



### PROTEKSI ISI LAPORAN AKHIR PENELITIAN FUNDAMENTAL - REGULER

Dilarang menyalin, menyimpan, memperbanyak sebagian atau seluruh isi proposal ini dalam bentuk apapun kecuali oleh pengusul dan pengelola administrasi penelitian dan pengabdian kepada masyarakat

#### LAPORAN AKHIR

#### 1. JUDUL PENELITIAN

Identifikasi Titik Kritis Kualitas Produk Berbasis Analisis Customer satisfaction dimensions dan SNI, untuk Optimalisasi Daya Saing Industri Shuttlecock

Bidang Fokus	Tema	Topik (jika ada)	Prioritas Riset
Produk rekayasa keteknikan	Pengembangan sistem/ platform berbasis Open Source	Framework/Platform penunjang industri kreatif dan kontrol	Ekonomi kreatif

Rumpun Ilmu Level 1	Rumpun Ilmu Level 2	Rumpun Ilmu Level 3
ILMU TEKNIK	ILMU KETEKNIKAN INDUSTRI	Rekayasa Keteknikan

Skema Penelitian	Strata (Dasar/Terapan/ Pengembangan)	Nilai SBK	Target Akhir TKT	Lama Kegiatan
Penelitian Fundamental - Reguler	Riset Dasar	150.000.000	3	2 Tahun

#### 2. IDENTITAS PENGUSUL

Nama, Peran	Jenis	Program Studi/Bagian	Bidang Tugas	ID Sinta
EKO LIQUIDDANU 0028017106  Ketua Pengusul Universitas Sebelas Maret	Dosen	Teknik Industri	merancang metodologi riset, mengkoordinasi riset dan menulis publikasi	<a href="#">6652338</a>
ILHAM PRIADYTHAMA 0024118002  Anggota Universitas Sebelas Maret	Dosen	Teknik Industri	merancang program phyton untuk Analisis Sentimen Pelanggan	<a href="#">2743</a>
RINA FITRIANA 0319097501  Anggota Universitas Trisakti	Dosen	Teknik Industri	analisis QFD dan analisis perbaikan sistem manufaktur	<a href="#">5981150</a>
Ardhy Yuliawan Norma Sakti 6769988  Anggota National Research and Innovation Agency	Umum	Sustainability	analisis data kualitas produk, menulis paper publikasi	-
AKHDAN HANIF KARTIKA ZAMAN 10321005  Mahasiswa Universitas Sebelas Maret	Mahasiswa	Teknik Industri	membantu membuat program ML	-
Dafi` Andinil Haqqi 10321027  Mahasiswa Universitas Sebelas Maret	Mahasiswa	Teknik Industri	membantu membuat dashboad basis WEB untuk pelaku usaha (UMKM)	-
PRADIPTA DANISWARA 10322097  Mahasiswa	Mahasiswa	Teknik Industri	membantu membuat proses filter / set data dan analisis data	-

Nama, Peran	Jenis	Program Studi/Bagian	Bidang Tugas	ID Sinta
Universitas Sebelas Maret				

### 3. MITRA KERJASAMA PENELITIAN (Jika Ada)

Pelaksanaan penelitian dapat melibatkan mitra kerjasama yaitu mitra kerjasama dalam melaksanakan penelitian, mitra sebagai calon pengguna hasil penelitian, atau mitra investor

Mitra	Nama Mitra	Dana
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### 4. LUARAN DAN TARGET CAPAIAN

#### Luaran Wajib

Tahun Luaran	Kategori Luaran	Jenis Luaran	Status target capaian	Keterangan
1	Artikel di Jurnal	Artikel di Jurnal Bereputasi Internasional	Accepted/Published	International Journal of Research in Industrial Engineering
2	Artikel di Jurnal	Artikel di Jurnal Bereputasi Internasional	Accepted/Published	Quality Engineering

### 5. ANGGARAN

Rencana Anggaran Biaya penelitian mengacu pada PMK dan buku Panduan Penelitian dan Pengabdian kepada Masyarakat yang berlaku.

**Total RAB 1 Tahun Rp 62.190.000,00**

**Tahun 1 Total Rp 62.190.000,00**

Kelompok	Komponen	Item	Satuan	Vol.	Biaya Satuan	Total
Analisis Data	Biaya analisis sampel	validasi hasil pengujian ke balai besar industri Yogyakarta	Unit	30	135.000	4.050.000
Analisis Data	HR Pengolah Data	Honor pengolah data	P (penelitian)	1	1.540.000	1.540.000
Analisis Data	Honorarium narasumber	Konsultasi ke balai besar industri Yogyakarta	OJ	2	900.000	1.800.000
Bahan	ATK	HVS A4 80 gram	Paket	5	53.600	268.000
Bahan	ATK	Jangka sorong	Paket	1	2.500.000	2.500.000
Bahan	ATK	Timbangan digital analitik 0,5mg	Paket	1	6.000.000	6.000.000
Bahan	ATK	Tinta Printer warna Canon	Paket	10	150.000	1.500.000
Bahan	Bahan Penelitian (Habis Pakai)	Biaya pembuatan dan editing foto dan video	Unit	1	2.000.000	2.000.000
Bahan	Bahan Penelitian (Habis Pakai)	Shuttlecock	Unit	30	120.000	3.600.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Biaya Publikasi artikel di Jurnal Bereputasi Internasional	biaya publikasi Jurnal open access	Paket	1	6.000.000	6.000.000
Pelaporan Hasil Penelitian dan Luaran Wajib	Biaya Publikasi artikel di Jurnal Bereputasi Nasional	pembuatan buku	Paket	1	700.000	700.000
Pengumpulan Data	HR Pembantu Lapangan	Mengikuti kegiatan perjalanan dinas	OH	30	80.000	2.400.000

Kelompok	Komponen	Item	Satuan	Vol.	Biaya Satuan	Total
Pengumpulan Data	Penginapan	Biaya penginapan perjalanan dinas ke Yogyakarta @Rp2 mlm @Rp845.000,00 = Rp1.690.000,00	OH	2	1.690.000	3.380.000
Pengumpulan Data	Penginapan	Biaya penginapan perjalanan dinas ke Malang @Rp2 mlm @Rp814.000,00 = Rp1.628.000,00	OH	2	1.628.000	3.256.000
Pengumpulan Data	Penginapan	Biaya penginapan perjalanan dinas ke Nganjuk @Rp2 mlm @Rp814.000,00 = Rp1.628.000,00	OH	2	1.628.000	3.256.000
Pengumpulan Data	Penginapan	Biaya penginapan perjalanan dinas ke Tegal @Rp2 mlm @Rp810.000,00 = Rp1.620.000,00	OH	2	1.620.000	3.240.000
Pengumpulan Data	Transport	Perjalanan Solo - Yogya PP 160km (1 liter = 10 km) Harga Pertamina Rp12.500,00 = Rp200.000,00	OK (kali)	2	200.000	400.000
Pengumpulan Data	Transport	Perjalanan Solo - Nganjuk PP 300km (1 liter = 10 km) Harga Pertamina Rp12.500,00 = Rp375.000,00	OK (kali)	2	375.000	750.000
Pengumpulan Data	Transport	Perjalanan Solo - Tegal PP 520km (1 liter 10 km) Harga Pertamina Rp12.500,00 = Rp650.000,00	OK (kali)	2	650.000	1.300.000
Pengumpulan Data	Transport	Perjalanan Solo -,Malang PP 720km (1 liter 10 km) Harga Pertamina Rp12.500,00 = Rp900.000,00	OK (kali)	2	900.000	1.800.000
Pengumpulan Data	Uang Harian	Uang Harian Perjalanan Dinas ke Tegal @3 hari @Rp370.000,00/hari = Rp1.110.000,00	OH	2	1.110.000	2.220.000
Pengumpulan Data	Uang Harian	Uang Harian Perjalanan Dinas ke Malang @3 hari @Rp410.000,00/hari = Rp1.230.000,00	OH	1	1.230.000	1.230.000
Pengumpulan Data	Uang Harian	Uang Harian Perjalanan Dinas ke Nganjuk @3 hari @Rp410.000,00/hari = Rp1.230.000,00	OH	1	1.230.000	1.230.000
Pengumpulan Data	Uang Harian	Uang Harian Perjalanan Dinas ke Yogya@3 hari @Rp420.000,00/hari = Rp1.260.000,00	OH	2	1.260.000	2.520.000
Sewa Peralatan	Peralatan penelitian	Alat uji layang shuttlecock	Unit	15	350.000	5.250.000

\*. KEMAJUAN PENELITIAN

## A. RINGKASAN

### 1. Latar belakang penelitian

Daya saing industri manufaktur Indonesia di pasar nasional sangat dipengaruhi oleh kualitas produk yang dihasilkan. Di era digital saat ini, ulasan pelanggan (online reviews) di marketplace menjadi sumber informasi yang sangat berharga untuk memahami persepsi dan kepuasan pelanggan (Customer satisfaction dimensions atau CSD) terhadap produk (Peña-García et al., 2024). CSD dapat mempengaruhi keputusan pembelian, membentuk kepercayaan konsumen, dan memberikan wawasan yang dapat ditindaklanjuti bagi bisnis (Kyriakidis & Tsafarakis, 2024). Namun, data ulasan pelanggan seringkali tidak terstruktur dan sulit dianalisis secara manual. Proposal menggunakan metode untuk penambangan teks TF-IDF dengan target minimal 20.000 ulasan konsumen marketplace. selanjutnya dengan metode Latent Dirichlet Allocation (LDA) dan Bidirectional Encoder Representations from Transformers (BERT) keduanya adalah metode yang efektif untuk mengubah ulasan menjadi data Sentimen konsumen. LDA sangat berguna untuk mengekstrak topik dan aspek laten dari ulasan, sementara BERT unggul dalam memahami nuansa kontekstual dan klasifikasi sentimen (Hyder et al., 2024)

Di sisi lain, Pemerintah melalui BSN telah menerbitkan SNI shuttlecock tahun 2014 no 36 (BPS, 2014). Tujuan standar ini adalah membantu pengusaha untuk menentukan pedoman standar produk yang harus diproduksi, dengan harapan produk yang dihasilkan akan diterima oleh pasar yang lebih luas. Integrasi antara analisis sentimen ulasan pelanggan dan analisis SNI dapat memberikan pemahaman yang lebih komprehensif tentang kualitas produk dan mengidentifikasi titik kritis di sepanjang rantai produksi.

Hingga saat ini masih sedikit penelitian preferensi konsumen produk ini yang dikaitkan dengan standar mutu yang diatur oleh SNI. Penelitian sebelumnya hanya mencoba meneliti hubungan antara harga dan kualitas keawetan produk shuttlecock terhadap kepuasan pelanggan. Karena itu pada tahun pertama, penelitian ini bertujuan untuk menganalisis preferensi konsumen terhadap beberapa produk shuttlecock yang ada dijual melalui di pasar online. Metode yang digunakan untuk mengetahui tingkat kepuasan konsumen adalah machine learning. Pada tahun kedua preferensi konsumen ini akan ditransformasi ke dalam bahasa teknis dengan menggunakan model QDF. Yang selanjutnya bahasa teknis ini akan diubah menjadi penentuan titik kritis proses produksi yang sangat bermanfaat dalam proses pengembangan defect prevention pada sistem penjaminan produksi shuttlecock. Proses transformasi melibatkan sejumlah pengusaha IKM dan pengrajin sebagai mitra pemasok di beberapa sentra industri seperti Kabupaten Tegal, Nganjuk dan Malang.

Hasil analisis ini sekiranya dapat menjadi masukan bagi IKM dan pengrajin untuk mendapatkan sejumlah titik kritis proses yang harus diperhatikan di sepanjang rantai produksi mulai pembelian bahan baku, proses pemotongan, perakitan hingga pengemasan dan penjualan. Luaran yang ditargetkan, tahun pertama publikasi Sinta 2 atau seminar internasional (terindeks scopus) dengan judul: "Assessing Customer satisfaction dimensions and SNI for quality attributes of Shuttlecock Production". Tahun kedua publikasi Sinta 2 atau jurnal scopus dengan judul "Development Of Production Critical Points Is Based On Consumer Preferences And National Standards" dan luaran wajib buku berbasis riset ber-ISBN dengan judul "Customer satisfaction dimensions dan standar

nasional Indonesia (SNI) sebagai dasar sistem produksi industri kecil dan menengah". Luaran TKT penelitian yang diusulkan pada tingkat 4 yaitu melakukan validasi kumpulan atribut atau komponen yang terkait dengan preferensi konsumen dan SNI dan telah dikonfirmasi oleh para pengusaha di sentra industri shuttlecock.

## 2. Tujuan

Secara umum tujuan penelitian adalah membantu pengusaha untuk menentukan pedoman standar produk yang harus diproduksi, dengan harapan produk yang dihasilkan akan diterima oleh pasar yang lebih luas. Integrasi antara analisis sentimen ulasan pelanggan dan analisis SNI dapat memberikan pemahaman yang lebih komprehensif tentang kualitas produk dan mengidentifikasi titik kritis di sepanjang rantai produksi.

Tujuan tahun pertama adalah untuk menganalisis preferensi konsumen terhadap beberapa produk shuttlecock yang ada dijual melalui di pasar online. Metode yang digunakan untuk mengetahui tingkat kepuasan konsumen adalah machine learning.

Tujuan pada tahun kedua adalah menyusun preferensi konsumen ini akan ditransformasi ke dalam bahasa teknis dengan menggunakan model QDF. Yang selanjutnya bahasa teknis ini akan diubah menjadi penentuan titik kritis proses produksi yang sangat bermanfaat dalam proses pengembangan defect prevention pada sistem penjaminan produksi shuttlecock.

## 3. Metodologi

Penelitian dilakukan melalui 3 tahapan, yaitu:

### Identifikasi Preferensi Konsumen (Tahun 1)

Penelitian ini dimulai dari hasil pengujian menggunakan standar SNI no 26 tahun 2014 terhadap sepuluh produk shuttlecock yang ada di pasar online dan diproduksi oleh sentra industri di Ngajuk, Tegal dan Malang. Dari sample tersebut hanya ada satu merek yang memenuhi kesesuaian standar SNI yaitu merek dari Ngajuk [17]. Dari hasil riset awal ini dilanjutkan dengan konfirmasi ke sepuluh pemilik merek tersebut. Selama ini para produsen (IKM) hanya mengandalkan informasi standar kualitas dari para pedagang yang menjadi pelanggan mereka. Mereka menyatakan belum pernah melakukan studi preferensi konsumen terhadap masyarakat yang menjadi pengguna langsung. Karena itu tahun pertama akan dilakukan identifikasi preferensi konsumen menggunakan data komen di ecommerce / marketplace. Adapun tahapan sebagai berikut:

#### 1. Pengumpulan Data:

- o Mengumpulkan ulasan pelanggan dari berbagai marketplace di Indonesia menggunakan teknik web scraping.
- o Mengumpulkan data SNI yang relevan dengan produk manufaktur yang diteliti.

#### 2. Pra-pemrosesan Data:

- o Membersihkan dan menormalisasi data ulasan pelanggan.
- o Melakukan tokenisasi dan penghapusan stop words.

#### 3. Analisis Sentimen:

- o Menggunakan algoritma machine learning (misalnya, Naïve Bayes, Support Vector Machine, atau model berbasis deep learning) untuk menganalisis sentimen ulasan pelanggan.
- o Melakukan klasifikasi sentimen menjadi positif, negatif, dan netral.

4. Ekstraksi Fitur:
  - o Menggunakan teknik Natural Language Processing (NLP) untuk mengekstrak fitur-fitur yang relevan dari ulasan pelanggan (misalnya, aspek produk yang dikeluhkan atau dipuji).
5. Analisis SNI:
  - o Menganalisis persyaratan kualitas yang ditetapkan dalam SNI.
  - o Mengidentifikasi parameter kualitas yang relevan dengan fitur-fitur yang diekstraksi dari ulasan pelanggan.
6. Integrasi Data:
  - o Mengintegrasikan hasil analisis sentimen dan analisis SNI.
  - o Memetakan hubungan antara keluhan pelanggan dan persyaratan kualitas SNI.
7. Identifikasi Titik Kritis:
  - o Menggunakan teknik analisis rantai nilai untuk mengidentifikasi titik kritis di sepanjang rantai produksi.
  - o Menentukan titik-titik di mana masalah kualitas paling sering terjadi.
8. Visualisasi Data:
  - o Menyajikan hasil penelitian dalam bentuk visualisasi yang mudah dipahami (misalnya, grafik, diagram, atau peta).

Untuk memperkuat hasil analisis, Penelitian ini juga diperkuat dengan pengujian sejumlah produk shuttlecock terhadap sejumlah merek yang dipilih dan sesuai hasil dari analisis mesin learning. Pengujian menggunakan standar SNI produk no 36 tahun 2014, dilakukan di Balai Besar Kerajinan Dan Batik Yogyakarta yang ditunjuk untuk tempat pengujian produk shuttlecock.

