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Publication details, including instructions for authors and subscription information:
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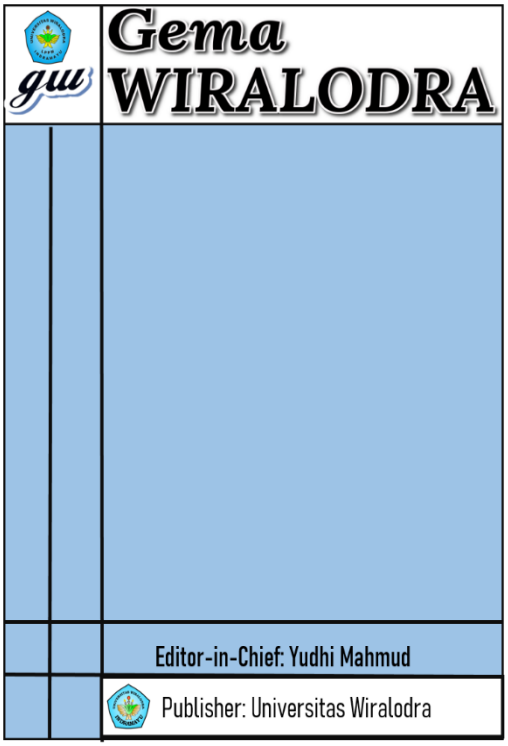

Implementation of solar cell booster to prevent damage to the electrical system and overcome CA N'T-Start Problems on PC2000-8 Units at PT PPA Jobsite Borneo Indobara

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To cite this article:
Margono, Suryana, Sugiyanto & Putra, A.F.B (2024). Implementation of solar cell booster to prevent damage to the electrical system and overcome CA N'T-Start Problems on PC2000-8 Units at PT PPA Jobsite Borneo Indobara. *Gema Wiralodra*, *15*(1), 585-595.
To link to this article:
https://gemawiralodra.unwir.ac.id/index.php/gemawiralodra/issue/view/24
Published by:
Universitas Wiralodra
Jln. Ir. H. Juanda Km 3 Indramayu, West Java, Indonesia

Gema Wiralodra, 15(1), 585-595
https://gemawiralodra.unwir.ac.id/index.php/gemawiralodra
p – ISSN: **1693-7945**
e – ISSN: **2622 - 1969**

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Implementation of solar cell booster to prevent damage to the electrical system and overcome CA N'T-Start Problems on PC2000-8 Units at PT PPA Jobsite Borneo Indobara

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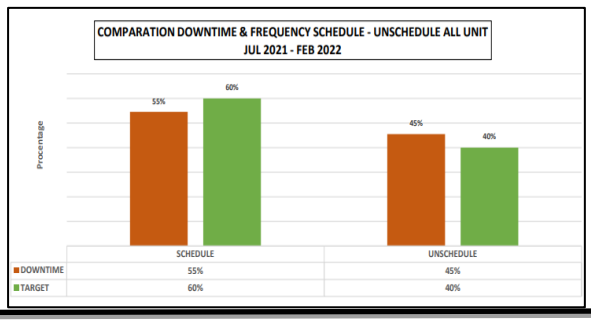
Abstract
One of the critical problems that disrupted production achievement at the Putra Perkasa Abadi (PPA) Jobsite Borneo Indobara (BIB) mine was the breakdown of the unscheduled electrical system engine can't start on the PC2000-8 unit due to low battery voltage. The problem is behind the modification or improvement in the battery charging system of the PC2000-8 unit by adding components in the form of solar cells that function as backup supplies of electrical energy or battery boosters on the main battery of the unit. In this study, there is a novelty term, namely "One Way Charge" which means that if the voltage of the unit's main battery is less than the stadium (PC2000-8 engine start voltage drop limit: 22 Volts), automatically electrical energy from the solar cell battery booster will be channeled to the unit's main battery to help meet voltage needs. The implementation shows that these improvements effectively reduce and prevent the frequency and downtime of unscheduled electrical system engine breakdowns that can't start on PC2000-8. Another benefit of this improvement is that it can eliminate potential lost costs both in terms of production and rental rates due to these problems and support the achievement of the Sustainable Development Goals (SDGs) of Clean and Affordable Energy through the use of renewable energy
Keywords: Solar cell, Electrical System PC 2000-8, PT Putra Perkasa Abadi

