SIRD #104
SOCIAL INVESTMENT ROUNDTABLE DISCUSSION

Social Investment Indonesia

Via zoom @SocialInvestment_Id

AI & DATA SCIENCE untuk Keberlanjutan



Prof. Dr. Yandra Arkeman, M.Eng.
Ketua - BRAIN IPB University



Khaliq Fikri SF
Sustainable Finance Analyst
WWF Indonesia



Jalal
Chairperson of Advisory Board
Social Investment Indonesia



Resensi Buku:



Host:



Nur Astri Mufthia S.
Associate
Social Investment Indonesia

Jumat,
18 September 2026

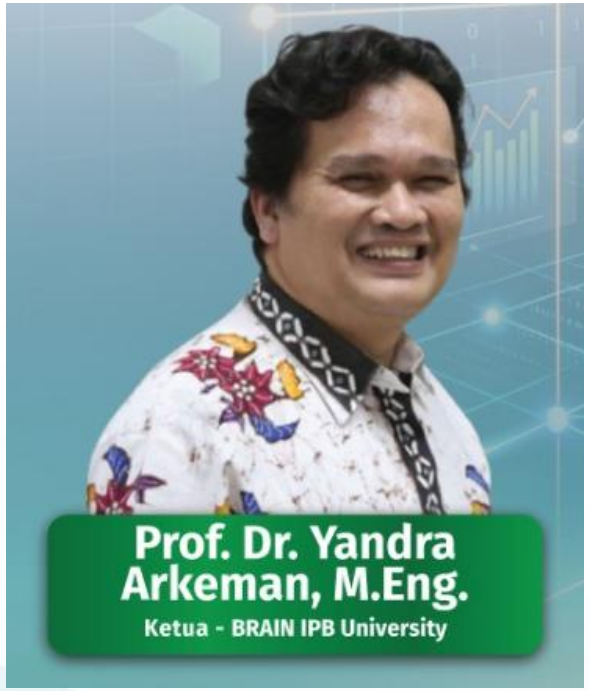
15.00 - 17.00 WIB

socialinvestment.id

SIRD #104
SOCIAL INVESTMENT ROUNDTABLE DISCUSSION

Social Investment Indonesia

AI & DATA SCIENCE untuk Keberlanjutan



Professional Experience

- *Professor of Agroindustrial Technology dan Founder BRAIN IPB, dengan kepakaran pada Artificial Intelligence, Computational Intelligence, Advanced Computing Technology, serta penerapannya pada sistem industri dan keberlanjutan.*
- *Pendiri BRAIN (Blockchain, Robotics and Artificial Intelligence Networks) IPB pada 2017.*
- *Pendiri Center of Excellence for Agroindustrial Logistics and Supply Chain Management (CEALS) pada 2014.*
- *Peneliti di Surfactant and Bioenergy Research Center (SBRC) IPB sejak 2008, dengan fokus pada bioenergy sustainability dan climate change.*



Educational Experience

- *S1 - Sarjana Teknologi Industri Pertanian, IPB Universit*
- *S2 - Master of Engineering in Advanced Manufacturing Technology, University of South Australia*
- *S3 - Manufacturing Systems Engineering, University of South Australia (2000)*

AI for Sustainability

Turning ESG Data into Predictive and Actionable Decisions

From ESG reporting to sustainability intelligence

Prof. Dr. Yandra Arkeman, M.Eng.
IPB University | BRAIN Research Group

The Quantum Leap to AGI: The Evolution of Intelligence

The Three Stages Of Intelligence

1 NARROW AI (Current)



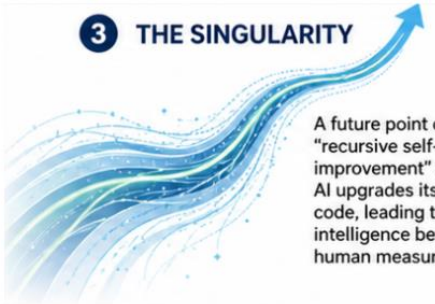
Statistical tools designed for specific tasks without cross-domain context.

2 ARTIFICIAL GENERAL INTELLIGENCE (AGI)



Human-level cognitive ability where machines learn independently and apply reasoning across diverse domains.

3 THE SINGULARITY



A future point of "recursive self-improvement" where AI upgrades its own code, leading to intelligence beyond human measure.

REAL-WORLD IMPLEMENTATIONS & QUANTUM SYNERGY

QUANTUM OPTIMIZATION

CLASSICAL AI (Today)



1. Sequential Probability
2. Limited variables
3. "Good enough" estimates

VS.

QUANTUM AI (Future)

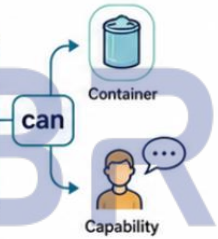


1. Massively Parallel (Superposition)
2. Trillions of data combinations
3. Absolute optimal solutions

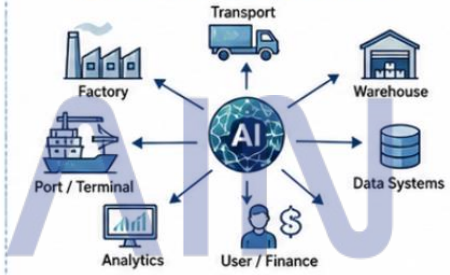
REAL-WORLD EXAMPLES

1 LLM SELF-ATTENTION

Current AI uses "attention" mechanisms to distinguish context, such as identifying if "can" refers to a container or a capability.