## 2) Pengembangan model sistem penjaminan mutu (Tahun 2)

Setelah atribut preferensi konsumen telah dikumpulkan selanjutnya ditransformasi menjadi bahasa teknik (titik kritis proses produksi) menggunakan model QFD. Pada tahap ini para pelaku usaha di sepanjang rantai nilai produksi (pemilik IKM dan pengrajin) dilibatkan dalam curah pendapat. Para pelaku yang dilibatkan dari sentra shuttlecock di Kabupaten Ngajuk, Tegal dan Malang. Selanjutnya dilakukan analisis rantai nilai digunakan untuk menentukan skenario yang memberikan hasil terbaik bagi IKM dan pengrajin dalam rantai pasok.

## 3. Luaran yang ditargetkan,

Tujuan tahun pertama penelitian ini bertujuan untuk identifikasi preferensi konsumen terhadap kualitas produk shuttlecock. Metode yang digunakan adalah Latent Dirichlet Allocation (LDA) dan Bidirectional Encoder Representations from Transformers (BERT) untuk mengubah ulasan on-line menjadi CSD dan klasifikasi sentimen positif dan negatif (puas atau tidak puas).

Tahun kedua transformasi preferensi ini menjadi atribut teknik kualitas dan titik kritis yang sangat bermanfaat dalam proses pengembangan defect prevention yang ada pada sistem penjaminan SNI. Metode yang digunakan adalah survei rantai nilai dan QFD.

## 4. Hasil yang diperoleh sesuai dengan tahun pelaksanaan (tahun pertama)

No Jenis luaran Identitas Status ketercaipan

1 Luaran wajib: jurnal terindeks scopus Q3 Nama jurnal: Journal of Information Systems Engineering and Business Intelligence (Terindeks scopus Q3)

Dengan link jurnal: <https://www.scopus.com/sourceid/21101152758>

Judul paper: "An Integrated BERT, ABSA and BERTopic Framework for Quality Improvement in Shuttlecock SMEs Based on ECommerce Reviews" Submitted

2 Luaran tambahan 1

Jurnal terindeks Sinta 2 Nama jurnal : Spektrum Industri

Vol. 23, No. 2, 2025, pp. 225-239 ISSN 1693-6590

Terindeks di DOAJ: <https://doaj.org/toc/2442-2630> & Proques : [www.proquest.com](http://www.proquest.com)

Judul paper: "Integrating Explainable AI and the Kano Model to Derive Improvement Strategies for Essential Oils from Online Reviews"

<https://www.proquest.com/docview/3276240933?fromopenview=true&pq-riqsite=gscholar&sourcetype=Scholarly%20Journals>

published: Oktober 2025,

3 Luaran tambahan 2

Hak kekayaan Intelaktual

(HKI) Jenis Ciptaan: Program Komputer

Judul Ciptaan: Aplikasi Evaluasi Kebutuhan Pelanggan Secara Holistik dengan Model Kano dan Explainable AI

published: 10 September 2025

## B. KATA KUNCI

SNI; Customer satisfaction dimensions; Quality Function Deployment; Machine learning ; Deep Learning

Pengisian poin C sampai dengan poin H mengikuti template berikut dan tidak dibatasi jumlah kata atau halaman namun disarankan ringkas mungkin. Dilarang menghapus/memodifikasi template ataupun menghapus penjelasan di setiap poin.

**C. HASIL PELAKSANAAN PENELITIAN:** Tuliskan secara ringkas hasil pelaksanaan penelitian yang telah dicapai sesuai tahun pelaksanaan penelitian. Penyajian meliputi data, hasil analisis, dan capaian luaran (wajib dan atau tambahan). Seluruh hasil atau capaian yang dilaporkan harus berkaitan dengan tahapan pelaksanaan penelitian sebagaimana direncanakan pada proposal. Penyajian data dapat berupa gambar, tabel, grafik, dan sejenisnya, serta analisis didukung dengan sumber pustaka primer yang relevan dan terkini.

Hasil pelaksanaan penelitian yang telah dicapai sesuai tahun Pertama Penelitian dapat disajikan sebagai berikut:

Penelitian diawali dengan membuat perangkat lunak berbasis Mesin learning dan deep learning. Dengan tahap Scaping data ulasan pelanggan di marketplace Indonesia khususnya produk shuttlecock, selanjutnya data dibersihkan dan urai menjadi beberapa kata atau token.

Pemrosesan Bahasa Alami (NLP) dapat menjadi alat untuk memahami ulasan pelanggan. Arsitektur berbasis BERT dengan konteks dua arah menggantikan model pembelajaran mesin (ML) konvensional dalam pengenalan sentimen [1]. Fenomena ini berlaku untuk morfologi bahasa Indonesia yang rumit [2]. Hasil polarisasi sentimen tidak cukup untuk memahami elemen peningkatan yang dapat ditindaklanjuti. Hal ini disebabkan kurangnya spesifisitas keluaran yang dihasilkan pada tingkat atribut kualitas. Oleh karena itu, Analisis Sentimen Berbasis Aspek (ABSA) diperlukan untuk mengidentifikasi atribut kualitas yang telah ditentukan sebelumnya berdasarkan teori atau konsep kualitas yang akan dikembangkan. Menghubungkan sentimen dan atribut kualitas yang sudah mapan memungkinkan diagnosis kualitas produk dan layanan [3]. Namun, ABSA menghadapi tantangan dalam menangani beragam ulasan yang sangat bervariasi, yang umum dalam ulasan e-commerce. Oleh karena itu, tantangan bagi model topik tunggal adalah mengidentifikasi tema laten dari sejumlah besar ulasan menggunakan proses yang dikenal sebagai analisis data besar. Studi terbaru menyoroti bahwa penggunaan BERTopic dapat menghasilkan topik yang lebih koheren dan detail untuk data yang didorong oleh keluhan [4]. Penelitian ini menggunakan ulasan negatif untuk detail teknis yang lebih kaya dan deskripsi produk yang cacat secara rinci [5].

C.1 Data

Berikut ini jumlah data yang berhasil dikumpulkan, dibersihkan dan dikelompokkan menjadi 47 topic komen dan mendapat sembilan dimensi atau atribut kualitas

Tabel 1. Hasil pengolahan menggunakan model ML BERTopic dan Model ABSA

Micro-Topics terkait (BERTopic)	Dimensi ABSA
Topic 11 – bulunya patah, Topic 44 – patah bulu / poin cepat, Topic 8 – kurang awet / kualitas buruk, Topic 14 – rusak cepat / gampang patah, Topic 37 – rusak cepat	Durabilitas Bulu (semua berisi keluhan bulu rapuh, mudah patah, tidak tahan lama)
Topic 9 – speed 77/78/75 (ketidaksesuaian speed → arah terbang), Topic 15 – stabil tidak stabil / goyang, Topic 27 – goyang / tidak stabil, Topic 28 – terlalu ringan (berpengaruh ke jalur terbang), Topic 45 – keras/kepala (berhubungan dengan keseimbangan dan stabilitas)	Flight Stability (keluhan terkait arah terbang, kecepatan, dan sensasi saat dipukul)
Topic 13 – kok terlihat bekas / bobot tidak konsisten, Topic 25 – deskripsi bekas / tampak tidak rapi, Topic 37 – rusak finish / susunan bulu tidak rapi	Neatness / Kerapian (keluhan seputar estetika, finishing, kerapian bulu, tabung terlihat bekas)
Topic 0 – packing aman penyok, Topic 3 – penyok / tabung rusak, Topic 16 – bubble wrap kurang	Packaging (keluhan terkait bubble wrap kurang, tabung penyok, perlindungan tidak memadai)
Topic 4 – pengiriman lama / cepat, Topic 17 – pengiriman sangat lama, Topic 35 – kurir datang malam / lama, Topic 36 – pesanan lambat / masalah seller + kurir, Topic 42 – lambat pengiriman (super lambat)	Delivery (isu SLA pengiriman, keterlambatan, pengalaman logistik buruk)

Topic 6 – respon seller lambat, Topic 29 – kesesuaian speed / kesalahan informasi seller, Topic 36 – penjual lambat proses, Topic 39 – dugaan manipulasi / barang tidak asli, Topic 41 – komunikasi seller, Topic 42 – komplain & penyelesaian	Seller Service (isu interaksi penjual, tanggapan terhadap komplain, kesalahan deskripsi)
Topic 13 – berat tidak konsisten, Topic 28 – terlalu ringan, Topic 40 – berat tidak sesuai (rusak → berat tidak stabil)	Weight (berhubungan dengan feel permainan dan stabilitas udara)
Topic 45 – keras / kepala terlalu berat	Kualitas Kepala (keluhan terkait material dan kekerasan kepala shuttlecock)
Topic -1 – barang yg kok nya (general dissatisfaction); Topic 1 – shuttlecock / kok, Topic 2 – tidak sesuai deskripsi (quality mismatch), Topic 5 – bagus kurang / kok kurang enak, Topic 7 – produk sesuai produksi, Topic 10 – kualitas jelek, Topic 12 – bagusnya oke, Topic 18 – koknya sudah datang, Topic 20 – mahal / tidak sesuai value, Topic 21 – telat ulasan / kualitas biasa, Topic 22 – lumayan / standar, Topic 23 – biasa saja, Topic 24 – smash main sudah, Topic 26 – belum dicoba, Topic 30 – badminton sports kami, Topic 31 – blm dicoba, Topic 32 – harga kualitas sesuai, Topic 33 – dicoba belum, Topic 34 – coba belum, Topic 38 – kualitas menurun, Topic 43 – smash sekali langsung rusak	Kualitas Produk (Umum) (general dissatisfaction)

Selanjutnya 27.000 ulasan konsumen di lakukan proses pengelompokan sentimen menjadi tiga kelompok: positif, negatif dan netral. BERTopic menciptakan kluster topik mikro yang secara akurat mencerminkan pengalaman dan ekspresi konsumen. Topik yang dihasilkan tidak mampu menggambarkan kebutuhan analisis kualitas produk dan layanan. Model LDA atau BERTopic dapat menganalisis ulasan untuk setiap kata (token) dan mengelompokkan istilah serupa ke dalam topik yang sama [6].

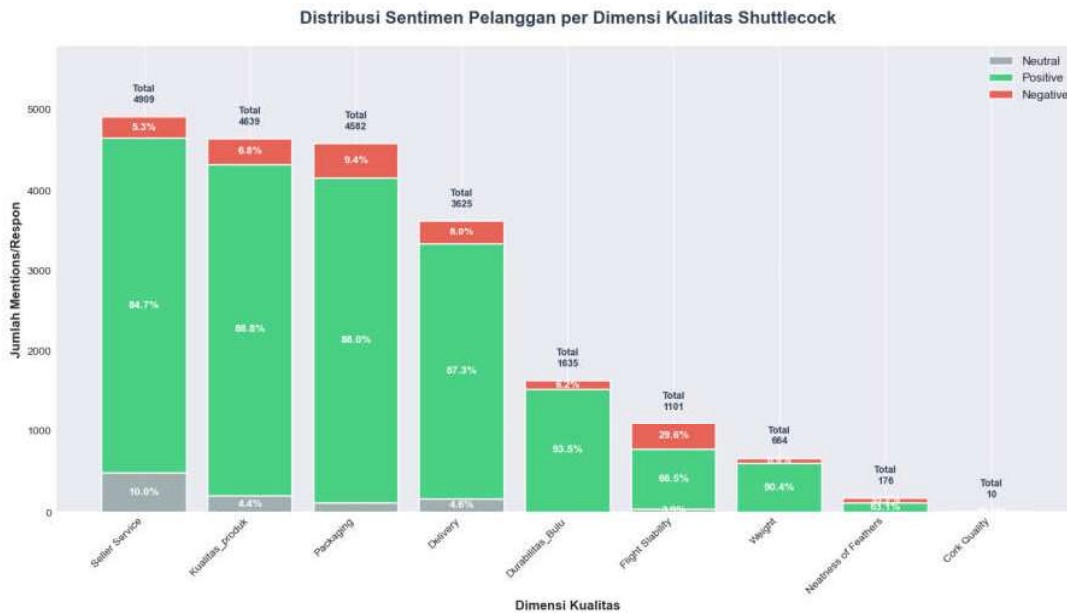
Tabel 2. Hasil ABSA dan BERTopic

Attribute Quality	Quality Dimensions	Tota_Mentions	Positive	Negative	Neutral	Positive_Pct	Negative_Pct	Net_Sentiment
Seller Service	E-Service Quality	4.909	4.158	262	489	84,70	5,34	79,36
General Product Quality	Product Quality	4.639	4.121	316	202	88,83	6,81	82,02
Packaging	E-Service Quality	4.582	4.034	430	118	88,04	9,38	78,66
Delivery	Delivery Performance	3.625	3.166	291	168	87,34	8,03	79,31
Feather Durability	Product Quality	1.635	1.529	102	4	93,52	6,24	87,28
Flight Stability	Product Quality	1.101	732	326	43	66,49	29,61	36,88
Weight	Product Quality	664	600	59	5	90,36	8,89	81,48
Neatness of Feathers	Product Quality	176	111	62	3	63,07	35,23	27,84
Cork Head Quality	Product Quality	10	2	8	-	20,00	80,00	-60,00

## C.2 Hasil analisis,

Penelitian ini bertujuan untuk menemukan peluang peningkatan kualitas produk e-commerce. Model BERTopic dipilih untuk mengidentifikasi ulasan negatif atau keluhan pelanggan. Ulasan negatif dapat mengidentifikasi beberapa faktor atau aspek utama yang memengaruhi pengalaman pengguna [7]. BERTopic dengan ulasan negatif menawarkan wawasan yang lebih mendalam tentang masalah yang sedang terjadi. Ulasan produk negatif atau kritik lebih mudah dipahami, dan masalah yang sebelumnya tersembunyi dapat muncul melalui berbagai jenis kritik produk [8]. Ulasan negatif juga berfungsi sebagai sinyal kualitas untuk perbaikan dan mewakili "pembelajaran berbasis cacat." BERTopic ini dapat menghasilkan peta keluhan yang benar-benar relevan untuk perbaikan. Model ini digunakan untuk mengekstrak topik mikro negatif, positif, dan netral yang lebih rinci. Model

ini mampu menyediakan topik yang lebih bermakna dan beragam dibandingkan dengan LDA dan LSA [9]. Dari data yang masuk dibuatkan analisis sentimen dan peluangnya sebagai berikut



Gambar 1. Distribusi sentimen pelanggan untuk sembilan dimensi kualitas produk

Untuk pemanfaatan data set yang telah dikumpulkan menjadi satu kebijakan perbaikan di level perusahaan, maka penelitian ini mengambil lima sample IKM yang memasarkan produknya melalui media pemasaran online seperti Bukalapak.com. sample yang diambil selama antara Agustus 2023 s/d Juli 2025. Lalu dipilih beberapa IKM yang memiliki total review di atas 1000 comment. Data sample dapat dilihat tabel 3 berikut ini:

Tabel 3. Sample Lima Merek Terbesar dalam Review Online

Product Label	Total Reviews	Cleaned Reviews	Total Mentions	%
BrandLabel_1	1141	788	557	70,69
BrandLabel_2	1247	1055	644	61,04
BrandLabel_3	1560	1272	1008	79,25
BrandLabel_4	1119	967	957	98,97
BrandLabel_5	1540	1287	1006	78,17

Kelima produk yang dianalisis menunjukkan pola **substantial review reduction** setelah proses pembersihan. Dalam riset komentar e-commerce, kondisi ini sering terjadi karena: **Banyak komentar tidak relevan**, Produk dengan tingkat popularitas tinggi biasanya memiliki **rasio noise lebih besar** (komentar noise / tidak bermakna, comment yang terlalu pendek, emogi, kalimat berulang). sehingga wajar clean-review antar 69%–86%. Analisis diarahkan pada *quality-related mentions* (Total Mentions) yang berisi komentar tentang **kualitas produk** dan **kualitas layanan**. Dari sample yang diambil hanya 61% sampai 79% yang mengandung *quality-related mentions*, kecuali Label\_4 yang cukup istimewa, Konsumen produk ini sangat terfokus pada kualitas, dimana comment yang direview 98,9% berkaitan kualitas. Tingginya rasio relevansi menunjukkan konsumen: sangat engaged, memiliki pengalaman berbeda antar batch, atau terdapat isu mutu yang membuat konsumen menulis ulasan mendalam.

