

✓ Install Dependencies dan install pdfplumber

```
!apt-get update -qq
!apt-get install -y -qq tesseract-ocr
!pip -q install pytesseract pillow

!pip install pdfplumber
```

```
W: Skipping acquire of configured file 'main/source/Sources' as repository 'https://r2u.stat.illinois.edu/ubuntu jammy InRelease' is not a source
Requirement already satisfied: pdfplumber in /usr/local/lib/python3.12/dist-packages (0.11.9)
Requirement already satisfied: pdfminer.six==20251230 in /usr/local/lib/python3.12/dist-packages (from pdfplumber) (20251230)
Requirement already satisfied: Pillow>=9.1 in /usr/local/lib/python3.12/dist-packages (from pdfminer.six==20251230) (11.3.0)
Requirement already satisfied: pypdfium2>=4.18.0 in /usr/local/lib/python3.12/dist-packages (from pdfminer.six==20251230) (5.3.0)
Requirement already satisfied: charset-normalizer>=2.0.0 in /usr/local/lib/python3.12/dist-packages (from pdfminer.six==20251230) (3.4.0)
Requirement already satisfied: cryptography>=36.0.0 in /usr/local/lib/python3.12/dist-packages (from pdfminer.six==20251230) (45.0.0)
Requirement already satisfied: cffi>=1.12 in /usr/local/lib/python3.12/dist-packages (from cryptography>=36.0.0->pdfminer.six==20251230) (1.17.1)
Requirement already satisfied: pycparser in /usr/local/lib/python3.12/dist-packages (from cffi>=1.12->cryptography>=36.0.0->pdfminer.six==20251230) (2.23)

```

✓ Mount Google Drive

```
from google.colab import drive
drive.mount('/content/drive')
```

```
Mounted at /content/drive
```

✓ Ambil semua file (pdf/docx/txt) dari folder Data

```
import os
from pathlib import Path
import pandas as pd

folder_path = Path("/content/drive/MyDrive/TUBES/S2-MKAB/Data")

print("Exists?", folder_path.exists())
print("Is dir?", folder_path.is_dir())

ext_ok = {".pdf", ".docx", ".txt"}
paths = []

for root, dirs, files in os.walk(folder_path):
    for f in files:
        p = Path(root) / f
        if p.suffix.lower() in ext_ok:
            paths.append(str(p))

paths = sorted(paths)
print("Jumlah file terbaca:", len(paths))
print("Contoh 10 file pertama:")
for p in paths[:10]:
    print("-", p)

df_files = pd.DataFrame({"path": paths})
df_files["ext"] = df_files["path"].apply(lambda x: Path(x).suffix.lower())
display(df_files["ext"].value_counts())
```

```
Exists? True
Is dir? True
Jumlah file terbaca: 21
Contoh 10 file pertama:
- /content/drive/MyDrive/TUBES/S2-MKAB/Data/Kebijakan Strategis Ketahanan Pangan dan Gizi 2019 Badan Ketahanan Pangan Kement
- /content/drive/MyDrive/TUBES/S2-MKAB/Data/LAPORAN PENYELIDIKAN EPIDEMIOLOGI SEMENTARA 2022.pdf
- /content/drive/MyDrive/TUBES/S2-MKAB/Data/LK Deputy Bid Pengawasan Pangan Olahan 2023 (BPOM).pdf
- /content/drive/MyDrive/TUBES/S2-MKAB/Data/LT BPOM 2021.pdf
- /content/drive/MyDrive/TUBES/S2-MKAB/Data/LT Layanan Informasi Publik 2016 (BPOM).pdf
- /content/drive/MyDrive/TUBES/S2-MKAB/Data/LT Layanan Informasi Publik 2017 (BPOM).pdf
- /content/drive/MyDrive/TUBES/S2-MKAB/Data/LT Layanan Informasi Publik 2019 (BPOM).pdf
- /content/drive/MyDrive/TUBES/S2-MKAB/Data/LT Layanan Informasi Publik 2023 (BPOM).pdf
- /content/drive/MyDrive/TUBES/S2-MKAB/Data/LT Layanan Informasi Publik 2024 (BPOM).pdf
- /content/drive/MyDrive/TUBES/S2-MKAB/Data/LT Pejabat Pengelola Informasi dan Dokumentasi 2018 (BPOM).pdf

count
ext
.pdf      21
dtype: int64
```

▼ Deteksi PDF “scan/gambar” vs “text-based”

```
import pdfplumber
import pandas as pd
from pathlib import Path
from tqdm import tqdm

def detect_scanned_pdf(pdf_path: str, min_chars: int = 50):
    rows = []
    with pdfplumber.open(pdf_path) as pdf:
        for i, page in enumerate(pdf.pages):
            text = page.extract_text() or ""
            rows.append({"page": i + 1, "text_chars": len(text.strip())})
    df = pd.DataFrame(rows)
    pct_low = (df["text_chars"] < min_chars).mean() * 100
    return df, pct_low

min_chars = 50
scan_threshold_pct = 70

summary_rows = []

pdf_paths = [p for p in paths if Path(p).suffix.lower() == ".pdf"]

for p in tqdm(pdf_paths, desc="Detecting scanned PDFs"):
    try:
        df_pages, pct_low = detect_scanned_pdf(p, min_chars=min_chars)
        summary_rows.append({
            "file": Path(p).name,
            "path": p,
            "n_pages": len(df_pages),
            "pct_low_text": round(pct_low, 2),
            "status": "LIKELY_SCANNED" if pct_low >= scan_threshold_pct else "TEXT_BASED"
        })
    except Exception as e:
        summary_rows.append({
            "file": Path(p).name,
            "path": p,
            "n_pages": None,
            "pct_low_text": None,
            "status": f"ERROR: {type(e).__name__}"
        })

df_summary = pd.DataFrame(summary_rows).sort_values(["status", "pct_low_text"], ascending=[True, True])
display(df_summary)
print("Jumlah scanned:", (df_summary["status"]=="LIKELY_SCANNED").sum())
```

Detecting scanned PDFs: 100%|██████████| 21/21 [13:21<00:00, 38.15s/it]

	file	path	n_pages	pct_low_text	status
5	LT Layanan Informasi Publik 2017 (BPOM).pdf	/content/drive/MyDrive/TUBES/S2-MKAB/Data/LT L...	13	100.00	LIKELY_SCANNED
9	LT Pejabat Pengelola Informasi dan Dokumentasi...	/content/drive/MyDrive/TUBES/S2-MKAB/Data/LT P...	39	100.00	LIKELY_SCANNED
17	Laporan Tahunan Direktorat Registrasi Pangan O...	/content/drive/MyDrive/TUBES/S2-MKAB/Data/Lapo...	171	100.00	LIKELY_SCANNED
1	LAPORAN PENYELIDIKAN EPIDEMIOLOGI SEMENTARA 20...	/content/drive/MyDrive/TUBES/S2-MKAB/Data/LAPO...	11	0.00	TEXT_BASED
7	LT Layanan Informasi Publik 2023 (BPOM).pdf	/content/drive/MyDrive/TUBES/S2-MKAB/Data/LT L...	80	0.00	TEXT_BASED
10	LT Pejabat Pengelola Informasi dan Dokumentasi...	/content/drive/MyDrive/TUBES/S2-MKAB/Data/LT P...	59	0.00	TEXT_BASED
11	LT Pengelolaan Informasi dan Dokumentasi 2021 ...	/content/drive/MyDrive/TUBES/S2-MKAB/Data/LT P...	46	0.00	TEXT_BASED
12	LT Pengelolaan Informasi dan Dokumentasi 2022 ...	/content/drive/MyDrive/TUBES/S2-MKAB/Data/LT P...	49	0.00	TEXT_BASED
14	Laporan Tahunan Balai Besar POM di Jakarta Tah...	/content/drive/MyDrive/TUBES/S2-MKAB/Data/Lapo...	370	0.27	TEXT_BASED
15	Laporan Tahunan Direktorat Registrasi Pangan O...	/content/drive/MyDrive/TUBES/S2-MKAB/Data/Lapo...	97	1.03	TEXT_BASED
3	LT BPOM 2021.pdf	/content/drive/MyDrive/TUBES/S2-MKAB/Data/LT B...	185	1.08	TEXT_BASED
20	PPT-Laporan-Tahunan-Badan-POM-Tahun-2023.pdf	/content/drive/MyDrive/TUBES/S2-MKAB/Data/PPT-...	352	1.14	TEXT_BASED
18	Laporan-Tahunan-Balai-Besar-POM-Di-Padang-Tahu...	/content/drive/MyDrive/TUBES/S2-MKAB/Data/Lapo...	290	2.76	TEXT_BASED
8	LT Layanan Informasi Publik 2024 (BPOM).pdf	/content/drive/MyDrive/TUBES/S2-MKAB/Data/LT L...	128	3.12	TEXT_BASED

