JURNAL IPTEK
MEDIA KOMUNIKASI TEKNOLOGI
homepage URL : ejurnal.itats.ac.id/index.php/iptek

Integrating the CARTER and KANO Models to Enhance Customer Satisfaction

Marnoto[1], Lukmandono[2]*

Master of Industrial Engineering, Adhi Tama Institute of Technology, Surabaya

ARTICLE INFORMATION

Jurnal IPTEK – Volume 29
Number 2, December 2025

Page:
167 – 178
Date of issue:
December 30, 2025

DOI:
10.31284/j.iptek.2025.v29i2.7999

E-MAIL

otonram@gmail.com
lukmandono@itats.ac.id

**Corresponding author:*
Lukmandono
lukmandono@itats.ac.id

PUBLISHER

LPPM- Adhi Tama Institute of Technology Surabaya
Address:
Jl. Arief Rachman Hakim No. 100, Surabaya 60117, Tel/Fax: 031-5997244

ABSTRACT

This research is motivated by the importance of improving customer satisfaction, a key to business success, particularly for wood pellet products. The study aims to integrate the CARTER and Kano methods to identify service and product attributes affecting customer satisfaction and assist in determining effective improvement priorities. A quantitative research method was used to collect data through questionnaires. The CARTER method assesses customer satisfaction dimensions such as compliance, assurance, reliability, tangibles, empathy, and responsiveness, while the Kano method classifies service and product attributes into must-be, one-dimensional, and attractive categories. The results show that integrating these two methods allows for effective categorization of attributes, enabling the company to focus on improving product and service quality. Fulfilling basic needs is crucial to avoid dissatisfaction, while performance and attractive needs contribute to higher customer satisfaction. The empathy and responsiveness aspects of service also significantly influence positive customer perceptions. Through the comprehensive and practical framework resulting from the integration of the CARTER and Kano methods, companies can enhance customer satisfaction sustainably while maintaining competitiveness in the wood pellet market.

Keywords: *customer decision; wood pellets; CARTER method; Kano method; service quality*

ABSTRAK

Penelitian ini dilatarbelakangi oleh pentingnya peningkatan kepuasan pelanggan yang merupakan salah satu kunci keberhasilan bisnis, khususnya untuk produk wood pellet. Tujuan dari penelitian ini adalah untuk mengintegrasikan metode CARTER dan Kano agar atribut layanan dan produk yang berpengaruh terhadap kepuasan pelanggan dapat diidentifikasi, untuk membantu dalam penentuan prioritas perbaikan yang efektif. Metode penelitian kuantitatif digunakan untuk mengumpulkan data melalui kuesioner. Dimensi kepuasan pelanggan melalui metode CARTER menggunakan compliance, assurance, reliability, tangibles, empathy, dan responsiveness, sedangkan pengelompokan atribut layanan dan produk ke dalam kategori must-be, one-dimensional, dan atractice dilakukan dengan metode Kano. Hasil penelitian menunjukkan bahwa melalui integrasi kedua metode tersebut pengkategorian atribut dapat dilakukan secara efektif, sehingga perusahaan dapat lebih fokus dalam melakukan peningkatan kualitas layanan dan produk. Pemenuhan kebutuhan dasar ditemukan sangat krusial untuk menghindari ketidakpuasan, sedangkan kebutuhan kinerja dan kebutuhan pemikat memberikan kontribusi terhadap peningkatan kepuasan pelanggan yang lebih tinggi. Aspek empati dan ketanggapan dalam pelayanan juga terbukti memiliki pengaruh signifikan terhadap persepsi positif dari pelanggan. Melalui kerangka kerja komprehensif dan praktis yang dihasilkan dari integrasi metode CARTER dan Kano dapat digunakan perusahaan guna meningkatkan kepuasan pelanggan secara berkelanjutan sekaligus mempertahankan daya saing di pasar wood pellet.

Kata kunci: Keputusan pelanggan; *wood pellet*; metode *CARTER*; metode kano; kualitas layanan

INTRODUCTION

The wood pellet industry, as a source of environmentally friendly biomass energy, has experienced rapid growth in recent years, in line with increasing global awareness of climate change issues and the need for sustainable energy [1], [2]. Wood pellets are considered a cleaner renewable energy alternative to fossil fuels, making them an important part of the global energy transition. The success of this industry's development depends not only on technical production aspects but is also greatly influenced by customer satisfaction levels, the main stakeholders in the biomass energy supply chain [3]. Customer satisfaction levels with wood pellet products are determined by various factors, including not only the physical quality of the product but also service aspects such as supply stability, after-sales service, and overall user experience [4], [5]. Although many methods have been used to measure customer satisfaction, conventional methods often fail to comprehensively identify the root causes of problems and are ineffective in classifying product characteristics based on their impact on customer satisfaction. This results in service and product improvement strategies that are less targeted and have less significant impact on customer retention and loyalty [6], [7], [8].

This study presents a new approach through the integration of two complementary methods, namely the CARTER method and the Kano method. The CARTER method focuses on the structural identification of factors causing consumer dissatisfaction with the variables of Compliance, Assurance, Reliability, Tangibles, Empathy, and Responsiveness, thereby providing a systematic overview of the quality of service received by consumers [9], [10]. Meanwhile, the Kano method categorizes product characteristics based on their influence on consumer satisfaction levels into basic, performance, and excitement categories, which helps prioritize product and service attributes that need improvement [11]. By combining these two methods, this study aims to provide a more holistic and in-depth approach to identifying and mapping the main factors that influence wood pellet consumer satisfaction.