2 AGENTIC MULTI-SYSTEMS

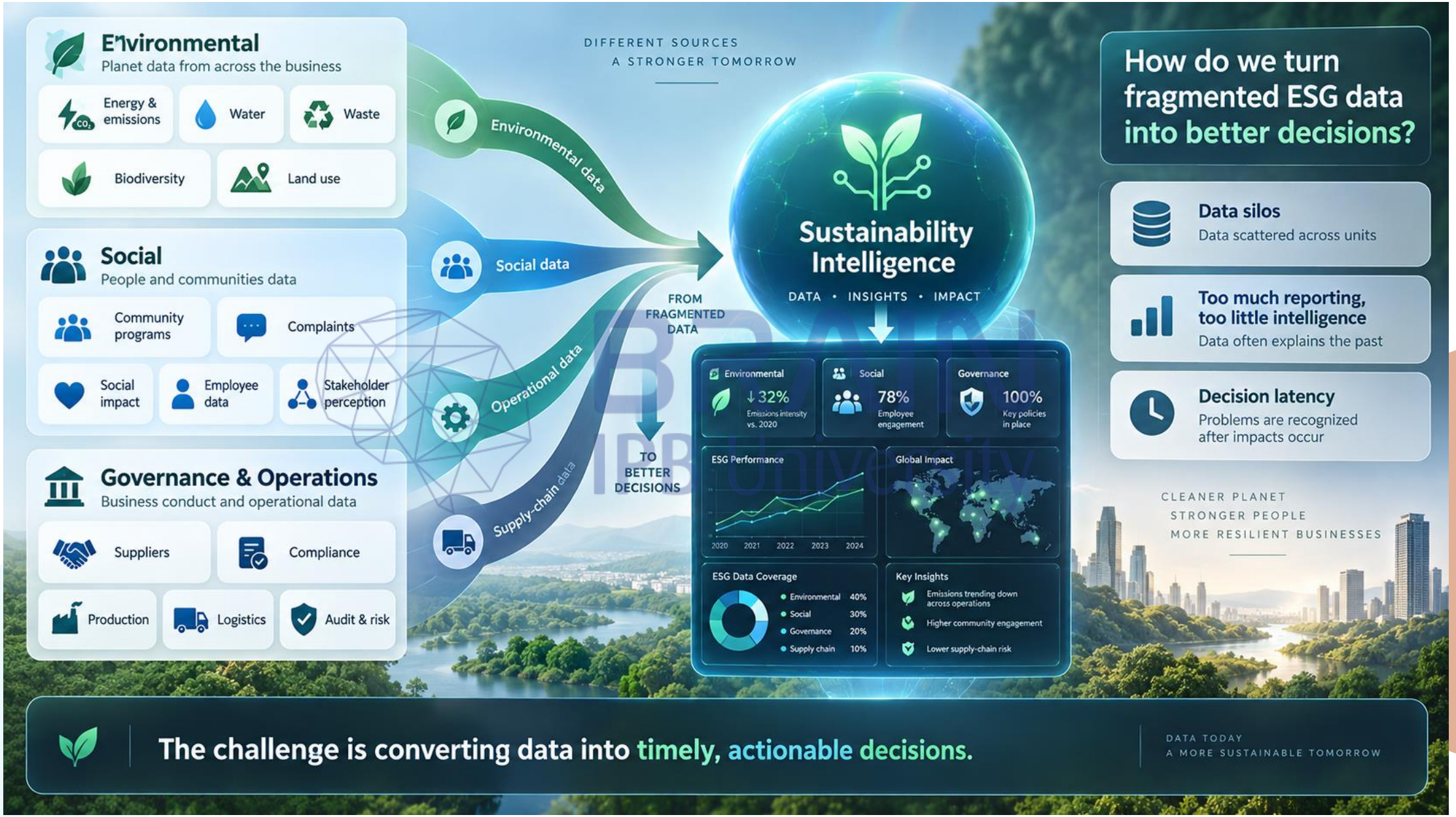


Autonomous "Control Towers" in supply chains that monitor data, analyze risks, and execute purchases without human intervention.

Teknologi AI	Aplikasi Dominan	Keuntungan Lingkungan	Keuntungan Sosial
Machine Learning (ML)	Prediksi Permintaan & Optimasi Inventaris Inventaris	Memotong emisi logistik & limbah	Ketersediaan produk yang lebih baik
Natural Language Processing (NLP)	Audit Laporan ESG otomatis	Mendeteksi pelanggaran lingkungan	Mengidentifikasi risiko kerja paksa di rantai pasok
Computer Vision	Kontrol Kualitas & Tata Letak Gudang	Menghemat ruang dan energi operasional	Keselamatan pekerja yang lebih baik

BRAIN IPB University

We have more data than ever.
But do we make better decisions?



PEOPLE
TECHNOLOGY
A CLEANER
TOMORROW

SMARTER
INSIGHTS
BRIGHTER
TOMORROWS

Moving from Reporting to Predictive Sustainability

AI moves sustainability from hindsight toward foresight.

SAME DATA. DEEPER INSIGHTS. A MORE SUSTAINABLE TOMORROW.

FROM
DATA
TO ACTION
FOR A MORE
SUSTAINABLE
WORLD

A
HEALTHIER
PLANET
A BRIGHTER
TOMORROW

01 — DESCRIPTIVE
LOOKING BACK

What happened?

Berapa emisi, waste, konsumsi energi, atau dampak sosial tahun lalu?

Reporting

02 — DIAGNOSTIC
FINDING CAUSES

Why did it happen?

- Mengapa penggunaan energi meningkat?
- Mengapa kinerja suatu program menurun?

Understanding

03 — PREDICTIVE
LOOKING AHEAD

What is likely to happen?

- Di mana risiko emisi meningkat?
- Supplier mana yang berisiko?
- Program mana yang berpotensi tidak mencapai target?

Anticipating

04 — PRESCRIPTIVE
TAKING ACTION

What should we do?

Intervensi apa yang memberikan dampak terbesar dengan sumber daya yang tersedia?

