



AI Innovation Summit 2023 | AIIIS2023

Unique AI & Genomic Application in Biopharmaceutical Industry



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Deputy President Director
Biofarma Group
August 2023

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Deputy President Director Biofarma Group

NOW

Deputy President Director
(Biofarma Group)

Digital Health Mentor
(Harvard Medical School)

Adjunct Faculty
(School of Business and Management, ITB)

Executive Chairman
(PT Kimia Farma Apotek)

President of BUMN Muda
(FHCI KBUMN)

Advisory Board
(Faculty of Engineering, UI)

Healthcare Advisory Board
(Google Cloud)

JUN' 2019

Director, Head of Digital Therapeutics & Data Science

- Novo Nordisk Therapeutics Algorithm R&D
- Research on new data & patient modelling
- External R&D collaboration

Work field history

- Software & Tech
- Hospital, Insurance, PBM, etc.
- Healthcare tech
- Pharma

JUN' 2017

Digital Health Mentor

- Harvard Medical School Mentor postdoc, MD, PhD student bringing research outcomes to industry
- MIT Hacking Medicine

Halodoc Advisor

JAN' 2017

Director of Innovation, R&D

- UnitedHealth Group
- Digital Tech., AI/ML, Blockchain
- Product development
- External collaboration (MIT, Harvard, CMU)
- UHG2025

JUN' 2013

Innovation Lead / Manager

- Innovation and Digital Health Accelerator Boston Children Hospital
- EMR
- Mobile app,
- Web app development ML,
- Big Data analytics

DEC' 2012

Postdoctoral Associate (Health and Rehabilitation Informatics Lab, University of Pittsburgh)

Human Engineering Lab, Pittsburgh (Veterans Affairs Healthcare System)

AUG' 2008

PhD Student / Software Engineer (PhD in Health Sciences, University of Pittsburgh)

Part-time

- Software Engineer
- University of Pittsburgh Medical Center (UPMC).
- Senior Research Engineer, Pittsburgh
- Veterans Affairs Healthcare System

2001-2007

BS-MS Student, ITB

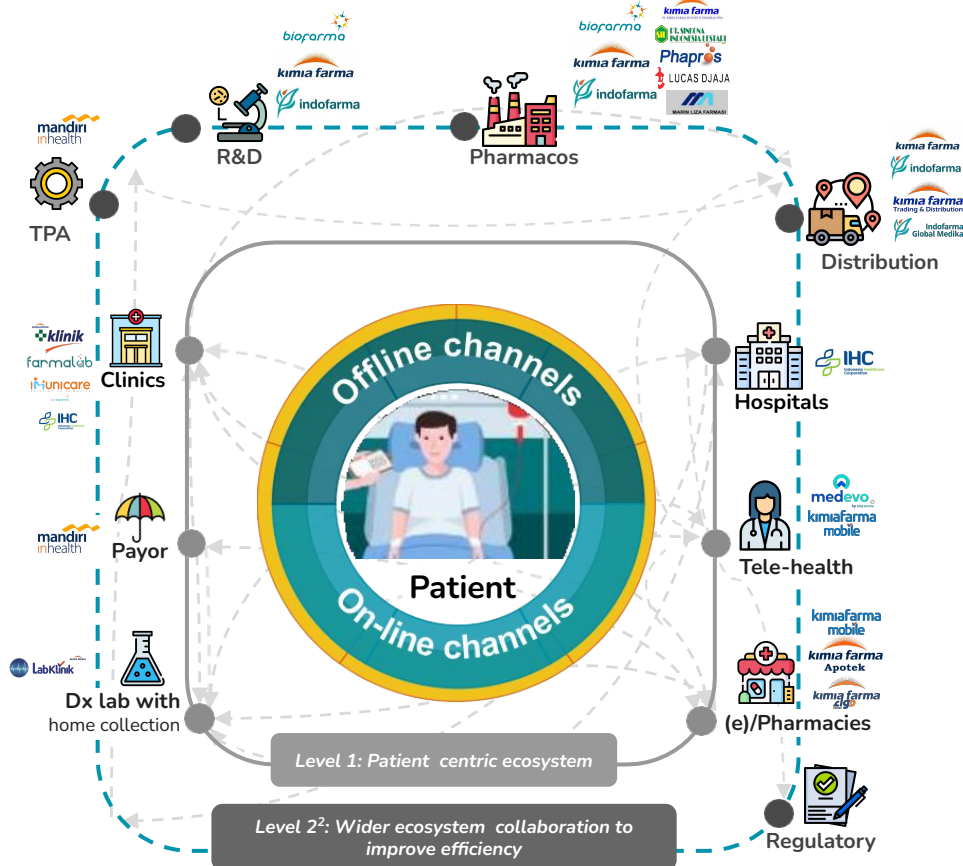
- BS in Informatics
- MS in Information System

