

## CHAPTER 5: CONCLUSIONS AND RECOMMENDATIONS

### 5.1 Conclusion

This research focuses on leveraging advanced analytics, specifically machine learning, to increase revenue from the heavy equipment component remanufacturing business. Based on the research objectives and proposed hypotheses, the study reaches the following conclusions:

1. Generate revenue min 5 billion/month.

This study successfully shows that by implementing a Machine Learning-based predictive system, an average revenue increase of around 12 billion/month can be achieved from the remanufacturing of major components. This figure far exceeds the minimum target of 5 billion/month that was set. This success was also supported by a shift in transaction patterns from being reactive (waiting for units to fail) to being proactive, enabling the team to prepare components earlier and significantly reduce unit downtime.

2. Utilize big data using Machine Learning.

The use of big data has revolutionized transaction patterns and increased revenue by changing the old approach of waiting for units to break down into a more proactive system. This system integrates various big data sources as predictor variables in a Machine Learning model. These data sources include:

- a. VHMS & Oil Analysis Data

VHMS data detects component degradation in real-time and historically, serving as an early signal for predicting remanufacturing needs. Oil analysis (PAP) is used to build classification models and detect opportunities for remanufacturing component needs, improving sales target accuracy.

- b. Historical Component Replacement

This data provides insights into failure frequency, life expectancy, and replacement patterns, which are highly useful for building ML-based predictive models for operational efficiency. But in actual condition, not every customer has this data because it needs good behavior to maintain historical.

- c. Component Targeted Lifetime & PCAR

This data serves as a reference for proactive maintenance planning, reducing downtime, and ensuring optimal performance.

d. Remaining Useful Lifetime

Algorithms such as Random Forest, Gradient Boosting (XGBoost), or Neural Networks are used for failure time regression. Classification models such as Random Forest or XGBoost are also used to identify feature combinations that are significant to the need for component replacement.

The implementation was carried out across all plants areas starting in January 2025. All opportunities generated by Machine Learning were fed into the Sales Force platform for follow-up by After Sales Consultants (ASCs). This enabled ASCs to educate customers about potential unit failures early, prepare components, and significantly reduce unit downtime.

## 5.2 Recommendations

Based on the conclusions reached, the implementation of a Machine Learning-based predictive system has succeeded in increasing revenue from heavy equipment component remanufacturing and utilizing big data effectively, the following recommendations are suggested for continuous improvement and further optimization of the successes that have been achieved will be divided into 2 sections:

1. For the company.

a. Creating a Comprehensive Standard Operating Procedure (SOP).

To ensure consistency and sustainability of the improved process, creating a clear and detailed SOP is essential. This SOP will give the After Sales Consultant (ASC) team confidence in approaching customers with sales opportunities generated by the analytics system, particularly in the areas of demand and planning.

b. New Business Process Transaction.

Standard procedures for managing the entire remanufacturing transaction cycle, from identifying opportunities generated by Machine Learning to completing the sales until returning component damage core in full cycle business process.

c. Customer Integration

Integrating customer profile data from a financial perspective will enable the forecasting system to filter and prioritize customers with healthy financial status. This will help teams allocate their sales efforts more effectively to the most prospective and transactable customers.

Entering data regarding customer component execution schedules can help prioritize opportunities relative to other customers in the remaining schedule and delivery. This information will enable more timely procurement and delivery planning for remanufactured components, reduce unit downtime, and improve customer satisfaction.

d. Sustainability Design Plan

To create a system that will run for a long time, the author propose framework that will capture and process data updates that arise at any time to then process within machine learning without changing the microstructure design that has been established as shown at figure 5.1.