Deciding

BRAIN
IPB University

HINDSIGHT
REPORT THE PAST

DATA → INSIGHTS → PREDICTIONS → ACTIONS → IMPACT

FORESIGHT
SHAPE A BETTER
TOMORROW

SUSTAINABILITY
IN ACTION

AI extends sustainability analytics from reporting to decision support.

CLEANER OPERATIONS • STRONGER BUSINESSES • BRIGHTER TOMORROWS

PEOPLE
IDEAS
TECHNOLOGY
LASTING IMPACT

PEOPLE
PLANET
PROGRESS

CLEANER
BRIGHTER
TOGETHER

Four Roles of AI for Sustainability

How AI creates value for sustainability and better decisions

PREDICT

Anticipate what may happen

- Climate & environmental risk
- Energy demand
- Production
- Food loss
- Supply disruption
- Social/community risk



DETECT & UNDERSTAND

Find patterns humans may miss

- Pollution anomalies
- Land-use change
- Equipment failure
- Supplier patterns
- Community sentiment
- ESG data anomalies



OPTIMIZE

Find better ways to allocate resources

- Energy
- Production
- Logistics
- Water
- Materials
- Program resources



TRACE & VERIFY

Strengthen transparency

- Product origin
- Supplier history
- Supplly-chain events
- Sustainability claims
- Compliance



Predict → Detect → Optimize → Trace → Better Decisions

Recent literature highlights forecasting, pattern recognition/data mining, system optimization, and decision support as major AI roles for sustainability.

BRAIN
IPB University

From sensing to sustainable decisions

Integrating data, AI, and traceability for a more resilient and sustainable value chain

> *Technology becomes valuable when prediction is connected to a real operational decision.*
>
> *Prof. Yandra Arkeman*

1 SENSING
Capture real-world data

- IoT & Sensors
- Satellite & Remote Sensing
- Environmental Sensors
- Transaction Data

2 DATA
Integrate and manage data

- Production Data
- Environmental Data
- Logistics Data
- Supplier Data

3 AI
Turn data into intelligence

- Forecasting
- Detection
- Prediction

4 OPTIMIZATION
Find the best solutions

- Production Optimization
- Inventory Planning
- Transport Optimization
- Resource Use Optimization

5 TRACEABILITY
Ensure transparency

- Blockchain
- Digital Records
- Product Tracking
- Compliance & Verification

6 DECISION
Enable real impact

- Operational Action
- Sustainability Action
- Policy & Strategy
- Continuous Improvement



BUSINESS OUTCOMES

- ↑ Efficiency
- ↓ Operational Cost
- ↓ Uncertainty
- ↑ Resilience

SUSTAINABILITY OUTCOMES

- ↓ Food Loss
- ↓ Waste
- ↓ Unnecessary Transportation
- ↓ Resource Use
- ↑ Transparency
- ↑ Traceability

DATA-DRIVEN DECISIONS FOR A HEALTHIER PLANET AND A STRONGER BUSINESS

BRAIN IPB University

AI and Blockchain Integration in Supply Chains

Two-Way Integration: AI to Blockchain and Blockchain to AI



PEOPLE
PLANET
PROGRESS

The hidden challenge

Before AI readiness comes DATA readiness

BETTER DATA
BRIGHTER DECISIONS
A MORE SUSTAINABLE TOMORROW

Example goal: Predict supplier sustainability risk

- Supplier ID differs across databases
- Indicator definitions are inconsistent
- Supplier location is incomplete
- Social data is narrative/unstructured
- Environmental data available for only one year
- Many missing values



Fragmented data. Inconsistent formats. Incomplete information.

FROM FRAGMENTED DATA...

AI MODEL
PREDICT
ANALYZE
SUPPORT DECISIONS

...TO BETTER DECISIONS

RELIABLE	Is the data correct?
RELEVANT	Is the data connected to the decision?
TRACEABLE	Can we see the data origin and changes?
CONTEXTUAL	Does it reflect business, social, and environmental context?
TIMELY	Is it available when decisions need to be made?

DATA READINESS BUILDS TRUST

With strong data governance:

- **More accurate insights**
  Understand and manage real risks
- **Greater sustainability impact**
  Make decisions that create long-term value
- **Higher stakeholder trust**
  Be transparent and accountable
- **More efficient operations**
  Less time fixing data, more time creating value

CREDIBLE DATA.
RESPONSIBLE BUSINESS.
A BRIGHTER TOMORROW.