The urgency of this research is very high, given the need for appropriate and data-driven strategic decision-making in managing the quality of wood pellet products and services, especially at this wood pellets company as a growing industry player. The results of this study are expected to form the basis for decision-making that can significantly improve customer satisfaction, thereby strengthening the company's competitiveness and its contribution to national renewable energy [12]. In the future, there will be significant opportunities for the wood pellet industry to meet the growing demand for clean energy, especially in countries that are focused on reducing carbon emissions.

LITERATURE REVIEW

The biomass industry as a source of renewable energy has shown significant development, especially *wood pellets*, which are solid fuels based on wood biomass. Wood pellets are made from sawdust or wood waste that is compacted into small cylindrical shapes with low moisture content and high calorific value, resulting in efficient and environmentally friendly combustion. The ideal characteristics of *wood pellets* include high density, resistance to friction, low moisture content, and uniform size, which ensure combustion process stability and energy distribution [3]. The use of *wood pellets* as an alternative to fossil fuels is gaining attention because it can help reduce carbon emissions and support environmentally friendly sustainable energy [4].

In the context of quality and customer satisfaction, measuring and analyzing the factors that cause dissatisfaction is key to improving service. One effective method for identifying the causes of customer dissatisfaction is the CARTER method. This method adapts the dimensions of service quality, which consist of Compliance, Assurance, Reliability, Tangibles, Empathy, and Responsiveness [8]. By using the CARTER method, causes of dissatisfaction can be identified systematically, allowing companies to direct their service improvement efforts appropriately based on these dimensions [10]. The Kano method provides a different and complementary approach to assessing consumer satisfaction. This method classifies product or service attributes into three main categories: basic needs (must-be), performance needs (one dimension), and attractive needs

(attractive) (Figure 1) [11]. Basic needs (must-be) are elements that, if not met, will cause significant dissatisfaction, but their fulfillment does not significantly increase satisfaction. Performance needs (one dimension) are elements that linearly affect customer satisfaction; the better they are met, the higher the satisfaction achieved. Meanwhile, attractive needs are elements that are not expected by consumers, but if provided will cause a significant increase in satisfaction [13]. This approach is useful for prioritizing the development of product and service attributes according to their contribution to customer satisfaction.

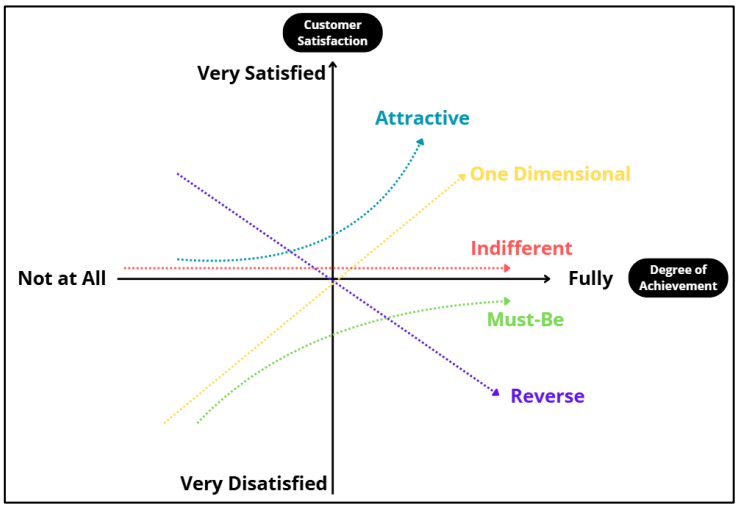

Figure 1. Kano Method

The integration of the *CARTER* and Kano methods provides a holistic and in-depth approach to evaluating wood pellet consumer satisfaction. The CARTER method helps identify in detail the factors causing customer dissatisfaction from a service quality perspective, while the Kano method helps map and group product attributes and prioritize their development based on their influence on customer satisfaction [14]. This combination enables the formulation of effective, empirically based strategies for improving product and service quality. Research using the CARTER and Kano methods simultaneously is relatively new and provides added value both academically and practically. This approach makes a significant contribution to the wood pellet industry, especially in improving customer satisfaction, which is directly correlated with loyalty and business sustainability [15]. This is particularly relevant given the dynamics of the renewable energy market and increasing consumer demand for product and service quality.

METHOD

This study used a quantitative approach with primary data collection through questionnaires distributed to wood pellet consumers [1]. The sample size was taken from all wood pellet customers, totaling 16 customers, using purposive sampling with the criteria of consumers who had used wood pellet products for at least 3 months, so that the data obtained was relevant to the actual consumer experience [16]. The research instrument was tested using validity and reliability tests to ensure that the questionnaire used was valid and reliable for conducting research, interpretation, and discussion. Data analysis was performed by integrating two main methods, namely the CARTER method and the Kano method. The CARTER method was used to identify and classify the factors causing customer dissatisfaction based on six dimensions of service quality: Compliance, Assurance, Reliability, Tangibles, Empathy, and Responsiveness. Data from the questionnaire was analyzed using descriptive statistical techniques to obtain a complete picture of service quality perceptions. The Kano method was applied to group wood pellet product attributes based on their impact on customer satisfaction. These attributes were classified into three categories, namely basic needs (must-be), performance needs (one-dimensional), and attractive needs (attractive). With this method, product and service development priorities can be strategically determined to focus on attributes that have the maximum impact on increasing customer satisfaction.