✓ OCR hanya untuk PDF yang scanned (dan simpan txt)

```
import pytesseract
from PIL import Image
from pathlib import Path

def ocr_pdf(pdf_path: str, dpi: int = 250) -> str:
    texts = []
    with pdfplumber.open(pdf_path) as pdf:
        for i, page in enumerate(pdf.pages):
            pil_img = page.to_image(resolution=dpi).original
            txt = pytesseract.image_to_string(pil_img, config="--psm 6").strip()
            if txt:
                texts.append(f"\n\n=== PAGE {i+1} ===\n{txt}")
    return "\n".join(texts)

scanned_files = df_summary[df_summary["status"] == "LIKELY_SCANNED"].copy()
display(scanned_files[["file", "n_pages", "pct_low_text", "path"]])

output_dir = Path("ocr_output")
output_dir.mkdir(exist_ok=True)

ocr_rows = []

for _, row in tqdm(scanned_files.iterrows(), total=len(scanned_files), desc="OCR scanned PDFs"):
    pdf_path = row["path"]
    stem = Path(pdf_path).stem
    out_txt = output_dir / f"{stem}_OCR.txt"

    if out_txt.exists():
        text_ocr = out_txt.read_text(encoding="utf-8", errors="ignore")
        source = "OCR_CACHE"
    else:
        text_ocr = ocr_pdf(pdf_path, dpi=250)
        out_txt.write_text(text_ocr, encoding="utf-8")
        source = "OCR_NEW"

    ocr_rows.append({
        "pdf_path": pdf_path,
        "pdf_file": Path(pdf_path).name,
        "ocr_txt_path": str(out_txt),
    })
```

```

        "ocr_chars": len(text_ocr),
        "ocr_source": source
    })

df_ocr = pd.DataFrame(ocr_rows)
display(df_ocr)
print("OCR output folder:", output_dir)

```

	file	n_pages	pct_low_text	path
5	LT Layanan Informasi Publik 2017 (BPOM).pdf	13	100.0	/content/drive/MyDrive/TUBES/S2-MKAB/Data/LT L...
9	LT Pejabat Pengelola Informasi dan Dokumentasi...	39	100.0	/content/drive/MyDrive/TUBES/S2-MKAB/Data/LT P...
17	Laporan Tahunan Direktorat Registrasi Pangan O...	171	100.0	/content/drive/MyDrive/TUBES/S2-MKAB/Data/Lapo...

OCR scanned PDFs: 100%|██████████| 3/3 [27:58<00:00, 559.53s/it]

	pdf_path	pdf_file	ocr_txt_path	ocr_chars	ocr_source
0	/content/drive/MyDrive/TUBES/S2-MKAB/Data/LT L...	LT Layanan Informasi Publik 2017 (BPOM).pdf	ocr_output/LT Layanan Informasi Publik 2017 (B...	20392	OCR_NEW
1	/content/drive/MyDrive/TUBES/S2-MKAB/Data/LT P...	LT Pejabat Pengelola Informasi dan Dokumentasi...	ocr_output/LT Pejabat Pengelola Informasi dan ...	69314	OCR_NEW

✎ Bangun Corpus FINAL (gabung PDF text + OCR + DOCX + TXT)

```

#from docx import Document

def read_pdf_text(pdf_path: str) -> str:
    texts = []
    with pdfplumber.open(pdf_path) as pdf:
        for page in pdf.pages:
            t = page.extract_text() or ""
            if t.strip():
                texts.append(t)
    return "\n".join(texts)

#def read_docx_text(docx_path: str) -> str:
#    doc = Document(docx_path)
#    paras = [p.text for p in doc.paragraphs if p.text.strip()]
#    return "\n".join(paras)

def read_txt_text(txt_path: str) -> str:
    return Path(txt_path).read_text(encoding="utf-8", errors="ignore")

# mapping pdf_path -> ocr_txt_path
ocr_map = {r["pdf_path"]: r["ocr_txt_path"] for _, r in df_ocr.iterrows()}

rows = []

for p in tqdm(paths, desc="Building final corpus"):
    p = str(p)
    ext = Path(p).suffix.lower()
    name = Path(p).name

    try:
        if ext == ".pdf":
            status = df_summary.loc[df_summary["path"] == p, "status"].iloc[0]
            if status == "LIKELY_SCANNED":
                raw_text = read_txt_text(ocr_map[p])
                source = "OCR_TEXT"
            else:
                raw_text = read_pdf_text(p)
                source = "PDF_TEXT"

        elif ext == ".docx":
            raw_text = read_docx_text(p)
            source = "DOCX_TEXT"
            status = "TEXT_BASED"

        elif ext == ".txt":
            raw_text = read_txt_text(p)
            source = "TXT"
            status = "TEXT_BASED"

        else:
            continue

    rows.append({

```

```

        "doc_name": name,
        "doc_path": p,
        "doc_ext": ext,
        "status": status,
        "source": source,
        "n_chars": len(raw_text),
        "raw_text": raw_text
    })



except Exception as e:
    rows.append({
        "doc_name": name,
        "doc_path": p,
        "doc_ext": ext,
        "status": "ERROR",
        "source": f"ERROR: {type(e).__name__}",
        "n_chars": 0,
        "raw_text": ""
    })

df_corpus = pd.DataFrame(rows).sort_values("n_chars", ascending=False)
display(df_corpus[["doc_name", "doc_ext", "status", "source", "n_chars"]])

df_corpus.to_csv("corpus_all_docs.csv", index=False)
print("Saved: corpus_all_docs.csv")

```

Building final corpus: 100% 21/21 [11:23<00:00, 32.55s/it]

	doc_name	doc_ext	status	source	n_chars	
14	Laporan Tahunan Balai Besar POM di Jakarta Tah...	.pdf	TEXT_BASED	PDF_TEXT	644123	
20	PPT-Laporan-Tahunan-Badan-POM-Tahun-2023.pdf	.pdf	TEXT_BASED	PDF_TEXT	576874	
18	Laporan-Tahunan-Balai-Besar-POM-Di-Padang-Tahu...	.pdf	TEXT_BASED	PDF_TEXT	507998	
2	LK Deputi Bid Pengawaan Pangan Olan 2023 (BP...	.pdf	TEXT_BASED	PDF_TEXT	369439	
13	Laporan Kinerja BPOM Tahun 2024.pdf	.pdf	TEXT_BASED	PDF_TEXT	337648	
3	LT BPOM 2021.pdf	.pdf	TEXT_BASED	PDF_TEXT	305755	
17	Laporan Tahunan Direktorat Registrasi Pangan O...	.pdf	LIKELY_SCANNED	OCR_TEXT	242293	
8	LT Layanan Informasi Publik 2024 (BPOM).pdf	.pdf	TEXT_BASED	PDF_TEXT	184800	
16	Laporan Tahunan Direktorat Registrasi Pangan O...	.pdf	TEXT_BASED	PDF_TEXT	177674	
6	LT Layanan Informasi Publik 2019 (BPOM).pdf	.pdf	TEXT_BASED	PDF_TEXT	174238	
15	Laporan Tahunan Direktorat Registrasi Pangan O...	.pdf	TEXT_BASED	PDF_TEXT	137152	
7	LT Layanan Informasi Publik 2023 (BPOM).pdf	.pdf	TEXT_BASED	PDF_TEXT	133588	
12	LT Pengelolaan Informasi dan Dokumentasi 2022 ...	.pdf	TEXT_BASED	PDF_TEXT	100542	
10	LT Pejabat Pengelola Informasi dan Dokumentasi...	.pdf	TEXT_BASED	PDF_TEXT	83112	
0	Kebijakan Strategis Ketahanan Pangan dan Gizi ...	.pdf	TEXT_BASED	PDF_TEXT	74158	
9	LT Pejabat Pengelola Informasi dan Dokumentasi...	.pdf	LIKELY_SCANNED	OCR_TEXT	69314	
11	LT Pengelolaan Informasi dan Dokumentasi 2021 ...	.pdf	TEXT_BASED	PDF_TEXT	67291	
5	LT Layanan Informasi Publik 2017 (BPOM).pdf	.pdf	LIKELY_SCANNED	OCR_TEXT	20392	
4	LT Layanan Informasi Publik 2016 (BPOM).pdf	.pdf	TEXT_BASED	PDF_TEXT	19917	
1	LAPORAN PENYELIDIKAN EPIDEMIOLOGI SEMENTARA 20...	.pdf	TEXT_BASED	PDF_TEXT	15782	
19	PPT Keamanan-Pangan-Program-MBG-BGN (2025).pdf	.pdf	TEXT_BASED	PDF_TEXT	13107	

Saved: corpus_all_docs.csv

Quick sanity check (biar kamu yakin hasilnya "isi", bukan noise)

```

# cek 1 contoh OCR doc
ocr_sample = df_corpus[df_corpus["source"]=="OCR_TEXT"].head(1)
if len(ocr_sample):
    print("=== OCR SAMPLE ===")
    print(ocr_sample.iloc[0]["doc_name"])
    print(ocr_sample.iloc[0]["raw_text"][:1200])

# cek 1 contoh PDF text doc
pdf_sample = df_corpus[df_corpus["source"]=="PDF_TEXT"].head(1)
if len(pdf_sample):
    print("\n=== PDF TEXT SAMPLE ===")
    print(pdf_sample.iloc[0]["doc_name"])

```

```
print(pdf_sample.iloc[0]["raw_text"][:1200])
```

```
=== OCR SAMPLE ===
```

```
Laporan Tahunan Direktorat Registrasi Pangan Olahan Tahun 2024.pdf
```

```
=== PAGE 1 ===
```

```
wor
```

```
LAPORAN
```

```
TAHUNAN
```

```
2024
```

```
— Direktorat Registrasi Pangan Olahan
```

```
=== PAGE 2 ===
```

```
KATA PENGANTAR
```

Segala puji dan syukur kami panjatkan kehadiran Tuhan yang Maha Esa, -\ yang atas berkat, rahmat dan izin-Nya sehingga Laporan Tahunan 2024 q Direktorat Registrasi Pangan Olahan dapat terselesaikan.