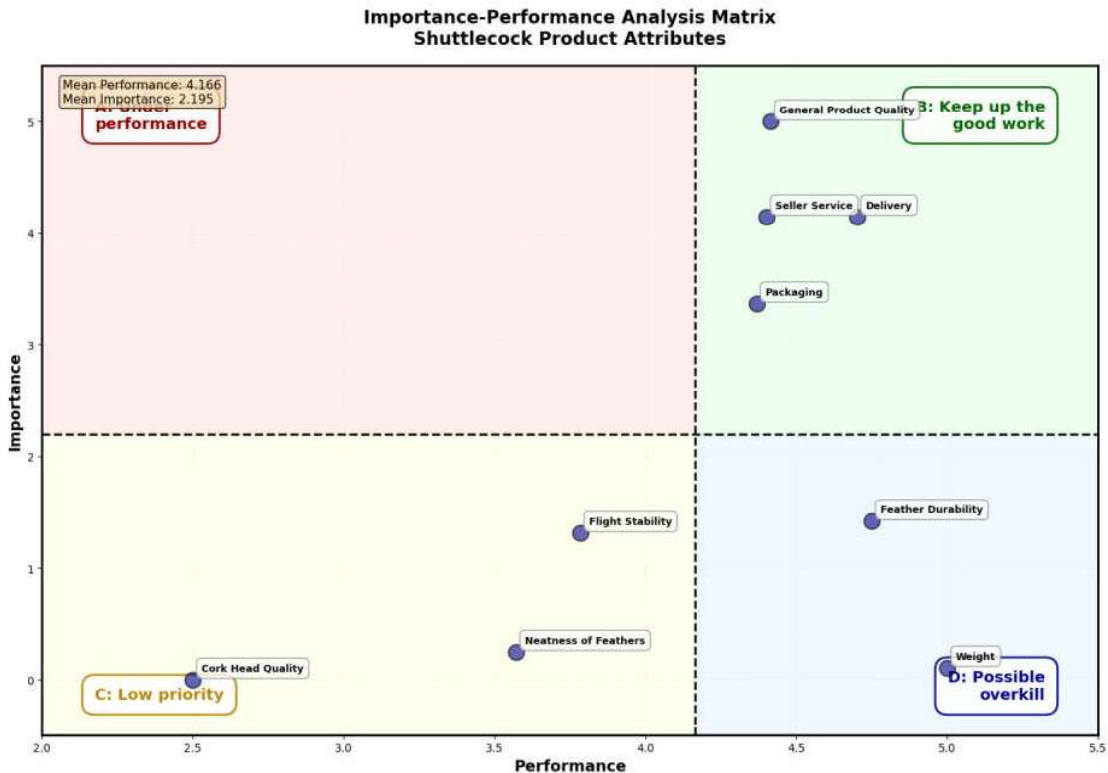
Berikut ini tabel 3 berupa dataset ini berisi 5 brand (Brand1–Brand5) dan 9 atribut kualitas:

Tabel 4 Perbandingan lima terhadap atribut kualitas produk dan layanan online

Attribute Quality	BrandLable_1				BrandLable_2				BrandLable_3				BrandLable_4				BrandLable_5			
	Total Mentions	P	N	Neu	Total Mentions	P	N	Neu	Total Mentions	P	N	Neu	Total Mentions	P	N	Neu	Total Mentions	P	N	Neu
Seller Service	117	97	8	12	177	145	14	18	233	190	15	28	205	174	8	23	260	218	12	30
General Product Quality	141	123	15	3	139	114	15	10	225	185	27	13	204	190	7	7	230	203	19	8
Delivery	117	108	5	4	139	119	14	6	216	178	26	12	125	114	7	4	225	195	22	8
Packaging	95	81	10	4	114	86	23	5	200	155	35	10	239	212	21	6	179	155	19	5
Feather durability	40	38	2	0	33	26	7	0	78	73	5	0	89	85	4	0	56	48	8	0
Flight Stability	37	27	8	2	23	14	9	0	31	11	20	0	25	17	6	2	47	26	18	3
Neatness of Feathers	7	5	2	0	11	5	6	0	13	8	5	0	2	1	1	0	3	2	1	0
Weight	3	3	0	0	7	3	4	0	12	9	3	0	68	67	1	0	5	5	0	0
Cork Head Quality	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	0	1	0
Total	557	482	50	25	644	513	92	39	1008	809	136	63	957	860	55	42	1006	852	100	54

Dari tabel tersebut secara umum, Brand 4 dan Brand 5 memiliki volume mention paling tinggi dimana ini menandakan tingkat konsumsi, popularitas, dan variasi pengalaman konsumen


Studi LDA atau BERTopic dan penerapannya untuk meningkatkan kinerja UMKM telah banyak diteliti. Penelitian ini menggunakan model Importance-Performance Analysis (IPA). Model ini cukup akurat, berbiaya rendah, dan fleksibel, sehingga berguna untuk peningkatan layanan [10]. Pendekatan IPA dari analisis atribut produk online untuk mengidentifikasi pentingnya dan kinerja fitur baru produk yang baru dirilis secara real-time [11].



Gambar 2 Peta atribut kualitas produk dan jasa dalam model IPA (importance-performance)

## Tahap 2: analisis hasil pengukuran sejumlah sample IKM yang menjual produk di ecommerce

Untuk tahun kedua, penelitian ini sudah menyiapkan sejumlah pengujian produk riil yang bekerjasama dengan Balai Besar Standarisasi dan Pelayanan Jasa Kerajinan dan Batik, Yogyakarta. Sejumlah sample dari berbagai merek dikumpulkan dan diuji di lab Kualitas Teknik Industri UNS. Yang selanjutnya divalidasi oleh tim Balai Besar Standarisasi dan Pelayanan Jasa untuk uji verifikasi kesesuaian standar SNI no 36 / 2014. Berikut bukti kerjasama pengujian sejumlah merek shuttlecock




**Kementerian Perindustrian**  
REPUBLIK INDONESIA

**BADAN STANDARDISASI DAN KEBIJAKAN JASA INDUSTRI**  
**BALAI BESAR STANDARDISASI DAN PELAYANAN**  
**JASA INDUSTRI KERAJINAN DAN BATIK**

Jl. Kusumanegara No. 7 Yogyakarta 55156, Telp. 0274-546111, Fex. 0274-543582  
Website: <http://www.bkbk.kemendperin.go.id>, E-mail: [bkbk@kemendperin.go.id](mailto:bkbk@kemendperin.go.id)

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**TANDA TERIMA PENGUJIAN**

Kode Pengujian :   
**GDGYZ**

Nama Pelanggan : Universitas Sebelas Maret Surakarta  
Alamat : Gedung LPPM Lt. I Universitas Sebelas Maret Surakarta,  
Jl. Ir. Sutami 36 A Kentingan Jebres Surakarta

Jenis Lembaga : pemerintah  
Pengirim : Eko Liquiddanu (HP:081220556616)  
Jenis Order : Lisan  
Nomor Surat : -

Jenis Uji : uji alat olahraga  
Jumlah Sempel : 15  
Jumlah SHU : 15  
Jumlah SSHU : 1 rankap  
Kondisi : Normal  
Tanggal masuk : 28/11/2025  
Tanggal proses : 01/12/2025  
Tgl Maks Jadi : 22/12/2025  
Tgl Maks Jadi valid jika transaksi lunas dan konfirmasi ke admin sebelum 28-11-2025, 24.00 WIB

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No	Item Uji	Jml	Biaya Sat	Biaya
1	BBT (Bola Bulu Tangkis) (GARUDA GOLD) (Sesuai SNI 0036-2014 butir 7.1-7.4)	1	Rp 155.000	Rp 155.000
2	BBT (Bola Bulu Tangkis) (GARUDA INTERNASIONAL) (Sesuai SNI 0036-2014 butir 7.1-7.4)	1	Rp 155.000	Rp 155.000
3	BBT (Bola Bulu Tangkis) (KALIMANTAN HB) (Sesuai SNI 0036-2014 butir 7.1-7.4)	1	Rp 155.000	Rp 155.000
4	BBT (Bola Bulu Tangkis) (ISAI) (Sesuai SNI 0036-2014 butir 7.1-7.4)	1	Rp 155.000	Rp 155.000
5	BBT (Bola Bulu Tangkis) (SAMURAI HIJAU) (Sesuai SNI 0036-2014 butir 7.1-7.4)	1	Rp 155.000	Rp 155.000
6	BBT (Bola Bulu Tangkis) (SANSANZ) (Sesuai SNI 0036-2014 butir 7.1-7.4)	1	Rp 155.000	Rp 155.000
7	BBT (Bola Bulu Tangkis) (PUMA) (Sesuai SNI 0036-2014 butir 7.1-7.4)	1	Rp 155.000	Rp 155.000
8	BBT (Bola Bulu Tangkis) (NINE) (Sesuai SNI 0036-2014 butir 7.1-7.4)	1	Rp 155.000	Rp 155.000
9	BBT (Bola Bulu Tangkis) (INDOCOCK) (Sesuai SNI 0036-2014 butir 7.1-7.4)	1	Rp 155.000	Rp 155.000
10	BBT (Bola Bulu Tangkis) (DELI) (Sesuai SNI 0036-2014 butir 7.1-7.4)	1	Rp 155.000	Rp 155.000
11	BBT (Bola Bulu Tangkis) (AW MALANG) (Sesuai SNI 0036-2014 butir 7.1-7.4)	1	Rp 155.000	Rp 155.000
12	BBT (Bola Bulu Tangkis) (GONG2000) (Sesuai SNI 0036-2014 butir 7.1-7.4)	1	Rp 155.000	Rp 155.000
13	BBT (Bola Bulu Tangkis) (INOVA) (Sesuai SNI 0036-2014 butir 7.1-7.4)	1	Rp 155.000	Rp 155.000
14	BBT (Bola Bulu Tangkis) (JP GOLD) (Sesuai SNI 0036-2014 butir 7.1-7.4)	1	Rp 155.000	Rp 155.000
15	BBT (Bola Bulu Tangkis) (CLAUDIA) (Sesuai SNI 0036-2014 butir 7.1-7.4)	1	Rp 155.000	Rp 155.000
16	Biaya Kirim (Langsung)			Rp 0
	<b>Total Biaya Pengujian</b>			<b>Rp 2.325.000</b>

==== dua juta tiga ratus dua puluh lima ribu rupiah ====

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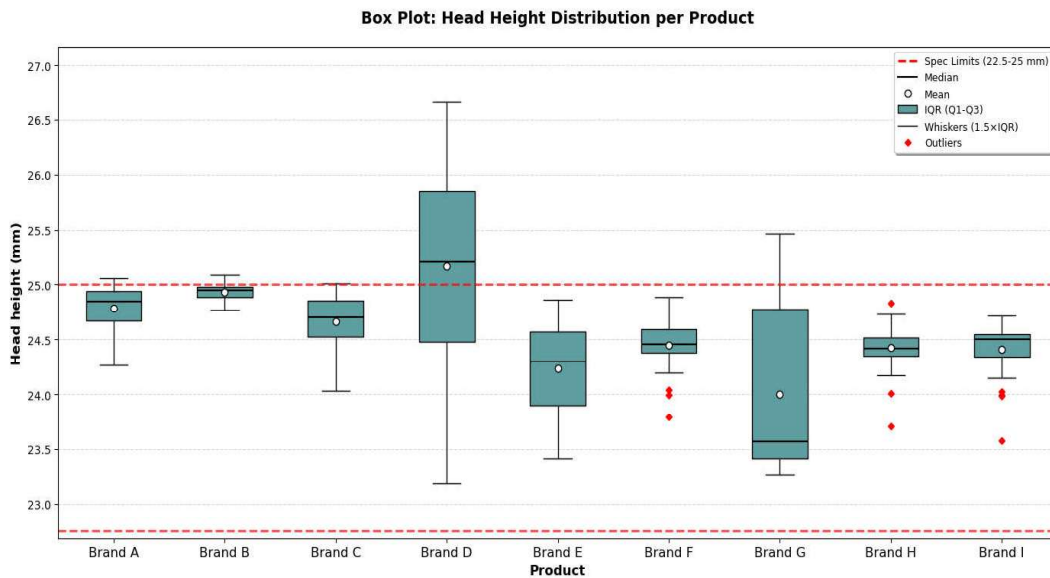
Catatan:

<input type="checkbox"/> Kaji Ulang Permohonan: <input type="checkbox"/> Toleransi	Lain-lain :
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Gambar 3. Kerjasama dengan pihak Balai Besar Standarisasi untuk pengujian produk berdasarkan SNI 36/2014

Untuk menilai kinerja objektif setiap merek produk, enam parameter kualitas utama diukur melalui pengujian laboratorium standar sesuai dengan spesifikasi produk nasional yang relevan[12]. Parameter-parameter tersebut meliputi Panjang Bulu, Diameter Bulu, Berat, Tinggi Kepala, Diameter Kepala, dan Stabilitas Penerbangan, yang mewakili karakteristik fisik dan aerodinamis kinerja kok. Pengukuran

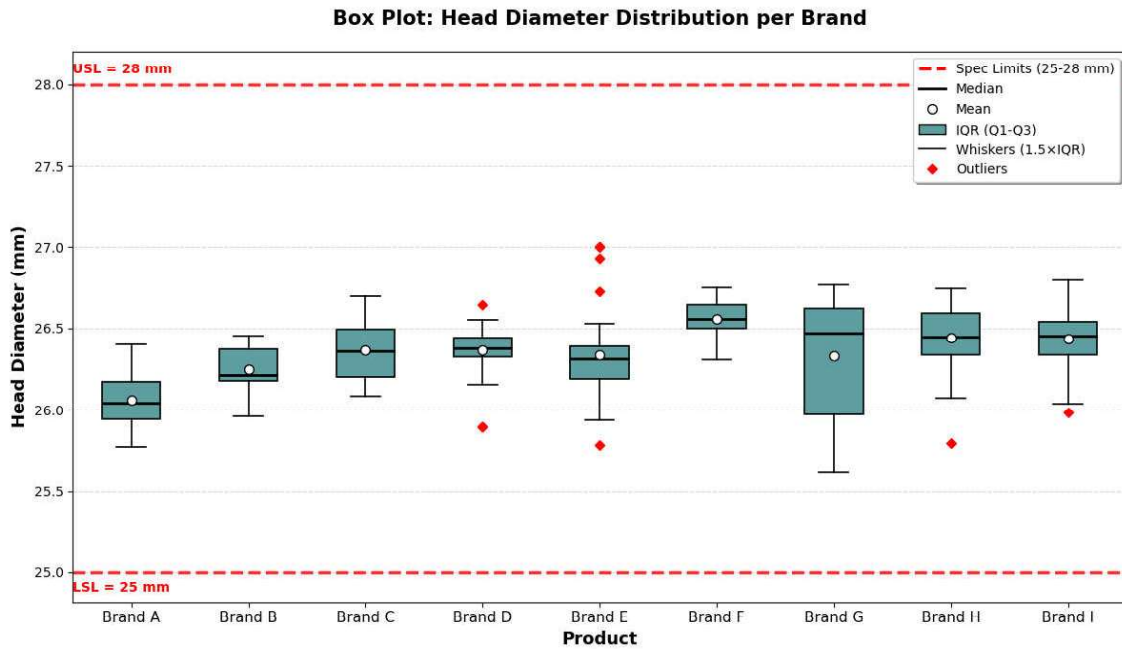
dinormalisasi pada skala 0–1 untuk memungkinkan perbandingan antar merek. Gambar 2 menyajikan distribusi dan variasi setiap parameter, mengilustrasikan posisi relatif merek terhadap standar referen



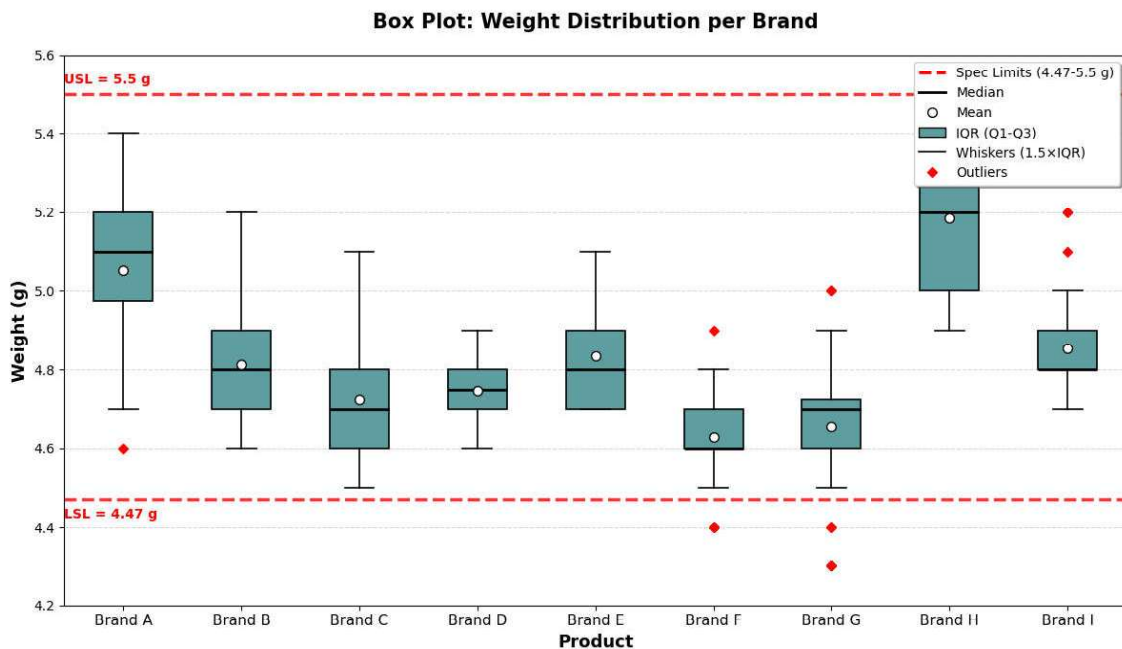
Gambar 4. Distribusi hasil pengujian tinggi dop sejumlah merek yang dijual online

Gambar 4 menunjukkan distribusi tinggi kepala (head height) untuk sembilan merek (Brand A–I). Setiap kotak merepresentasikan interquartile range (IQR, Q1–Q3), garis tengah menunjukkan median, titik putih menunjukkan mean, dan titik merah mewakili outliers. Dua garis horizontal putus-putus merah menggambarkan batas spesifikasi (spec limits) sebesar 22.5 mm (batas bawah) dan 25 mm (batas atas). Secara umum, sebagian besar merek memiliki distribusi tinggi kepala yang terkonsentrasi di sekitar rentang 24–25 mm, namun terdapat variasi signifikan di beberapa merek tertentu. Brand A, C, E, F, dan I menunjukkan konsistensi tinggi dan berada sepenuhnya dalam rentang spesifikasi. Brand D menunjukkan penyimpangan terbesar, dengan median dan rentang atas di atas batas spesifikasi (indikasi potensi non-conformity). Brand G dan H memiliki variasi tinggi dan outlier cukup banyak, mengindikasikan ketidakstabilan proses manufaktur.