RESULTS AND DISCUSSION

Validity and Reliability Test

The research instrument was tested using validity and reliability tests to ensure the validity and reliability of the questionnaire used in the research, interpretation, and discussion. After testing the validity of 30 attributes, the r value was greater than the r table value, so it was declared valid. The validity test results can be seen in Table 1 below:

Table 1. Validity Test

Attribute	r-value	r-table (5%)	Attribute	r-value	r-table (5%)	Attribute	r-value	r-table (5%)
Compliance			Reliability			Empathy		
A1	0.939	0.497	C1	0.941	0.497	E1	0.974	0.497
A2	0.869	0.497	C2	0.937	0.497	E2	0.973	0.497
A3	0.858	0.497	C3	0.929	0.497	E3	0.889	0.497
A4	0.93	0.497	C4	0.980	0.497	E4	0.94	0.497
A5	0.81	0.497	C5	0.980	0.497	E5	0.974	0.497
Assurance			Tangibles			Responsive		
B1	0.906	0.497	D1	0.933	0.497	F1	0.859	0.497
B2	0.969	0.497	D2	0.948	0.497	F2	0.976	0.497
B3	0.928	0.497	D3	0.973	0.497	F3	0.927	0.497
B4	0.917	0.497	D4	0.973	0.497	F4	0.949	0.497
B5	0.918	0.497	D5	0.954	0.497	F5	0.953	0.497

Source: Data processing results (SPSS Ver-25.0)

The reliability test (Table 1) shows that the Crombach Alpha value is greater than 0.600, indicating that the questionnaire is reliable. After the validity test for 30 attributes, the r-value is greater than Crombach Alpha, indicating that the questionnaire is reliable. The reliability test results can be seen in Table 2.

Table 2. Reliability Test

Attribute	Cronbach's Alpha-calculated	Standard Reliability Value	Results
Compliance	0.823	0.600	Reliable
Assurance	0.952	0.600	Reliable
Reliability	0.974	0.600	Reliable
Tangibles	0.876	0.600	Reliable
Empathy	0.973	0.600	Reliable
Responsive	0.965	0.600	Reliable

Source: Data processing results (SPSS Ver-25.0)

CARTER Method Analysis

To determine the strong and weak service quality attributes of the company's service quality, the CARTER gap analysis method was applied to the service quality scale of wood pellet product service providers. In gap analysis, a positive difference between expectations and reality indicates strong service quality, while a negative difference indicates weak service quality. In this context, data collected from 16 respondents was analyzed, and the findings showed that the company's service quality performance was weak for 30 service quality attributes. The results of this analysis can be seen in Table 3.

Table 3. GAP Analysis and Pair Sample t-test

Attribute	Average Perceived	Average Expectation	GAP	Results	t	Sig. (2-tailed)	Results
Compliance							
A1	3.2500	4.0000	0.7500	Weak	-5.196	0.000	Significant
A2	3.2500	4.0000	0.7500	Weak	-4.392	0.001	Significant
A3	3.3125	4.0000	0.6875	Weak	-4.568	0.000	Significant
A4	3.1250	4.0000	0.8750	Weak	-7.000	0.000	Significant
A5	3.0625	4.0000	0.9375	Weak	-6.536	0.000	Significant
Assurance							
B1	3.1538	4.0000	0.8462	Weak	-3.395	0.005	Significant
B2	3.2500	4.0000	0.7500	Weak	-3.333	0.006	Significant
B3	3.2500	4.0000	0.7500	Weak	-4.500	0.001	Significant
B4	3.1538	4.0000	0.8462	Weak	-5.500	0.000	Significant
B5	3.3077	4.0000	0.6923	Weak	-3.959	0.002	Significant
Reliability							
C1	3.1875	4.0000	0.8125	Weak	-4.333	0.001	Significant
C2	3.2500	4.0000	0.7500	Weak	-3.503	0.003	Significant
C3	3.1875	4.0000	0.8125	Weak	-3.505	0.001	Significant
C4	3.3750	4.0000	0.6250	Weak	-3.907	0.007	Significant
C5	3.3750	4.0000	0.6250	Weak	-3.101	0.007	Significant
Tangibles							
D1	3.3750	4.0000	0.6250	Weak	-3.101	0.007	Significant
D2	3.1875	4.0000	0.8125	Weak	-4.333	0.001	Significant
D3	3.1875	4.0000	0.8125	Weak	-4.333	0.001	Significant
D4	3.1875	4.0000	0.8125	Weak	-4.907	0.001	Significant
D5	3.1875	4.0000	0.6175	Weak	-3.467	0.003	Significant
Empathy							
E1	3.1875	4.0000	0.8125	Weak	-3.896	0.001	Significant
E2	3.2500	4.0000	0.7500	Weak	-3.503	0.003	Significant
E3	3.0625	4.0000	0.9375	Weak	-4.341	0.000	Significant
E4	3.2500	4.0000	0.85	Weak	-4.896	0.001	Significant
E5	3.1875	4.0000	0.8125	Weak	-3.896	0.001	Significant
Responsive							
F1	3.1250	4.0000	0.8750	Weak	-4.341	0.001	Significant
F2	3.3125	4.0000	0.6875	Weak	-3.467	0.003	Significant
F3	3.3125	4.0000	0.6875	Weak	-3.149	0.007	Significant
F4	3.3125	4.0000	0.8125	Weak	-4.333	0.001	Significant
F5	3.3125	4.0000	0.6875	Weak	-3.467	0.003	Significant