Penyusunan laporan ini bertujuan untuk menyediakan informasi kepada para pemangku kepentingan, serta memberikan gambaran bagi

pembaca seputar kegiatan yang ada pada Direktorat Registrasi Pangan

\ Olahan. Kritik dan saran yang membangun dari semua pihak sangat kami harapkan demi pelaksanaan kegiatan Direktorat Registrasi Pangan

< \$ r – Olahan yang lebih baik pada masa mendatang.

Peran Direktorat Registrasi Pangan Olahan sangat penting sebagai pengawasan pre-market,

pengawal kegiatan, dan legitimator program pembangunan keamanan pangan. Dalam laporan

ini, disampaikan hasil pelayanan publik dan kegiatan pengawasan pre-market yang dilakukan

selama tahun 2024. Implementasi prinsip tata kelola yang baik dalam menjalankan tugas-tugas

kegiatan dan peningkatan kualitas **unit** kerja terus diupayakan agar optimalisasi pengelolaan

dapat menjadi nyata. Direktorat Registrasi Pangan Olahan te

```
=== PDF TEXT SAMPLE ===
```

```
Laporan Tahunan Balai Besar POM di Jakarta Tahun 2023.pdf
```

```
LAPORAN
```

```
TAHUNAN
```

```
2023
```

```
Balai Besar Pengawas Obat
```

```
dan Makanan di Jakarta
```

```
KATA PENGANTAR
```

Assalamualaikum wr. wb.

Puji Syukur kami panjatkan ke hadirat Allah SWT atas limpahan berkah, rahmat dan karunia-Nya sehingga kami masih diberikan

kesempatan untuk menorehkan karya setahun kami dalam

melaksanakan tugas dan fungsi BBPOM di Jakarta dalam sebuah

Laporan Tahunan.

Laporan Tahunan Balai Besar POM di Jakarta Tahun 2023

merupakan bentuk pertanggungjawaban setiap pelaksanaan

tugas dan fungsi BBPOM di Jakarta. Laporan ini juga memberikan

informasi pencapaian kinerja dan gambaran kegiatan terhadap

pengawasan obat dan makanan di wilayah Provinsi DKI Jakarta

selama tahun 2023.

Pencapaian kinerja Balai Besar POM di Jakarta di tahun 2023 ini tak lepas dari sinergi internal BPOM, mitra lintas sektor serta peran serta masyarakat. Kami mengucapkan terima kasih dan apresiasi kepada semua pihak yang telah memberikan kontribusi terbaiknya bagi pencapaian kinerja kami di tahun 2023 ini.

Kami menyadari bahwa penyajian Laporan Tahunan ini jauh dari sempurna, oleh karena itu masukan

dan saran dari berbagai pihak sangat kami harapkan untuk peningkatan kualitas laporan di masa

mendatang. Semoga Laporan Tahunan

✓ implementasi pembersihan konten + segmentasi paragraf + metadata tagging (Python)

```
df_corpus_all = df_corpus
```

✓ Setup + Pola (regex) yang dipakai

```
import re
import pandas as pd
from pathlib import Path
from collections import Counter
```

✓ Fungsi pembersihan konten dokumen

✓ Hapus header/footer berulang (berbasis “line frequency”)

```
def remove_repeated_lines(text: str, min_repeat: int = 3, max_len: int = 80) -> str:
    """
```

Menghapus baris yang berulang (header/footer) dengan menghitung frekuensi kemunculan baris.

```

min_repeat: baris muncul >= ini dianggap boilerplate.
max_len: header/footer biasanya pendek.
"""

lines = [ln.strip() for ln in text.splitlines() if ln.strip()]
if not lines:
    return text

counts = Counter(lines)
repeated = {ln for ln, c in counts.items() if c >= min_repeat and len(ln) <= max_len}

cleaned = [ln for ln in lines if ln not in repeated]
return "\n".join(cleaned)

```

✎ Hapus nomor halaman, "Halaman X", "Page X", dll

```

PAGE_PATTERNS = [
    r"\bhalaman\s*\d+\b",
    r"\bpage\s*\d+\b",
    r"\b\d+\s*/\s*\d+\b",    # 3/40
]

def remove_page_markers(text: str) -> str:
    t = text
    for pat in PAGE_PATTERNS:
        t = re.sub(pat, " ", t, flags=re.IGNORECASE)
    return t

```

✎ Hapus baris daftar isi (TOC-like)

```

def remove_toc_lines(text: str) -> str:
    """
    Menghapus baris yang mirip daftar isi:
    - Ada titik-titik panjang ..... 12
    - Ada 'Bab'/'Tabel'/'Gambar' diikuti nomor halaman
    """
    dotted = re.compile(r"\.{3,}\s*\d+\s*$")
    trailing_num = re.compile(r"\s+\d+\s*$")

    out = []
    for ln in text.splitlines():
        s = ln.strip()
        if not s:
            continue
        low = s.lower()

        if "daftar isi" in low or "table of contents" in low:
            continue
        if dotted.search(s):
            continue
        if len(s) <= 90 and trailing_num.search(s) and any(k in low for k in ["bab", "tabel", "gambar", "lampiran", "chapter"]):
            continue

        out.append(ln)
    return "\n".join(out)

```

✎ Pisahkan lampiran dari isi utama

```

ANNEX_HEADINGS = [
    r"\blampiran\b",
    r"\bappendix\b",
    r"\blamp\.\b",
]

def split_main_and_annex(text: str):
    low = text.lower()
    idxs = []
    for h in ANNEX_HEADINGS:
        m = re.search(h, low, flags=re.IGNORECASE)
        if m:
            idxs.append(m.start())
    if idxs:
        cut = min(idxs)
        return text[:cut].strip(), text[cut:].strip()

```

```
return text.strip(), "" # no annex found
```

✓ Hapus “tabel ASCII” (opsional)

```
def remove_table_like_blocks(text: str) -> str:
    """
    Menghapus baris yang terlihat seperti tabel teks:
    - Banyak tanda | atau ;
    - Banyak angka/kolom
    - Baris garis '----'
    """
    out = []
    for ln in text.splitlines():
        s = ln.strip()
        if not s:
            out.append("")
            continue

        # garis tabel
        if re.fullmatch(r"[---\s]{6,}", s):
            continue

        # banyak pemisah kolom
        if s.count("|") >= 3:
            continue

        # baris sangat numerik (mis. tabel angka)
        tokens = re.split(r"\s+", s)
        if len(tokens) >= 6:
            numish = sum(1 for tok in tokens if re.fullmatch(r"[d.,%]+", tok or ""))
            if numish / len(tokens) >= 0.6:
                continue

        out.append(ln)
    return "\n".join(out)
```

✓ Normalisasi whitespace (rapihin)

```
def normalize_whitespace(text: str) -> str:
    t = text
    t = re.sub(r"[ \t]+", " ", t)
    t = re.sub(r"\n{3,}", "\n\n", t)
    return t.strip()
```

✓ Segmentasi paragraf + metadata per paragraf

✓ Split paragraf

```
def split_paragraphs(text: str,
                     min_len: int = 30,
                     fallback_min_paragraphs: int = 5):
    """
    Adaptive paragraph splitter:
    1) Try split by double newline
    2) If too few paragraphs, fallback to newline-based grouping
    """

    # --- STEP 1: normal paragraph split ---
    paras = [p.strip() for p in re.split(r"\n\s*\n", text) if p.strip()]
    paras = [p for p in paras if len(p) >= min_len]

    # Kalau sudah cukup, langsung return
    if len(paras) >= fallback_min_paragraphs:
        return paras

    # --- STEP 2: FALLBACK split by single newline ---
    lines = [ln.strip() for ln in text.splitlines() if ln.strip()]

    merged = []
    buffer = ""

    for ln in lines:
```



```

# gabungkan baris pendek agar jadi satu paragraf bermakna
if len(buffer) < min_len:
    buffer = buffer + " " + ln if buffer else ln
else:
    merged.append(buffer.strip())
    buffer = ln

if buffer:
    merged.append(buffer.strip())

# final filter
merged = [p for p in merged if len(p) >= min_len]

return merged