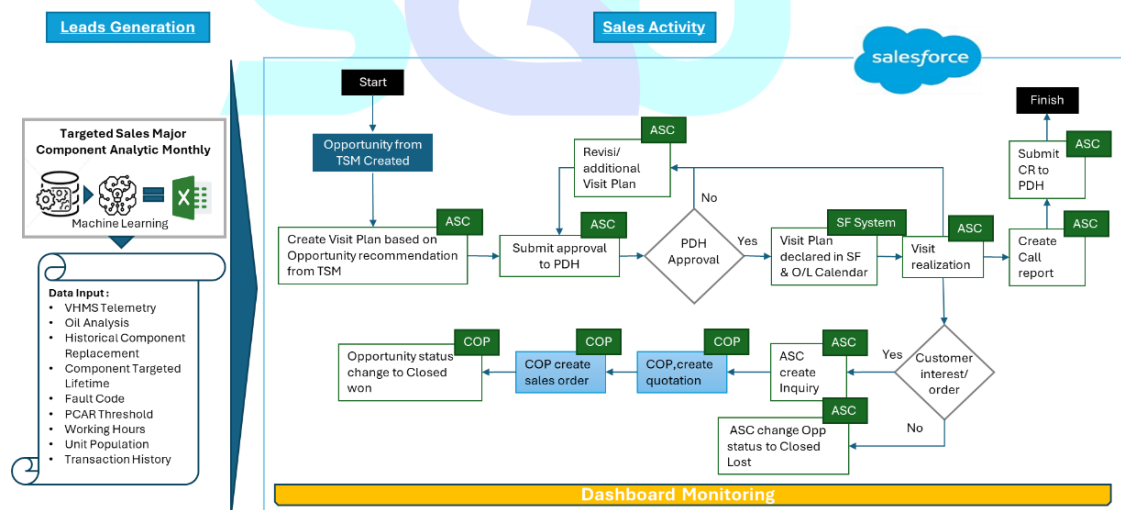


Figure 5. 1 System Sustainability Plan

2. For future research.

Continuing to Improve Big Data Utilization, it is recommended to continue enriching and improving the quality and types of data used in machine learning

models. Areas of focus for improvement are another heavy equipment unit, accuracy and quality level.



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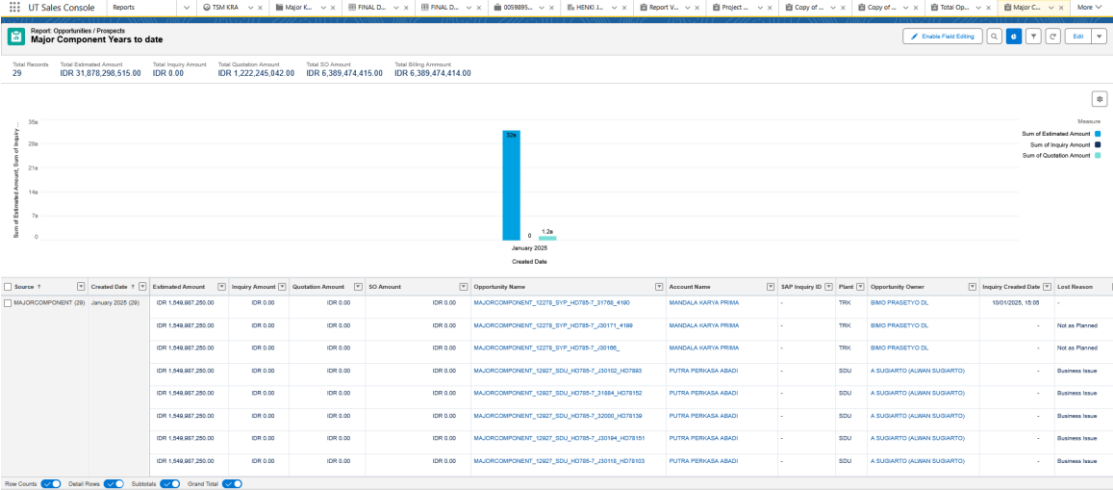