Dari panjang whisker dan banyaknya outlier, terlihat bahwa **Brand D, G, dan H** memiliki *process variation* yang relatif tinggi. Hal ini bisa disebabkan oleh: Variasi bahan baku, Inkonsistensi setelan mesin, atau Kurangnya kontrol kualitas proses produksi. Sebaliknya, **Brand A, B, C, dan I** memperlihatkan *tight process control*, di mana variasi antar sampel minimal dan median mendekati mean, menandakan distribusi yang simetris. Dalam konteks pengendalian mutu berbasis standar industri (misal SNI atau ISO), hasil ini menunjukkan bahwa: **Brand A, F, dan I** berpotensi memiliki **tingkat konformitas tertinggi**, dengan **Cpk (Capability Index)** yang tinggi. **Brand D dan G** perlu dilakukan **analisis akar masalah (root cause analysis)** untuk menelusuri sumber variasi. Pendekatan seperti **Fishbone Diagram** atau **5-Why Analysis** relevan untuk mengidentifikasi faktor penyebab (misal perbedaan material, operator, atau suhu proses). Secara bisnis, konsistensi terhadap spesifikasi tidak hanya meningkatkan *product reliability*, tetapi juga memperkuat **reputasi merek** di pasar yang kompetitif.



Gambar 5. Distribusi hasil pengujian diameter dop sejumlah merek yang dijual online



Gambar 6. Distribusi hasil pengujian berat produk sejumlah merek yang dijual online

**Gambar 5** menunjukkan distribusi berat shuttlecock untuk sembilan merek (Brand A–I), masing-masing berdasarkan 36 sampel produk. Setiap box plot merepresentasikan **interquartile range (IQR, Q1–Q3)**, garis horizontal pada kotak menunjukkan **median**, titik putih adalah **rata-rata (mean)**, dan simbol berlian merah menunjukkan **outliers**. Dua garis horizontal merah putus-putus menunjukkan **batas spesifikasi sesuai standar (SNI/ISO)**, yaitu:

- **Lower Specification Limit (LSL) = 4.47 g**
- **Upper Specification Limit (USL) = 5.50 g**

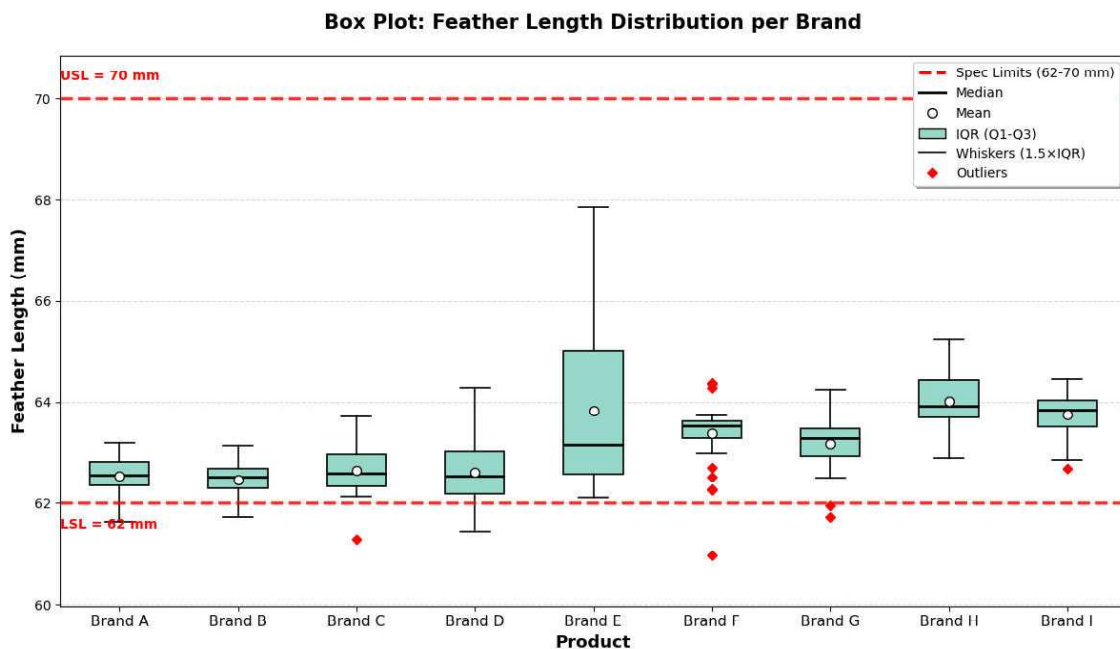
Secara umum, sebagian besar merek memiliki median berat yang berada dalam rentang toleransi. Namun beberapa temuan penting dapat diidentifikasi:

1. **Brand H** memiliki rata-rata dan median tertinggi, berada dekat batas atas spesifikasi (sekitar 5.2–5.3 g), serta menunjukkan variasi yang relatif lebar. Kehadiran beberapa outlier mengindikasikan ketidakstabilan proses dan potensi overweight (over-spec). → Hal ini berpotensi memengaruhi aerodinamika shuttlecock (lebih berat → kecepatan turunnya lebih cepat).
2. **Brand F dan Brand G** menunjukkan nilai median yang lebih rendah dibandingkan merek lainnya, bahkan beberapa sampel berada **di bawah batas spesifikasi (LSL = 4.47 g)**. → Produk yang terlalu ringan berisiko menghasilkan laju terbang yang tidak stabil serta tidak memenuhi syarat mutu kompetisi.
3. **Brand A, C, dan I** menunjukkan distribusi paling konsisten (IQR sempit, tanpa outlier signifikan), menandakan **proses produksi yang stabil (tight process control)**.
4. Tingginya jumlah outlier pada beberapa merek (mis. Brand H dan Brand G) mengindikasikan adanya **ketidakkonsistenan produksi**, yang dapat disebabkan oleh:
  - Variasi densitas material cork,
  - Ketidaktepatan cutting process,
  - Kelemahan quality gate inspection.

Jika dikaitkan dengan **process capability (Cp/Cpk)**:

- **Brand A, C, dan I** berpotensi memiliki nilai **Cpk > 1.33** (kategori capable → proses stabil dan memenuhi spesifikasi).
- **Brand F, G, dan H** diprediksi memiliki **Cpk < 1.0**, sehingga masuk kategori **not capable**, karena mean/median terlalu dekat batas spesifikasi atau terdapat nonconforming units.

**Implikasi bisnis:** Merek dengan variansi rendah dan kepatuhan tinggi pada spesifikasi (Brand A, C, I) lebih konsisten dalam performa terbang dan perceived value di pasar.



Gambar 7. Distribusi hasil pengujian panjang bulu sejumlah merek yang dijual online

**Gambar 7** memperlihatkan distribusi **panjang bulu shuttlecock** dari sembilan merek yang sama (Brand A–I) dengan jumlah sampel identik ( $n = 36$  per brand). Batas spesifikasi ditetapkan berdasarkan standar kompetisi internasional:

- **LSL = 62 mm**
- **USL = 70 mm**

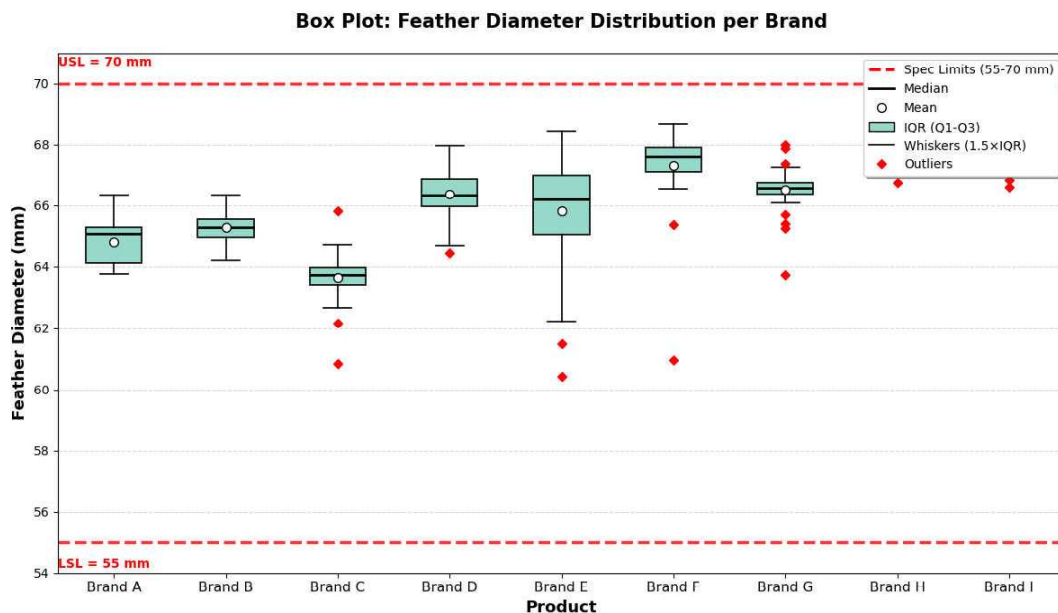
Temuan utama berdasarkan visualisasi:

1. **Brand A, B, C, D, dan I** memiliki IQR yang sempit dan median berada dekat 63–64 mm, menunjukkan **konsistensi geometri feather** dan kontrol proses yang baik.
2. **Brand E** menampilkan **rentang variasi terbesar** (whisker panjang), bahkan terdapat sampel yang mendekati **USL ( $\approx 67\text{--}68$  mm)**. Variabilitas seperti ini menunjukkan ketidakconsistenan pemilihan panjang feather dari sisi material handling atau inconsistency cutting.
3. **Brand F dan G** menunjukkan beberapa **outlier di bawah LSL ( $\leq 62$  mm)**. Feather yang terlalu pendek dapat mengubah stabilitas aerodinamika shuttlecock selama permainan (flight & rotation stability).
4. **Brand H** memiliki median lebih tinggi dibanding brand lainnya tetapi masih dalam spesifikasi. Meskipun demikian, adanya outlier menandakan ketidakstabilan manufaktur atau batch mixing antara feather grade yang berbeda.

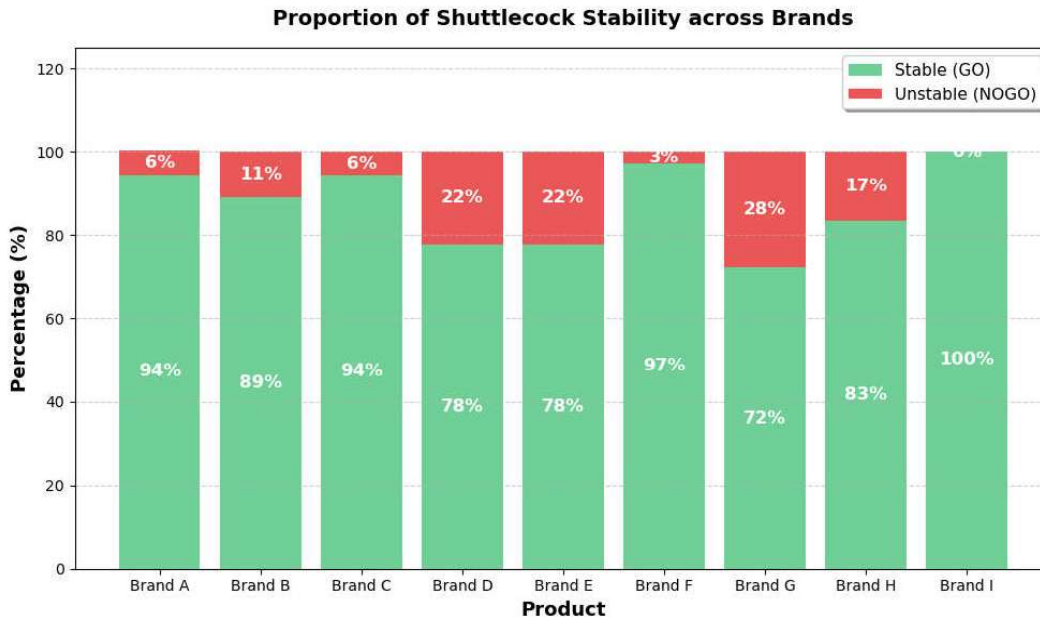
Jika dikaitkan dengan mutu proses:

- **Brand A, B, C, dan I** merupakan brand dengan potensi **Cpk tinggi**, karena mean terletak di tengah rentang spesifikasi dan variansi rendah.
- **Brand E, F, dan G** merupakan kandidat untuk **process root cause analysis**, sebab tingginya variasi (IQR besar) dan kemunculan outlier menandakan kualitas material dan parameter proses belum stabil.

Kontrol dimensi feather yang baik sangat penting, karena panjang feather adalah faktor dominan dalam kestabilan putaran (spin) dalam permainan profesional.



Gambar 8. Distribusi hasil pengujian diameter bulu sejumlah merek yang dijual online



**Gambar 9 uji kestabilan layang**

**Gambar 9** menampilkan proporsi kestabilan terbang shuttlecock untuk sembilan merek (Brand A–I), masing-masing diuji menggunakan 36 sampel produk per merek. Dua kategori hasil uji flight stability ditunjukkan dengan diagram **stacked bar: GO (Stable)** — shuttlecock terbang stabil, layang konsisten, dan memenuhi standar performa (warna hijau). **NOGO (Unstable)** — shuttlecock mengalami ketidakstabilan aerodinamis, cenderung oleng, atau putaran tidak konsisten (warna merah).

Tabel 5 hasil rekap pengujian sejumlah merek shuttlecock pada tahun 1

SMES	Feather Legth	Feather Diameter	Weight	Head height	Head Diameter	Flight Stability	Measured Product Quality (Objective)
Brand A	0,561	0,692	0,228	0,610	0,813	0,944	0,641
Brand B	0,578	0,751	0,340	0,668	0,872	0,889	0,683
Brand C	0,540	0,725	0,310	0,607	0,855	0,944	0,664
Brand D	0,477	0,638	0,593	0,067	0,873	0,778	0,571
Brand E	0,310	0,372	0,473	0,597	0,793	0,778	0,554
Brand F	0,556	0,486	0,356	0,678	0,916	0,972	0,661
Brand G	0,571	0,650	0,124	0,362	0,724	0,722	0,526
Brand H	0,617	0,614	0,292	0,690	0,857	0,833	0,651
Brand I	0,640	0,614	0,499	0,673	0,867	1,000	0,716

Hasil pengukuran objektif terhadap enam parameter mutu fisik menunjukkan adanya variasi yang jelas antar-merek dalam hal kesesuaian terhadap standar kualitas produk. Brand I menunjukkan kualitas tertinggi (0,716), diikuti oleh Brand B (0,683) dan Brand F (0,661). Ketiga merek ini secara konsisten unggul pada atribut struktural kritis seperti *feather length consistency*, *head diameter precision*, dan *flight stability*, yang merupakan determinan utama performa shuttlecock dalam permainan. Kinerja Brand I sangat dominan pada parameter *flight stability* (skor 1,000), sedangkan Brand F mencapai skor tertinggi pada *head diameter* (0,916) dan stabilitas terbang (0,972). Temuan ini mengindikasikan bahwa kedua brand tersebut bukan hanya dipersepsikan positif oleh konsumen, tetapi juga memenuhi dimensi kualitas yang dapat diukur secara obyektif di laboratorium.

Sebaliknya, Brand E (0,554) dan Brand G (0,526) berada di kelompok kualitas rendah. Kedua merek gagal mencapai skor memadai pada atribut struktural seperti *feather diameter* dan *head height*, yang merefleksikan ketidakstabilan proses fabrikasi, kemungkinan terkait variabilitas material atau

kurangnya kontrol kualitas pada tahap produksi. Brand D menunjukkan penurunan tajam pada parameter *head height* (0,067), meskipun dimensi lain tampak moderat—hal ini memperlihatkan bahwa ketidakkonsistenan pada satu atribut kritikal dapat menurunkan nilai keseluruhan mutu produk. Pola ini memperkuat temuan studi sebelumnya bahwa kualitas fisik yang terstandarisasi merupakan prediktor utama performa aerodinamis shuttlecock ([13],[14]). Selain itu, kesesuaian antara hasil pengukuran objektif dan persepsi konsumen pada brand berkinerja tinggi (Brand I dan F) menunjukkan bahwa *consumer sentiment* dalam e-commerce tidak hanya dipengaruhi oleh *brand equity*, tetapi juga mencerminkan actual product performance.