Part-time

- Software
- Engineer Consultant



To transform Biofarma Group into a world-class healthcare ecosystem, digital transformation is a must.



Facts about Biofarma Group



#1 Largest Healthcare services network in Indonesia (1174 retail pharmacies, 406 clinics, 72 diagnostic laboratories, 100k+ daily visit)



Top 20 Indonesia's pharma company with USD 637 million revenue and 7.4% market share



Currently have 1,343 products and expected to launch over 200 new products in the next 3 years



700+ millions lives touched every year globally.



5th largest pharma manufacturer, have 10 manufacturing plant spread over Java - Bali and currently building new plant for biological line with US FDA certification



1 API & HFC Manufacturing Plant

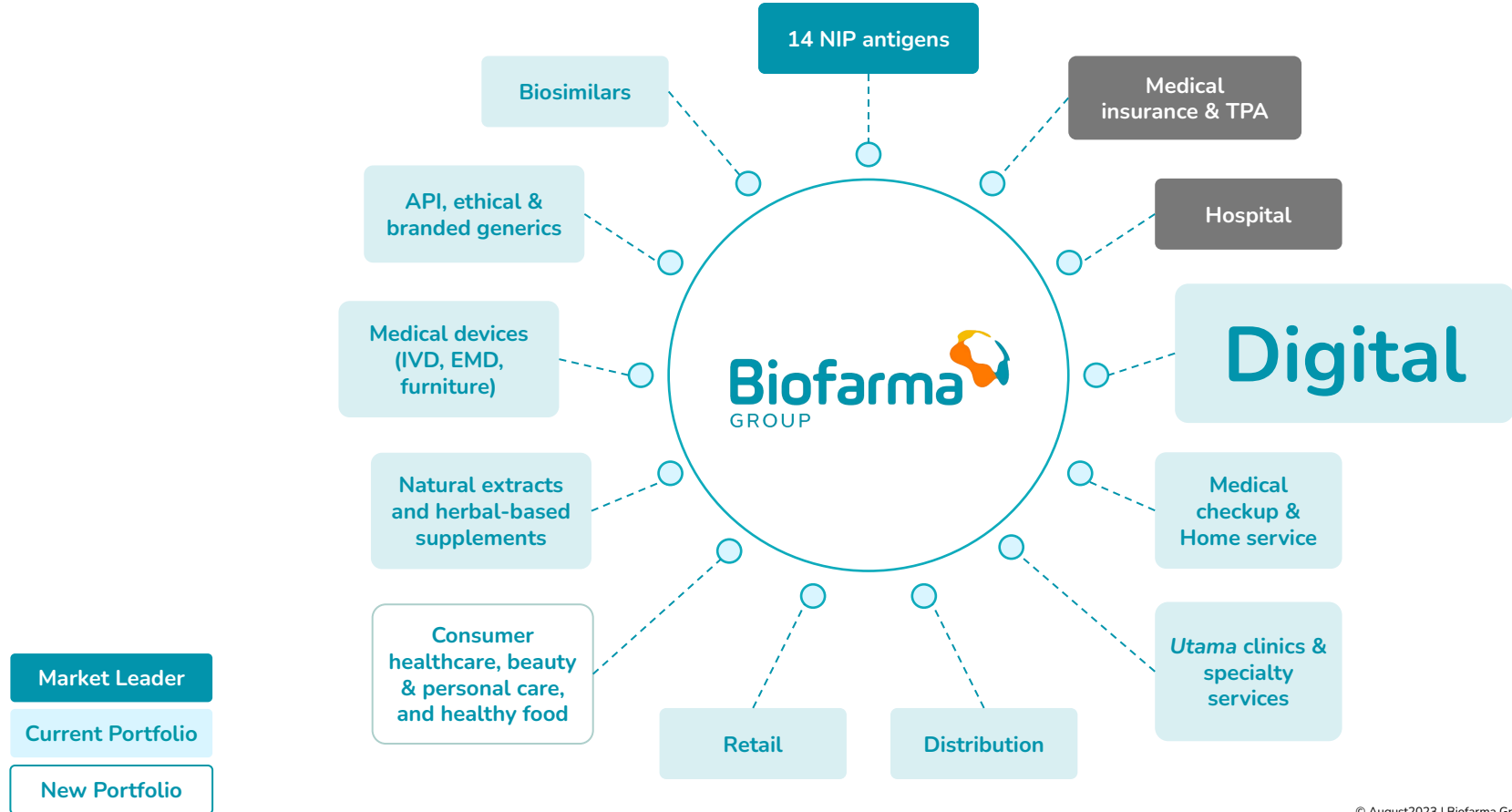


6th Largest pharma distributor with 78 distribution arms




















Exported our products into 150+ countries


To make a stronger impact and to achieve a significantly better financial performance, Biofarma is strengthening the current selected business portfolios and building the new ones. Digital plays roles as enabler and accelerator.




Zoom in  In Biofarma R&D and manufacturing, we'd like to share two stories on construct design and process optimization leveraging AI/ML & Genomic

| Case | Polio, Tetanus, Dengue, COVID-19 Vaccines | | | | | | | | | | | |