APPENDIX

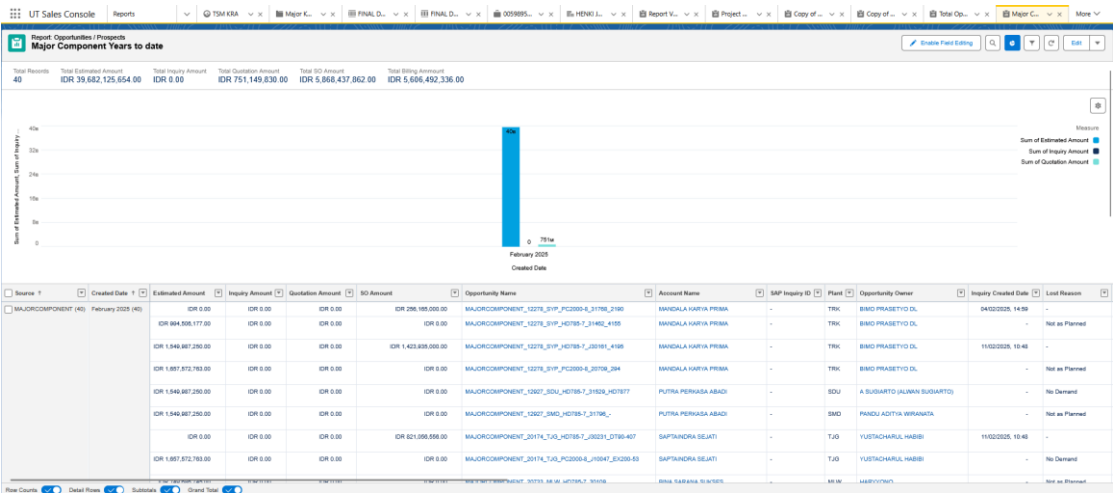
Output sample prediction with highest priority based on their SMR & condition

| ModelNumber | SerialNumber | Component    | SMR_Comp | rul_final | next_smr | predicted_replace  | prediction_source | Healt_Score_10days | VHMS_Problem                                | Fault_1mo                                                                                                                                                       |
|-------------|--------------|--------------|----------|-----------|----------|--------------------|-------------------|--------------------|---------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|
| HD785-7     | 8649         | ENGINE ASSY  | 58587.1  | 148.5148  | 66000    | September 5, 2023  | RUL               | 10%                | BlowbyPress;BoostPress;EngOilTempMx;ExhTemp |                                                                                                                                                                 |
| HD785-7     | N10288       | ENGINE ASSY  | 58186.2  | 290.3393  | 66000    | September 18, 2023 | RUL               | 10%                | BoostPress;EngOilTempMx;ExhTemp             | CB274-PCV2 Open Error (111);CB559-Rail Press. Low Error (4);CA274-PCV2 Open Error (3);B@BAZK-Drop in Engine Oil Level (1);CB2249-Rail Press. Very Low Error (1) |
| HD785-7     | 31388        | ENGINE ASSY  | 32698.7  | 5592.942  | 32698.7  | August 20, 2023    | Targeted Lifetime |                    | BoostPress;EngOilTempMx                     |                                                                                                                                                                 |
| HD785-7     | 8434         | TRANSMISSION | 57310.6  |           | 57310.6  | August 21, 2023    | Targeted Lifetime |                    | TMOilTemp                                   |                                                                                                                                                                 |
| HD785-7     | N10289       | TRANSMISSION | 56997.2  |           | 56997.2  | August 19, 2023    | Targeted Lifetime |                    | TMOilTemp                                   |                                                                                                                                                                 |
| HD785-7     | 8433         | TRANSMISSION | 56692.9  |           | 56692.9  | August 7, 2023     | Targeted Lifetime |                    | TMOilTemp                                   |                                                                                                                                                                 |
| PC2000-8    | J10051       | ENGINE ASSY  | 21583.6  | 16363.8   | 21583.6  | August 30, 2023    | Targeted Lifetime | 10%                |                                             |                                                                                                                                                                 |
| PC2000-8    | J10052       | ENGINE ASSY  |          | 20393     | 18000    | August 31, 2023    | Targeted Lifetime | 30%                | EngOilTempMx                                |                                                                                                                                                                 |
| PC2000-8    | J10051       | MAIN PUMP 1  | 21583.6  |           | 23000    | November 21, 2023  | Targeted Lifetime |                    | FanPump_PMax                                |                                                                                                                                                                 |
| PC2000-8    | J10051       | MAIN PUMP 2  | 21583.6  |           | 23000    | November 21, 2023  | Targeted Lifetime |                    | FanPump_PMax                                |                                                                                                                                                                 |

Display Opportunity in January 2025



Display Opportunity in February 2025



UT Sales Console

Reports

TSM KSA
Major K...
FINAL D...
005985...
H... HEN...
Report V...
Project...
Copy of...
Copy of...
Total Op...
Major C...
More N...