Source: Data processing results (SPSS Ver-25.0)

In Gap analysis, a paired t-test is required to determine whether the Gap difference is significant or not. The test results show that there is no significant difference or Gap, as seen in Table 3, where all attributes show Gap significance. However, for integration with the Kano model analysis, Gap weighting is performed. These scores are used to weight the quality of service received in order to produce a more accurate service quality score. The ranking order of these weightings can be seen in Table 4.

Table 4. Attribute Value Gap

Attribute	GAP	Weight	Weighted GAP	Rank	Attribute	GAP	Weight	Weighted GAP	Rank
Compliance					Tangibles				
A1	0.7500	0.0323	0.0242	4	D1	0.6250	0.0269	0.0168	1
A2	0.7500	0.0323	0.0242	4	D2	0.8125	0.0350	0.0284	6
A3	0.6875	0.0377	0.0330	2	D3	0.8125	0.0350	0.0284	6
A4	0.8750	0.0377	0.0330	8	D4	0.8125	0.0350	0.0284	6
A5	0.9375	0.0403	0.0378	9	D5	0.6875	0.0296	0.0203	2
Assurance					Empathy				
B1	0.8462	0.0364	0.0308	7	E1	0.8125	0.0350	0.0284	6
B2	0.7692	0.0331	0.0255	5	E2	0.7500	0.0333	0.0250	4
B3	0.7692	0.0331	0.0255	5	E3	0.9375	0.0377	0.0353	9
B4	0.8462	0.0364	0.0308	7	E4	0.8750	0.0377	0.0330	8
B5	0.6923	0.0298	0.0206	3	E5	0.8125	0.0350	0.0284	6
Reliability					Responsive				
C1	0.8125	0.0350	0.0284	6	F1	0.8750	0.0377	0.0330	8
C2	0.7500	0.0324	0.0242	4	F2	0.6875	0.0296	0.0203	2
C3	0.8125	0.0350	0.0284	6	F3	0.6875	0.0296	0.0203	2
C4	0.6250	0.0269	0.0168	1	F4	0.6875	0.0296	0.0203	6
C5	0.6250	0.0269	0.0168	1	F5	0.6875	0.0296	0.0203	2

Weight scores for each attribute are calculated to indicate the level of importance of each attribute in influencing the perception of service quality. For example, the Compliance attribute in A5 shows the largest gap (0.9370), which indicates a significant discrepancy between user expectations and the reality they experience, meaning that this attribute requires more attention in service improvement efforts. The rank in this table also indicates the priority of each attribute based on the weight given, which provides an overview of which factors should be prioritized in service quality improvement.

Integration of CARTER and Kano Models

The results of product or service attribute evaluation based on the Kano model, which maps customer perceptions based on the dimensions of compliance, assurance, reliability, tangibles, empathy, and responsiveness. Each attribute is tested with functional and dysfunctional questions to gain a deeper understanding of customer needs characteristics. This provides important insights for identifying which attributes require attention for improvement.

Values are assigned using color codes and category abbreviations: Must-be (M), One-dimensional (O), Attractive (A), Indifferent (I), Reverse (R), and Questionable (Q). Figure 2 is an example of data processing integrating the CARTER and Kano models, showing the customer needs analysis matrix based on the Compliance and Assurance dimensions, with each dimension having several attributes. Attributes A1 to A5 are for the Compliance dimension, and attributes B1 to B5 are for the Assurance dimension.