1. Introduction

PT Putra Perkasa Abadi in carrying out mining operations requires the use of heavy equipment on a high scale. Therefore, good maintenance management is carried out as the main demand on heavy equipment units, especially PC Excavator 2000-8. One of the periodic maintenances that needs to be considered is the charging system (*charging system*) battery. The system functions to recharge the battery that has been used when initially turning on the *Engine* and the use of accessories so that the battery is always in full condition (*full charge*) because the battery capacity cannot be used continuously so it requires recharging. But in actual terms, the number of *breakdowns unscheduled can't start* becoming the highest problem for *Electrical System* PC2000-8 units for the period July 2021 to February 2022. The problem is caused by a low battery drop and damage to the battery charging system (Komatsu Ltd, 2010).

Figure 1
Comparison Downtime &; Frequency Schedule – Unschedule All Units July 2021 – February 2022



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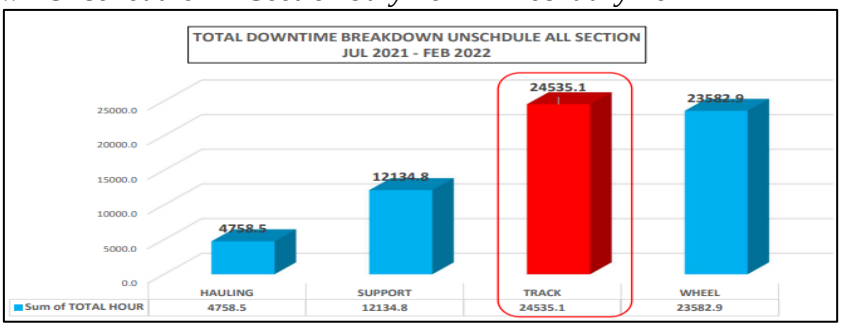
Comparison of breakdown schedule and unscheduled data from July 2021 to February 2022: Downtime 55%: 44% not by the KPI target, namely schedule 60% and unscheduled 40% (Figure 2).

Figure 2

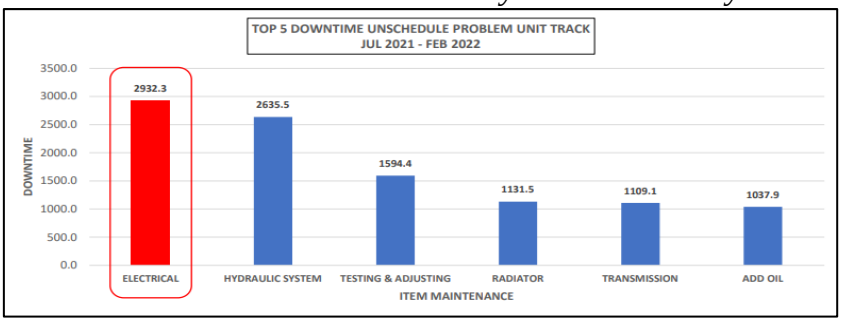
Total Breakdown Unschedule All Section July 2021 – February 2022



The mapping results of each section show that the highest unscheduled breakdown is in the track section, which is 24535 hours, so the main target for improvement steps is units in the track section (Figure 3).

Figure 3

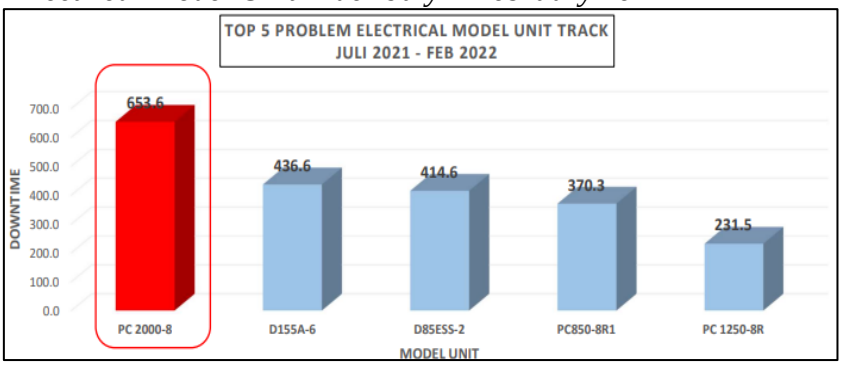
Top 5 Downtime Unschedule Problem Unit Track July 2021 – February 2022



The specification of unscheduled unit track breakdown data shows that the highest component downtime problem is electrical as much as 2932.3 hours, so electrical problems are the main target for improvement (Figure 4).