|---------------|---|---|---|----------|--|---------------------------------------|---------------------------------|--|---|---|--------|---|
| Value Chain |  Research and Development | | | |  Manufacturing | | | | | | | |
| Process | In vitro research | Trials on animal | Clinical trials on human | Approval | Maintaining the health of monkey and its reproductivity | Harvesting kidney from monkey's fetus | Culturing cells from the kidney | Inoculating self-grown poliovirus seed | Incubating | Harvesting | Mixing | Filling and packaging |
| AI Innovation |  |  |  | - |  | - | - | - |  |  | - |  |

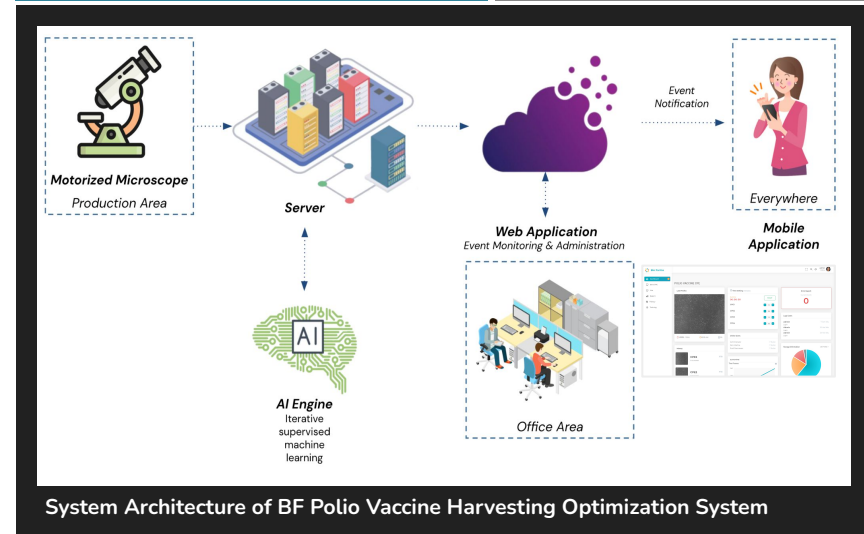
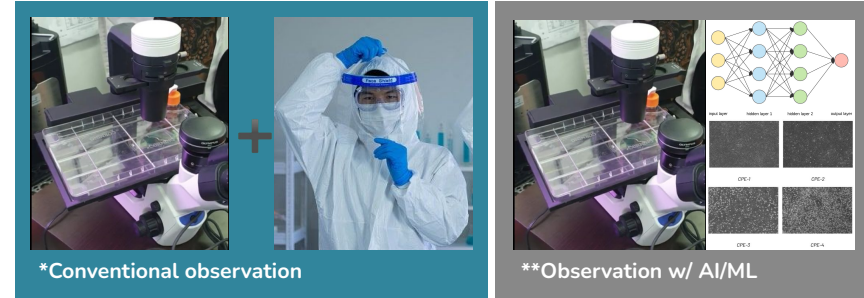
| Case | Anti-tetanus, Anti-difteria, Anti-snake venom | | | | | | | | | | | |
|---------------|---|---|---|----------|--|---|---|-------------------------------------|----------------------|--------|---------------------|---|
| Value Chain |  Research and Development | | | |  Manufacturing | | | | | | | |
| Process | In vitro research | Trials on animal | Clinical trials on human | Approval | Monitoring horse's health before toxin inoculation | Plasmapheresis process for extracting plasma from blood | Monitoring horse health during plasmapheresis process | Plasma clarification and filtration | Pure bulk collection | Mixing | Filling & Packaging | |
| AI Innovation |  |  |  | - |  | - |  | - | - | - | - |  |