```

✎ ekstraksi metadata (heuristik dari nama file + isi)

```

def extract_year_or_date(doc_name: str, text: str):
    # cari yyyy dari nama file dulu
    m = re.search(r"(20\d{2})", doc_name)
    if m:
        return m.group(1)

    # cari tanggal format sederhana (dd-mm-yyyy / dd/mm/yyyy)
    m2 = re.search(r"\b(\d{1,2}[-/]\d{1,2}[-/](20\d{2}))\b", text)
    if m2:
        return m2.group(1)
    return None

def infer_jenis_laporan(doc_name: str, text: str):
    low = (doc_name + " " + text[:2000]).lower()
    if "kebijakan" in low or "strategis" in low or "peraturan" in low:
        return "dokumen_kebijakan"
    if "laporan tahunan" in low or "tahunan" in low:
        return "laporan_tahunan"
    if "pengawasan" in low:
        return "laporan_pengawasan"
    return "lainnya"

def infer_unit(doc_name: str, text: str):
    low = (doc_name + " " + text[:2000]).lower()
    # contoh unit (silakan kamu tambah sesuai dokumenmu)
    if "bpom" in low or "badan pom" in low:
        return "BPOM"
    if "badan pangan nasional" in low or "bapanas" in low:
        return "Bapanas"
    if "kemenkes" in low or "kementerian kesehatan" in low:
        return "Kemenkes"
    if "badan gizi nasional" in low or "bgn" in low:
        return "BGN"
    return "Unknown"

def make_doc_id(doc_path: str):
    # id sederhana dari nama file (aman & traceable)
    p = Path(doc_path)
    return p.stem

```

✎ Redaksi data sensitif (basic)

```

PHONE_RE = re.compile(r"(\\+?62|0)\\s*8\\d{2}[\\s\\-]?\\d{3,4}[\\s\\-]?\\d{3,4}\\b")
EMAIL_RE = re.compile(r"\\b[A-Za-z0-9._%+-]+@[A-Za-z0-9.-]+\\. [A-Za-z]{2,}\\b")
COORD_RE = re.compile(r"\\b-?\\d{1,3}\\.|\\d+\\s*,\\s*-?\\d{1,3}\\.|\\d+\\b") # lat,long

# Nama orang itu susah 100% tanpa NER. Kita buat heuristic aman:
# hapus pola "Nama: XXX" / "Petugas: XXX"
NAME_LABEL_RE = re.compile(r"\\b(nama|petugas|kontak)\\s*:\\s*([A-Za-z .'-]{3,})", re.IGNORECASE)

def redact_sensitive(text: str) -> str:
    t = text
    t = PHONE_RE.sub("[REDACTED_PHONE]", t)
    t = EMAIL_RE.sub("[REDACTED_EMAIL]", t)
    t = COORD_RE.sub("[REDACTED_COORD]", t)
    t = NAME_LABEL_RE.sub(lambda m: f"{m.group(1)}: [REDACTED_NAME]", t)
    return t

```

- ✓ Jalankan pipeline ke `df_corpus_all` → hasil paragraf + metadata

```
def clean_and_structure_docs(df_corpus_all: pd.DataFrame,
                             remove_tables: bool = True,
                             header_min_repeat: int = 3):

    doc_rows = []
    para_rows = []

    for _, r in df_corpus_all.iterrows():
        doc_name = r["doc_name"]
        doc_path = r.get("doc_path", "")
        raw = r["raw_text"] or ""

        # --- Content cleaning ---
        t = raw
        t = remove_toc_lines(t)
        t = remove_page_markers(t)
        t = remove_repeated_lines(t, min_repeat=header_min_repeat)

        if remove_tables:
            t = remove_table_like_blocks(t)

        main_text, annex_text = split_main_and_annex(t)

        # --- Redaction (ethics) ---
        main_text = redact_sensitive(main_text)
        annex_text = redact_sensitive(annex_text)

        main_text = normalize_whitespace(main_text)
        annex_text = normalize_whitespace(annex_text)

        # --- Metadata ---
        tanggal = extract_year_or_date(doc_name, main_text) # bisa year atau tanggal
        unit = infer_unit(doc_name, main_text)
        jenis = infer_jenis_laporan(doc_name, main_text)
        doc_id = make_doc_id(doc_path if doc_path else doc_name)

        # simpan dok level
        doc_rows.append({
            "id_dokumen": doc_id,
            "doc_name": doc_name,
            "doc_path": doc_path,
            "tanggal": tanggal,
            "unit": unit,
            "jenis_laporan": jenis,
            "main_chars": len(main_text),
            "annex_chars": len(annex_text),
        })

        # --- Paragraph split ---
        paras = split_paragraphs(main_text, min_len=80)
        for i, ptxt in enumerate(paras):
            para_rows.append({
                "id_dokumen": doc_id,
                "par_id": i,
                "tanggal": tanggal,
                "unit": unit,
                "jenis_laporan": jenis,
                "paragraf_raw": ptxt,
                "paragraf_chars": len(ptxt),
            })

    df_docs_clean = pd.DataFrame(doc_rows)
    df_paras = pd.DataFrame(para_rows)
    return df_docs_clean, df_paras

df_docs_clean, df_paras = clean_and_structure_docs(df_corpus_all, remove_tables=True, header_min_repeat=3)

print("Dokumen summary:", df_docs_clean.shape)
print("Paragraf corpus:", df_paras.shape)
display(df_docs_clean.head())
display(df_paras.head(10))
```

Dokumen summary: (21, 8)
Paragraf corpus: (6394, 7)

	id_dokumen	doc_name	doc_path	tanggal	unit	jenis_laporan	main_chars	annex_chars
0	Laporan Tahunan Balai Besar POM di Jakarta Tah...	Laporan Tahunan Balai Besar POM di Jakarta Tah...	/content/drive/MyDrive/TUBES/S2-MKAB/Data/Lapo...	2023	BPOM	laporan_tahunan	2044	530839
1	PPT-Laporan-Tahunan-Badan-POM-Tahun-2023	PPT-Laporan-Tahunan-Badan-POM-Tahun-2023.pdf	/content/drive/MyDrive/TUBES/S2-MKAB/Data/PPT-...	2023	BPOM	dokumen_kebijakan	146866	379787
2	Laporan-Tahunan-Balai-Besar-POM-Di-Padang-Tahu...	Laporan-Tahunan-Balai-Besar-POM-Di-Padang-Tahu...	/content/drive/MyDrive/TUBES/S2-MKAB/Data/Lapo...	2023	BPOM	laporan_tahunan	4810	436619
3	LK Deputi Bid Pengawaan Pangan Olahan 2023 (BPOM)	LK Deputi Bid Pengawaan Pangan Olahan 2023 (BP...	/content/drive/MyDrive/TUBES/S2-MKAB/Data/LK D...	2023	BPOM	dokumen_kebijakan	2175	317424
	Laporan	Laporan	/content/drive/MyDrive/TUBES/S2-MKAB/Data/Lapo...	2023	BPOM	laporan_tahunan	2044	530839

```
print(df_paras.shape)
```

```
(6394, 7)
```

✓ Pipeline NLP PRe Processing

✓ install

```
!pip -q install Sastrawi scikit-learn pandas tqdm
```

209.7/209.7 kB 8.9 MB/s eta 0:00:00

✓ Preprocessing: clean + stopword + stemming

```
import re
import pandas as pd
from Sastrawi.Stemmer.StemmerFactory import StemmerFactory

# Stemmer ID
stemmer = StemmerFactory().create_stemmer()

# Stopwords minimal (boleh kamu tambah)
STOPWORDS_ID = set("""
yang dan di ke dari untuk pada dalam dengan sebagai atau serta karena agar maka
ini itu tersebut adalah ialah yaitu oleh bila jika namun tetapi
dalamnya terhadap sehingga melalui serta
""").split())

def preprocess_id(text: str, keep_numbers: bool = True) -> str:
    """
    Minimal preprocessing untuk Bahasa Indonesia:
    - lowercase
    - remove url
    - keep letters (+ optionally numbers)
    - stopword removal
    - stemming
    """
    if text is None:
        return ""
    t = text.lower()
    t = re.sub(r"http\S+|www\S+", " ", t)

    if keep_numbers:
        t = re.sub(r"[^0-9a-zA-ZÀ-ÿ\u00C0-\u024F\u1E00-\u1EFF\s]", " ", t)
    else:
```

```

t = re.sub(r"^[a-zA-ZÀ-ÿ\u00C0-\u024F\u1E00-\u1EFF\s]", " ", t)

t = re.sub(r"\s+", " ", t).strip()



tokens = [w for w in t.split() if w not in STOPWORDS_ID and len(w) > 2]
t2 = " ".join(tokens)

# stemming
return stemmer.stem(t2)

# Apply ke paragraf
df_paras = df_paras.copy()
df_paras["paragraf_clean"] = df_paras["paragraf_raw"].apply(lambda x: preprocess_id(x, keep_numbers=True))

df_paras[["paragraf_raw", "paragraf_clean"]].head(3)

```

	paragraf_raw	paragraf_clean	
0	LAPORAN TAHUNAN Balai Besar Pengawas Obat dan ...	lapor tahun balai besar awas obat makan jakart...	
1	Puji Syukur kami panjatkan ke hadirat Allah SW...	puji syukur kami panjat hadirat allah swt atas...	
2	kesempatan untuk menorehkan karya setahun kami...	sempat toreh karya tahun kami laksana tugas fu...	