Report Opportunities / Prospects

Major Component Years to date

[Enable Full Editing](#)
[Q](#)
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Total Records

38

Total Estimated Amount

IDR 33,350,723,801.00

Total Inquiry Amount

IDR 0.00

Total Quotation Amount

IDR 2,170,000,002.00

Total SO Amount

IDR 16,666,429,994.00

Total Billing Amount

IDR 13,607,368,596.00

Sum of Estimated Amount, Sum of Inquiry ...

25k

20k

15k

10k

5k

0

March 2025

0

2.3k

Created Date

38k

2.3k

Sum of Estimated Amount

Sum of Inquiry Amount

Sum of Quotation Amount

| Source 1            | Created Date 1  | Estimated Amount     | Inquiry Amount | Quotation Amount     | SO Amount            | Opportunity Name                                | Account Name               | SAP Inquiry 10 | Place | Opportunity Owner      | Inquiry Created Date 1 | Lead Reason        |
|---------------------|-----------------|----------------------|----------------|----------------------|----------------------|-------------------------------------------------|----------------------------|----------------|-------|------------------------|------------------------|--------------------|
| MAJORCOMPONENT (38) | March 2025 (38) |                      |                |                      |                      |                                                 |                            |                |       |                        |                        |                    |
|                     |                 | IDR 604,506,177.00   | IDR 0.00       | IDR 0.00             | IDR 0.00             | MAJORCOMPONENT_12278_31VP_HD785-7_31458_4166    | MANDALA KARYA PRIMA        | -              | TRN   | BMD PRASETJO DL        |                        | Not as Planned     |
|                     |                 | IDR 1,549,887,280.00 | IDR 0.00       | IDR 0.00             | IDR 0.00             | MAJORCOMPONENT_12278_31VP_HD785-7_31458_4167    | MANDALA KARYA PRIMA        | -              | TRN   | BMD PRASETJO DL        |                        | Double Opportunity |
|                     |                 | IDR 804,506,177.00   | IDR 0.00       | IDR 0.00             | IDR 0.00             | MAJORCOMPONENT_12687_3MD_HD785-7_31186_...      | PUTRA PERKASA ABADI        | -              | SMD   | PANEXU ADITYA WIRANATA |                        | Not as Planned     |
|                     |                 | IDR 1,687,572,783.00 | IDR 0.00       | IDR 0.00             | IDR 0.00             | MAJORCOMPONENT_12687_3MD_HD785-7_31186_...      | PUTRA PERKASA ABADI        | -              | SMD   | PANEXU ADITYA WIRANATA |                        | No Demand          |
|                     |                 | IDR 0.00             | IDR 0.00       | IDR 0.00             | IDR 0.00             | MAJORCOMPONENT_20174_7JG_HD785-7_31947_0790-383 | SAPTANDIRA SEJATI          | -              | TJG   | YUSTACHARUL HABIBI     | 07/03/2025, 21:12      | -                  |
|                     |                 | IDR 0.00             | IDR 0.00       | IDR 0.00             | IDR 0.00             | MAJORCOMPONENT_20174_7JG_HD785-7_31947_0790-329 | SAPTANDIRA SEJATI          | -              | TJG   | YUSTACHARUL HABIBI     | 07/03/2025, 21:12      | -                  |
|                     |                 | IDR 1,010,000,000.00 | IDR 0.00       | IDR 1,010,000,000.00 | IDR 1,010,000,000.00 | MAJORCOMPONENT_20733_MUJ_HD785-7_30294...       | BINA SARANA SLICES         | -              | MUJ   | HARYONO                | 07/03/2025, 21:12      | -                  |
|                     |                 | IDR 1,549,887,280.00 | IDR 0.00       | IDR 0.00             | IDR 0.00             | MAJORCOMPONENT_20773_MUJ_HD785-7_3023_7R_3104   | MAGHANI TALAHITA NUSANTARA | -              | BUJ   | AREHAD EUPHORO         | 07/03/2025, 21:12      | -                  |