### C.3 Capaian luaran (wajib dan atau tambahan).

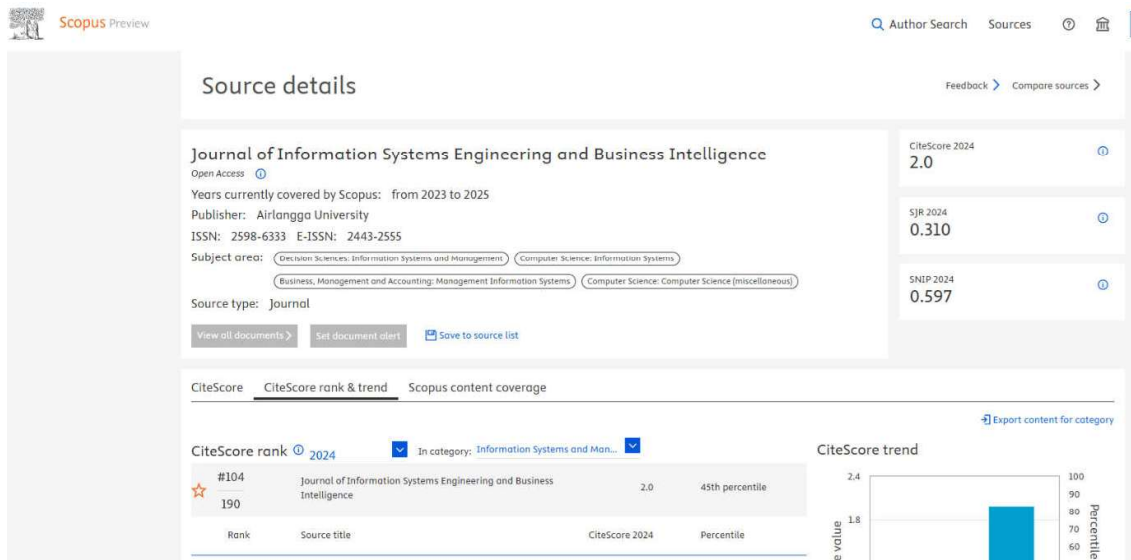
Terdapat tiga jenis luaran yang diperoleh pada tahun pertama, yang dapat dilihat tabel berikut:

Tabel 6 Jenis luaran wajib dan tambahan yang dihasilkan pada tahun pertama

No	Jenis luaran	Identitas	Status ketercaipan
1	Luaran wajib: jurnal terindeks scopus Q3	Nama jurnal: <b>Journal of Information Systems Engineering and Business Intelligence (Terindeks scopus Q3)</b> Dengan link jurnal: <a href="https://www.scopus.com/sourceid/21101152758">https://www.scopus.com/sourceid/21101152758</a> Judul paper: “An Integrated BERT , ABSA and BERTopic Framework for Quality Improvement in Shuttlecock SMEs Based on ECommerce Reviews”	<b>Submitted</b>
2	Luaran tambahan 1 Jurnal terindeks <b>Sinta 2</b>	Nama jurnal : <b>Spektrum Industri</b> <b>Vol. 23, No. 2, 2025</b> , pp. 225-239 ISSN 1693-6590 Terindeks di DOAJ: <a href="https://doaj.org/toc/2442-2630">https://doaj.org/toc/2442-2630</a> & Proques : <a href="http://www.proquest.com">www.proquest.com</a> Judul paper: “Integrating Explainable AI and the Kano Model to Derive Improvement Strategies for Essential Oils from Online Reviews” <a href="https://www.proquest.com/docview/3276240933?fromopenview=true&amp;pq-rigsite=gscholar&amp;sourcetype=Scholarly%20Journals">https://www.proquest.com/docview/3276240933?fromopenview=true&amp;pq-rigsite=gscholar&amp;sourcetype=Scholarly%20Journals</a>	<b>published: Oktober 2025,</b>
3	Luaran tambahan 2 Hak kekayaan Intelaktual (HKI)	Jenis Ciptaan: Program Komputer Judul Ciptaan: Aplikasi Evaluasi Kebutuhan Pelanggan Secara Holistik dengan Model Kano dan Explainable AI	<b>published: 10 September 2025</b>

D. **STATUS LUARAN:** Tuliskan jenis, identitas dan status ketercapaian setiap luaran wajib dan luaran tambahan (jika ada) yang dijanjikan. Jenis luaran dapat berupa publikasi, perolehan kekayaan intelektual, atau luaran lainnya yang telah dijanjikan pada proposal. Uraian status luaran harus didukung dengan bukti kemajuan ketercapaian luaran sesuai dengan luaran yang dijanjikan. Lengkapi isian jenis luaran yang dijanjikan serta mengunggah bukti dokumen ketercapaian luaran melalui BIMA.

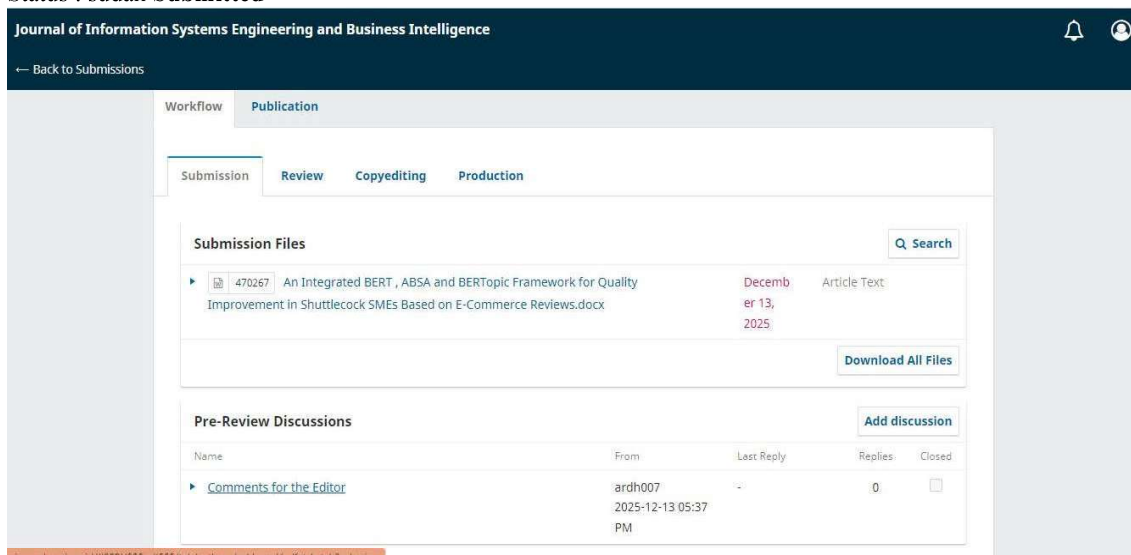
1. Jenis luaran wajib : Jurnal bereputasi Internasional (**terindeks Scopus Q3**)  
 Nama jurnal: **Journal of Information Systems Engineering and Business Intelligence** (. Dengan link jurnal: <https://www.scopus.com/sourceid/21101152758>)



Gambar 10 Informasi identitas jurnal di dalam WEB Scopus (Q3)

Judul paper: **“An Integrated BERT , ABSA and BERTopic Framework for Quality Improvement in Shuttlecock SMEs Based on ECommerce Reviews”**

Status : sudah **Submitted**



Gambar 11.a Bukti pengiriman (submitted) paper ke jurnal **Journal of Information Systems Engineering and Business Intelligence**

Journal of Information Systems Engineering and Business Intelligence

← Back to Submissions

84022 / Sakti et al. / An Integrated BERT , ABSA and BERTopic Framework for Quality Improvement in Shuttlecock SMEs Based on E-Co Library

Workflow Publication

Status: Unscheduled

Title & Abstract

Contributors

References

Galleys

List of Contributors				
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Rina Fitriana	rinaf@trisakti.ac.id	Author		<input checked="" type="checkbox"/>

[JISEBI] Submission Acknowledgement External inbox x

JISEBI Editorial Office <jisebi@journal.unair.ac.id>  
to me, Rina

Dec 13, 2025, 5:43 PM (9 hours ago)

Hello,

Ardhy Yulawan Norma Sakti has submitted the manuscript, "An Integrated BERT , ABSA and BERTopic Framework for Quality Improvement in Shuttlecock SMEs Based on E-Commerce Reviews" to Journal of Information Systems Engineering and Business Intelligence.




If you have any questions, please contact me. Thank you for considering this journal as a venue for your work.

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<http://e-journal.unair.ac.id/index.php/JISEBI>

Gambar 11.b Bukti pengiriman (submitted) paper ke jurnal **Journal of Information Systems Engineering and Business Intelligence**

## An Integrated BERT , ABSA and BERTopic Framework for Quality Improvement in Shuttlecock SMEs Based on E-Commerce Reviews

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### Abstract

Consumer perceptions of product quality, as reflected in e-commerce reviews, have become an alternative for improving product and e-commerce service quality. Nonetheless, not all small and medium enterprises can leverage customer review data to generate improvement ideas due to insufficient data-processing skills. This study aims to explore key quality attributes that shape consumer perception through e-commerce reviews. This research also investigates how non-product factors, including seller service and delivery performance, can impact the overall customer experience. This research uses a BERT-based deep learning model to classify reviews of positive, neutral, and negative narratives. In the 3,267 negative review dataset, an attempt was made to explore several quality attributes. Aspect-Based Sentiment Analysis (ABSA) is used to identify nine key quality dimensions. Additionally, a BERTopic was applied to categorize reviews into 47 micro-topics. Importance-Performance Analysis (IPA) to determine which attributes need improvement. A small- to medium-sized enterprise mentor review was also integrated to validate the identified product attributes. The non-product factors, especially seller service, packaging reliability, and delivery performance, are significant drivers of customer dissatisfaction. A feather's durability and flight stability, categorized as engineering product attributes, were found to be crucial in shaping dissatisfaction. Feather durability was considered an industry-standard expectation. At the same time, flight stability varied significantly across brands. Product weight, cork head quality, and feather neatness were of lower importance due to the infrequency of reviews. This study provides a model integration on sentiment analysis with the BERT model, ABSA, BERTopic, and IPA. The result showed that quality perception is shaped by seller service, packaging reliability, and delivery performance. Still, technical product attributes remain critical in forming dissatisfaction.

**Keywords:** Aspect-Based Sentiment Analysis (ABSA), BERT Model, BERTopic, Quality Perception, Importance Performance Analysis (IPA)

**Article history:** Received 5 April 20XX, first decision 22 April 20XX, accepted 22 August 20XX, available online 28 October 20XX

### I. INTRODUCTION

Customer review about a product have been recognized as a key factor in improving its quality. For many years, companies mostly used structured questionnaires, expert evaluations, and manually collected customer comments to find the most important areas to improve product performance [1]. These traditional methods are becoming less useful in today's digital marketplace. Sales using e-commerce have changed the way consumers evaluate and provide reviews of product and service quality. Customer reviews can be gathered through e-commerce platforms and spread quickly on social media. Customer reviews on e-commerce have become one of the references for potential buyers to decide on product purchases. Thus, Small and Medium Enterprises (SME) can gather the reviews to get valuable feedback and a critical indicator of perceived quality [2]. However, SMEs lack advanced data processing capabilities and thus cannot identify improvement proposals from customer review data [3]. SMEs ensure that the quality of the products produced is always consistent with the established standards. From a quality management perspective, the integration of customer feedback into product design and improvement is deeply rooted in the principles of Total Quality Management (TQM) and Quality Assurance [1]. But in practice, the products' quality may not meet expectations, and this inconsistency is perceived by buyers through subjective evaluations and reviews [4]. Studies show that consumer

\* Corresponding author

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Terindeks di DOAJ: <https://doaj.org/toc/2442-2630> & Proques : [www.proquest.com](http://www.proquest.com)

The screenshot shows the SINTA website interface. At the top, there are navigation links for Author, Subjects, Affiliations, Sources, FAQ, WCU, Registration, and Log. The main content area displays 'Journals' with a search bar and a 'Filter' button. Below this, there are three summary cards: 'Total Journals' (13,520), 'Total Publishers' (1,791), and 'Accreditations Level' (a donut chart showing levels S1-S4 and Net Accredited). A search bar contains 'Spektrum Industri' and shows 'Results for "Spektrum Industri"'. Below the search results, there are navigation buttons for 'Previous', '1', and 'Next', and a page indicator 'Page 1 of 1 Total Records 1'. The main entry for 'SPEKTRUM INDUSTRI' is shown, including its logo, a green checkmark, and various details: Google Scholar, Website, Editor URL, Universitas Ahmad Dahlan, P-ISSN: 16936590, E-ISSN: 24422630, Subject Area: Engineering, S2 Accredited, and Garuda Indexed. At the bottom of the entry, there are four circular icons representing metrics: 2,39 Impact, 17 H5-index, 1,539 Citations Syr, and 2,130 Citations.

Gambar 13 Informasi identitas jurnal di dalam WEB SINTA DIKTI

Judul paper: “Integrating Explainable AI and the Kano Model to Derive Improvement Strategies for Essential Oils from Online Reviews” Bukti paper <https://www.proquest.com/docview/3276240933?fromopenview=true&pq-riqsite=gscholar&sourcetype=Scholarly%20Journals>

The screenshot shows the ProQuest website interface. At the top, there is a search bar with the text 'Enter search terms...'. Below the search bar, there is a section for 'Full Text | Scholarly Journal' with the title 'Integrating Explainable AI and the Kano Model to Derive Improvement Strategies for Essential Oils from Online Reviews' and the authors 'ZAMAN, HANIF; LIQUIDDANU, EKO'. Below the title, there is a PDF viewer showing the first page of the document. The PDF viewer has a toolbar with various icons and a page indicator '1 / 16' and '121%' zoom. The document content includes the journal title 'Spektrum Industri', volume and issue information 'Vol. 23, No. 2, 2025, pp. 225-239', ISSN '1693-6590', and the URL 'https://journal3.uad.ac.id/index.php/spektrum/index'. The article title is 'Integrating Explainable AI and the Kano Model to Derive Improvement Strategies for Essential Oils from Online Reviews' and the authors are 'Akhdan Hanif Kartika Zaman\*, Eko Liquiddanu'. The department is 'Department of Industrial Engineering, Universitas Sebelas Maret, Surakarta, 57126, Indonesia' and the corresponding author is 'ekoliquiddanu@staff.ums.ac.id'. At the bottom of the PDF viewer, there are two tabs: 'ARTICLE INFO' and 'ABSTRACT'.

Gambar 14 Bukti paper dapat diunduh di <https://www.proquest.com>

## Integrating Explainable AI and the Kano Model to Derive Improvement Strategies for Essential Oils from Online Reviews

Akhdan Hanif Kartika Zaman \*, Eko Liquiddanu

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### ARTICLE INFO

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#### Keywords

Customer satisfaction;

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Kano model;

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### ABSTRACT

Growing consumer interest in natural wellness products, particularly essential oils, highlights the need to understand key quality product attributes affecting consumer satisfaction. In the digital era, customer reviews in marketplaces have become the main source of consumer-driven insights for improving production and service processes. However, conventional approaches often fail to systematically extract actionable insights from these unstructured data sources. This study proposes an integrated machine learning framework for three market on essential oils and their derivatives. This framework transforms thousands of online customer reviews into a structured analysis of satisfaction dimensions. The approach uniquely contributes by employing regression model combined with Explainable AI (SHAP) and KANO Classification to systematically applied based on SHAP insights to develop a marketing strategy based on three market segments for essential oil products and their derivatives. Eleven critical satisfaction dimensions were extracted, including aroma, price, packaging, delivery, and others. These segment-specific insights imply that producers should prioritize reliable pricing and delivery for low-tier markets, ensure strict price fairness and value consistency for mid-tier consumers, and, for high-tier segments, focus on integrating diffuser compatibility as a basic requirement while leveraging bonuses as emotional value-adds to enhance customer delight. Theoretically, this research introduces a scalable, Explainable AI-based approach for applying the Kano model to unstructured textual data, overcoming limitations of traditional survey methods. Despite its strengths, this study is limited by the absence of validation for the Kano categorization through survey-based procedures. Future work will address this limitation by conducting perception-based surveys or interviews to validate and refine the inferred categorizations. Nonetheless, this research contributes a methodology and provides actionable strategies for essential oil producers to align product improvements with consumer expectations in digital commerce environments.