Figure 4

Top 5 Problem Electrical Model Unit Track July – February 2022



Based on the graph above, it is known that the electrical damage trend specifications are based on the unit model. The first highest damage was the PC2000-8 unit with a downtime of 653.6 hours, so repairs were focused on the unit.

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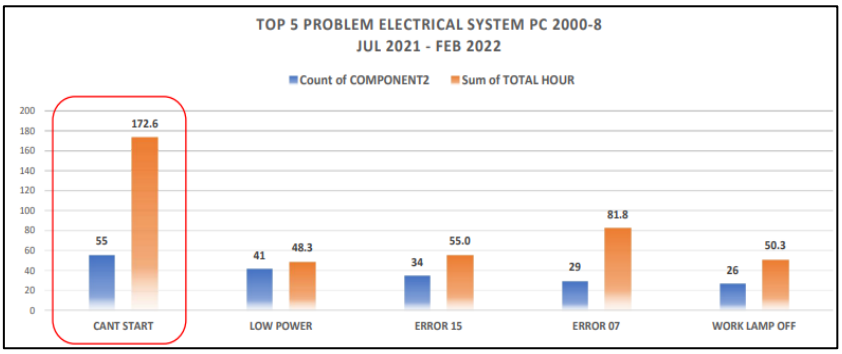
Figure 5
Top 5 PC 2000-8 Electrical System Problems for July 2021 – February 2022



In the TOP 5 data of electrical damage to the PC2000-8 system above (Figure 5), the problem *of can't start* is the main trend of unscheduled breakdown in the unit. It was noted that the frequency and downtime experienced 55 times the damage with a total time of 172.6 hours. To deal with the electrical problems of the engine can't start system on the PC2000-8, PT Putra Perkasa Abadi carried out improvements with the theme of Implementation of Solar cell *Booster to Prevent Damage to the Electrical System and Overcome Can't Start Problems on the PC2000-8 Unit at PT PPA Jobsite Borneo Indobara*.

2. Method

This research was conducted at the PPA Jobsite PT Borneo Indobara from July 2021 to February 2022. The data collection process involved several methods, including direct observation in the field to understand existing working conditions, the development of an effective solar cell installation design for use at that location, as well as implementation of a method of testing and adjusting to refine and optimize the design. After the data was collected, analysis was carried out before and after the implementation of the research to evaluate the effectiveness of the changes that had been made. Thus, this research not only explores information from the field situation but also tries to provide concrete solutions that can improve the efficiency or performance of the system under study.

3. Results and Discussion

Adding *Solar Cell* to *PC2000-8* Unit

To overcome the problem of breakdown unscheduled electrical system can't start, PT Putra Perkasa Abadi developed an improvement in the addition of solar cells to the PC2000-8 unit through a scheme of procuring a backup power source on the unit so that if there is an abnormality in the alternator charging system or a decrease in the voltage of the unit's main battery, the solar cell will automatically help supply electricity or booster an existing main battery. The improvement was chosen because the installation of solar cells can anticipate and overcome potential problems related to electricity in the PC2000-8 unit. In addition, other supporting activities can be implemented to support the success of the improvement, namely through the installation of stickers prohibiting the use of electricity when the unit is off and adding a battery voltage indicator on the panel screen. The implementation of these improvements is expected to prevent and reduce the frequency or breakdown time of unscheduled electrical engine can't start problems due to low battery voltage (Figure 6).