N	Question	COMPLIACE										ASSURACE									
		A1	K-A1	A2	K-A2	A3	K-A3	A4	K-A4	A5	K-A5	B1	K-B1	B2	K-B2	B3	K-B3	B4	K-B4	B5	K-B5
1	Functional	4	I	4	I	4	M	4	M	4	I	4	M	4	M	4	I	4	M	5	O
	Dysfunctional	2		2		1		1		2		1		1		2		1		1	
2	Functional	4	M	4	I	5	A	4	M	4	M	4	M	4	M	4	I	4	I	4	I
	Dysfunctional	1		2		2		1		1		1		1		2		2		2	
3	Functional	5	O	5	Q	5	O	5	A	5	O	5	A	5	A	5	O	5	O	5	O
	Dysfunctional	1		5		1		1		1		2		2		1		1		1	
4	Functional	5	M	5	O	5	O	5	A	5	O	5	O	5	A	5	O	5	O	5	O
	Dysfunctional	2		1		1		2		1		1		2		1		1		1	
5	Functional	5	M	5	A	4	M	4	M	4	I	4	M	5	A	5	A	4	I	5	A
	Dysfunctional	1		2		1		2		2		1		2		2		2		2	
6	Functional	4	I	5	O	5	A	4	M	3	M	5	O	5	A	4	I	4	I	5	A
	Dysfunctional	2		1		2		1		1		1		2		2		2		2	
7	Functional	4	I	4	I	4	I	4	I	4	I	4	I	4	M	4	I	4	I	4	I
	Dysfunctional	2		2		2		2		2		2		1		2		2		2	
8	Functional	4	M	4	I	4	R	4	I	4	I	5	A	4	M	4	M	4	M	4	M
	Dysfunctional	1		2		5		3		2		2		1		1		1		1	
9	Functional	5	A	5	O	5	O	4	M	4	I	5	O	5	A	5	Q	5	Q	5	A
	Dysfunctional	2		1		1		1		2		1		2		5		5		2	
10	Functional	4	A	4	M	4	M	4	M	4	M	4	M	4	I	4	M	4	M	4	M
	Dysfunctional	1		1		1		1		1		1		2		1		1		1	
11	Functional	4	M	3	I	4	I	4	I	4	I	3	R	4	I	4	M	4	M	4	M
	Dysfunctional	1		2		2		2		2		5		2		1		1		1	
12	Functional	3	M	3	I	3	M	3	M	3	M	2	I	2	I	3	I	3	I	3	I
	Dysfunctional	1		2		1		1		1		2		2		3		3		2	
13	Functional	4	I	4	M	4	I	4	I	4	I	4	I	4	M	4	I	4	I	4	I
	Dysfunctional	2		1		3		2		2		2		1		2		2		2	
14	Functional	4	M	4	M	4	M	4	I	4	M	4	I	5	A	4	M	4	M	4	M
	Dysfunctional	1		1		1		2		1		2		2		1		1		1	
15	Functional	4	I	4	I	4	M	4	M	4	I	4	I	4	I	4	M	4	I	4	M
	Dysfunctional	2		2		1		1		2		2		2		1		2		1	
16	Functional	5	O	5	O	5	A	5	O	5	O	5	A	5	O	5	A	5	A	5	A
	Dysfunctional	1		1		2		1		1		2		1		2		2		2	
Must-be [M] :		7		3		6		8		5		4		5		5		5		5	
One dimensional [O] :		2		4		3		1		4		3		1		2		2		3	
Attractive [A] :		2		1		3		2		0		3		6		2		1		4	
Indefferent [I] :		5		7		3		5		7		5		4		6		7		4	
Reverse [R] :		0		0		1		0		0		1		0		0		0		0	
Quesionable [Q] :		0		1		0		0		0		0		0		1		1		0	
Jml. Sampel [n] :		16		16		16		16		16		16		16		16		16		16	

Figure 2. Kano Model Analysis (Compliance and Assurance) Example
Source: Data processing results

In the same way as in Figure 2, calculations were also performed on the Reliability and Tangibles attributes with the aim of informed decision-making in product and service development, identifying mandatory attributes, innovation opportunities, and avoidable risk potential, showing the customer needs analysis matrix based on the dimensions of reliability and tangibles, with each dimension having several attributes, namely attributes C1 to C5 for the reliability dimension, and attributes D1 to D5 for the tangibles dimension.

Then also on the Empathy and Responsiveness attributes, understanding customer needs from two main dimensions, namely empathy and staff responsiveness. A deep understanding of these results enables informed decision-making in product and service development, identifying mandatory attributes, innovation opportunities, and potential risks that can be avoided. The customer needs analysis matrix is based on the dimensions of empathy and responsiveness, with each dimension having several attributes, namely attributes E1 to E5 representing the empathy dimension, and attributes F1 to F5 representing the responsiveness dimension. The results of the data processing will be analyzed using the Kano model attribute matrix.

Kano Model Analysis

Figure 8 shows the assessment of various dimensions of wood pellet service and product quality, including Compliance, Assurance, Reliability, Tangibles, Empathy, and Responsiveness. Each attribute is assessed in the categories M, O, A, I, R, and Q, with 16 respondents for each attribute. Several attributes with very high scores marked in red indicate areas that require special attention and further improvement. The empathy and compliance dimensions have several attributes with high scores, indicating that these two dimensions need more attention. In the tangibles and reliability dimensions, there is considerable variation in scores, indicating a need for improved consistency in products and services. In addition, the responsiveness dimension shows that the company needs to improve its response to customer questions and complaints in order to increase customer satisfaction.

