			50	50	
7	Functional	100				
	Dysfunctional				20	80
8	Functional	100				
	Dysfunctional			50	50	
9	Functional	80	20			
	Dysfunctional			100		
10	Functional	60		40		
	Dysfunctional			100		
	Dysfunctional					100

Table 10: Kano's evaluation table (sourced by Matzler and Hinterhuber [88]).

Functional	Dysfunctional				
	Like	Must-be	Neutral	Live-with	Dislike
Like	Q	A	A	A	O
Must-be	R	I	I	I	M
Neutral	R	I	I	I	M
Live-with	R	I	I	I	M
Dislike	R	R	R	R	Q

Table 11: Summary of identified customer satisfaction level.

Participant number	Responses					
	M	O	A	I	R	Q
1	0	0	0.6	0.4	0	0
2	1	0	0	0	0	0
3	0.5	0.5	0	0	0	0
4	0	0	0.333	0.333	0.167	0.167
5	0.1	0.4	0.4	0.1	0	0
6	0	0	1	0	0	0
7	0	0.8	0.2	0	0	0
8	0	0	1	0	0	0
9	0	0	0.8	0.2	0	0
10	0.125	0.375	0.375	0.125	0	0

who are directly or indirectly involved in purchase decisions must be particularly relevant. The minimum sample size for a reasonably acceptable analysis is 30, and for AHP, it is likely to be considerably lower [25]. Having many experts undertake the comparison adds greater value [25]. However, the greater the number of experts is, the more difficult the decision is to make. A team of eight industrial engineers, one procurement officer, and two maintenance managers

Table 12: Frequency of the satisfaction level for all participants.

Participant number	Responses					
	M	O	A	I	R	Q
1	0	0	1	1	0	0
2	1	0	0	0	0	0
3	1	1	0	0	0	0
4	0	0	0	0	0	0
5	0	1	1	0	0	0
6	0	0	1	0	0	0
7	0	1	0	0	0	0
8	0	0	1	0	0	0
9	0	0	1	0	0	0
10	0	0	0	0	0	0
Sum of frequency of 102 participants	14	38	22	2	21	1

Table 13: Frequency of all attributes' user satisfaction level.

Attributes	Frequency of user identified satisfaction level					
	M	O	A	I	R	Q
Wiper facility	14	38	22	2	21	1
Under thread trimmer facility	51	19	23	4	16	0
Folder attachment	30	33	39	11	4	0
Automatic needle feed	18	9	31	12	24	3
Programmable	7	36	19	29	36	0
Knee lever facility	23	44	35	6	13	2
Button powering system	48	13	36	34	2	0
Measuring scale along with the table	23	28	26	9	19	0
Convenient drawer for storing sewing accessories	4	12	37	24	18	0

The higher the frequency in a category is, the more likely the attributes will meet that user satisfaction level.

developed the decision matrix. Industrial engineers provided data on the efficiency, durability, and performance of the machines utilized in production. Procurement officers gave pricing and warranty information, while the maintenance manager offered information on the machine's design, ergonomics, and the lubrication system available with the machines under consideration. To make their decisions in this study, the authors relied on real data and the purchase experience of the decision makers. Several research studies aggregated expert evaluations by taking the geometric mean of the experts' individual ratings [18].