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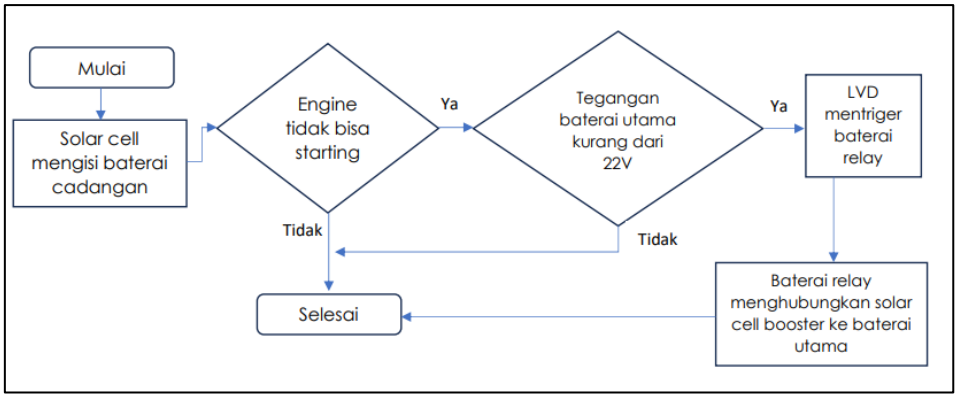
Figure 6
Solar Cell Working Process Flow Diagram



The following is a risk analysis of selected solutions to overcome electrical problems in the PC2000-8 unit.

Table 1
Risk Analysis

Activity	Potential	Impact	Precautions	Countermeasures
Adding solar cells to PC22000-8 units	Wiring Improvement	When the main battery of the unit voltage is less than 22 Volts, the battery booster cannot supply electrical energy to the main battery	Checking wiring ssat periodic service and periodic inspection	Rewarding Improvement
	Damaged/malfunctioning LV Break	When the main battery of the unit voltage is less than 22 Volts, the battery booster cannot supply electrical energy to the main battery	Checking LVD during periodic service and periodic inspection	Replacing LVD
	Battery relay putas/malfunctioning	When the main battery of the unit voltage is less than 22 Volts, the battery booster cannot supply electrical energy to the main battery	Check the relay battery during periodic service and periodic inspection	Replacing the relay battery
Installing a sticker prohibiting the use of electricity when the unit is off	Popular stickers	Information on the prohibition of electricity use when the unit is off is not conveyed	Sticker replacement when it fades	Periodic checks
Add a battery voltage indicator	Indicator light off	Unmonitored beta performance	Midlife Components	Periodic checks

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Implementation of Improvement Plan Solar Cell *Booster* Series

Figure 8
Wiring Diagram Solar Booster PC2000-8

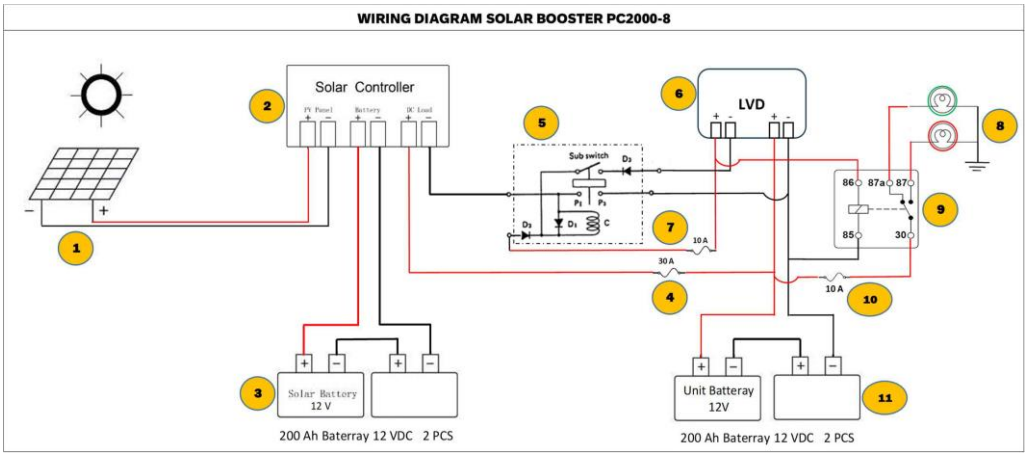

Table 2
Solar Cell Booster Components

No	Nama Komponen	Jumlah	Satuan
1	Solar cell 100WP	1	Pcs
2	Solar Charge controller	1	Pcs
3	Batteray Booster 24 Volt	2	Pcs
4	Fuse 30 Ampere	1	Pcs
5	Baterray relay 24 V 500 Ampere	1	Pcs
6	LVD setting voltage	1	Pcs
7	Fuse 10 Ampere	1	Pcs
8	Lampu indicator	2	Pcs
9	Relay 24 volt	1	Pcs
10	Fuse 10 ampere	1	Pcs
11	Batteray unit 24 volt	2	Pcs