Row Counts

0

Detail Rows

0

Subtotal

0

Grand Total

0

**Report Opportunities / Prospects**

### Major Component Years to date

Total Results: 54    Total Estimated Amount IDR 37,227,996,781.00    Total Inquiry Amount IDR 0.00    Total Quotation Amount IDR 229,127,486.00    Total SO Amount IDR 13,194,677,677.00    Total Billing Amount IDR 12,854,692,781.00

| Month      | Sum of Estimated Amount | Sum of Inquiry Amount | Sum of Quotation Amount |
|------------|-------------------------|-----------------------|-------------------------|
| April 2020 | ~37,228,000             | 0                     | 0                       |

Legend:

- Sum of Estimated Amount (Blue)
- Sum of Inquiry Amount (Light Blue)
- Sum of Quotation Amount (Teal)

Report: Opportunities / Prospects  
Major Component Years to date

Enable Fast Editing

|    | Total Receipts        | Total Estimated Amount | Total Inquiry Amount | Total Quotation Amount | Total SO Amount       | Total Billing Amount |
|----|-----------------------|------------------------|----------------------|------------------------|-----------------------|----------------------|
| 66 | IDR 51,449,202.639.00 | IDR 0.00               | IDR 3,625,548,857.00 | IDR 14,534,563,723.00  | IDR 11,756,394,327.00 |                      |

| Source *            | Created Date * | Estimated Amount     | Inquiry Amount | Quotation Amount | SO Amount | Opportunity Name                            | Account Name        | SAP Inquiry ID | Plant | Opportunity Owner | Inquiry Created Date | Lost Reason        | TS       |
|---------------------|----------------|----------------------|----------------|------------------|-----------|---------------------------------------------|---------------------|----------------|-------|-------------------|----------------------|--------------------|----------|
| MAJORCOMPONENT (86) | May 2025 (86)  | IDR 1,949,987,290.00 | IDR 0.00       | IDR 0.00         | IDR 0.00  | MAJORCOMPONENT_12278_51P_H2195-7_20193_4198 | MANDALA KARYA PRIMA | -              | TRK   | IBAO PRAISETJO DL | -                    | Double Opportunity | 80<br>16 |
|                     |                | IDR 2,182,494,798.00 | IDR 0.00       | IDR 0.00         | IDR 0.00  | MAJORCOMPONENT_12278_51P_H2195-7_20193_4174 | MANDALA KARYA PRIMA | -              | TRK   | IBAO PRAISETJO DL | -                    | Double Opportunity | 80<br>16 |
|                     |                | IDR 944,906,177.00   | IDR 0.00       | IDR 0.00         | IDR 0.00  | MAJORCOMPONENT_12278_51P_H2195-7_20193_4174 | MANDALA KARYA PRIMA | -              | TRK   | IBAO PRAISETJO DL | -                    | Double Opportunity | 80<br>16 |
|                     |                | IDR 1,949,987,290.00 | IDR 0.00       | IDR 0.00         | IDR 0.00  | MAJORCOMPONENT_12278_51P_H2195-7_31782_4179 | MANDALA KARYA PRIMA | -              | TRK   | IBAO PRAISETJO DL | -                    | Double Opportunity | 80<br>16 |
|                     |                | IDR 1,949,987,290.00 | IDR 0.00       | IDR 0.00         | IDR 0.00  | MAJORCOMPONENT_12278_51P_H2195-7_20448_4132 | MANDALA KARYA PRIMA | -              | TRK   | IBAO PRAISETJO DL | -                    | Double Opportunity | 80<br>16 |
|                     |                | IDR 1,949,987,290.00 | IDR 0.00       | IDR 0.00         | IDR 0.00  | MAJORCOMPONENT_12278_51P_H2195-7_31748_4174 | MANDALA KARYA PRIMA | -              | TRK   | IBAO PRAISETJO DL | -                    | Double Opportunity | 80<br>16 |
|                     |                | IDR 1,949,987,290.00 | IDR 0.00       | IDR 0.00         | IDR 0.00  | MAJORCOMPONENT_12278_51P_H2195-7_31834_4191 | MANDALA KARYA PRIMA | -              | TRK   | IBAO PRAISETJO DL | -                    | Double Opportunity | 80<br>16 |
|                     |                | IDR 1,949,987,290.00 | IDR 0.00       | IDR 0.00         | IDR 0.00  | MAJORCOMPONENT_12278_51P_H2195-7_20193_4198 | MANDALA KARYA PRIMA | -              | TRK   | IBAO PRAISETJO DL | -                    | Double Opportunity | 80<br>16 |