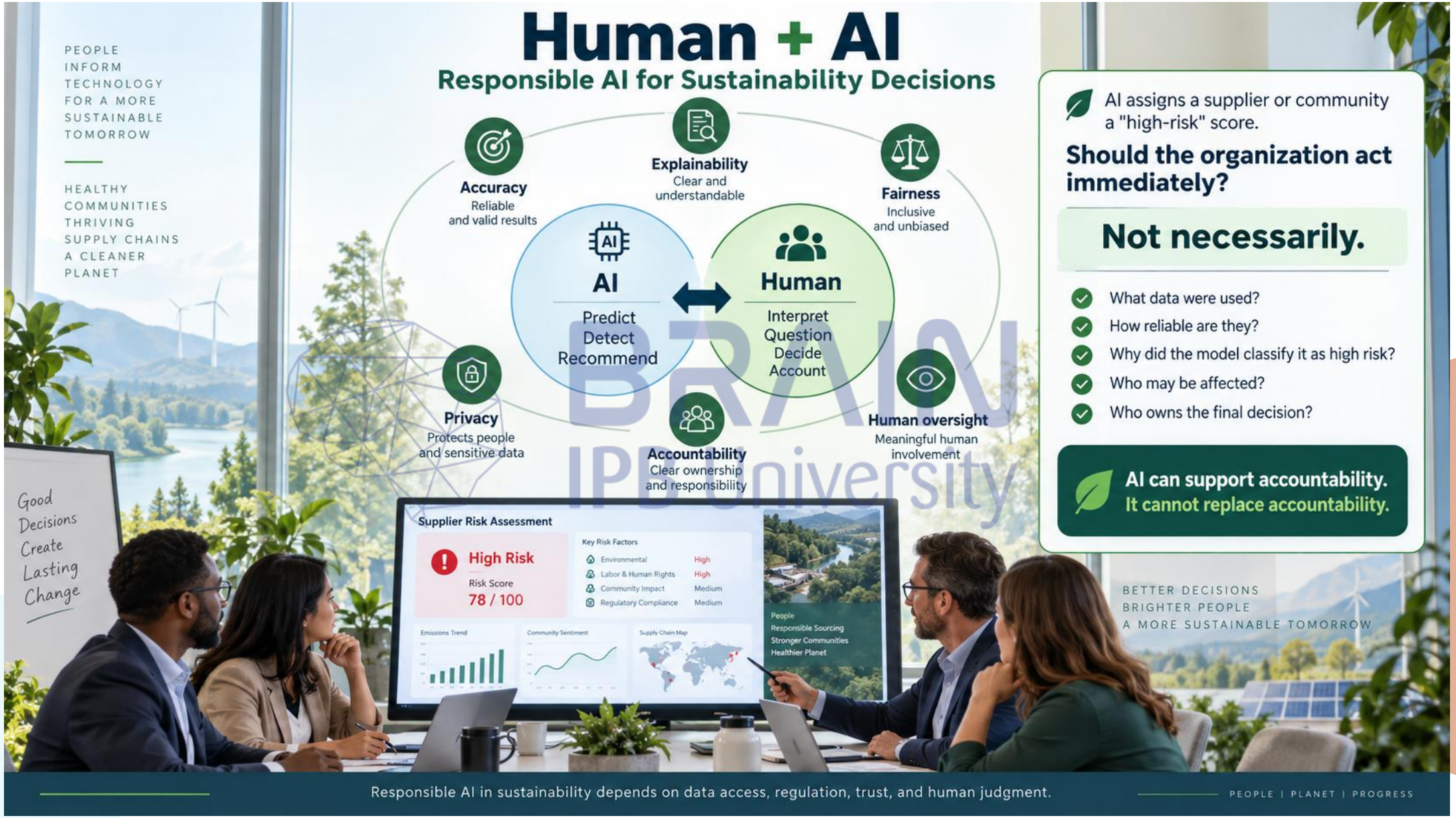


This is not primarily an AI problem.
It is a data governance problem.

BETTER GOVERNANCE LEADS TO BETTER DECISIONS.

CLEANER SUPPLY CHAINS
STRONGER COMMUNITIES
A HEALTHIER PLANET

SAME DATA.
A BRIGHTER FUTURE.


PEOPLE
INFORM
TECHNOLOGY
FOR A MORE
SUSTAINABLE
TOMORROW
HEALTHY
COMMUNITIES
THRIVING
SUPPLY CHAINS
A CLEANER
PLANET
Human + AI
Responsible AI for Sustainability Decisions
Accuracy
Reliable and valid results
Explainability
Clear and understandable
Fairness
Inclusive and unbiased
AI
Predict
Detect
Recommend
Human
Interpret
Question
Decide
Account
Privacy
Protects people and sensitive data
Accountability
Clear ownership and responsibility
Human oversight
Meaningful human involvement
AI assigns a supplier or community a "high-risk" score.
Should the organization act immediately?
Not necessarily.
What data were used?
How reliable are they?
Why did the model classify it as high risk?
Who may be affected?
Who owns the final decision?
AI can support accountability.
It cannot replace accountability.
Good Decisions Create Lasting Change
Supplier Risk Assessment
High Risk
Risk Score
78 / 100
Key Risk Factors
Environmental High
Labor & Human Rights High
Community Impact Medium
Regulatory Compliance Medium
Emissions Trend
Community Sentiment
Supply Chain Map
People
Responsible Sourcing
Stronger Communities
Healthier Planet
BETTER DECISIONS
BRIGHTER PEOPLE
A MORE SUSTAINABLE TOMORROW
Responsible AI in sustainability depends on data access, regulation, trust, and human judgment.
PEOPLE | PLANET | PROGRESS

From AI project to sustainability impact

A Practical Roadmap for Organizations

Real problems. Better decisions.
A more sustainable tomorrow.



01 — PROBLEM

Start with a material sustainability problem

> Not:
> *"Kami ingin menggunakan AI."*
>
> But:
> *"Kami ingin mengurangi food loss 20%."*
> *"Kami ingin mengetahui supplier berisiko lebih awal."*



02 — DATA

Assess data readiness

- Available?
- Reliable?
- Representative?
- Integrated?

From fragmented data to a fuller picture.

03 — INTELLIGENCE

Use the simplest method that works

Analytics
↓
ML
↓
AI
↓
Optimization

Not every problem needs **GenAI** or deep learning.

04 — DECISION

Embed AI into real workflows

- Siapa yang menerima insight?
- Siapa yang mengambil tindakan?
- Berapa cepat?

From insight to action, at scale.