How *Solar Cell* Booster Works

a) Under normal conditions when the unit battery has a voltage of more than 22 Volts, the electric current in the booster battery is not connected to the unit battery, automatically the indicator light will display green and the solar panel will charge the booster battery because the LVD trigger is set at a voltage of less than 22 volts.

b) When the battery condition of the unit is abnormal or the voltage is less than 22 volts, the indicator light will change to red. LVD will activate the battery relay to pass electric current from the booster battery to the main battery of the unit. This lasts until the unit's battery voltage again reaches more than 22 volts. When the voltage has reached more than 22 volts, the indicator light will again turn green. LVD will trigger the battery relay again to cut off the electric current from the *solar cell booster battery* to the unit battery.

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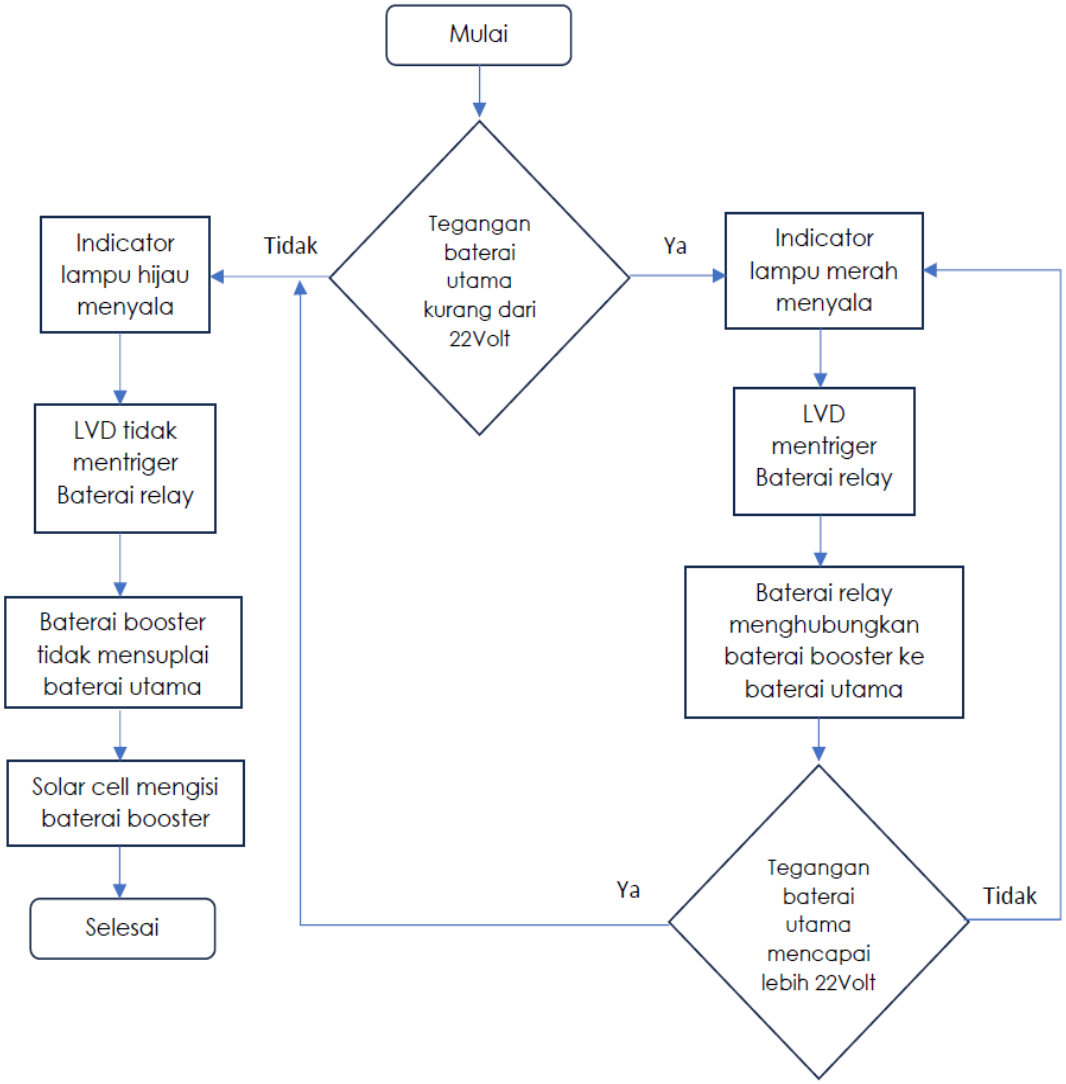
Solar cell *Booster* Working Flow Diagram
Figure 9
Solar Cell Booster Working Flow Diagram