## GLOSSARY

**After Sales Consultant (ASC):** Salesman in spare parts divisions.

**Sales Order:** A request for official components recorded as a customer request from ASC, which initiates the remanufacturing production process.

**Damage Core:** Used components that are reconditioned in the remanufacturing process.

**Component Remanufacturing:** An industrial process in which used components (damage cores) are reconditioned and restored to meet quality and performance standards equivalent to new components.

**Digitalization Task Force:** Team who is responsible for implementing the project to all factories throughout Indonesia, including socialization, monthly reviews, and ensuring that all ASCs understand and know how to use the platform correctly.

**Fault Code:** Error code data recorded by the VHMS system, serves as an early indicator of component failure and signals the need for replacement.

**Historical Component Replacement:** Historical data on previous component replacements, which forms a reference for failure times and wear trends. Useful for developing predictive models.

**Komatsu Remanufacturing Asia (KRA):** Big Machine Remanufacturing Component factory.

**Komatsu Marketing and Support Indonesia (KMSI):** Company who supporting genuine spare parts and collaborating in the production of remanufactured components.

**Sales Force:** A cloud-based platform designed to help businesses streamline sales, service, marketing, and operational processes. It provides a set of tools to manage customer interactions and automate workflows.

**SAP:** A world class platform used in all transaction.

**Overhaul Business Department (OBD):** A department at the Jakarta Head Office responsible for all major component transactions across the plant. They coordinate with vendors and principals and have full authority over pricing decisions, delivery schedules, allocations, and component inventory monitoring.

**Ready for Use (RFU) components:** Remanufactured components that have been prepared and ready to install.

**Total Cost of Ownership (TCO):** Total cost of ownership, which remanufacturing attempts to reduce by providing more economical yet reliable component replacement options.

**CBM (Condition Based Monitoring):** Historical data of the unit that will be used as input in the analysis by Machine Learning to predict the condition and needs of components.

**VHMS (Vehicle Health Monitoring System):** A vehicle health monitoring system that provides technical data from heavy equipment sensors, such as temperature, pressure, rotational speed, and oil analysis results. It exists on big machine units in mining.

## CURRICULUM VITAE



### PERSONAL INFORMATION

Full Name : BAYU NOVIANTO FERRY  
E-mail Address : [bayunf@unitedtractors.com](mailto:bayunf@unitedtractors.com)

### ACADEMIC PROFILE

- ❖ Bachelor Degree Mechanical Engineering, Brawijaya University 2009
- ❖ Master of Engineering Management, Swiss German University 2025

### CAREER PROFILE

**Des 2009 – May 2010**

#### **PT. UNITED TRACTORS Tbk**

- ❖ **Management Trainee Apprentice Program**
  - Make a good forecast for spare parts in order to support customer demand with a detail LIB and maintain SLA
- ❖ **Project for Increase Revenue Pekanbaru Branch.**
  - Backup & support komatsu product for PT CPI and PT PTSI site Kerinci, Riau for increase machine availability & reduce unit breakdown.
  - New project spare parts consignment at PT. PTSI for increasing parts availability in order to support the customer.

**June 2010 – December 2011**

#### **PT. BINA PERTIWI (United Tractors Group Company)**

- ❖ **On Job Training PT. Bina Pertiwi (Agro Contracting Program)**
  - As a Junior Project Manager Agro Contracting.
  - Role & Responsibility:
    - a. Create a new project, Agro Contracting Business, for support PT. MEDCO Ethanol Lampung at Lampung, South Sumatera as a new business in Astra Group.
    - b. Create feasibility study.
    - c. Create business process.