The major goal of this study was to weigh and rate the various sewing machine attributes to make the best machine choice possible. The first stage in implementing AHP is identifying and ranking the major and subcriteria relevant to the decision problem. The criteria comparison matrix, created based on the expert's viewpoint, was used to hierarchize the 10 core attributes under five groups. The criteria comparison matrix's consistency was determined to be feasible (Table 8), and the matrix's rankings were assessed to be acceptable. The AHP implementation outcomes show that the attribute "separate servo motor" was given the highest weighting (eigenvector of 0.24), indicating that it should be the most significant. In contrast, the criteria "warranty period" and "table lamp" were given the lowest priority (eigenvector of 0.02) (Table 7). Pairwise comparisons of these ten attributes were also performed. The pairwise comparison matrix established here is the result of expert decisions. When creating the comparison matrix, 45 direct and 45 reverse decisions were made. These choices were consistent throughout all comparisons, making the final judgment more accurate (Table 8). There is a wide range of plain sewing machines with varying features and pricing available on the market. When a purchaser intends to purchase a machine, he should first confirm the machine's core attributes. To the client, the hierarchy created by applying AHP should be referred to as a priority list. He can prioritize which machine properties should be prioritized first and which should be prioritized later. For instance, suppose the purchaser has two goals to achieve: he wants to acquire a sewing machine that is both durable and inexpensive. Because the machine's durability is ranked higher than its cost, he can make a priority decision by purchasing the more durable machine while sacrificing a bit of cost, by making a simulation decision.

The second portion of this study is concerned with categorizing the optional sewing machine features that the user desired. Some automated sewing machines allow all the operations to be programmed, although most machines do not. Some sewing machines have measurement scales attached to the machine bed, while others do not. A discussion with experts was held again to determine which unique characteristics offered in a sewing machine satisfied the users' desires to have them in all of the machines they want to purchase. This is how these attributes were discovered to determine the extent to which these features satisfy the users. It also answers whether all sewing machines should have these functions. Then, they must decide which features should be prioritized for product development. According to the hierarchy decision made by implementing the Kano model in this research, the "thread trimmer facility" and the "machine's button powering mechanism" are the 2 most important attributes that most users look for as "must-be" attributes (Table 13), which means that users no longer want these two attributes to be optional, but rather a "must-be" included feature in the sewing machines. The absence of either of these two features in a machine will result in user dissatisfaction. The four facilities or attributes such as "wiper facility," "programmable machine feature," "knee lever," and "measuring tape" as attachments with the machine were mostly found to be one-dimensional attributes, which means that providing these facilities with the machines will result in higher satisfaction and avoiding them may result in lower satisfaction. The attractive attributes found were "folder attachment," "automatic need feed facility," and "drawer facility" for storing sewing equipment, which can produce higher user satisfaction. Still, in the case of higher costing decisions, these can be denied without generating dissatisfaction for the user. If a supplier wants to satisfy more clients and expand their target market, they should concentrate on these attributes from the Kano model.

The weighting technique for the comparison matrix is based on a range of criteria, including personal experience, expertise, linguistic facts, and a judge's subjective assessment [89]. The experts likely have a bias or inclination towards their previously observed decision. That is why it is critical to check the matrix's consistency. The consistency of the criteria comparison matrix is dependent on the interviewers' ability to derive the optimal decision from the responses they obtain from those being interviewed. All the people who made decisions were part of the brainstorming process, not just the author. The author asked them if their conclusion aligned with what the authors had obtained. Chen et al. addressed two major challenges in adopting MAGDM (multi-criteria group decision making): the first is the information loss all through the decision-making process, and the second is how to scientifically incorporate decision makers' perspectives into the MAGDM [90]. The authors involved experts from various fields to create the decision matrix, allowing them to view the problem from multiple perspectives and contribute their diverse attitudes to make it more accurate. In this study, the authors formed a team of 11 experts from three different departments who are directly or indirectly related to the purchase of these machines (such as the procurement department) and their functionality (such as the industrial engineering and maintenance departments), which primarily eradicates the first issue of information loss. The authors attempted to aggregate all decisions made by all decision makers into a single decision to assign a single priority ranking through negotiation and discussion among themselves, which alleviated some of the challenges associated with adopting an irrelative perspective.