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### 1. Introduction

Essential oils have gained increasing popularity in recent years, driven by rising consumer interest in natural wellness, aromatherapy, and organic personal care (Sharmeen et al., 2021). Indonesia's export market has shown consistent growth over the last three years, with export values

**Luaran tambahan 2:** Hak kekayaan Intelaktual (HKI), Jenis Ciptaan: Program Komputer.

Judul Ciptaan: Aplikasi Evaluasi Kebutuhan Pelanggan Secara Holistik dengan Model Kano dan Explainable AI

Status: published pada tanggal 10 September 2025

REPUBLIC INDONESIA  
KEMENTERIAN HUKUM

## SURAT PENCATATAN CIPTAAN

Dalam rangka perlindungan ciptaan di bidang ilmu pengetahuan, seni dan sastra berdasarkan Undang-Undang Nomor 28 Tahun 2014 tentang Hak Cipta, dengan ini menerangkan:

Nomor dan tanggal permohonan : EC002025163730, 26 Oktober 2025

**Pencipta**  
Nama : **Eko Liquidanu dan Akhdan Hanif Kartika Zaman**  
Alamat : Perum Triyagan Asri III No B-6 Triyagan, Mojolaban, Kab. Sukoharjo, Jawa Tengah, 57554  
Kewarganegaraan : Indonesia

**Pemegang Hak Cipta**  
Nama : **Universitas Sebelas Maret**  
Alamat : Lembaga Penelitian dan Pengabdian kepada Masyarakat Gedung Haris Mudjiman Lt. 4 Universitas Sebelas Maret Jl. Ir Sutami 36A Ketingan Jebres Surakarta, Jebres, Kota Surakarta, Jawa Tengah, 57126  
Kewarganegaraan : Indonesia

Jenis Ciptaan : **Program Komputer**  
Judul Ciptaan : **APLIKASI EVALUASI KEBUTUHAN PELANGGAN SECARA HOLISTIK DENGAN MODEL KANO DAN EXPLAINABLE AI**

Tanggal dan tempat diumumkan untuk pertama kali di wilayah Indonesia atau di luar wilayah Indonesia : 10 September 2025, di Kota Surakarta

Jangka waktu perlindungan : Berlaku selama 50 (lima puluh) tahun sejak Ciptaan tersebut pertama kali dilakukan Pengumuman.

Nomor Pencatatan : 001003990

adalah benar berdasarkan keterangan yang diberikan oleh Pemohon.  
Surat Pencatatan Hak Cipta atau produk Hak terkait ini sesuai dengan Pasal 72 Undang-Undang Nomor 28 Tahun 2014 tentang Hak Cipta.

a.n. MENTERI HUKUM  
DIREKTUR JENDERAL KEKAYAAN INTELEKTUAL  
u.b  
Direktur Hak Cipta dan Desain Industri

Agung Damarsasongko,SH.,MH.  
NIP. 196912261994031001

**Balai Besar Sertifikasi Elektronik**

Dislaimer:  
1. Dalam hal pemohon memberikan keterangan tidak sesuai dengan surat pernyataan, Menteri berwenang untuk mencabut surat pencatatan permohonan.  
2. Surat Pencatatan ini telah dipegel secara elektronik menggunakan segel elektronik yang diterbitkan oleh Balai Besar Sertifikasi Elektronik, Badan Siber dan Sandi Negara.

Gambar 16. Bukti alat program yang membantu untuk mengolah data telah dibuatkan hak cipta sebagai output tambahan tahun pertama

E. **PERAN MITRA:** Tuliskan realisasi kerjasama dan kontribusi Mitra baik *in-kind* maupun *in-cash* serta mengunggah bukti dokumen pendukung sesuai dengan kondisi yang sebenarnya. Bukti dokumen realisasi kerjasama dengan Mitra dapat diunggah melalui BIMA.

**Catatan:**

*Bagian ini wajib diisi untuk penelitian terapan, untuk penelitian dasar (Fundamental, Pascasarjana, PKDN, Dosen Pemula) boleh mengisi bagian ini (tidak wajib) jika melibatkan mitra dalam pelaksanaan penelitiannya*

Penelitian *Fundamental* ini melibatkan mitra dalam pelaksanaan penelitian.

Tabel 7 Keterlibatan mitra & Stakeholder yang membantu pelaksanaan penelitian

No	Pihak mitra dalam pelaksanaan penelitian	Kontribusi Mitra (baik <i>in-kind</i> maupun <i>in-cash</i> )
1	Dinas Perindustrian dan Perdagangan prov Jawa Tengah . Bidang standar	<ul style="list-style-type: none"> <li>• Mendapatkan akses kontak person di Dinas kabupaten di Provinsi Jateng khususnya Kab Tegal</li> <li>• Mendapatkan data resmi bentuk program dan pembinaan industri shuttlecock terkait dengan standar di Jateng &amp; informasi pengalaman membina IKM di lapangan. Termasuk isu yang menjadi prioritas kebijakan provinsi untuk peningkatan mutu produk yang tidak konsisten</li> </ul>
2	Dinas Perindustrian dan Perdagangan Kabupaten Tegal dan Kelompok sentra Industri shuttlecock Desa Lawatan Kab Tegal	<ul style="list-style-type: none"> <li>• Dihubungkan dengan ketua / pengurus kelompok industri atau sentra industri di Desa Lawatan</li> <li>• Mendapatkan data resmi IKM yang memiliki merek dagang dan bentuk-bentuk pembinaan terkait standar yang pernah dilakukan</li> </ul>
3.	Dinas Perindustrian dan Perdagangan Kabupaten Ngajuk Prov Jawa Timur dan Kelompok sentra Industri shuttlecock Desa Semongko Kab Ngajuk	<ul style="list-style-type: none"> <li>• Dihubungkan dengan ketua / pengurus kelompok industri atau sentra industri di Desa Semungko</li> <li>• Mendapatkan data resmi IKM yang memiliki merek dagang dan bentuk-bentuk pembinaan terkait standar yang pernah dilakukan</li> </ul>
4	Balai Besar Standarisasi dan Pelayanan Jasa Kerajinan dan Batik, Yogyakarta	<ul style="list-style-type: none"> <li>• Penjelasan tahapan standar produk SNI untuk shuttlecock dan sistem penjaminan mutu berdasarkan SNI</li> <li>• Kerjasama untuk pengujian sejumlah produk shuttlecock dengan merek-merek terpilih yang menjual produknya di marketplace.</li> <li>•</li> </ul>

Bukti realisasi kerjasama dapat dilihat sebagai berikut:



Gambar 17 Kerjasama sama dengan pihak Balai Besar Standarisasi dan Pelayanan Jasa, Yogyakarta



Gambar 18 Kerjasama Pengujian sejumlah Merek Shuttlecock di Balai Besar Standarisasi dan Pelayanan Jasa



Gambar 19 Diskusi dengan Dinas Perindustrian dan Pergagangan Prov Jawa Tengah



Gambar 20 Pertemuan dengan Sekretaris Dinas Perindustrian dan Perdagangan Kab. Tegal



Gambar 21 Kerjasama dengan Bapak Irwan sebagai Sekretaris Sentra Shuttlecock Lawatan



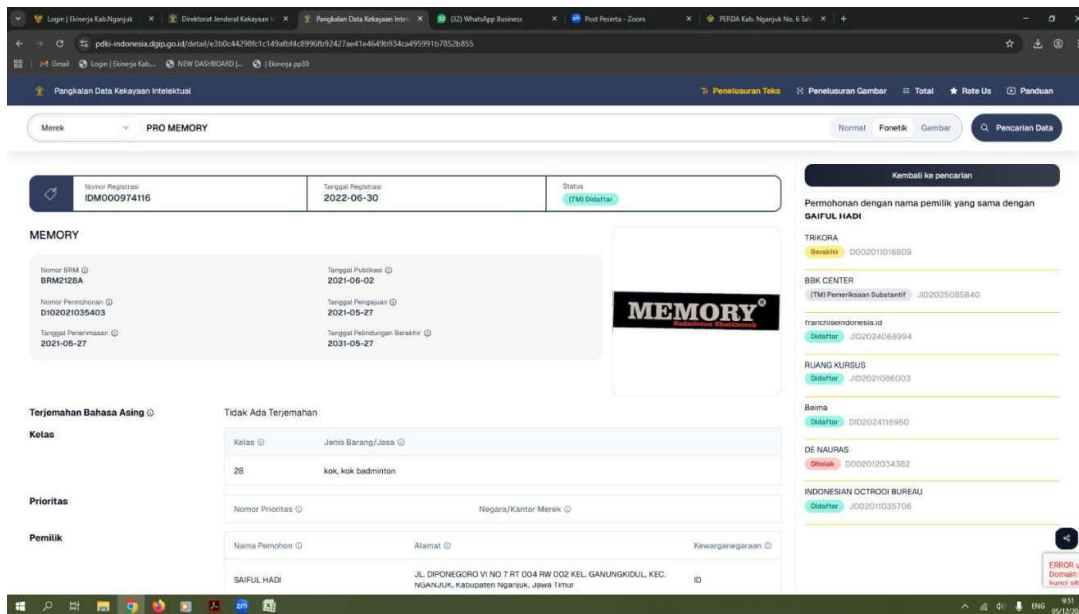
Gambar 21 Kkerjasama dengan Dinas Perindustrian Kab. Ngajuk Jawa Timur

F. **KENDALA PELAKSANAAN PENELITIAN:** Tuliskan kesulitan atau hambatan yang dihadapi selama melakukan penelitian dan mencapai luaran yang dijanjikan, termasuk penjelasan jika pelaksanaan penelitian dan luaran penelitian tidak sesuai dengan yang direncanakan atau dijanjikan.

Selama penelitian hampir TIM peneliti merasa tidak menemukan kendala yang sangat berarti, kendala secara umum :

#### A. Hambatan teknis di Lapangan

Pada awalnya akses ke lapangan cukup terhambat, tetapi dengan adanya kerjasama baik dengan dinas terkait semua hambatan ini dapat diatasi. Hal yang menarik ditemukan dilapangan dan dapat mengganggu proses penelitian adalah: banyak Industri kecil (IKM atau UMKM) ternyata tidak memiliki perizinan merek yang resmi. Tim peneliti sudah melakukan konfirmasi dengan pihak terkait ternyata banyak kasus khusus yang membutuhkan penanganan tersendiri. Berikut contoh merek IKM di Ngajuk yang coba tim peneliti untuk dorong mendapatkan standar SNI, terhambat karena merek yang pernah diajukan ke pihak terkait ternyata di tolak.



Gambar 22 Contoh merek Memory yang dimiliki IKM di Ngajuk masih bermasalah izin mereknya

Solusinya adalah TIM peneliti akan bekerja sama dengan dinas Perindustrian dan Pergangangan Kab Ngajuk, Tegal dan Malang. Untuk menyeleksi beberapa IKM yang telah memiliki izin merek dagang yang resmi. Untuk coba diperbaiki mutu produk melalui riset di tahun ke dua.

#### B. Hambatan metodologis

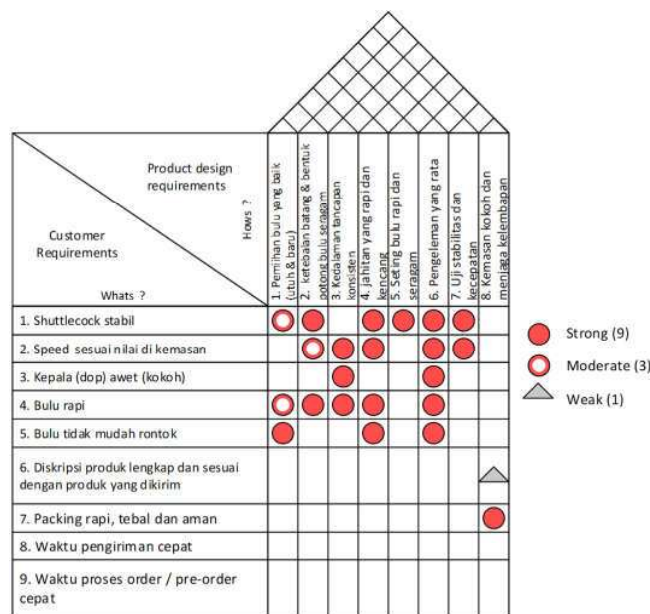
Pada Awal penelitian menggunakan model LDA (model *Mechine Learning*) tetapi ketika dicoba digunakan ulasan bahasa Indonesia, mengalami banyak kesalahan dan tingkat akurasi rendah. Sehingga model ini diganti dengan model yang lebih baru yaitu BERT analysis (model *DeepLearning*) dengan kembangan varian khusus bahasa Indonesia adalah IndoBERT. Penggantian model ini dapat meningkatkan akurasi analisis dan meningkatkan jumlah ulasan yang ada kaintannya dengan atribut kualitas produk dan layanan.

**G. RENCANA TAHAPAN SELANJUTNYA:** Tuliskan dan uraikan rencana penelitian selanjutnya berdasarkan indikator luaran yang telah dicapai, rencana realisasi luaran wajib yang dijanjikan dan tambahan (jika ada) di tahun berikutnya serta *roadmap* penelitian keseluruhan. Pada bagian ini diperbolehkan untuk melengkapi penjelasan dari setiap tahapan dalam metoda yang akan direncanakan termasuk jadwal berkaitan dengan strategi untuk mencapai luaran seperti yang telah dijanjikan dalam proposal. Jika diperlukan, penjelasan dapat juga dilengkapi dengan gambar, tabel, diagram, serta pustaka yang relevan. Jika laporan kemajuan merupakan laporan pelaksanaan tahun terakhir, pada bagian ini dapat dituliskan rencana penyelesaian target yang belum tercapai.

Hasil penelitian tahun sebelas diperoleh rekapan data kemampuan kualitas yang beragam. Penelitian selanjutnya adalah melakukan analisis mendalam dengan melakukan konfirmasi ke sejumlah IKM / UMKM yang memproduksi shuttlecock dan memiliki merek secara resmi. Konfirmasi ini penting untuk memastikan akar masalah di setiap industri kecil dan menengah yang memiliki perbedaan besar dalam sumber daya, peralatan dan sistem penjaminan mutu. **Proses Benchmarking** terhadap industri yang sudah memiliki sistem penjaminan mutu terbaik dapat dibandingkan dengan sejumlah industri yang belum memiliki sistem penjaminan yang baik. Akan sangat membantu melihat akar masalah dan bagaimana cara menyelesaikannya dari sisi praktis.

Pada tahun kedua penelitian ini akan ditekankan integrasi hasil analisis sentimen Ulasan Pelanggan dan Standar Nasional Indonesia (SNI) untuk Identifikasi Titik Kritis Kualitas Produk Manufaktur shuttlecock [15] di beberapa Industri kecil dan menengah di sejumlah sentra Industri seperti di Kab Tegal (Jawa Tengah), Kab Ngajuk dan Kab Malang (Jawa Timur). untuk kebutuhan transformasi preferensi konsumen dan SNI ke dalam bahasa teknis dengan menggunakan model QFD (Quality Function Deployment)[16][17]. Selanjutnya bahasa teknis ini akan diubah menjadi penentuan titik kritis proses produksi yang sangat bermanfaat dalam proses pengembangan defect prevention yang ada pada sistem penjaminan produksi shuttlecock[18],[19]. Proses transformasi melibatkan sejumlah pengusaha IKM dan pengrajin sebagai mitra pemasok di beberapa sentra industri seperti Kabupaten Tegal, Nganjuk dan Malang

Setelah proses pengumpulan data attribute mutu untuk sejumlah merek, dan proses Benchmarking telah dikumpulkan, selanjutnya ditransformasi menjadi bahasa teknik (titik kritis proses produksi) menggunakan model QFD. Pada tahap ini para pelaku usaha di sepanjang rantai nilai produksi (pemilik IKM dan pengrajin) dilibatkan dalam curah pendapat. Para pelaku yang dilibatkan dari sentra shuttlecock di Kabupaten Ngajuk, Tegal dan Malang. Selanjutnya dilakukan analisis rantai nilai digunakan untuk menentukan skenario yang memberikan hasil terbaik bagi IKM dan pengrajin dalam rantai pasok.



Gambar 23 QFD dengan menghubungkan Customer requirement dengan produc design improvement

**Selanjutnya tahun kedua** transformasi preferensi ini menjadi atribut teknik kualitas dan titik kritis yang sangat bermanfaat dalam proses pengembangan defect prevention yang ada pada sistem penjaminan SNI. **Metode yang digunakan** adalah survei rantai nilai dan QFD seperti pada gambar di atas

Dengan metode ini hasil yang diharapkan:

- Peta titik kritis kualitas produk di sepanjang rantai produksi industri manufaktur.
- Rekomendasi perbaikan proses produksi untuk meningkatkan kualitas produk dan daya saing industri.
- Publikasi hasil penelitian dalam jurnal reputasi internasional (scopus Q2)
- Seminar Internasional dari hasil penelitian dan mencoba desiminasi hasil kepada sejumlah pemangku kepentingan industri shuttlecock di Kab Tegal, Najuk dan Malang.

Luaran yang ditargetkan untuk tahun kedua jurnal scopus Q2 dengan judul “*Development Of Production Critical Points Is Based On Consumer Preferences And National Standards*”. Yang akan dikirim ke jurnal “*International Journal of System Assurance Engineering and Management*”, dengan link informasi jurnal sebagai berikut: <https://www.scopus.com/sourceid/19700177002>

Luaran TKT penelitian yang diusulkan pada tingkat 4 yaitu melakukan validasi kumpulan atribut atau komponen yang terkait dengan preferensi konsumen dan SNI dan telah dikonfirmasi oleh para pengusaha di sentra industri shuttlecock.