05 — IMPACT

Measure real outcomes

Environmental
Lower emissions, less waste, healthier ecosystems

Social
Stronger communities, fairer opportunities

Operational
Higher efficiency, more resilient operations

Financial
Higher value, long-term growth

Progress today A brighter tomorrow



BRAIN IPB University

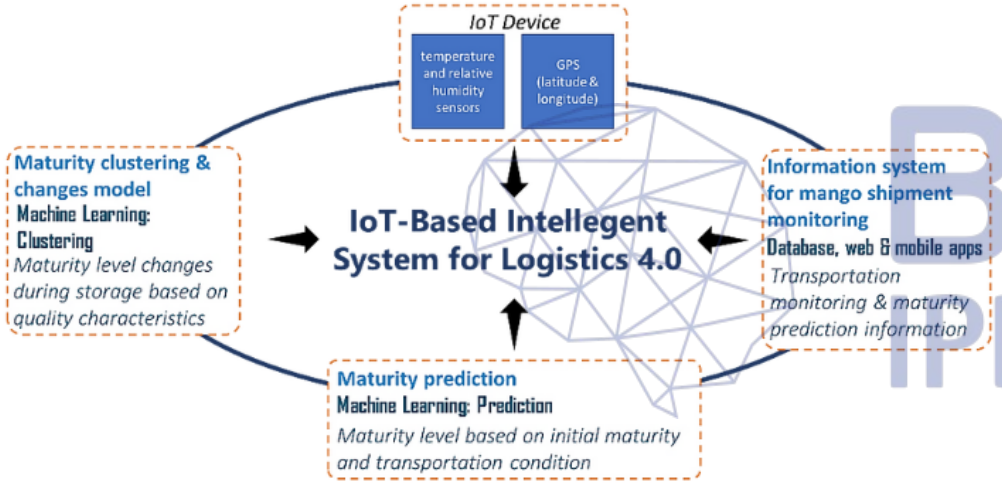
BRAIN'S PROJECTS

BRAIN
IPB University

The Application of the Internet of Things and Machine Learning in Agroindustrial Supply Chain

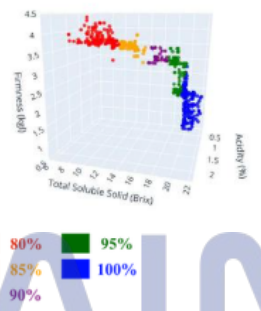
IoT & AI for Real-Time Logistics Monitoring (Case Study: M...)

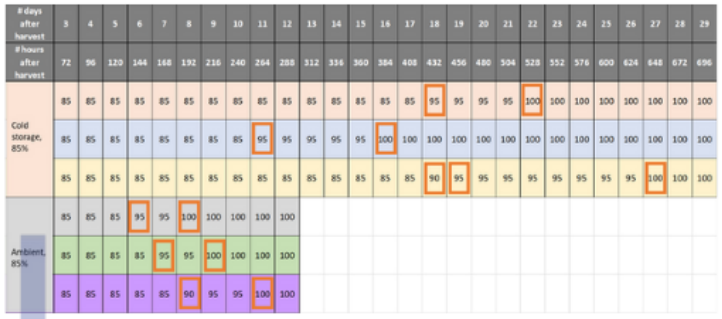
- Frekuensi transportasi logistik antarpulau yang intensif
- Perlu perhatian lebih pada penjagaan kualitas pangan mudah rusak
- Penentuan usia panen optimal
- Sistem IoT untuk pemantauan secara real-time dan akses jarak jauh terhadap informasi kondisi penyimpanan



Sari Intan Kailaku, Yandra Arkeman, Y Aris Purwanto, Faqih Udin. Appropriate harvest age of mango (Mangifera indica cv. Arumanis) for quality assurance in long distance transportation planning in Indonesia,. Journal of Agriculture and Food Research

Quality Clustering and Prediction





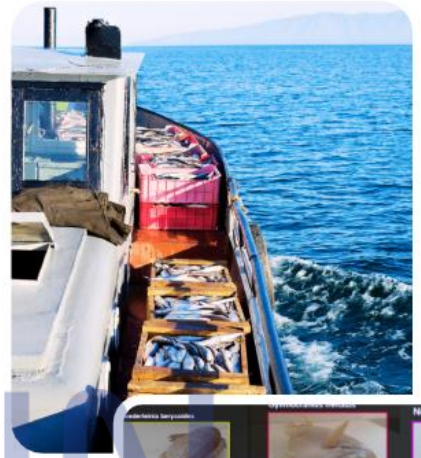
- Efficiently handles large datasets
- Can formulate a new classification based on similarity and multiple parameters
- Provides precise, interpretable results
- Prediction accuracy 98% >> accurately predict the real-time maturity level during shipment, allowing managers to plan ahead for logistics actions

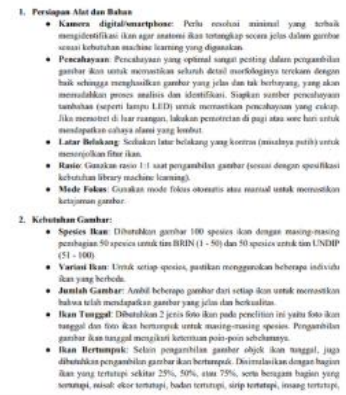
Journal Publication:
Sari Intan Kailaku, Yandra Arkeman, Y Aris Purwanto, Faqih Udin. 2023. Appropriate harvest age of mango (Mangifera indica cv. Arumanis) for quality assurance in long distance transportation planning in Indonesia. Journal of Agriculture and Food Research.

SMART FISHERIES

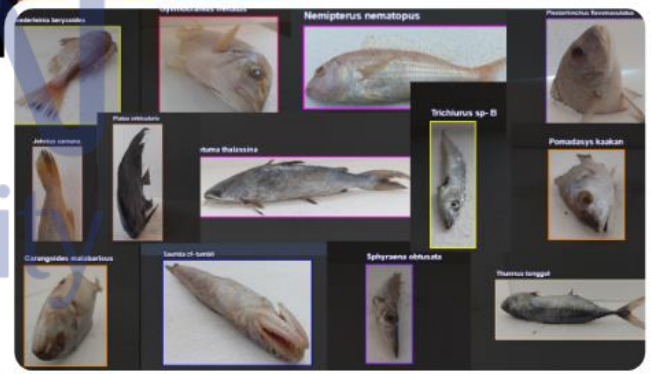
A Comprehensive AI Solution for Regional Fish Species Identification in Indonesian Maritime Zones

AI-based fish species identification system developed to enhance the efficiency of catch data collection in Indonesian waters, map species distribution across regions, facilitate fisheries management, and prevent catch data misreporting. A collaborative research project between IPB, the Data Science Center (DSC) of Universitas Indonesia, Universitas Diponegoro, and BRIN.