However, some aspects could be improved. When AHP is integrated with other methods deployed in the upstream or downstream parts of AHP for the same objective, it can provide excellent support to users (Table 1). Users can use AHP ranking matrix inputs by the DEA (data envelopment analysis) method to make it more efficient in application

[45]. Through focusing on individual observations, linear programming can also be utilized to maximize the performance of individual observations [45]. The modified Delphi approach can also serve the same purpose [35]. The software can be developed to determine the most suitable alternative as well as to simplify iterations. In addition to building the comparison matrix and determining eigenvalues, the expert choice software can run a sensitivity analysis to see how the alternatives vary as the criterion's importance varies [54]. Quality function deployment (QFD) is a well-known tool for converting customer requirements (CRs) into engineering characteristics (ECs). QFD can be applied to the extracted customer attributes to uncover the voice of the customer whose supplier's attributes significantly impact attaining the defined objectives [91]. Since both the AHP and the Kano Model involve linguistic words, addressing some fuzzy linguistic term sets will examine the experts' complex language expressions to portray their emotions [92] appropriately. According to Chen et al. two major issues may arise when experts attempt to employ the language assessment paradigm [92]. The first is that the experts' opinions may be dubious. They may occasionally provide multiple linguistic terms to demonstrate their hesitancy during evaluation rather than just one linguistic term to indicate their preferences. The second point is that when solving the MCDM problem, the process of creating decision matrices should be done in a single decision-making stage. However, in most circumstances, it is not practised or recognized.

This research might guide machine manufacturers and suppliers to find the best possible solution to satisfy their customers and users. Customers' perceptions and expectations fluctuate over the time. What users think now could be better product development advice to manufacturers and suppliers. This research may provide improved messages or suggestions to sewing machine manufacturers in this manner. Another issue with purchasing is that the process becomes more complicated when there are multiple decision makers. The purchasing process should be made as simple as possible. The decision to buy the best sewing machine is no longer difficult. It is now based on simple metrics and rankings that are easy to understand and do not require the buyer to be very technical.

5. Conclusion

Several strategies have been used to solve the supplier selection problem. It is now widely accepted that price alone should not be the primary consideration when making a purchase; other factors impact product performance more than price. When choosing a supplier, both customer and engineering factors are considered. AHP is perhaps the first method for resolving the supplier selection problem and making the optimal purchasing decision. It is well known for its simplicity of use and wide range of applications. The AHP technique is founded on three basic principles: model structure, alternative comparison, and priority setting. This research begins by determining the core characteristics of a sewing machine, which are then prioritized using the AHP method. Using the AHP and fuzzy Kano models, two categories of product attributes, core and optional, were discovered and hierarchized. The core attributes were hierarchized using AHP. The consistency approach was used to assess the consistency of the AHP process and the output result.

The Kano model was used to identify if users expected more features from the sewing machines they intended to buy. Thousands of sewing machines are used across the readymade garment industries of Bangladesh. After infrastructure, most of an RMG manufacturing company's investment is earmarked for purchasing sewing machines. To purchase these machines, they must first determine which machine will serve them best and be the most productive. They require some hierarchy or purchasing criteria. Before purchasing sewing machines, buyers can study the product characteristics and hierarchy of user needs. The manufacturer can see the optional features that need to be prioritized or developed as machine characteristics for their sewing machine. Purchasers and users will profit from making the best purchase decisions, and manufacturers will benefit from product development insights from this research. This research will also contribute to creating a competitive sewing machine market by providing numerous features at a lower cost and analyzing those aspects. That is how the primary objectives of this research were met by benefiting both suppliers and manufacturers.

6. Limitations and Future Scopes of This Study

There are always some risks associated with multi-criteria decision making, especially when multiple experts' viewpoints are involved. Both the AHP and Kano models require expert input in creating a decision matrix and user satisfaction scores. Since numerous elements might influence a decision maker's behavior towards a product or service, in future studies, some risk factor calculation methods could be integrated with both methods to improve the accuracy of the results. Researchers may contact purchasers from various industries in different areas to see if our study's rating differs from theirs. Following the Kano model implementation procedures, questionnaires must be prepared and instructed for them to be filled out completely and accurately to gain the maximum possible benefits and outcomes. More optional attributes could be found if the sample size and demography were increased. In future research, the authors may look into any system that ranks suppliers based on how they want them to be ranked.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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