Solar cell *Booster* installation
Solar Panel Installation
Figure 10
Solar Cell Installation

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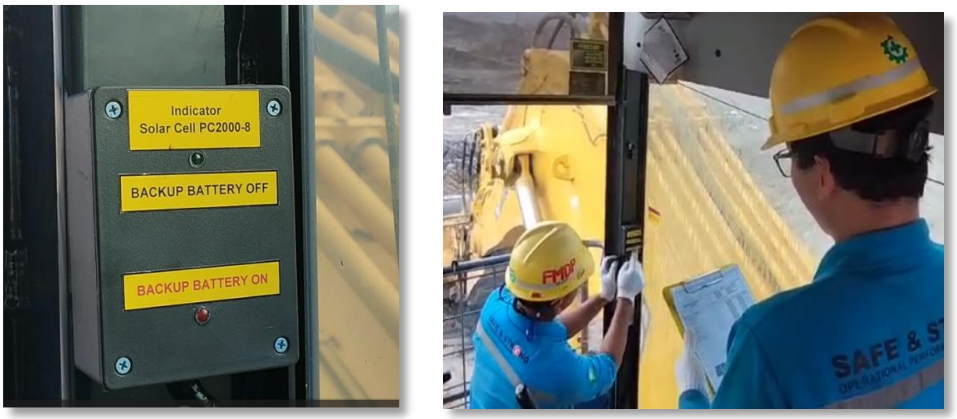
Solar Cell *Controller Installation*
Figure 11
Solar Cell Controller Installation

Battery Booster Installation
Figure 12
Battery Booster installation

Installation of Indicator Lights
Figure 13
Installation of Indicator Lights



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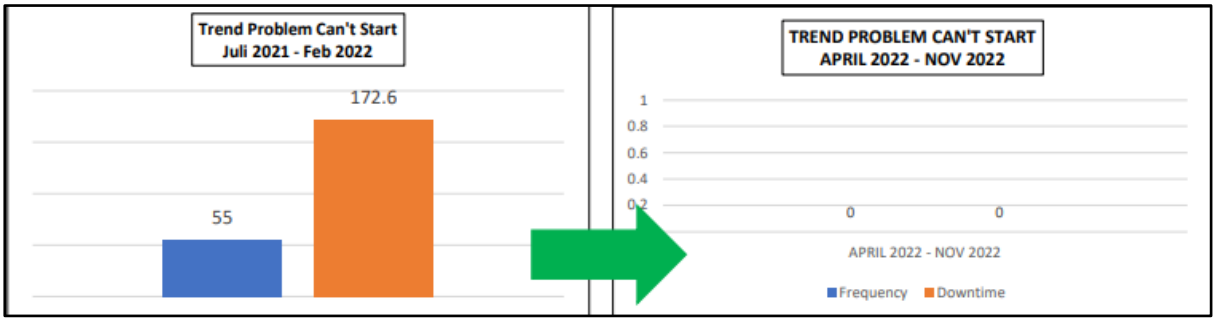
Analysis of Improvement Results
Review of Breakdown Unschedule Electrical System Can't Start PC2000-8
Figure 14
Review Breakdown Unschedule Electrical System Can't Start PC2000-8



Before the installation of the improved solar cell on the PC2000-8 unit, it was known that in the period July 2021 – February 2022, the frequency of breakdown of the unscheduled electrical system can't start was 55 times with a downtime of 172.6 hours. Then after the installation of the solar cell improvement, it is known that based on the dispatcher data record for April 2022 – November 2022 is zero (0) frequency and zero (0) hours of downtime or no breakdown of the unscheduled electrical system, can't start again.