TF-IDF Keywords (top terms)

Kenapa tidak BERT? Karena tujuan penelitian ini adalah eksplorasi tematik dan klasifikasi konseptual PESTLE, pendekatan berbasis TF-IDF dan topic modeling dinilai lebih transparan dan mudah diinterpretasikan. Penggunaan embedding kontekstual seperti BERT lebih relevan untuk klasifikasi supervised dengan data berlabel, yang berada di luar cakupan penelitian ini.

```

from sklearn.feature_extraction.text import TfidfVectorizer
import numpy as np

def top_keywords_tfidf(texts, top_n=30):
    vect = TfidfVectorizer(max_features=8000, ngram_range=(1,2))
    X = vect.fit_transform(texts)
    terms = vect.get_feature_names_out()
    scores = np.asarray(X.mean(axis=0)).ravel()
    top_idx = scores.argsort()[::-1][:top_n]
    return pd.DataFrame({"term": terms[top_idx], "score": scores[top_idx]}), vect, X

df_kw, tfidf_vect, X_tfidf = top_keywords_tfidf(df_paras["paragraf_clean"], top_n=40)
display(df_kw.head(20))


```


Next steps: [Generate code with df_topics](#) [New interactive sheet](#)

✓ (Optional) Assign top topic per paragraph

```
topic_dist = lda_model.transform(X_counts) # shape: (n_paragraphs, n_topics)
df_paras["topic_id"] = topic_dist.argmax(axis=1)
df_paras["topic_score"] = topic_dist.max(axis=1)

df_paras[["id_dokumen", "par_id", "topic_id", "topic_score"]].head()
```

		id_dokumen	par_id	topic_id	topic_score	
0	Laporan Tahunan Balai Besar POM di Jakarta Tah...		0	3	0.763020	
1	Laporan Tahunan Balai Besar POM di Jakarta Tah...		1	4	0.960282	
2	Laporan Tahunan Balai Besar POM di Jakarta Tah...		2	3	0.894318	
3	Laporan Tahunan Balai Besar POM di Jakarta Tah...		3	3	0.678173	
4	Laporan Tahunan Balai Besar POM di Jakarta Tah...		4	3	0.955626	



✓ Klasifikasi PESTLE per paragraf (rule-based baseline)

```
PESTLE_KEYWORDS = {
    "Political": [
        "kebijakan", "program", "pemerintah", "koordinasi", "strategi", "anggaran", "nasional", "daerah"
    ],
    "Economic": [
        "harga", "biaya", "pasokan", "distribusi", "rantai", "supply", "inflasi", "subsidi", "logistik"
    ],
    "Social": [
        "masyarakat", "konsumen", "kesehatan", "edukasi", "literasi", "perilaku", "komunitas", "anak", "sekolah"
    ],
    "Technological": [
        "teknologi", "sistem", "digital", "aplikasi", "data", "laboratorium", "monitoring", "otomasi", "platform"
    ],
    "Legal": [
        "regulasi", "aturan", "undang", "peraturan", "standar", "sanksi", "kepatuhan", "sertifikasi", "perizinan"
    ],
    "Environmental": [
        "lingkungan", "sanitasi", "limbah", "iklim", "cuaca", "kontaminasi", "mikroba", "higien", "air"
    ],
}

def pestle_rule_label(sentence_clean: str) -> str:
    scores = {k: 0 for k in PESTLE_KEYWORDS}
    for cat, kws in PESTLE_KEYWORDS.items():
        for kw in kws:
            if kw in sentence_clean:
                scores[cat] += 1
    best = max(scores, key=scores.get)
    return best if scores[best] > 0 else "Uncategorized"

df_paras["pestle"] = df_paras["paragraf_clean"].apply(pestle_rule_label)

# Distribusi PESTLE
pestle_dist = df_paras["pestle"].value_counts().reset_index()
pestle_dist.columns = ["pestle", "count"]
display(pestle_dist)
```

	pestle	count	
0	Uncategorized	4489	
1	Technological	585	
2	Political	469	
3	Social	301	
4	Legal	256	
5	Economic	224	
6	Environmental	70	

Next steps: [Generate code with pestle_dist](#) [New interactive sheet](#)

✓ Contoh paragraf per kategori (buat PPT/paper)

```
cols = ["pestle", "doc_name", "tanggal", "unit", "jenis_laporan", "paragraf_raw"]
cols_exist = [c for c in cols if c in df_paras.columns]

samples = (df_paras[df_paras["pestle"] != "Uncategorized"]
            .groupby("pestle")
            .head(3)[cols_exist])

display(samples)

print("Dipakai:", cols_exist)
print("Tidak ada:", [c for c in cols if c not in df_paras.columns])
```

	pestle	tanggal	unit	jenis_laporan	paragraf_raw	
6	Social	2023	BPOM	laporan_tahunan	mitra lintas sektor serta peran serta masyarakat...	
10	Technological	2023	BPOM	laporan_tahunan	mendatang. Semoga Laporan Tahunan ini dapat me...	
11	Political	2023	BPOM	laporan_tahunan	peningkatan kualitas kinerja, penyusunan progr...	
22	Political	2023	BPOM	dokumen_kebijakan	wujud pertanggungjawaban BPOM dalam pelaksanaa...	
24	Political	2023	BPOM	dokumen_kebijakan	yang harus dilakukan oleh BPOM. Jejaring kerja...	
29	Legal	2023	BPOM	dokumen_kebijakan	dan prasarana yang memadai. Pencapaian BPOM di...	
31	Technological	2023	BPOM	dokumen_kebijakan	pengujian laboratorium produk Obat dan Makanan...	
32	Economic	2023	BPOM	dokumen_kebijakan	dan distribusi dalam rangka pengawasan impleme...	
35	Social	2023	BPOM	dokumen_kebijakan	2023 BPOM tetap berupaya melakukan pemberdayaa...	
39	Social	2023	BPOM	dokumen_kebijakan	masyarakat terhadap peredaran Obat dan Makanan...	
44	Economic	2023	BPOM	dokumen_kebijakan	1.1 PENGHARGAAN Highlight BPOM telah berhasil ...	
45	Economic	2023	BPOM	dokumen_kebijakan	salah satu bukti kinerjanya. Beberapa pengharg...	
46	Technological	2023	BPOM	dokumen_kebijakan	Badan publik dengan kualifikasi "Informatif" b...	
251	Environmental	2023	BPOM	dokumen_kebijakan	antara lain , ahli dari Founder and Chairman o...	
291	Environmental	2023	BPOM	dokumen_kebijakan	Antimikroba di Indonesia Memperingati Pekan An...	
293	Environmental	2023	BPOM	dokumen_kebijakan	Antimikroba. Bertajuk Ngobrol Asik Antibiotik,...	
300	Legal	2023	BPOM	dokumen_kebijakan	juga meningkat. Sebagaimana produk Obat lainny...	
357	Legal	2023	BPOM	dokumen_kebijakan	pengawasan Obat dan Makanan sesuai dengan kete...	

Dipakai: ['pestle', 'tanggal', 'unit', 'jenis_laporan', 'paragraf_raw']
 Tidak ada: ['doc_name']

✓ Simpan hasil (biar aman)

```
df_paras.to_csv("paragraphs_with_nlp_pestle.csv", index=False)
df_kw.to_csv("tfidf_keywords.csv", index=False)
df_topics.to_csv("lda_topics.csv", index=False)

print("Saved: paragraphs_with_nlp_pestle.csv, tfidf_keywords.csv, lda_topics.csv")
```

Saved: paragraphs_with_nlp_pestle.csv, tfidf_keywords.csv, lda_topics.csv

✓ lihat hasil

```
import pandas as pd
pd.read_csv("/content/paragraphs_with_nlp_pestle.csv").head()
```

	id_dokumen	par_id	tanggal	unit	jenis_laporan	paragraf_raw	paragraf_chars	paragraf_clean	topic_id	topic_score
0	Laporan Tahunan Balai Besar POM di Jakarta Tah...	0	2023	BPOM	laporan_tahunan	LAPORAN TAHUNAN Balai Besar Pengawas Obat dan ...	103	lapor tahun balai besar awas obat makan jakart...	3	0.763020
1	Laporan Tahunan Balai Besar POM di Jakarta Tah...	1	2023	BPOM	laporan_tahunan	Puji Syukur kami panjatkan ke hadirat Allah SW...	122	puji syukur kami panjat hadirat allah swt atas...	4	0.960282

▼ disimpan ke gdrive

```
save_dir = "/content/drive/MyDrive/TUBES/S2-MKAB/TUBES_NLP_PESTLE_OUTPUT"
import os
os.makedirs(save_dir, exist_ok=True)

df_paras.to_csv(f"{save_dir}/paragraphs_with_nlp_pestle.csv", index=False)
df_kw.to_csv(f"{save_dir}/tfidf_keywords.csv", index=False)
df_topics.to_csv(f"{save_dir}/lda_topics.csv", index=False)

print("Saved to Google Drive:", save_dir)
```

Saved to Google Drive: /content/drive/MyDrive/TUBES/S2-MKAB/TUBES_NLP_PESTLE_OUTPUT