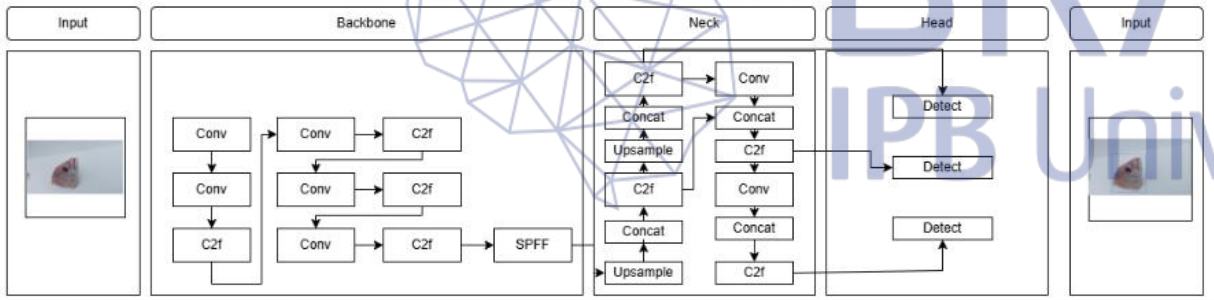




1. **Persiapan Alat dan Bahan**
   - **Kamera digital/smartphone**: Perlu resolusi minimal yang terbaik mengidentifikasi ikan agar anatomi ikan tertangkap secara jelas dalam gambar sesuai kebutuhan machine learning yang digunakan.
   - **Pencahayaan**: Pencahayaan yang optimal sangat penting dalam pengambilan gambar ikan untuk memastikan seluruh detail morfologinya terekam dengan baik sehingga menghasilkan gambar yang jelas dan tak berbayang, yang akan memudahkan proses analisis dan identifikasi. Siapkan sumber pencahayaan tambahan (seperti lampu LED) untuk memastikan pencahayaan yang cukup. Jika memotret di luar ruangan, lakukan pemotretan di pagi atau sore hari untuk mendapatkan cahaya alami yang lembut.
   - **Latar Belakang**: Sediakan latar belakang yang kontras (misalnya putih) untuk menonjolkan fitur ikan.
   - **Rasio**: Gunakan rasio 1:1 saat pengambilan gambar (sesuai dengan spesifikasi kebutuhan library machine learning).
   - **Mode Fokus**: Gunakan mode fokus otomatis atau manual untuk memastikan ketajaman gambar.
2. **Kebutuhan Gambar:**
   - **Spesies Ikan**: Dibutuhkan gambar 100 spesies ikan dengan masing-masing pembagian 50 spesies untuk tim BRIN (1 - 50) dan 50 spesies untuk tim UNIMP (51 - 100)
   - **Variasi Ikan**: Untuk setiap spesies, pastikan menggunakan beberapa individu ikan yang berbeda.
   - **Jumlah Gambar**: Ambil beberapa gambar dari setiap ikan untuk memastikan bahwa telah mendapatkan gambar yang jelas dan berkualitas.
   - **Ikan Tunggal**: Dibutuhkan 2 jenis foto ikan pada penelitian ini yaitu foto ikan tunggal dan foto ikan bertumpuk untuk masing-masing spesies. Pengambilan gambar ikan tunggal mengikuti ketentuan poin-poin sebelumnya.
   - **Ikan Bertumpuk**: Selain pengambilan gambar objek ikan tunggal, juga dibutuhkan pengambilan gambar ikan bertumpuk. Disimulasikan dengan bagian ikan yang tertutupi sekitar 25%, 50%, atau 75%, serta beragam bagian yang tertumpuk, misal: ekor tertutupi, badan tertutupi, sirip tertutupi, insang tertutupi,

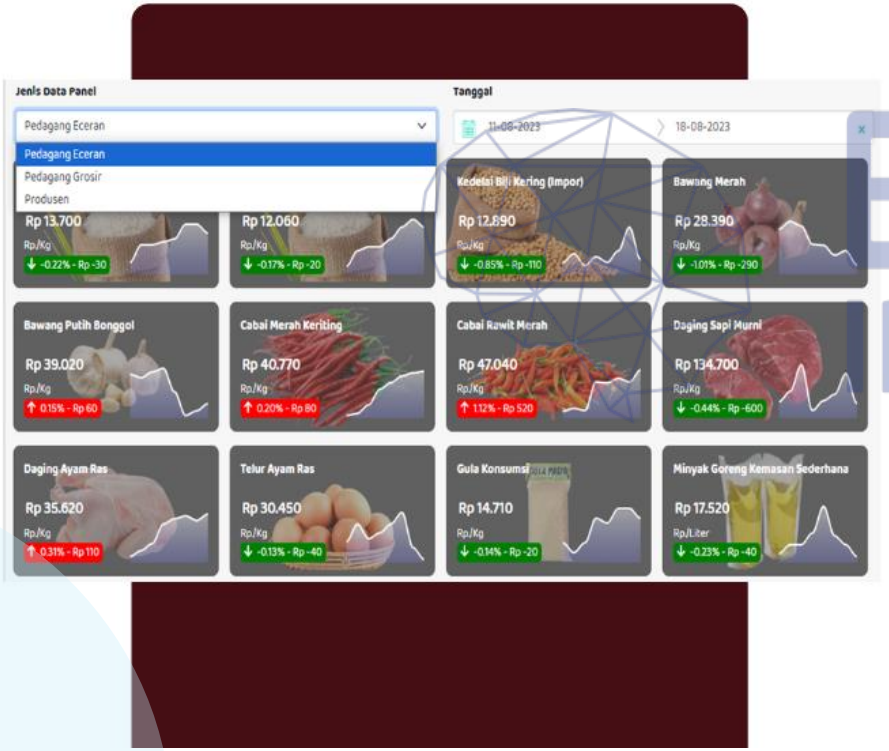


YOLOv8 Architecture Model



- **High Accuracy,** the AI model precisely identifies fish species, enriching national fisheries data.
- **Data Collection Efficiency,** streamlines the process of recording catch data.
- **Standardized Dataset,** establishes a benchmark image dataset of Indonesian fish for future research.
- **Standard Operating Procedure,** Provides standardized guidelines for image collection to ensure data quality and consistency.