- d. Design organization structure.
- e. Design product application and innovation.
- f. Generate revenue.

**Jan 2012 – Feb 2013**

**PT. UNITED TRACTORS Tbk**

❖ **Forestry Contracting Division**

- As a Junior Project Manager Forestry Contracting Business.
- Role & Responsibility:
  - a. Lead new site project forestry contracting at Pangkalan Bun, Central Kalimantan for support PT. Korintiga Hutani.
  - b. Develop harvesting methods for increasing production.
  - c. Develop new microplanning as a strategic business plan.
  - d. Maintain cost effectiveness.

**March 2013 – March 2014**

**PT. UNITED TRACTORS Tbk**

❖ **Forestry Contracting Division**

- As a Business Development
- Role & Responsibility:
  - a. Create new End to End Forestry Business at PT Musi Hutan Persada, Tanjung Enim, South Sumatera.
  - b. Develop new concept for supporting forestry business (Planting, Maintenance, Harvesting) as “An Arranger” which manage all existing contractors in PT Musi Hutan Persada.
  - c. Create feasibility study.
  - d. Create business process, operational work process and ‘Arranger’ concept.
  - e. Design legal concept.
  - f. Design building facility and general affair concept for support operational.
  - g. Create standard operation procedure.

**March 2014 – Oct 2014**

**PT. UNITED TRACTORS Tbk**

❖ **Forestry Contracting Division**

- As a Heavy Equipment Rental Business Development.
- Role & Responsibility:
  - a. Create business models and strategy as a bridge strategy for penetrate competitor user to increase market share.
  - b. Setting target market.
  - c. Canvassing activity.
  - d. Create end to end business.
  - e. Create system for rental business (business process, SOP, risk management, BC incentive, KPI, invoice, reporting).
  - f. Prepare stock, product support, disposal management & infrastructure (IT yard, warehouse, etc).

- g. Risk management.

**Oct 2014 – 2015**

**PT. UNITED TRACTORS Tbk**

❖ **Forestry Contracting Division**

- As a Business Development Road Construction Contractor Project.
- Role & Responsibility:
  - a. Mapping of construction Trans Jawa Tol Road Project in.
  - b. Handle project toll road project (Depok Antasari, Cinere-Jagorawi, Cikampek-Palimanan, Pejagan-Pemalang, Brebes-Pekalongan)
  - c. Canvassing West java project
  - d. Market research with PT ACSET.

**Oct 2015 – 2016**

**PT. UNITED TRACTORS Tbk**

❖ **Product Support Bomag**

- As a Business Development Bomag Product.
- Role & Responsibility:
  - a. Mapping of unit population.
  - b. Create matrix function with another division (Marketing, CSSD, and branch/site)
  - c. Create unit problem matrix and solution
  - d. Manage UT OTIF Solution

**Aug 2016 – 2018**

**PT. UNITED TRACTORS Tbk**

❖ **Overhaul Business Department**

- As a support unit small component remanufacturing transaction collaborating with PT UTR.
- Role & Responsibility:
  - a. Support Small Machine Component Reman Sales
  - b. Lead coordination with PT UTR in small machine component transaction.
  - c. Management reporting.

**Aug 2018 – now**

**PT. UNITED TRACTORS Tbk**

❖ **Service Division – DAD Service Solution Stream**

- As Transformation Head in Reman Management System and Service Solution Dashboard Workstream
- Role & Responsibility:
  - a. Build system in to support component small machine and big machine transaction.
  - b. Lead and Manage 1 Business Analyst, 6 Backend, 6 Frontend and 4 Data Engineer teams.
  - c. Create digital products to support operational

- d. Collaborate with users to create digital products to support operational sites and branches.
- e. Lead and Manage Collaboration dan Relationship with stakeholders (principal and vendor component).

### **Skills**

Managing Profitability • Agile Leadership • Agile Project Management • Vision and Business Sense • Strategic Planning • Supply Chain • Remanufactured Business • Human Resource Development • Customer Experience • Strategy Implementation • Project Management • Financial Engineering • Maintenance Management