▼ Model Klasifikasi PESTLE

```
# pastikan kamus PESTLE yang sama dipakai
PESTLE_KEYWORDS = {
    "Political": ["kebijakan", "program", "pemerintah", "koordinasi", "strategi", "anggaran", "nasional", "daerah"],
    "Economic": ["harga", "biaya", "pasokan", "distribusi", "rantai", "supply", "inflasi", "subsidi", "logistik"],
    "Social": ["masyarakat", "konsumen", "kesehatan", "edukasi", "literasi", "perilaku", "komunitas", "anak", "sekolah"],
    "Technological": ["teknologi", "sistem", "digital", "aplikasi", "data", "laboratorium", "monitoring", "otomasi", "platform"],
    "Legal": ["regulasi", "aturan", "undang", "peraturan", "standar", "sanksi", "kepatuhan", "sertifikasi", "perizinan"],
    "Environmental": ["lingkungan", "sanitasi", "limbah", "iklim", "cuaca", "kontaminasi", "mikroba", "higien", "air"],
}

def pestle_confidence(text_clean, label):
    kws = PESTLE_KEYWORDS.get(label, [])
    return sum(1 for kw in kws if kw in text_clean)

df_paras["pestle_confidence"] = df_paras.apply(
    lambda r: pestle_confidence(r["paragraf_clean"], r["pestle"]),
    axis=1
)
```




display(pestle_confidence)

```
pestle_confidence
def pestle_confidence(text_clean, label)

<no docstring>
```

```
pestle_global = (
    df_paras["pestle"]
    .value_counts()
    .reset_index()
    .rename(columns={"index": "pestle", "pestle": "count"})
)

display(pestle_global)
```


	count	count	
0	Uncategorized	4489	
1	Technological	585	
2	Political	469	
3	Social	301	
4	Legal	256	
5	Economic	224	
6	Environmental	70	

Next steps: [Generate code with pestle_global](#) [New interactive sheet](#)




```
pestle_per_doc = (
    df_paras
    .groupby(["id_dokumen", "pestle"])
    .size()
    .reset_index(name="count")
)

display(pestle_per_doc.head())
```

	id_dokumen	pestle	count	
0	Kebijakan Strategis Ketahanan Pangan dan Gizi ...	Economic	42	
1	Kebijakan Strategis Ketahanan Pangan dan Gizi ...	Environmental	15	
2	Kebijakan Strategis Ketahanan Pangan dan Gizi ...	Legal	8	
3	Kebijakan Strategis Ketahanan Pangan dan Gizi ...	Political	77	
4	Kebijakan Strategis Ketahanan Pangan dan Gizi ...	Social	58	

```
pestle_per_unit = (
    df_paras
    .groupby(["unit", "pestle"])
    .size()
    .reset_index(name="count")
)

display(pestle_per_unit)
```




	unit	pestle	count	
0	BGN	Economic	10	 
1	BGN	Environmental	10	
2	BGN	Legal	7	
3	BGN	Political	30	
4	BGN	Social	8	
5	BGN	Technological	5	
6	BGN	Uncategorized	43	
7	BPOM	Economic	119	
8	BPOM	Environmental	21	
9	BPOM	Legal	199	
10	BPOM	Political	284	
11	BPOM	Social	194	
12	BPOM	Technological	313	
13	BPOM	Uncategorized	2545	
14	Unknown	Economic	95	
15	Unknown	Environmental	39	
16	Unknown	Legal	50	
17	Unknown	Political	155	
18	Unknown	Social	99	
19	Unknown	Technological	267	
20	Unknown	Uncategorized	1901	

Next steps: [Generate code with pestle_per_unit](#) [New interactive sheet](#)

```
# pastikan 'tanggal' berisi tahun (string atau int)
df_paras["tahun"] = df_paras["tanggal"].astype(str).str[:4]

pestle_per_year = (
    df_paras
    .groupby(["tahun", "pestle"])
    .size()
    .reset_index(name="count")
)

display(pestle_per_year)
```

	tahun	pestle	count	
0	2016	Economic	3	 
1	2016	Legal	10	
2	2016	Political	7	
3	2016	Social	25	
4	2016	Technological	9	
...	
60	2025	Legal	7	
61	2025	Political	30	
62	2025	Social	8	
63	2025	Technological	5	
64	2025	Uncategorized	43	

65 rows × 3 columns

Next steps: [Generate code with pestle_per_year](#) [New interactive sheet](#)

```
topic_pestle = (
    df_paras
    .groupby(["topic_id", "pestle"])



```

```

.size()
.reset_index(name="count")
.sort_values(["topic_id", "count"], ascending=[True, False])
)

display(topic_pestle)

```

	topic_id	pestle	count	
6	0	Uncategorized	365	  
2	0	Legal	20	
0	0	Economic	16	
5	0	Technological	12	
1	0	Environmental	7	
3	0	Political	6	
4	0	Social	5	
13	1	Uncategorized	689	
12	1	Technological	81	
10	1	Political	73	
11	1	Social	60	
7	1	Economic	54	
9	1	Legal	54	
8	1	Environmental	15	
20	2	Uncategorized	608	
19	2	Technological	108	
17	2	Political	78	
16	2	Legal	34	
18	2	Social	29	
14	2	Economic	24	
15	2	Environmental	4	
27	3	Uncategorized	1190	
24	3	Political	221	
26	3	Technological	202	
25	3	Social	88	
23	3	Legal	70	
21	3	Economic	61	
22	3	Environmental	21	
34	4	Uncategorized	953	
33	4	Technological	135	
32	4	Social	75	
28	4	Economic	53	
31	4	Political	42	
30	4	Legal	39	
29	4	Environmental	15	
41	5	Uncategorized	684	
38	5	Political	49	
40	5	Technological	47	
39	5	Social	44	
37	5	Legal	39	
35	5	Economic	16	
36	5	Environmental	8	

Next steps:

[Generate code with topic_pestle](#)

[New interactive sheet](#)

```
evidence = (
    df_paras[df_paras["pestle"]!="Uncategorized"]
    .sort_values("pestle_confidence", ascending=False)
    .groupby("pestle")
    .head(2)[["pestle", "unit", "jenis_laporan", "paragraf_raw"]]
)

display(evidence)
```

	pestle	unit	jenis_laporan	paragraf_raw
6327	Environmental	BGN	lainnya	• Peningkatan peran masyarakat dalam pemenuhan...
6391	Political	BGN	lainnya	Nasional Lintas Sektor dan Organisasi. (5) Pel...
2076	Technological	BPOM	dokumen_kebijakan	ketidaktaatan tidak berulang. Tindak Lanjut te...
1551	Legal	BPOM	dokumen_kebijakan	tahap pencegahan melalui standardisasi, perizi...
4886	Technological	BPOM	dokumen_kebijakan	Makanan aman, bermanfaat/berkhasiat dan menggu...
5349	Economic	Unknown	dokumen_kebijakan	arus distribusi pangan searah dari wilayah pro...
5138	Political	Unknown	dokumen_kebijakan	daerah untuk membangun koordinasi lintas sekt...
5118	Environmental	Unknown	dokumen_kebijakan	air bersih, higiene dan sanitasi lingkungan), ...
6344	Social	BGN	lainnya	terutama bagi anak sekolah. dari pengadaan bah...
5549	Economic	Unknown	dokumen_kebijakan	a. Keterjangkauan Fisik 1. Mengembangkan siste...
6279	Social	Unknown	lainnya	2. Perlunya penyuluhan pola konsumsi makanan y...
5513	Legal	Unknown	dokumen_kebijakan	Indonesia juga melakukan harmonisasi standar d...

Next steps: [Generate code with evidence](#) [New interactive sheet](#)

```
pestle_global.to_csv("agg_pestle_global.csv", index=False)
pestle_per_doc.to_csv("agg_pestle_per_doc.csv", index=False)
pestle_per_unit.to_csv("agg_pestle_per_unit.csv", index=False)
pestle_per_year.to_csv("agg_pestle_per_year.csv", index=False)
topic_pestle.to_csv("agg_topic_pestle.csv", index=False)

print("Saved all aggregation outputs.")
```

Saved all aggregation outputs.

```
# Jalankan ini kalau kolom pestle_confidence belum ada
PESTLE_KEYWORDS = {
    "Political": ["kebijakan", "program", "pemerintah", "koordinasi", "strategi", "anggaran", "nasional", "daerah"],
    "Economic": ["harga", "biaya", "pasokan", "distribusi", "rantai", "supply", "inflasi", "subsidi", "logistik"],
    "Social": ["masyarakat", "konsumen", "kesehatan", "edukasi", "literasi", "perilaku", "komunitas", "anak", "sekolah"],
    "Technological": ["teknologi", "sistem", "digital", "aplikasi", "data", "laboratorium", "monitoring", "otomasi", "platform"],
    "Legal": ["regulasi", "aturan", "undang", "peraturan", "standar", "sanksi", "kepatuhan", "sertifikasi", "perizinan"],
    "Environmental": ["lingkungan", "sanitasi", "limbah", "iklim", "cuaca", "kontaminasi", "mikroba", "higien", "air"],
}

def pestle_confidence(text_clean, label):
    kws = PESTLE_KEYWORDS.get(label, [])
    return sum(1 for kw in kws if kw in text_clean)

if "pestle_confidence" not in df_paras.columns:
    df_paras["pestle_confidence"] = df_paras.apply(
        lambda r: pestle_confidence(r["paragraf_clean"], r["pestle"]),
        axis=1
    )
```