Table 5. Kano Model Attribute Matrix

No	Dimensions/Attributes	M	O	A	I	R	Q	Total
I.	Compliance							
A1	Wood pellet product meets the promised technical standards	7	2	2	5	0	0	16
A2	Wood pellet product complies with environmental regulations	3	4	1	7	0	1	16
A3	Product has valid quality certification	6	3	3	3	1	0	16
A4	Wood pellet product meets customer specifications	8	1	2	5	0	0	16
A5	Product is manufactured with industry-standard processes	5	4	0	7	0	0	16
II.	Assurance							
B1	Wood pellet product is guaranteed safe during storage	4	3	3	5	1	0	16
B2	Product information and usage are clearly and accurately provided	5	1	6	4	0	0	16
B3	Wood pellet service provider staff have trusted expertise	5	2	2	6	0	1	16
B4	Wood pellet product comes with an adequate warranty	5	2	1	7	0	1	16
B5	Wood pellet provider offers reliable after-sales service	5	3	4	4	0	0	16
III.	Reliability							
C1	Wood pellet product is delivered on time as promised	8	4	1	2	1	0	16
C2	Wood pellet product functions stably and consistently	6	5	2	2	1	0	16
C3	Wood pellet product is free from defects or damage	7	3	3	2	1	0	16
C4	Wood pellet product has long durability	4	2	5	3	1	1	16
C5	Wood pellet product is reliable for production needs	5	1	6	2	1	1	16
IV.	*Tangibles*							
D1	The appearance of the wood pellets meets quality standards	4	3	5	4	0	0	16
D2	The size and shape of the wood pellets are consistent and uniform	7	2	3	4	0	0	16
D3	The overall physical appearance of the product enhances trust	4	3	2	7	0	0	16
D4	Storage and handling facilities during delivery maintain product quality	5	1	4	6	0	0	16
D5	The product arrives in good condition without any damage from shipping	2	6	1	7	0	0	16
V.	Emphaty							
E1	Customer service staff pay special attention to my needs	5	3	2	4	1	1	16
E2	The company is easy to contact when I need assistance	3	4	2	5	1	1	16
E3	Company staff are friendly and polite when serving me	8	0	4	4	0	0	16
E4	The company understands my specific needs as a customer	6	1	3	5	1	0	16
E5	The company provides personalized services based on my needs	6	3	2	3	1	1	16
VI.	Responsiveness							
F1	The company responds to customer inquiries quickly	6	1	3	5	1	0	16
F2	The company quickly responds to customer complaints	3	3	4	6	0	0	16
F3	Service staff provide immediate solutions when needed	2	3	6	5	0	0	16
F4	The company provides easily accessible communication channels	6	3	2	5	0	0	16
F5	The company proactively informs about order status	6	1	5	3	0	1	16

After obtaining the numbers or values for each attribute in the Kano category for all respondents, the Kano category was generated for each service attribute as shown in Table 5. It is known that all wood pellet product attributes in the dimensions of compliance, assurance, reliability, physical evidence, empathy, and responsiveness have small GAP values and are in the adequate Must-be (M) category, which indicates that the products and services have met customer expectations as a whole. However, the GAP score is slightly higher in the empathy dimension, especially staff friendliness, which indicates potential for improvement in providing more personalized services and meeting specific customer needs.

Must-be (M) Category

Table 6. Must-be (M) Category Attributes

Attribute	GAP	Category
Compliance		
Wood pellet products comply with environmental regulations	0.0323	M
Products have valid quality certification	0.0296	M
The wood pellet product complies with customer specifications	0.0377	M
Assurance		
Wood pellet suppliers provide reliable after-sales service	0.0298	M
Reliability		
Wood pellet products are delivered on time as promised	0.0350	M
Wood pellet products function stably and consistently.	0.0323	M
Wood pellet products are free from defects or damage.	0.0350	M
Tangibles		
Wood pellet products function stably and consistently	0.0350	M
Empathy		
Customer service staff paid special attention to my needs	0.0350	M
Company staff were friendly and polite when serving me	0.0403	M
The company understands my special needs as a customer.	0.0377	M
The company provides personalized service tailored to my needs	0.0350	M
Responsiveness		
The company responds to customer inquiries quickly.	0.0377	M
The company provides easily accessible communication channels	0.0350	M
The company proactively informs customers about order status	0.0296	M

Source: Data processing results

Regulatory compliance, after-sales service, product and delivery reliability, and customer responsiveness show good performance. The small gap in all attributes in this table indicates that the company meets customer expectations well. However, the slightly higher Gap score for empathy (staff friendliness) could be a focus for improving services to be more personalized for customers.

Attractive (A) Category

In the context of the Kano model, attractive attributes are features or characteristics of a product or service that are not explicitly expected by customers, but if available, can enhance user satisfaction and experience. These attributes are not usually basic requirements, but can be a competitive advantage.

Table 7. Attributes of the Attractive (A) Category

Attribute	GAP	Category
Assurance		
Information on wood pellet products and usage is provided clearly	0.0331	A
Reliability		
Wood pellet products have long durability	0.0269	A
Wood pellet products are reliable for production needs.	0.0269	A
Tangibles		
Wood pellet products are delivered on time as promised.	0.0269	A
Responsiveness		
Service staff provide immediate solutions when I need them	0.0296	A

Source: Data processing results

In terms of assurance, product information and wood pellet usage are provided clearly and accurately with a gap of 0.0331. This indicates highly transparent and trustworthy product communication, thereby increasing customer safety. In terms of reliability, the product has long durability (gap of 0.0269) and is reliable for production needs (gap of 0.0269). This durability and reliability are crucial for maintaining customer continuity. In terms of tangibility, product delivery is on time and as promised (gap of 0.0269), thereby increasing the company's trust and commitment to its customers. In terms of responsiveness, service staff immediately provide solutions when needed (gap of 0.0296), supporting responsive service and helping to resolve customer issues quickly. A small Gap value indicates a minimal gap between expectations and actual service, resulting in equal satisfaction and impressions for customers. The Attractive (A) category reinforces the position of this attribute as an attractive factor that increases the value of the product in the eyes of customers.