Goal Achievement Analysis
Table 3
Goal Achievement Analysis

Aspects	Problem	Goal	Achievement
Quality	Event breakdown unscheduled electrical system can't start Unit PC2000-8 with a total of 55 events	Preventing the breakdown of the unscheduled electrical system can't start unit PC2000-8	Event breakdown unscheduled electrical system can't start PC2000-8 April 2022 – November 2022
Cost	The high potential loss cost rental rate of the Plant Department due to the breakdown of the unscheduled electrical system can't start unit PC2000-8 amounted to Rp.529.968.602.98,-	Reduce potential loss cost rental rate due to breakdown of unscheduled electrical system can't start unit PC2000-8 as much as Rp.0,-	The potential loss cost rental rate due to the breakdown of the unscheduled electrical system can't start April 2022 – November 2022 is Rp.0,-
	Potential lost production cost due to breakdown unscheduled electrical system can't start unit PC2000-8 Rp.3.371.352.914,-	Reduce potential loss cost of production due to breakdown of unscheduled electrical system can't start unit PC2000-8 as much as Rp.0,-	Potential loss cost of production due to breakdown of unscheduled electrical system can't start April 2022 – November 2022 Rp.0,-
Delivery	Breakdown schedule and unscheduled Jul 21 – Feb 22	Increase the percentage of schedule breakdown and	Breakdown schedule and unscheduled Apr 2022 – Nov 2022.

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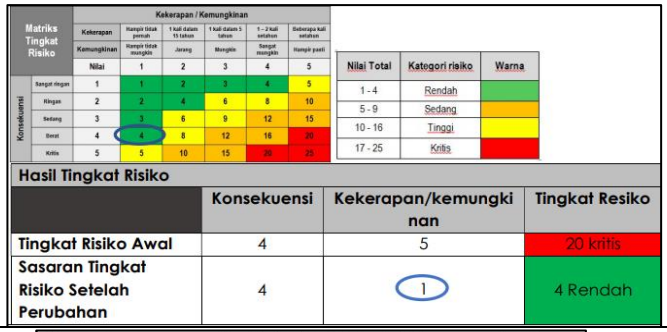
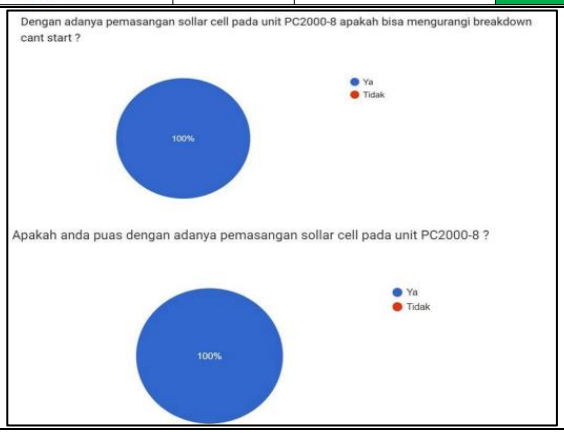
Aspects	Problem	Goal	Achievement
	SCH-UCH / DISCRIB / DOWNTIME: SCH 55%, UNSCH 45%	unscheduled KPIs to 60%: 40%.	SCH - UCH / DISCRIB / DOWNTIME: SCH 64%, UNSCH 36%
Safety, Health, environment, Security	1. High potential incidents due to ups and downs of the unit when performing the battery jumper process when the unit breakdown can't start. Before the implementation of the improvement, the total risk value was 20 which was included in the "critical" category, but after the improvement of the addition of solar cells, the risk value decreased to 4 "low" categories. This is explained through the risk matrix as follows:  Hasil Tingkat Risiko: Tingkat Risiko Awal — Konsekuensi 4, Kekerapan/kemungkinan 5, Tingkat Resiko 20 kritis; Sasaran Tingkat Risiko Setelah Perubahan — Konsekuensi 4, Kekerapan/kemungkinan 1, Tingkat Resiko 4 Rendah		
Morale			

Assess Value Added

The following is an analysis of the added value of the positive impact on the company for improvements made to the PC2000-8 unit:

1) Adding *solar cells* as a backup source of electric current in PC2000-8 can reduce B3 waste, especially battery waste.