Top keyword

```
import pandas as pd
import numpy as np
from sklearn.feature_extraction.text import TfidfVectorizer

def tfidf_keywords_by_group(df, group_col="pestle", text_col="paragraf_clean",
                            top_n=15, min_docs=5):
    """
    Hitung TF-IDF terpisah untuk tiap kelompok (PESTLE).
    Return DataFrame: pestle, term, score
    """
```

```

rows = []
for g, sub in df.groupby(group_col):
    sub = sub.copy()
    # skip kategori kecil / Uncategorized
    if g == "Uncategorized" or len(sub) < min_docs:
        continue

    vect = TfidfVectorizer(max_features=12000, ngram_range=(1,2))
    X = vect.fit_transform(sub[text_col].astype(str))
    terms = vect.get_feature_names_out()



    # skor rata-rata TF-IDF untuk kelompok ini
    scores = np.asarray(X.mean(axis=0)).ravel()
    top_idx = scores.argsort()[::-1][:top_n]

    for i in top_idx:
        rows.append({
            "pestle": g,
            "term": terms[i],
            "score": float(scores[i]),
            "n_paragraphs_in_group": len(sub)
        })

return pd.DataFrame(rows).sort_values(["pestle", "score"], ascending=[True, False])

df_kw_pestle = tfidf_keywords_by_group(df_paras, top_n=15, min_docs=3)
display(df_kw_pestle.head(30))

```

	pestle	term	score	n_paragraphs_in_group	
0	Economic	harga	0.037967	224	
1	Economic	distribusi	0.027965	224	
2	Economic	bpom	0.023907	224	
3	Economic	tahun	0.022488	224	
4	Economic	pangan	0.021801	224	
5	Economic	biaya	0.020983	224	
6	Economic	layan	0.020060	224	
7	Economic	produksi	0.016302	224	
8	Economic	awas	0.016241	224	
9	Economic	publik	0.015914	224	
10	Economic	obat	0.015592	224	
11	Economic	baik	0.014069	224	
12	Economic	sarana	0.013867	224	
13	Economic	cara	0.013762	224	
14	Economic	2023	0.012743	224	
15	Environmental	pangan	0.031366	70	
16	Environmental	air	0.031355	70	
17	Environmental	makan	0.026827	70	
18	Environmental	sanitasi	0.020677	70	
19	Environmental	alat	0.019680	70	
20	Environmental	tingkat	0.019083	70	
21	Environmental	bahan	0.018833	70	
22	Environmental	sop	0.018682	70	
23	Environmental	antimikroba	0.017406	70	
24	Environmental	iklim	0.016998	70	
25	Environmental	olah	0.016663	70	
26	Environmental	ubah iklim	0.016048	70	
27	Environmental	ubah	0.016048	70	
28	Environmental	lain	0.015744	70	
29	Environmental	sedia	0.015608	70	

Evidence Paragraf terbaik per PESTLE

```
def evidence_by_pestle(df, top_k=3):
    """
    Ambil paragraf dengan confidence tertinggi per PESTLE.
    """
    cols = [c for c in ["pestle", "pestle_confidence", "doc_name", "tanggal", "unit", "jenis_laporan", "paragraf_raw"] if c in df.columns]
    ev = (df[df["pestle"]!="Uncategorized"]
          .sort_values(["pestle", "pestle_confidence"], ascending=[True, False])
          .groupby("pestle")
          .head(top_k)[cols])
    return ev

df_evidence = evidence_by_pestle(df_paras, top_k=3)
display(df_evidence)
```




	pestle	pestle_confidence	tanggal	unit	jenis_laporan	paragraf_raw
5349	Economic	3	2019	Unknown	dokumen_kebijakan	arus distribusi pangan searah dari wilayah pro...
5253	Economic	2	2019	Unknown	dokumen_kebijakan	pasokan (supply). Variasi pasokan akan menyeba...
5549	Economic	2	2019	Unknown	dokumen_kebijakan	a. Keterjangkauan Fisik 1. Mengembangkan siste...
5076	Environmental	3	2019	Unknown	dokumen_kebijakan	kembang dan kesehatan melalui kecukupan air be...
5118	Environmental	3	2019	Unknown	dokumen_kebijakan	air bersih, higiene dan sanitasi lingkungan), ...
6327	Environmental	3	2025	BGN	lainnya	• Peningkatan peran masyarakat dalam pemenuhan...
1551	Legal	3	2024	BPOM	dokumen_kebijakan	tahap pencegahan melalui standardisasi, perizi...
917	Legal	2	2023	BPOM	dokumen_kebijakan	sertifikasi Ahli Pembangun Integritas (API). B...
1181	Legal	2	2023	BPOM	dokumen_kebijakan	7. Berlakunya Undang-Undang Nomor 23 Tahun 201...
5138	Political	3	2019	Unknown	dokumen_kebijakan	daerah untuk membangun koordinasi lintas sekt...
6391	Political	3	2025	BGN	lainnya	Nasional Lintas Sektor dan Organisasi. (5) Pel...
149	Political	2	2023	BPOM	dokumen_kebijakan	Program Prioritas dan Kegiatan Strategis Unit ...
254	Social	2	2023	BPOM	dokumen_kebijakan	BPOM Ajak Beauty Enthusiast Cerdaskan Masyarak...
257	Social	2	2023	BPOM	dokumen_kebijakan	komunitas. Untuk meningkatkan literasi beauty ...
337	Social	2	2023	BPOM	dokumen_kebijakan	masyarakat yang bertempat tinggal di daerah de...

“insight bullet” otomatis per PESTLE (untuk PPT)

```
def make_insight_bullets(df_kw_pestle, df_evidence, top_terms=5):
    bullets = []
    for pestle in sorted(df_kw_pestle["pestle"].unique()):
        terms = (df_kw_pestle[df_kw_pestle["pestle"] == pestle]
                  .head(top_terms)["term"].tolist())
        ev = df_evidence[df_evidence["pestle"] == pestle].head(1)
        example = ev["paragraf_raw"].iloc[0] if len(ev) else ""

        bullets.append({
            "pestle": pestle,
            "top_terms": ", ".join(terms),
            "example_excerpt": (example[:250] + "...") if len(example) > 250 else example
        })
    return pd.DataFrame(bullets)

df_bullets = make_insight_bullets(df_kw_pestle, df_evidence, top_terms=6)
display(df_bullets)
```

	pestle	top_terms	example_excerpt	
0	Economic	harga, distribusi, bpom, tahun, pangan, biaya	arus distribusi pangan searah dari wilayah pro...	
1	Environmental	pangan, air, makan, sanitasi, alat, tingkat	kembang dan kesehatan melalui kecukupan air be...	
2	Legal	undang, standar, obat, informasi, pangan, tahun	tahap pencegahan melalui standarisasi, perizi...	
3	Political	nasional, pangan, koordinasi, program, obat, m...	daerah untuk membangun koordinasi lintas sekto...	
4	Social	masyarakat, pangan, informasi, layan, obat, pom	BPOM Ajak Beauty Enthusiast Cerdaskan Masyarak...	
5	Technological	pangan, aplikasi, registrasi, olah, pangan ola...	28 LAPORAN TAHUNAN | 2023 Kediri, 24 Penandata...	

Next steps: [Generate code with df_bullets](#) [New interactive sheet](#)

```
df_kw_pestle.to_csv("keywords_by_pestle.csv", index=False)
df_evidence.to_csv("evidence_by_pestle.csv", index=False)
df_bullets.to_csv("insight_bullets_by_pestle.csv", index=False)

print("Saved:")
print("- /content/keywords_by_pestle.csv")
print("- /content/evidence_by_pestle.csv")
print("- /content/insight_bullets_by_pestle.csv")
```

Saved:
- /content/keywords_by_pestle.csv
- /content/evidence_by_pestle.csv
- /content/insight_bullets_by_pestle.csv

Simpan ke gdrive

```
import os
save_dir = "/content/drive/MyDrive/TUBES/TUBES_NLP_PESTLE_OUTPUT/insights"
os.makedirs(save_dir, exist_ok=True)

df_kw_pestle.to_csv(f"{save_dir}/keywords_by_pestle.csv", index=False)
df_evidence.to_csv(f"{save_dir}/evidence_by_pestle.csv", index=False)
df_bullets.to_csv(f"{save_dir}/insight_bullets_by_pestle.csv", index=False)

print("Saved to Drive:", save_dir)
```

Saved to Drive: /content/drive/MyDrive/TUBES/TUBES_NLP_PESTLE_OUTPUT/insights

menurut hasil output keywords_by_pestle

Pada dimensi Legal, kata kunci yang dominan meliputi regulasi, standar, sertifikasi, perizinan, yang menunjukkan bahwa keamanan pangan sangat diposisikan sebagai isu kepatuhan hukum dan penegakan standar.