**H. DAFTAR PUSTAKA:** Penyusunan Daftar Pustaka berdasarkan sistem nomor sesuai dengan urutan pengutipan. Hanya pustaka yang disitasi pada laporan kemajuan yang dicantumkan dalam Daftar Pustaka.

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# An Integrated BERT , ABSA and BERTopic Framework for Quality Improvement in Shuttlecock SMEs Based on E-Commerce Reviews

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## Abstract

Consumer perceptions of product quality, as reflected in e-commerce reviews, have become an alternative for improving product and e-commerce service quality. Nonetheless, not all small and medium enterprises can leverage customer review data to generate improvement ideas due to insufficient data-processing skills. This study aims to explore key quality attributes that shape consumer perception through e-commerce reviews. This research also investigates how non-product factors, including seller service and delivery performance, can impact the overall customer experience. This research uses a BERT-based deep learning model to classify reviews of positive, neutral, and negative narratives. In the 3,267 negative review dataset, an attempt was made to explore several quality attributes. Aspect-Based Sentiment Analysis (ABSA) is used to identify nine key quality dimensions. Additionally, a BERTopic was applied to categorize reviews into 47 micro-topics. Importance-Performance Analysis (IPA) to determine which attributes need improvement. A small- to medium-sized enterprise mentor review was also integrated to validate the identified product attributes. The non-product factors, especially seller service, packaging reliability, and delivery performance, are significant drivers of customer dissatisfaction. A feather's durability and flight stability, categorized as engineering product attributes, were found to be crucial in shaping dissatisfaction. Feather durability was considered an industry-standard expectation. At the same time, flight stability varied significantly across brands. Product weight, cork head quality, and feather neatness were of lower importance due to the infrequency of reviews. This study provides a model integration on sentiment analysis with the BERT model, ABSA, BERTopic, and IPA. The result showed that quality perception is shaped by seller service, packaging reliability, and delivery performance. Still, technical product attributes remain critical in forming dissatisfaction.

**Keywords:** Aspect-Based Sentiment Analysis (ABSA), BERT Model, BERTopic, Quality Perception, Importance Performance Analysis (IPA)

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## I. INTRODUCTION

Customer review about a product have been recognized as a key factor in improving its quality. For many years, companies mostly used structured questionnaires, expert evaluations, and manually collected customer comments to find the most important areas to improve product performance [1]. These traditional methods are becoming less useful in today's digital marketplace. Sales using e-commerce have changed the way consumers evaluate and provide reviews of product and service quality. Customer reviews can be gathered through e-commerce platforms and spread quickly on social media. Customer reviews on e-commerce have become one of the references for potential buyers to decide on product purchases. Thus, Small and Medium Enterprises (SME) can gather the reviews to get valuable feedback and a critical indicator of perceived quality [2]. However, SMEs lack advanced data processing capabilities and thus

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cannot identify improvement proposals from customer review data [3]. SMEs ensure that the quality of the products produced is always consistent with the established standards. From a quality management perspective, the integration of customer feedback into product design and improvement is deeply rooted in the principles of Total Quality Management (TQM) and Quality Assurance [1]. But in practice, the products' quality may not meet expectations, and this inconsistency is perceived by buyers through subjective evaluations and reviews [4]. Studies show that consumer dissatisfaction in e-commerce is not only influenced by intrinsic product defects but also by extrinsic service attributes. As a result, review-based quality management requires a multidimensional framework that can integrate user reviews with improvement proposals. A huge amount of consumer-generated text data can be accessed. But quality-related insights from unstructured and varied information require analytical methods.

Natural Language Processing (NLP) can become a tool for understanding customer reviews. BERT-based architectures with bidirectional context replace conventional machine learning (ML) models in sentiment recognition [5]. This phenomenon is true for the Indonesian language's intricate morphology [6]. The results of sentiment polarization are insufficient to understand actionable improvement elements. This is due to a lack of generated output specificity at the quality attribute level. Thus, the Aspect-Based Sentiment Analysis (ABSA) is needed to identify predefined quality attributes based on the quality theory or concept to be developed. Linking the established quality sentiments and attributes allowed product and service quality diagnostics [7]. However, ABSA faced challenges in handling the wide variety of highly diverse reviews that are common in e-commerce reviews. Therefore, the challenge for a single topic model is to identify latent themes from a vast number of reviews using a process known as big data analysis. Recent studies highlight that using BERTopic can generate more coherent and detailed topics for complaint-driven data [8]. The research used negative reviews for richer technical details and detailed descriptions of defective products [9]. Despite these advances, several methodological gaps remain in translating online consumer reviews into structured quality requirements. Sentiment analysis models can detect polarity but lack detailed attribution to specific product aspects. Customer reviews on e-commerce platforms typically mix remarks about the product with feedback about platform services. Filtering and separating these heterogeneous comment types remains a major research challenge. The novelty of this research is the integration of sentiment analysis and BERT-ABSA-BERTopic. The modeling also involved SME mentors as validators. There is research studies have developed a hybrid model combining BERT-ABSA-BERTopic for identifying quality attributes. This study uses Importance-Performance Analysis (IPA), which has been established as a simple and widely used method for evaluating quality attributes.

## II. LITERATURE REVIEW

Identify potential improvements in product and service quality based on customer experience, so the analysis is specifically directed toward the collection of negative reviews. Research explained the application of text mining analysis to what customers truly need, which can improve the technical details required by customers [10]. This is different from positive comments, which are more likely to be affirmative. Empirically, negative comments are discussed more by customers after they use and find product failures or quality that doesn't meet expectations. Negative customer reviews on topics such as product quality and shipping services significantly impact product sales through e-commerce [11].

This research uses a hybrid model of BERT, ABSA, and BERTopic. BERT is used to improve the semantic representation of text because it can generate contextual embeddings and better capture contextual relationships between words. BERT works bidirectionally (simultaneously considering words before and after), so it can see the entire sentence when processing sentences or comments [5]. Therefore, BERT creates truly contextual embeddings. This research uses IndoBERT, which has been fine-tuned for the Indonesian language. This model is considered one of the best options for sentiment analysis tasks in Indonesian language data [12]. The IndoBERT model is able to capture emotional relationships that ML/LSTM cannot [13]. Therefore, it is now being widely used in Indonesian-language NLP tasks with a high accuracy rate, achieving a weighted F1 score of 81.0%. Other research shows that Fine-Tuned IndoBERT has an accuracy rate of 97% and a precision level of 98% [14]. The IndoBERT model has a strong foundation to understand the context and general meaning of Indonesian-language customer comment texts [15].

The BERT model has limitations, namely that it only provides a contextual representation of text. It is not designed to automatically identify specific aspects present in a sentence (e.g., 'delivery speed,' feather neatness, 'flight stability') and the sentiment directly related to those aspects. Therefore, this research uses ABSA, which can work with a predetermined list of specific quality attributes or parameters or follow a standard theoretical model. The ABSA model can provide more detailed and specific user opinion information [16], [17]. The ABSA model uses a word dictionary (lexicon) to detect the aspects and sentiment of the consumer comments. The word dictionary compiled in this study consists of 5 basic aspects of quality collected from Indonesian National Standards (SNI) shuttlecock standards and

literature related to shuttlecocks. The five aspects are flight stability, corkhead quality, and weight & balance, taken from SNI 0036 of 2014, while Feather durability and neatness of feathers were obtained from in-depth interviews with five business owners and two supervisors of the shuttlecock industrial center in Nganjuk district and industry supervisors at the Central Java provincial level. Feather shuttlecocks are considered important for manufacturers because they provide consumers the impression that the product is of excellent quality. Feather durability is also essential because, based on the experience of coaches working with the Djarum Badminton Club (PB Jarum), one of the main weaknesses of MSME products when tested by the club's players is the durability of the feathers. Meanwhile, regarding service quality, three aspects are being addressed: packaging, delivery (shipping/speed), and seller service [18], [19].

The research aims to find opportunities for improving the e-commerce products' quality. The BERTopic model is chosen to identify negative reviews or customer complaints. Negative reviews can identify several key factors or aspects that influence user experience [20]. BERTopic with negative reviews offers more profound insights into the issues that are occurring. Negative product reviews or criticism are easier to understand, and issues that were previously hidden may emerge through various types of product criticism [21]. Negative reviews also serve as a quality signal for improvement and represent "defect-based learning." This BERTopic can generate complaint maps that are truly relevant for improvement. This model is used to extract more granular negative, positive, and neutral micro-topics. The model is capable of providing more meaningful and diverse topics compared to LDA and LSA [22].

LDA or BERTopic studies and their application for improving MSME performance have been widely researched. This research uses Importance-Performance Analysis (IPA) model. This model is quite accurate, low-cost, and flexible, making it useful for service improvement [23]. The IPA approach from online product attribute analysis to identify the importance and performance of new features of newly released products in real time [10].

### III. METHODOLOGY

This research implemented three stages that consists of Data Collection and Text Pre-processing, Pipeline This research combines BERT, ABSA, and BERTopic, Measuring Attribute Importance and Performance. Stage 1: Data Collection and Text Pre-processing Collecting consumer reviews from those who have purchased shuttlecock products on e-commerce marketplaces. To ensure a sufficient number of reviews, reviews were collected from 2024 to June 2025. Next, the data was cleaned by removing duplicates, eliminating emoticons, symbols, and URLs, and normalizing Indonesian text. This stage also involves tokenization and stemming to simplify the vocabulary. The output is a ready-to-analyze comment dataset. Stage 2: Pipeline This research combines BERT, ABSA, and BERTopic. The IndoBERT model, which is a small base model, has had its functions fine-tuned and is now ready to be used as the final sentiment classifier within the context of the Indonesian language. This model uses mdhugol/indonesia-bert-sentiment-classification. IndoBERT is used here as a document-level sentiment classifier for Indonesian language text. All reviews are classified as positive, neutral, or negative. The ABSA model is designed to transform raw review data into structured and actionable information. Implementation in small and medium-sized industries. ABSA employs a lexicon-based approach that utilizes predefined aspects and analyzes language patterns or keyword matches from an aspect dictionary (lexicon-based ABSA). This research, in compiling a lexicon dictionary based on negative reviews, was built using approximately 1000 reviews out of 3,267 negative reviews. Next, it is linked to the theory of product and service quality in e-commerce. This research focuses on finding opportunities to improve the quality of e-commerce products and services, so the input for the BERTopic model consists of negative reviews or customer complaints containing detailed or richer technical information. Negative comments also serve as a quality signal for improvement and represent "defect-based learning." This means that the BERTopic model can ultimately generate complaint maps that are truly relevant for improvement. The BERTopic method is used to extract more granular negative, positive, and neutral micro-topics. Stage 3: Measuring Attribute Importance and Performance. This study selected five brands with over 1000 reviews each. The importance and performance levels were calculated for these five brands. Performance is calculated as follows:

$$AdjustedPerformance_{A,d} = 2.5 \left( 1 + \frac{1}{N_{A,d}} \sum_i Senti_i \right) \quad (1)$$

Where  $Senti_i$  = sentiment polarity of review  $i$  (-1, 0, +1) while  $N_{A,d}$  = number of reviews related to attribute  $A$  for brand/destination  $d$ .

Sentiment-based performance is calculated by converting the 0–5 IPA scale into a single expression. This single-step formula computes the normalized performance score directly on the 0–5 IPA scale. To measure the importance level of attributes using the frequency of attribute occurrences in user reviews, with the formula:

$$Importance_{i,b} = 5 \times \frac{Count(A_{i,b})}{\max_j (Count(A_{j,b}))} \quad (2)$$

Where:  $Count(A_{i,b})$  = the number of comments mentioning attribute i for brand b. While  $\max_j (Count(A_{j,b}))$  the highest frequency of any attribute for that brand. The quadrant cut-off points are determined using the data-centered crosshair method of the IPA MODEL, which is:  $X_{mean}$  = "mean of overall Performance" and  $Y_{mean}$  = "mean of overall Performance".

#### IV. RESULTS

The data collected amounted to 33,314 consumer reviews. This dataset still contains noise, such as duplicate comments, empty comments, comments containing only emojis or periods, uninformed comments, and comments that are too short or contain only one word. Therefore, in the initial step, cleaning was performed, and 5,870 records were removed. The cleaning process left a total of 27,444 records, or 17.62% of the records were discarded. This cleaning improved the quality of the model because NLP models are very sensitive to noise. With 27,444 comments, the dataset is substantial (containing topic variation) and is considered ideal and stable for topic extraction (using sentiment analysis methods (BERT) or LDA).

In the second stage, 27,444 reviews were mapped into positive, neutral, and negative groups using the BERT Sentiment method. A total of 3,267 negative reviews (or 11.9%), 2,590 neutral comments (9.44%), and 21,586 positive comments (78.66%) were obtained. From the results of BERT Sentiment (a deep learning model), the number of negative comments was 3,267, neutral comments were 2,590, and the remaining comments were 21,586 positive. This labeled dataset was then processed using the ABSA Model and BERTopic. Where the ABSA (Aspect-Based Sentiment Analysis) model generates 9 quality dimensions. This process resulted in the extraction of 1,481 specific aspect mentions from a total of 3,267 negative reviews. ABSA input = 3,267 negative reviews determined by BERT Sentiment (a deep learning model). ABSA does not analyze positive or neutral reviews because the research focuses solely on identifying areas for improvement, specifically negative aspects. The goal of BERTopic, which focuses solely on negative reviews, is to generate 47 micro-topics related to complaints, which will then be used to build 47 comprehensive complaint topics.

BERTopic creates micro-topic clusters that accurately reflect the experiences and expressions of consumers. The generated topics are unable to describe the needs of product and service quality analysis. The LDA or BERTopic model can analyze reviews for each word (token) and group similar terms into the same topic [24]. An algorithm is used for grouping. The process begins by extracting each micro-topic from the BERTopic. Next, each topic was analyzed to identify semantic patterns and the focus of its substance, such as packaging, feather durability, flight stability, shuttlecock weight, feather neatness, head quality, seller service, and shipping aspects. This semantic analysis then matched with the nine dimensions of quality that had been defined in the ABSA stage. The keyword triangulation aims to review context coherence and meaning alignment with the characteristics of each dimension. Thus, 47 fragmented micro-topics were consolidated into nine interpretable macro-dimensions for analyzing quality dimensions. The mapping results are shown in the following table 1.

TABLE 1  
THE MICRO TOPICS AND ASPECT QUALITY

Related Micro-Topics (BERTopic)	Aspects ( ABSA)
Topic 11 – feathers broken, Topic 44 – broken feathers / quick points, Topic 8 – not durable / poor quality, Topic 14 – breaks easily / fragile, Topic 37 – breaks quickly	Feather Durability (all contain complaints about brittle, easily broken, and non-durable feathers)
Topic 9 – speed 77/78/75 (speed mismatch → flight direction), Topic 15 – stable-unstable / shaky, Topic 27 – shaky / unstable, Topic 28 – too light (affects flight path), Topic 45 – hard/stubborn (related to balance and stability)	Flight Stability (complaints regarding flight direction, speed, and sensation upon impact)
Topic 13 – appearance of marks / inconsistent weight, Topic 25 – description of marks / untidy appearance, Topic 37 – damaged finish / untidy bristle arrangement	Neatness (complaints about esthetics, finishing, hair neatness, tubes appearing used)
Topic 0 – safe packaging dented, Topic 3 – dented / tube damaged, Topic 16 – not enough bubble wrap	Packaging (complaints regarding insufficient bubble wrap, dented tube, inadequate protection)
Topic 4 – slow/fast delivery, Topic 17 – very slow delivery, Topic 35 – courier arrived late/slow, Topic 36 – slow order/seller + courier issues, Topic 42 – slow delivery (super slow)	Delivery (shipping issues, delays, poor logistics experience)

Topic 6 – slow seller response, Topic 29 – speed suitability / seller misinformation, Topic 36 – slow seller processing, Topic 39 – suspected manipulation / non-genuine goods, Topic 41 – seller communication, Topic 42 – complaints & resolution Topic 13 – inconsistent weight, Topic 28 – too light, Topic 40 – incorrect weight (damaged → unstable weight) Topic 45 – cork resilience / head too heavy Topic -1 – general dissatisfaction; Topic 1 – shuttlecock, Topic 2 – not as described (quality mismatch), Topic 5 – good but not good enough / shuttlecock not good enough, Topic 7 – product matches production, Topic 10 – poor quality, Topic 12 – good, Topic 18 – shuttlecock has arrived, Topic 20 – expensive / not worth the price, Topic 21 – late review / average quality, Topic 22 – decent / standard, Topic 23 – just average, Topic 24 – smash play already, Topic 26 – not yet tried, Topic 30 – our badminton sports, Topic 31 – not yet tried, Topic 32 – price matches quality, Topic 33 – not yet tried, Topic 34 – not yet tried, Topic 38 – quality has decreased, Topic 43 – broke immediately after one smash	Seller Service (issues with seller interaction, response to complaints, description errors)  Weight (related to the feel of the game and air stability) Cork Resilience (Complaints regarding the material and the hardness of the shuttlecock head)   Overall Quality (general dissatisfaction)
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Negative customer reviews serve as the building blocks for the micro topics in Table 1. This condition provides a strategic advantage in uncovering the root cause and identifying critical points in the e-commerce ecosystem. This result aligns with the research by Xu [4][25], who used deep learning on negative online reviews and obtained various service attributes that contribute to customer satisfaction. Each customer review with a topic related to quality aspects was then mapped and counted against sentiment in three groups (positive, negative, and neutral). The percentage of sentiment and the Net\_Sentiment indicator are also calculated, as shown in the following table 2. With this data, research can identify priority areas for improvement based on the number of consumer reviews (high Total Mentions) and the dimensions with the most complaints (high Negative\_review).