Indifferent (I) category

The Indifferent category in the Kano model describes attributes that do not significantly affect customer satisfaction, whether they are present or absent or lacking. In the context of Table 7, all wood pellet attributes have a low Gap and are categorized as indifferent, indicating that changes in these attributes do not elicit a strong emotional response from customers. In the compliance dimension, the attributes "Wood pellet products meet the promised technical standards" and "Products are manufactured using processes that comply with industry standards" fall into this category because customers consider compliance with these standards to be a basic expectation. The small gaps (0.0323 and 0.0403) indicate that customers are not very sensitive to small variations in the fulfillment of these standards as long as the level is still within acceptable standards. Psychologically, customers consider these things as must-haves, so their absence or improvement in these attributes tends not to generate significant positive or negative attention.

Table 8. Indifferent Category Attributes (I)

Attribute	GAP	Category
Compliance		
Wood pellet products meet the promised technical standards	0.0323	I
Products are manufactured using processes that comply with industry standards	0.0403	I
Assurance		
The safety of wood pellet products is guaranteed during storage.	0.0364	I
Staff or wood pellet service providers have reliable expertise	0.0331	I
Wood pellet products come with adequate warranty coverage	0.0364	I
Tangibles		
Wood pellet products are free from defects or damage	0.0350	I
Wood pellet products have long durability	0.0350	I
Wood pellet products are reliable for production needs.	0.0296	I
Empathy		
The company is easy to contact when I need help.	0.0323	I
Responsiveness		
The company responds quickly to customer complaints	0.0323	I

Source: Data processing results

The assurance dimension includes attributes such as *wood pellet* products being guaranteed to be safe during storage, staff having reliable expertise, and adequate warranties. Both Gap scores are low (~0.0331 and -0.0364), indicating that customers generally feel safe and confident about these attributes, but further improvement does not increase satisfaction. This shows that safety and warranty are minimum standards expected, not differentiating factors that drive loyalty or exceptional satisfaction. Tangible dimension, covering the physical quality of the product, such as freedom from defects, durability, and reliability in production. The low gap (0.0296-0.0350) indicates that the product meets basic expectations, but this quality is still considered fundamental

rather than a unique advantage. Since product consistency is already considered a quality standard by customers, minor variations are not particularly noticeable. A small gap (0.0323) indicates that customers accept this basic communication service as the norm, without feeling more satisfied if the service is slightly improved. The responsive dimension attribute is "The company responds to customer complaints quickly." Although this is important, the low gap and "Indifferent" category indicate that response speed is a minimum expectation that has already been met. Improving this level does not necessarily increase customer satisfaction.

In terms of compliance, the product has met technical standards (A1) and environmental regulations (A2) well, but customer specifications (A4) and production processes (A5) still need improvement. Certification quality (A3) also needs to be improved. The assurance dimension shows that storage safety (B1) and warranty (B4) require more attention, although product information (B2) is already quite clear. After-sales service (B5) also needs to be improved. In the reliability dimension, on-time delivery (C1), product stability (C2), and product durability (C4) need improvement. The capacity of products to meet production needs (C5) also varies and requires further evaluation. The tangible dimension shows the need to improve the physical quality of products, on-time delivery (D1-D4), and packaging. Production support (D5) has shown improvement. The empathy dimension reveals the need to improve customer attention (E1), communication when assistance is needed (E2), and staff friendliness (E3). Although understanding customer needs (E4) and personalized service (E5) have been improved, more attention is needed. In the responsiveness dimension, quick responses to questions (F1) and complaints (F2), as well as quick solutions (F3), need improvement. Proactive communication channels and order status information (F4, F5) also need to be improved.

CONCLUSION

The integration of the CARTER and Kano methods is effective in classifying the attributes of wood pellet services and products into Must-Be, Attractive, and Indifferent categories. This grouping helps in understanding customer expectations and prioritizing service improvements. This study identifies key factors, such as compliance, assurance, empathy, and responsiveness, which play an important role in customer satisfaction. The results of this study can be used as a reference for company. Bio AKS to develop services and products that are more in line with customer expectations, increase customer satisfaction and loyalty, and encourage systematic and comprehensive service evaluation.

Company is advised to continue developing wood pellet services and products, focusing on the basic needs and performance requirements identified through the CARTER and Kano methods. The company also needs to pay more attention to the dimensions of empathy and responsiveness in customer service, as well as improve employee competence in these areas. In addition, periodic customer satisfaction evaluations using these methods can help the company adjust its service strategy to changes in customer preferences. The results of this study can also be used as a basis for developing long-term business strategies that are more focused on customer satisfaction, with appropriate resource allocation. Further research is recommended to examine other variables that may potentially affect customer satisfaction or apply this method to other industrial sectors.

ACKNOWLEDGEMENT

The researchers would like to express their gratitude for the funding support provided by the Ministry of Higher Education, Science and Technology under the 2025 Master's Thesis Research scheme with contract No.128/C3/DT.05.00/PL/2025;095/LL7/DT.05.00/PL/2025; 03/05.LITI/LPPM/ITATS/PL/2025.