AI Design for Food Supply and Price Stability through the Affordable Food Movement (GPM) --National Food Agency



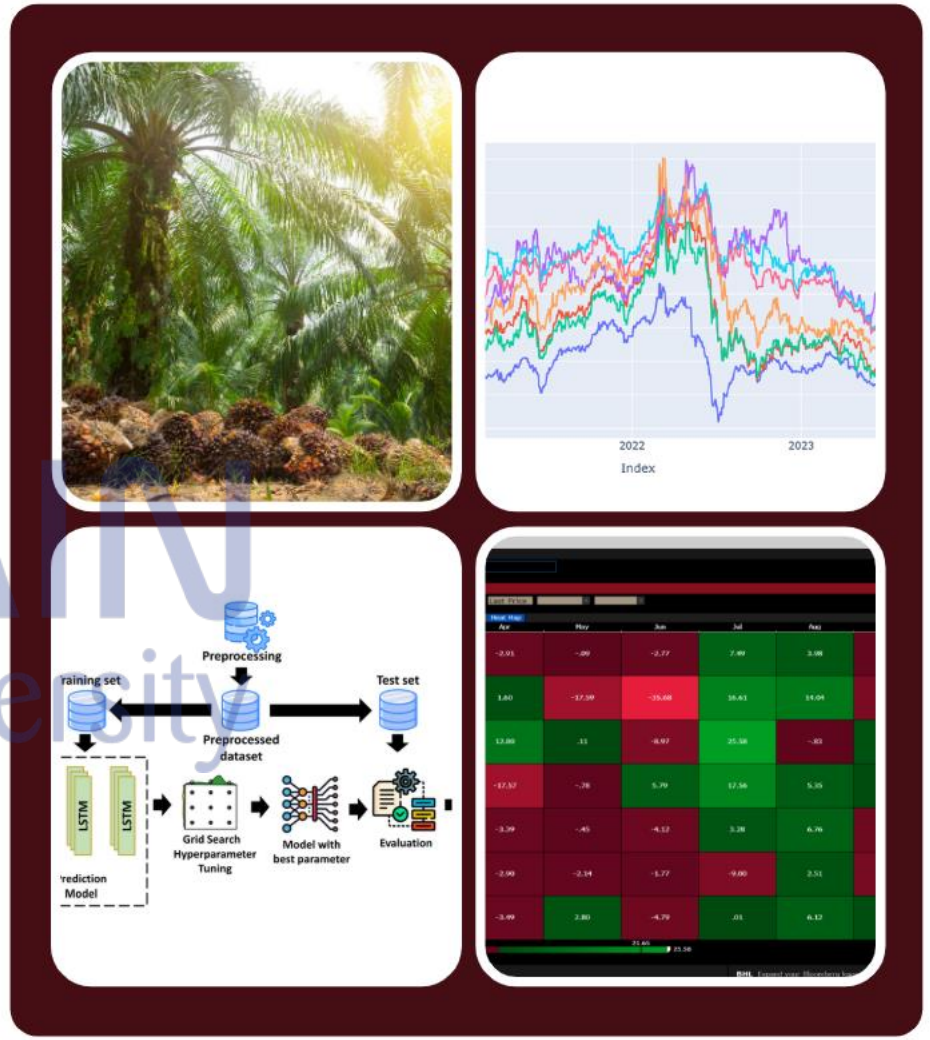
Pasar	11 Aug	12 Aug	13 Aug	14 Aug	15 Aug	16 Aug	17 Aug	18 Aug
SEMUA PROVINSI	13.600	13.660	13.660	13.670	13.680	13.730	13.730	13.700
Aceh	13.020	13.020	13.050	12.960	13.030	12.990	13.000	13.070
Kab. Simeulue	13.300	13.600	13.600	13.600	13.600	13.600	13.600	13.600
Kab. Aceh Singkil	15.000	15.000	15.000	-	15.000	15.000	15.000	15.000
Kab. Aceh Selatan	12.850	-	12.850	12.850	12.850	12.850	12.850	12.950
Kab. Aceh Tenggara	12.000	12.300	12.300	12.300	12.300	12.300	12.300	12.300
Kab. Aceh Timur	12.330	12.330	12.330	12.330	12.330	12.330	12.330	12.330
Kab. Aceh Tengah	13.200	-	13.300	13.300	13.300	13.300	13.300	13.300



Forecasting CPO Prices and Production using Artificial Intelligence

Development of an AI-based system for predicting CPO (Crude Palm Oil) trends, prices, and volumes to support data-driven strategic decision-making, reduce price fluctuation risks, and enhance business efficiency and stability.

- **AI-based** approach using LSTM to capture long-term patterns.
- **Multi-feature input** involving external factors such as currency exchange rates (USD/IDR, MYR/IDR) and global crude oil prices (Brent/Rotterdam).
- **Threshold-based alert system** that automatically notifies users when predicted CPO prices rise or fall beyond a defined threshold.



Industrial Land Use Planning Sustainable Biodiesel Using A Multi-Objective Genetic Algorithm

This research utilizes the NSGA-II genetic algorithm to find the "Pareto Optimal" balance between economic profit, carbon sequestion and soil fertility.