TABLE 2  
 TOTAL MENTIONS AND SENTIMENT OF CUSTOMER REVIEWS

Attribute Quality	Quality Dimensions	Total_Mentions	Positive	Negative	Neutral	Positive_Pct	Negative_Pct	Net_sentiment
Seller Service	E-Service Quality	4,909	4,158	262	489	84.70	5.34	79.36
General Product Quality	Product Quality	4,639	4,121	316	202	88.83	6.81	82.02
Packaging	E-Service Quality	4,582	4,034	430	118	88.04	9.38	78.66
Delivery	Delivery Performance	3,625	3,166	291	168	87.34	8.03	79.31
Feather Durability	Product Quality	1,635	1,529	102	4	93.52	6.24	87.28
Flight Stability	Product Quality	1,101	732	326	43	66.49	29.61	36.88
Weight	Product Quality	664	600	59	5	90.36	8.89	81.48
Neatness of Feathers	Product Quality	176	111	62	3	63.07	35.23	27.84
Cork Head Quality	Product Quality	10	2	8	-	20.00	80.00	-60.00

The Total\_Mentions column describes the level of consumer "concern" or salience regarding a specific attribute. In online review-based quality research, the most frequently mentioned dimensions are usually directly related to usage experience, core expectations, and failure-prone components [26]. From the table, the most frequently discussed attributes, or those with the highest total mentions, are related to customer experiences during information gathering and the product purchase process, while specific product quality reviews are relatively less common. The high volume of seller service and packaging-related issues indicates that the e-commerce experience significantly influences overall quality perception. If we delve deeper, although the Seller Service attribute is the most frequently discussed, the majority of the 262 major complaints are related to slow response times, input errors, and a lack of communication. The packaging attribute has the highest negative score (430 complaints, 9.38%). This has strong implications for making improvements. These complaints commonly include damage during shipping, dented boxes, no bubble wrap used, and products arriving wet or damaged. Packaging is one of the critical points in the e-commerce system. The

Delivery attribute also has 8.03% negative reviews. These complaints include delayed shipping, stagnant tracking status, and delivery to a different address.

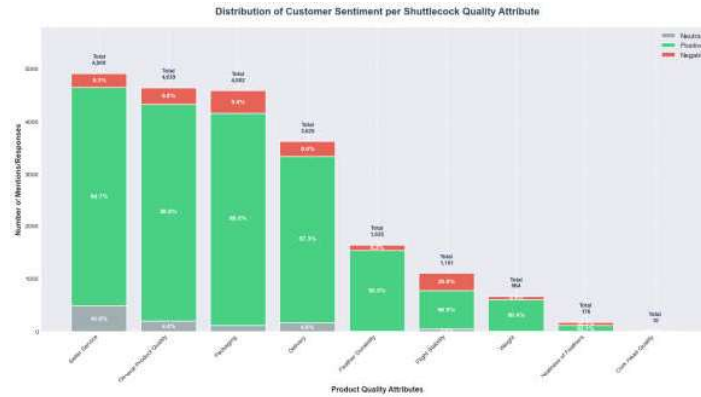


Fig. 1 Distribution of Customer Sentiment on Shuttlecock Quality Dimension

At the product level, consumers tend to discuss product-related quality less. Consumers need to try some of the products from the 12 shuttlecocks in one package. Only after trying it can consumers provide honest reviews. The attributes of feather durability and flight stability have over 1000 mentions in reviews. The attributes of weight and neatness in feathers have over 100 mentions, while cork quality has only 10 mentions. Among the five analyzed attributes, flight stability received the most complaints, with a significant number of negative reviews. This indicates a very low consistency in product quality. Although positive reviews still make up the majority, negative reviews have the largest proportion at 29.6% compared to other attributes. This indicates a very serious product quality issue that needs to be addressed immediately. The most common negative reviews are that the shuttlecock doesn't fly straight, the rotation is too fast or too slow, and the trajectory is unstable between units within the same batch. Interviews with SME producers and mentors suggest many possible causes. One of the main factors is that technological limitations mean that SME actors still sort and grade raw feather materials manually, especially for stem thickness, feather shape, and angle. Other factors include feather installation quality (angle, spacing), head-feather balance, construction symmetry, and glue quality and insertion depth. This finding indicates the need for reengineering before assembly, not just simple QC. Five SME brands, which have over 1000 comments, were selected to utilize the collected dataset in a single improvement policy at the company level. The sample data can be seen in the following table 3.

TABLE 3  
 REVIEW OF FIVE BRANDS HAS A TOTAL OF OVER 1000 REVIEWS

Product Label	Total Reviews	Cleaned Reviews	Total Mentions	%
BrandLabel_1	1141	788	557	70.69
BrandLabel_2	1247	1055	644	61.04
BrandLabel_3	1560	1272	1008	79.25
BrandLabel_4	1119	967	957	98.97
BrandLabel_5	1540	1287	1006	78.17

The five products analyzed showed a substantial reduction in reviews after the cleaning process. In e-commerce comment research, this condition often occurs because many comments are irrelevant, and products with high popularity levels usually have a higher noise ratio (noisy/meaningless comments, comments that are too short, emojis, and repetitive sentences). Therefore, it is natural for clean-review rates to be between 69% and 86%. The analysis focuses on quality-related mentions (Total Mentions), which contain remarks about product quality and service quality. From the sample taken, only 61% to 79% contained quality-related mentions, except for Label\_4, which was quite exceptional. Consumers of this product were very focused on quality, with 98.9% of the reviewed comments related to quality. A high relevance ratio indicates that consumers are highly engaged, have varying experiences across batches, or that there are quality issues causing consumers to write in-depth reviews. The following is Table 4 contains the dataset with 5 brands (Brand1–Brand5) and 9 quality attributes.

TABLE 4  
RESULTS OF MACHINE LEARNING AND DEEP LEARNING ANALYSIS OF FIVE SELECTED BRANDS

Attribute Quality	BrandLabel_1			BrandLabel_2			BrandLabel_3			BrandLabel_4			BrandLabel_5					
	Total Mentions	P	N	Total Mentions	P	N	Total Mentions	P	N	Total Mentions	P	N	Total Mentions	P	N			
Seller Service	117	97	8	177	145	14	233	190	15	28	205	174	8	23	260	218	12	30
General Product Quality	141	123	15	139	114	15	225	185	27	13	204	190	7	7	230	203	19	8
Delivery	117	108	5	139	119	14	216	178	26	12	125	114	7	4	225	195	22	8
Packaging	95	81	10	114	86	23	200	155	35	10	239	212	21	6	179	155	19	5
Feather Durability	40	38	2	33	26	7	78	73	5	0	89	85	4	0	56	48	8	0
Flight Stability	37	27	8	23	14	9	31	11	20	0	25	17	6	2	47	26	18	3
Neatness of Feathers	7	5	2	11	5	6	13	8	5	0	2	1	1	0	3	2	1	0
Weight	3	3	0	7	3	4	12	9	3	0	68	67	1	0	5	5	0	0
Cork Head Quality	0	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	1	0
Total	557	482	50	644	513	92	1008	908	136	63	957	860	55	42	1006	852	100	54

Table 4 also shows that all brands prioritize seller service, delivery, and packaging. Meanwhile, reviews related to the five product quality attributes across all brands have fewer than 100 reviews. In contrast, reviews for the general product category ranged from 139 to 225. This indicates that this research superficially examined product quality attributes. This showed a limitation of product quality theory using the ABSA model. From the table, Brand 4 and Brand 5 generally have the highest mention volume, indicating the highest levels of consumer consumption, popularity, and variety of consumer experiences.

To determine which attributes need improvement, this study uses the IPA model and customer voice data. At the company level, the research attempts to map the nine quality attributes to the IPA model. Figure 2 uses brand one as an example. The results show that the attributes of seller service, delivery, and packaging fall into the “Keep Up the Good Work” quadrant. This means consumers are satisfied with that quality attribute.

Meanwhile, for the Flight Stability attribute, cork head quality and feather neatness fall into the Low Priority quadrant, indicating that consumers consider these qualities unimportant, and their performance is low. The feather durability and weight attributes are in the Possible Overkill quadrant, indicating that while both have high performance (as reflected by the dominance of positive reviews), the few reviews suggest they are less important. For other brands, the performance and importance of quality attributes are almost in the same quadrant, but they have different performance values.

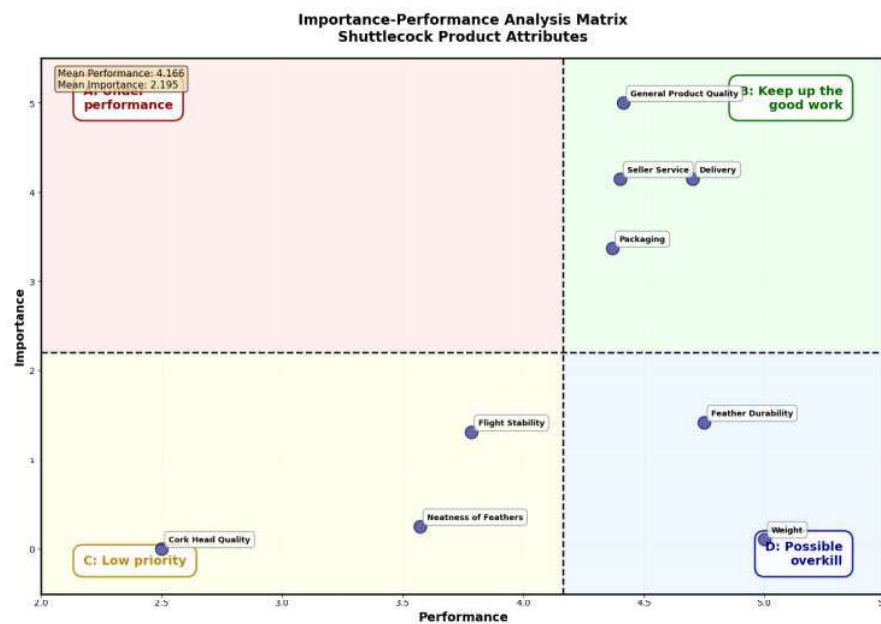


Fig. 2 Importance-Performance Analysis for Brand 1

This condition is due to the company-level quality review (packaging, seller service, and delivery) being overly dominant, causing the cut-off points to shift toward positive values and higher levels of importance. If we examine this at the product level, including only five product quality attributes shifts the cut-off value to the average of those five attributes, resulting in a different quadrant location, as shown in Table 5.

TABLE 5  
 SUMMARY OF STRENGTHS AND WEAKNESSES ACROSS THE FIVE SHUTTLECOCK BRANDS (BASED ON IPA RESULTS)

BrandLabel	Quadrant A (Concentrate Here)	Quadrant B (Keep Up the Good Work)	Quadrant C (Low Priority)	Quadrant D (Possible Overkill)
Brand1	No critical weaknesses	Feather Durability and Flight Stability	Neatness of Feathers and Cork Head Quality	Weight
Brand2	No critical weaknesses	Feather Durability	Flight Stability, Neatness of Feathers and Cork Head Quality	Weight
Brand3	Flight Stability	Feather Durability	Neatness of Feathers and Cork Head Quality	Weight
Brand4	No critical weaknesses	Feather Durability and Weight	Flight Stability, Neatness of Feathers and Cork Head Quality	Weight
Brand5	No critical weaknesses	Feather Durability	Flight Stability, Neatness of Feathers and Cork Head Quality	Weight

An IPA of five shuttlecock brands reveals a consistent pattern: e-commerce consumers rate core technical attributes, specifically Feather Durability and Flight Stability, as the most dominant factors in shaping quality perceptions. Feather Durability is the only attribute that consistently falls into Quadrant B for all brands. This indicates that the shuttlecock industry in the segment studied has relatively mature production capabilities in terms of feather selection and processing. This consistency implies that durability has become a baseline expectation for consumers, no longer a differentiating factor. Conversely, Flight Stability shows significant variation: some brands are in quadrant C (Low Priority), while one brand (Brand 3) falls into quadrant A (Concentrate Here), indicating critical underperformance on an attribute considered quite important. Consumers consider Flight Stability a core part of the gaming experience, so when it is not met, dissatisfaction is much higher than for other attributes. These findings support previous literature stating that durability and flight stability are important technical attributes and influence shuttlecock performance [27], [28].

Attributes like Neatness of Feathers and Cork Head Quality consistently fall into quadrant C, which is Low Priority. Consumers do not consider these two attributes to contribute significantly to forming their overall quality perception. This indicates that the product’s functionality (core performance), such as shuttlecocks, needs further exploration through in-depth research on feather neatness relative to other product quality attributes. Almost all brands place the Weight attribute in quadrant D (Possible Overkill), which requires careful consideration to draw this conclusion. Considering that the weight of the shuttlecock significantly affects its speed in the air, consumers can feel the product’s weight through the shuttlecock’s speed. In this case, consumers technically do not measure the weight with a scale. Consumers perceive the weight through the shuttlecock’s speed.

## V. CONCLUSIONS

A hybrid model combining BERT Sentiment, ABSA, and BERTopic identified 47 subjects and nine attributes of product and service quality in e-commerce from 27,444 consumer reviews. After the data cleaning process, negative reviews were analyzed in depth to identify the root causes of quality issues. A 47 micro-topics were consolidated into nine quality dimensions relevant to the production–seller–logistics context. This finding indicates that deep learning-based NLP methods can uncover the structure of complaints that is not visible through manual approaches or traditional surveys.

Analysis shows that e-commerce experiences (seller service, packaging, and delivery) are the most frequently discussed aspects by consumers and contribute the most to complaints. These results indicate that the perception of quality among e-commerce users is more complex. The identified quality is based not only on product quality but also on the company’s service quality and the shipping company’s logistics performance. The most frequently reviewed main attributes specifically regarding product quality are Feather Durability and Flight Stability. Feather Durability consistently falls into Quadrant B (Keep Up the Good Work) across all reviewed brands. The fall indicates that this attribute has become an industry standard and is no longer a competitive differentiator. Conversely, the Flight Stability

attribute shows significant quality variation across brands. One brand even exhibits a critical weakness (Quadrant A) that warrants immediate improvement.

The reviews assigned lower relevance weights to Feather Neatness, Cork Head Quality, and Product Weight. A lower relevance means that people who buy sports gear usually submit evaluations only after receiving the item from an online store. There are only a few reviews on product quality because customers cannot immediately assess the technical specifications without playing the game. Specifically, the Weight attribute's position in Quadrant D for almost all brands indicates that consumers interpret weight through the shuttlecock's flight behavior rather than from physical numbers. Hence, the perception of this attribute's "unimportance" is indirect.

A study at the company level, reviewing five brands, revealed a consistent pattern of dominance in sales service issues and logistics performance. When the analysis was conducted at the product level, the IPA boundary shifted, making the attribute analysis more straightforward for the five product quality attributes, particularly for flight stability, which showed inconsistent quality. Overall, this research provides a big data-driven analytical framework for linking consumer complaints to critical points in the production-e-commerce ecosystem. This approach offers a more accurate alternative to conventional surveys by capturing real consumer experiences at scale. Additionally, this research strengthens the literature on the utilization of deep learning and topic modeling for product quality improvement and digital service quality management.

Research can be expanded by incorporating objective data from shuttlecock physical testing results, improving the domain-specific lexicon-based ABSA model, and developing a real-time quality monitoring system for SMEs using consumer review data. This integration has the potential to build a holistic quality model that can sustainably enhance SME competitiveness in the e-commerce ecosystem.

**Author Contributions:** *Eko Liquiddanu:* Conceptualization, Methodology, Writing - Original Draft, Supervision. *Ardhy Yuliawan Norma Sakti:* Investigation, Writing - Original Draft, Writing - Review & Editing. *Rina Fitriana:* Data Curation, Writing - Original Draft.

All authors have read and agreed to the published version of the manuscript.

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**Conflicts of Interest:** The authors declare no conflict of interest.

**Data Availability:** The data used in this study were obtained by web scraping customer review texts from an e-commerce platform, with numerical ratings intentionally excluded from the analysis. Due to platform privacy policies and data-sharing restrictions, the full dataset cannot be made publicly available. However, aggregated results, analytical methods, and representative anonymized examples are included within the manuscript to support the reproducibility of the findings.

**Informed Consent:** There were no human subjects.

**Animal Subjects:** There were no animal subjects.

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