 Potential process to be improved by AI

 Process already improved by AI

First story: ✔ Machine Learning for Polio, Tetanus, Dengue, & Covid-19 vaccines.
 Machine learning reduces **Biofarma's operational cost** by optimizing virus vaccine harvesting time and improved the quality

| Aspect | Conventional* | Biofarma Polio CPE Machine Learning** |
|-----------------------|---|--|
| Observation method | Manual , operator needs to periodically going into sterile rooms | Automatic , can be monitored anywhere by operators |
| Observation result | Subjective , depending on the operator | Objective , based on data and predetermined criteria |
| Observation interval | 2-3 times per day | 24 hours non stop |
| Harvest time accuracy | Medium accuracy , optimum harvest time might be missed due to limited observation interval | High accuracy , because of the 24 hours non stop observation |
| Cost | 3 billion doses need 34 batches of vaccine' bulk. | 3 billion doses only need 22-27 batches of vaccine' bulk . Cost efficiency up to IDR 72 billion |



Second story: Health Monitoring of Antisera-producing horse

A research sponsored by LPDP and BF, to be developed by proposing scientists

Horse helps to produce anti-toxin of tetanus, diphtheria, & snake venom

Example on one cases of antisera production from horses: Anti-diphtheria

<https://www.quora.com/Is-horse-serum-still-used-for-tetanus-injections>

HOW DID THEY MAKE DIPHTHERIA ANTITOXIN?



SCIENTISTS LEARNED TO HARNESS THE IMMUNE SYSTEMS of some animals to produce antitoxin serums to use as medicines. Diphtheria antitoxin was one of these medicines. Doctors used diphtheria antitoxin to treat and prevent diphtheria, an often deadly childhood disease.

- 1 Scientists grow diphtheria-causing bacteria in the laboratory and harvest its toxin.
- 2 Next, researchers inject horses with the diphtheria toxin. As an immune response, the animals' blood produces diphtheria antitoxin.
- 3 Scientists collect blood from the horses and separate out the antitoxin rich serum.
- 4 Then, researchers purify the antitoxin serum for use as a medicine for people.



30,13%
Death rate

44%
Death in 2019

35%
Death in 2021

Averagely 7 BF's horses/year
experiencing colic: a fatal horse emergency that can be occurred anytime esp. un-monitored situation

Rp352 million/year
Cost related to horse's death e.c colic.
Almost none of horse experiencing colic is survived.

400.000
Horse population in Indonesia.
Colic prevalence per year 4% (16.000 cases)

Second story: Health Monitoring of Antisera-producing Horse Overview of Biofarma's Smart Halter



Embedded Technology

- Sensors
- Microprocessors
- Transceivers
- Batteries
- More



Hardware (IoT):
Central sensors to collect and process data connected to applications/software

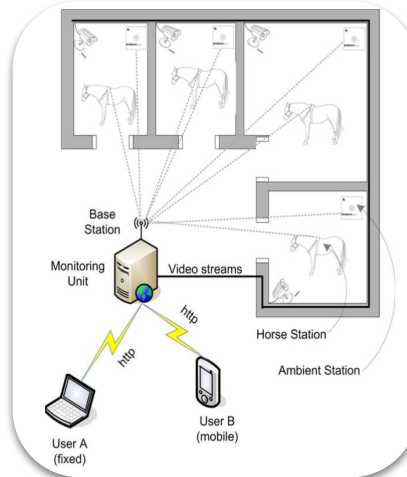
Software (AI and apps):
Monitoring apps developed for desktop and mobile applications, completed with dashboards and mobile notifications.