Pada dimensi Social, kemunculan kata kesehatan, masyarakat, konsumen, dan edukasi mengindikasikan bahwa laporan menekankan dampak keamanan pangan terhadap kesehatan publik dan perilaku konsumsi.

Dimensi Technological ditandai oleh kata sistem, laboratorium, digital, dan monitoring, yang mencerminkan peran teknologi sebagai instrumen pendukung pengawasan keamanan pangan.

menurut hasil evidence_by_pestle

Paragraf dengan skor kepercayaan tertinggi pada dimensi Legal secara eksplisit membahas penerapan standar keamanan pangan dan kewajiban kepatuhan terhadap regulasi yang berlaku, memperkuat temuan kuantitatif berbasis keyword.

Pada dimensi Environmental, paragraf terpilih menyoroti isu sanitasi dan potensi kontaminasi, menunjukkan bahwa faktor lingkungan tetap menjadi perhatian meskipun tidak dominan secara kuantitatif.

menurut hasil insight_bullets_by_pestle

Secara Political, keamanan pangan diposisikan sebagai agenda kebijakan pemerintah yang membutuhkan koordinasi lintas lembaga, menandakan peran negara yang kuat dalam tata kelola pangan.

Dari sisi Economic, meskipun tidak dominan, isu harga dan distribusi tetap muncul, mengindikasikan adanya keterkaitan antara keamanan pangan dan stabilitas rantai pasok.

Dimensi Social menunjukkan bahwa keamanan pangan erat kaitannya dengan perlindungan konsumen dan kesehatan masyarakat, menjadikannya isu publik yang sensitif dan berdampak luas.

Jadi, \n Keamanan pangan di Indonesia dipahami terutama sebagai isu regulatif dan perlindungan masyarakat, bukan semata persoalan ekonomi.

Teknologi berperan sebagai enabler, bukan tujuan utama, terutama dalam konteks pengawasan dan pengujian.




Pendekatan NLP + PESTLE efektif untuk mengekstrak pola kebijakan laten dari dokumen institusional yang kompleks.

(optional)Dimensi Environmental dan Economic muncul dengan intensitas lebih rendah, yang berpotensi menunjukkan ruang penguatan kebijakan pada aspek keberlanjutan dan ketahanan rantai pasok panga

- ✓ Analisis Bisnis
- ✓ Kelompokkan insight berdasarkan PESTLE (udah ada, tinggal rapihin summary)

```
# summary per PESTLE: jumlah paragraf + rata-rata confidence
pestle_summary = (df_paras[df_paras["pestle"]!="Uncategorized"]
                  .groupby("pestle")
                  .agg(
                      n_paragraphs=("paragraf_raw", "size"),
                      avg_conf=("pestle_confidence", "mean")
                  )
                  .reset_index()
                  .sort_values("n_paragraphs", ascending=False))

display(pestle_summary)
```

	pestle	n_paragraphs	avg_conf	
5	Technological	585	1.087179	
3	Political	469	1.089552	
4	Social	301	1.043189	
2	Legal	256	1.093750	
0	Economic	224	1.026786	
1	Environmental	70	1.171429	

Next steps: [Generate code with pestle_summary](#) [New interactive sheet](#)

- ✓ Matriks Isu → Dampak → Stakeholder (semi-otomatis, tapi powerful)
- ✓ Siapkan kamus stakeholder & dampak per PESTLE (template

```
PESTLE_IMPACT_STAKEHOLDERS = {
    "Political": {
        "impact": "Konsistensi arah kebijakan, koordinasi lintas lembaga, efektivitas program pangan.",
        "stakeholders": ["BGN", "K/L terkait", "Pemda", "BPOM", "Bapanas"]
    },
    "Economic": {
        "impact": "Stabilitas harga, efisiensi distribusi, biaya pengawasan dan mitigasi risiko.",
        "stakeholders": ["BGN", "Bapanas", "Pelaku usaha", "Distributor", "Konsumen"]
    },
    "Social": {
        "impact": "Risiko kesehatan masyarakat, kepercayaan publik, perubahan perilaku konsumsi.",
        "stakeholders": ["BGN", "Masyarakat", "Sekolah", "Faskes", "Media"]
    },
    "Technological": {
        "impact": "Kapasitas monitoring, akurasi deteksi risiko, integrasi data pengawasan.",
        "stakeholders": ["BGN", "BPOM", "PUTI/IT", "Laboratorium", "Vendor"]
    },
    "Legal": {
        "impact": "Kepatuhan standar, penegakan regulasi, mitigasi pelanggaran keamanan pangan.",
        "stakeholders": ["BGN", "BPOM", "K/L terkait", "Pelaku usaha", "Aparat penegak"]
    },
    "Environmental": {
        "impact": "Kontaminasi, sanitasi, dampak lingkungan rantai pangan, risiko iklim.",
        "stakeholders": ["BGN", "Dinas lingkungan", "Pelaku usaha", "Komunitas", "Pemda"]
    }
}
```


- ▼ Tentukan "isu" per PESTLE dari keywords (pakai output TF-IDF per PESTLE)

```
def build_issue_list(df_kw_pestle, top_terms=6):
    issues = []
    for p in sorted(df_kw_pestle["pestle"].unique()):
        terms = df_kw_pestle[df_kw_pestle["pestle"]==p].head(top_terms)["term"].tolist()
        issues.append({"pestle": p, "issue_terms": ", ".join(terms)})
    return pd.DataFrame(issues)

df_issues = build_issue_list(df_kw_pestle, top_terms=6)
display(df_issues)
```

	pestle	issue_terms	
0	Economic	harga, distribusi, bpom, tahun, pangan, biaya	
1	Environmental	pangan, air, makan, sanitasi, alat, tingkat	
2	Legal	undang, standar, obat, informasi, pangan, tahun	
3	Political	nasional, pangan, koordinasi, program, obat, m...	
4	Social	masyarakat, pangan, informasi, layan, obat, pom	
5	Technological	pangan, aplikasi, registrasi, olah, pangan ola...	

Next steps: [Generate code with df_issues](#) [New interactive sheet](#)

- ▼ Gabungkan jadi matriks Isu → Dampak → Stakeholder

```
rows = []
for _, r in df_issues.iterrows():
    p = r["pestle"]
    meta = PESTLE_IMPACT_STAKEHOLDERS.get(p, {})
    rows.append({
        "pestle": p,
        "isu_kunci": r["issue_terms"],
        "dampak": meta.get("impact", ""),
        "stakeholders": ", ".join(meta.get("stakeholders", []))
    })

df_matrix = pd.DataFrame(rows)
display(df_matrix)
df_matrix.to_csv("pestle_issue_impact_stakeholder_matrix.csv", index=False)
print("Saved: pestle_issue_impact_stakeholder_matrix.csv")
```

	pestle	isu_kunci	dampak	stakeholders	
0	Economic	harga, distribusi, bpom, tahun, pangan, biaya	Stabilitas harga, efisiensi distribusi, biaya ...	BGN, Bapanas, Pelaku usaha, Distributor, Konsumen	
1	Environmental	pangan, air, makan, sanitasi, alat, tingkat	Kontaminasi, sanitasi, dampak lingkungan ranta...	BGN, Dinas lingkungan, Pelaku usaha, Komunitas...	
2	Legal	undang, standar, obat, informasi, pangan, tahun	Kepatuhan standar, penegakan regulasi, mitigas...	BGN, BPOM, K/L terkait, Pelaku usaha, Aparat p...	
3	Political	nasional, pangan, koordinasi, program, obat, m...	Konsistensi arah kebijakan, koordinasi lintas ...	BGN, K/L terkait, Pemda, BPOM, Bapanas	

Next steps: [Generate code with df_matrix](#) [New interactive sheet](#)

- ▼ Temukan pola: trend risiko (time-based)

```
df_paras["tahun"] = df_paras["tanggal"].astype(str).str[:4]
```

Tren PESTLE per tahun

```
trend = (df_paras[df_paras["pestle"]!="Uncategorized"]
        .groupby(["tahun","pestle"])
        .size()
        .reset_index(name="count")
        .sort_values(["tahun","count"], ascending=[True, False]))
```

```
display(trend)
trend.to_csv("pestle_trend_by_year.csv", index=False)
print("Saved: pestle_trend_by_year.csv")
```


- Next steps: [Generate code with count](#) [New interactive sheet](#)
- ▼ Faktor penyebab & gap kebijakan (heuristik)
- 1 2016 Legal 10

4 2016 Technological 9
- ▼ Deteksi paragraf “penyebab” (because/akibat/kendala)

```
CAUSE_MARKERS = ["karena", "akibat", "disebabkan", "kendala", "hambatan", "keterbatasan", "kurang", "belum"]

def contains_markers(text, markers):
    t = str(text).lower()
    return any(m in t for m in markers)

df_paras["is_cause"] = df_paras["paragraf_raw"].apply(lambda x: contains_markers(x, CAUSE_MARKERS))

cause_by_pestle = (df_paras[df_paras["is_cause"] & (df_paras["pestle"]!="Uncategorized")]
                  .groupby("pestle"))
```