THE TRIPLE-OBJECTIVE OPTIMIZATION

PROFIT
(Maximize Economic Gain)

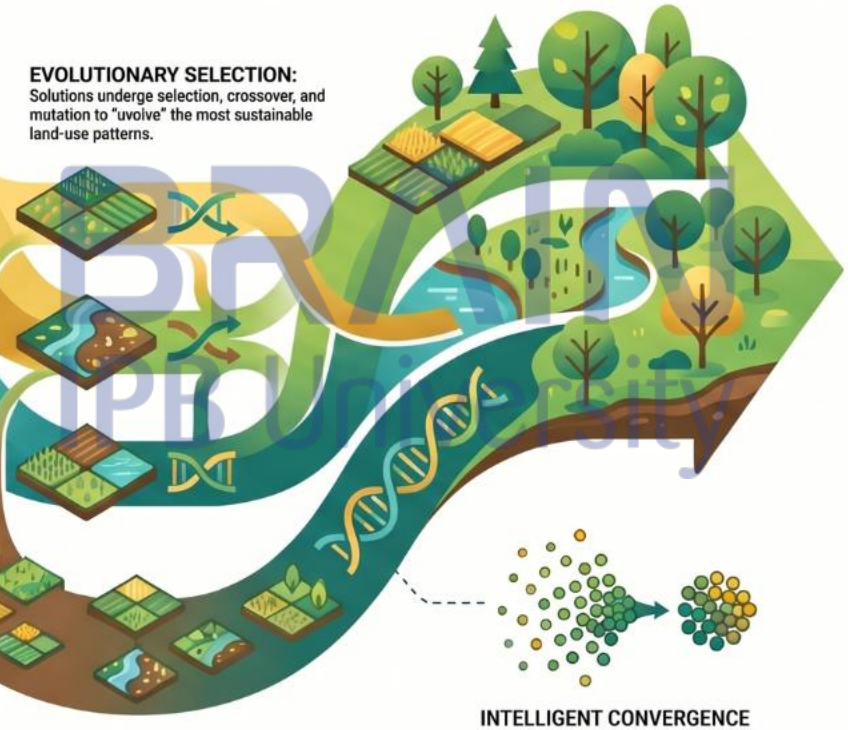
CO_2 ABSORPTION
(Maximize Carbon Sequestration)

SOIL FERTILITY
(Maximize Health & Nutrients)



Massive Search Space
With 3^{100} possible combinations, the problem is too complex for traditional manual planning.

EVOLUTIONARY SELECTION:
Solutions undergo selection, crossover, and mutation to "uvolve" the most sustainable land-use patterns.



INTELLIGENT CONVERGENCE
By generation 100, the population stabilizes into a "Pareto Optimal" front of ideal trade-offs.

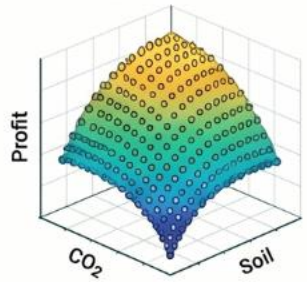
PERFORMANCE & PARETO RESULTS

81.38% Speed Increase



Standard Matlab Library (Baseline) — **Custom NSGA-II Tool** (Custom Build)

The custom-built NSGA-II software executes significantly faster than standard MATLAB libraries.



STRATEGIC DECISION SUPPORT
Output provides a "quarter-ball" plot of solutions for government and corporate decision-makers.

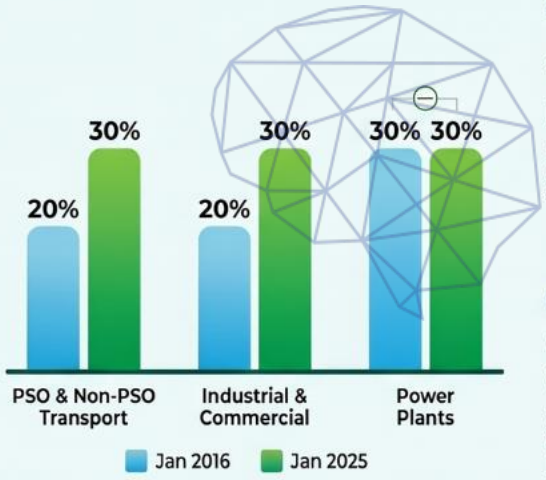
Modeling Indonesian Biodiesel Policy for National Energy Security

THE 2025 MANDATE CHALLENGE

30%

Biodiesel Mandate by 2025

Indonesia requires a 30% biodiesel blend across transportation, industrial, and power sectors.



42.3%

Petroleum Dependency

High fossil fuel reliance and rising consumption necessitate a rapid shift to renewables.

Current Policies are Falling Short

Existing subsidies only benefit fuel mixers, leaving farmers and producers without economic gain.

A COMPREHENSIVE POLICY SOLUTION



Incentivize the Full Supply Chain

Move beyond end-user subsidies to support farmers, CPO producers, and refineries.



Subsidies for Competitive Pricing

Achieve "Economic Price" Parity

Provide subsidies that allow biodiesel to compete effectively with fossil diesel prices.

Boost Production Capacity

Increase plant productivity and expand industrial infrastructure to meet the projected supply gap.



BRAIN IPB University

Journal Publication:
Wijaya, H., Arkeman, Y., & Hambali, E. 2017. Formulation of Indonesian palm oil biodiesel policy for energy security by using system dynamics model. Agricultural Engineering International: CIGR Journal, 19(2), 268–282.

CONCLUSION:

AI is not the goal.
Better sustainability decisions are.

The goal is not to become an AI-driven organization.
The goal is to make better sustainability decisions—with AI where it adds real value.

BRAIN
IPB University

1

Move beyond reporting

Gunakan ESG data untuk melihat ke depan.

2

Connect intelligence to decisions

Prediksi tanpa tindakan tidak menciptakan dampak.

3

Keep humans accountable

AI membantu sustainability professionals — bukan menggantikan tanggung jawab mereka.