BIBLIOGRAPHY

[1] R. Picchio *et al.*, “Pellet Production from Pruning and Alternative Forest Biomass: A Review of the Most Recent Research Findings,” *Materials (Basel).*, vol. 16, no. 13, 2023, doi: 10.3390/ma16134689.

[2] H. Mortadha, H. B. Kerrouchi, A. Al-Othman, and M. Tawalbeh, "A Comprehensive Review of Biomass Pellets and Their Role in Sustainable Energy: Production, Properties, Environment, Economics, and Logistics," *Waste and Biomass Valorization*, 2025, doi: 10.1007/s12649-024-02873-x.

[3] M. Fargnoli, N. Haber, D. Platti, and M. Tronci, "The soft side of QFD: a comparative study on customer requirements' prioritization in the food sector," *Proc. Int. Conf. Ind. Eng. Oper. Manag.*, no. February 2022, pp. 78–89, 2021, doi: 10.46254/eu04.20210123.

[4] Y. Tandiono and H. Rau, "An Enhanced Model Using the Kano Model, QFDE, and TRIZ with a Component-Based Approach for Sustainable and Innovative Product Design," *Sustain.*, vol. 15, no. 1, 2023, doi: 10.3390/su15010527.

[5] A. Y. Tripariyanto and L. Lukmandono, "Pengaruh Kualitas Produk, Harga Produk, Promosi Dan Layanan Purna Jual Terhadap Keputusan Pembelian Sepeda Motor Honda (Type Beat Mathic) (Studi Kasus Pada Siswa Smk Al Bashtomi Loceret Nganjuk)," *JATI UNIK J. Ilm. Tek. dan Manaj. Ind.*, vol. 1, no. 2, p. 111, 2018, doi: 10.30737/jatiunik.v1i2.120.

[6] A. F. Ahsan and Lukmandono, "The Influence of Product Quality, Service Quality and Price on Customer Satisfaction and Loyalty of Anita Family Bakery Sumenep Products.," *Nas. Teknol. Ind. Berkelanjutan I (SENANSTITAN I)*, vol. 1, no. 2, pp. 35–42, 2021, [Online]. Available: https://ejurnal.itats.ac.id/senastitan/article/view/1638

[7] W. D. Putra and Lukmandono, "Analisis Layanan Konsumen Menggunakan Metode Service Quality (SERVQUAL) dan Fuzzy untuk Meningkatkan Kualitas Layanan," *Senastitan*, vol. 2, no. 8, pp. 78–85, 2022.

[8] I. Aji and Lukmandono, "Integrasi Metode Servqual, KANO, dan QFD untuk Meningkatkan Kualitas Layanan (Studi Kasus : Fakultas Teknik UG)," *Pros. SENASTITAN Semin. Nas. Sains dan Teknol.*, vol. 1, no. 1, pp. 8–16, 2021.

[9] J. Asamoah, "Evaluating Key Determinants of Customer Satisfaction: A Focus on Customer Rela-tions, Service Quality, Product Quality, and Supply Chain Management," p. 111, 2025.

[10] D. Susiati and Lukmandono, "Product Development of Sneakers Design Based on Consumer Preference Through Integration of Kano Method and Quality Function Deployment," *Tibuana*, vol. 5, no. 01, pp. 1–7, 2022, doi: 10.36456/tibuana.5.01.4982.1-7.

[11] Lukmandono, "Analysis of service quality at fertilizer distribution using servqual method and kano model to customer satisfaction increasing," p. 118, 2021.

[12] F. Barrios-Ipenza, A. Calvo-Mora, F. Criado-García, and W. H. Curioso, "Quality evaluation of health services using the kano model in two hospitals in peru," *Int. J. Environ. Res. Public Health*, vol. 18, no. 11, 2021, doi: 10.3390/ijerph18116159.

[13] C. Damanik, V. Drago, M. Windasari Siallagan, and O. Jaya Harmaja, "Customer Satisfaction Evaluation At Sapadia Guest House Through Servqual And Csi Approaches Based On Information Systems," *Int. J. Sci. Environ.*, vol. 5, no. 2, pp. 213–219, 2025, doi: 10.51601/ijse.v5i2.120.

[14] F. Amalia and S. Nasution, "Analisis Kepuasan Pelanggan Dengan Pendekatan Model Kano Dan Quality Function Deployment (Qfd) Dalam Meningkatkan Kualitas Desain Kemasan Minuman Herbal Serbuk," *J. Ilm. Teknol. dan Rekayasa*, vol. 28, no. 3, pp. 199–217, 2023, doi: 10.35760/tr.2023.v28i3.8364.

[15] H. Shan, X. Fan, S. Long, X. Yang, and S. Yang, "An Optimization Design Method of Express Delivery Service Based on Quantitative Kano Model and Fuzzy QFD Model," *Discret. Dyn. Nat. Soc.*, vol. 2022, 2022, doi: 10.1155/2022/5945908.

[16] Dino Rimantho, "Soft System Methodology Approach: Case Study of Renewable Energy Development of Wood Pellets as an Implementation of a Circular Economy," *J. Asiimetrik J. Ilm. Rekayasa Inov.*, vol. 6, pp. 165–174, 2024, doi: 10.35814/asiimetrik.v6i1.5958.