Smart Halter is a **continuous and real-time horse health monitoring** technology which send notifications to veterinarians to prevent horse deaths by emergency events.

Smart Halter used AI that study the horse physiology to **identify abnormalities** that occur in horses such as colic, casts, and calving.

Durable Enclosure

- Fully-protected electronics
- Water and dust proof



The goal of AI use: To **continuously classify antisera-producing horse condition**

- **Sehat Istirahat:** no treatment on horses, ranges from 4-8 weeks
- **Sehat Imunisasi Booster:** immunized horses will usually experience temperature changes ranging from 3-4 weeks
- **Sehat Produksi:** horse plasma will be taken for 2-6 weeks
- **Sakit**

As unique implementation Genomics for diagnostics, Biofarma has **launched and have been working on several products**



BioColoMelt Dx
Colon cancer detection kit



PMK kit
FMD detection kit on livestock. Production capacity: 3-5M per month



mBioCov Generations 1, 2 and 3
Total production: 3-4M kits, 2002-2022



Varscreen
Total production: 300K million kits, 2021-2022



HPV kit
Cervical cancer detection kit

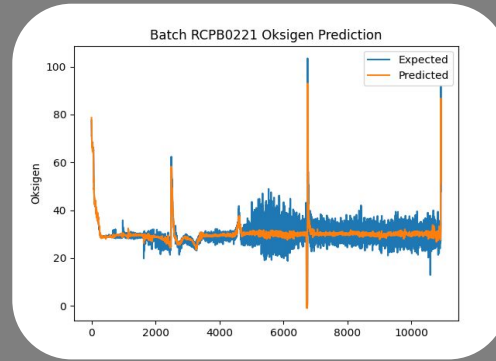
Last but not least, the most anticipated Indonesia-made COVID-19 vaccine: Vaksin BUMN - Indovac, has leveraged AI to maximize production

ML Prediction for Indovac

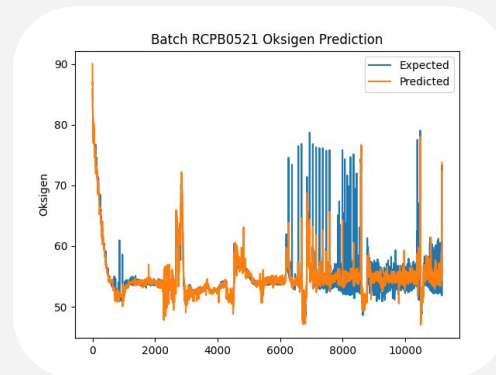
Understanding the science better: Preventing vaccine production failure

- Indovac formulation is using bacteria medium which needs methanol as the source of energy. Too much methanol can be toxic for the medium and inducing lysis. Lysis will fail the whole batch of vaccine to be harvested. When lysis, the oxygen will spike.
- An algorithm is developed to find optimum value of methanol by evaluating the oxygen level in Indovac fermentor. So, ML will notice when to stop adding methanol before the oxygen spike happened. The results of the model can predict spike of oxygen with high accuracy.
- ML to answer “How the parameters such as methanol, pH, stirring, time, temperature, etc predict the oxygen spike?”
- ML to answer “Given some exact numbers on parameters, how many methanol should be given to the medium?”

Results (2 Batches)

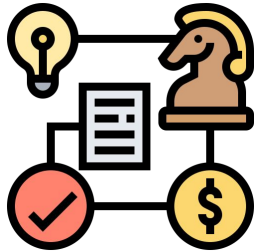


RMSE: 6.483029



RMSE: 183.715847

Three key challenges on leveraging AI/ML & Genomics within whole end-to-end Biofarma value chain



Alignment between Physics, Data,
Science & Business, and Culture



Technical complexity (Data, Bias,
Explainability)



Balancing between investment,
long term vision and quick win

Thank You



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