Figure 15
Monitoring Waste Battery Entering the TPS 2021 – 2022

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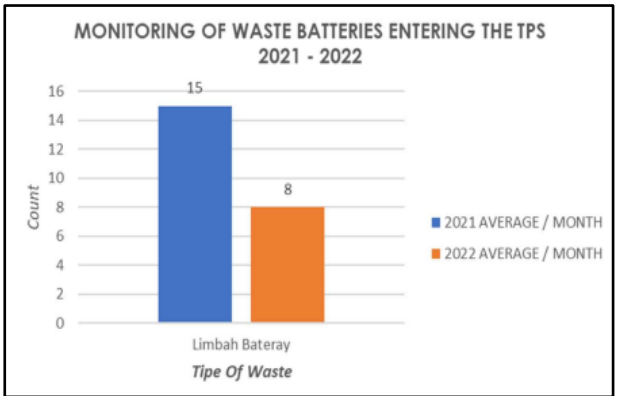
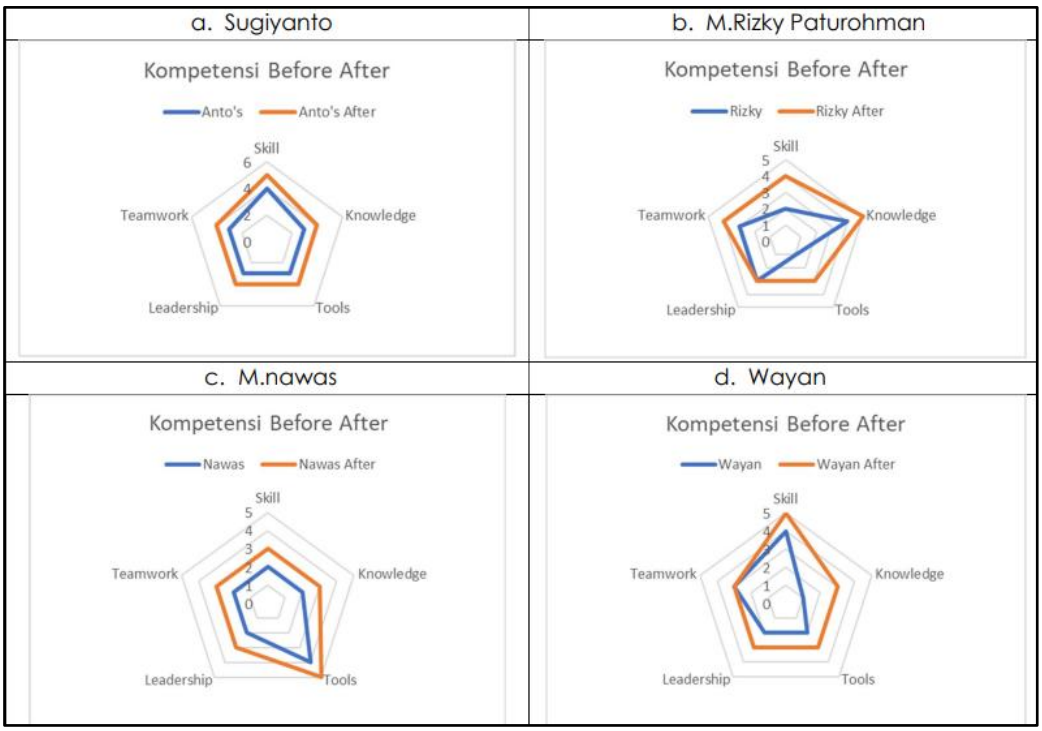


2) Improve the competence of team members before and after the implementation of the improvement of adding *solar cells* to the PC2000-8 unit.

Figure 16
Team Member Competencies Before and After the Implementation of Improvement Solar Cell Booster



3) Verification of Financial Performance.

The following are the results of the analysis and evaluation *Cost & Benefit* installation of *solar cell* PC2000-8 against engine electrical system breakdown can't start as follows:

a) *Loss Cost* Rental Rate PC2000-8

Table 3
Loss Cost Rental Rate PC2000-8

PERIODE	DOWNTIME	LOSS COST
April – Nov 2022	0	Rp. 0.00

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b) *PC2000-8 Production* Loss Cost

Table 4
PC2000-8 Production Loss Cost

PERIODE	DOWNTIME	PRODUKTIVITY(BCM/Jam)	LOSS COST
April – Nov 2022	0	Target 750 BCM/Jam	Rp 0.00

Based on the Table 4, it can be concluded that the total loss cost rental rate and production loss cost due to the *breakdown of the electrical system engine can't start* on the PC2000-8 unit after the implementation of *solar cell* improvement is Rp.0.00 during the period April 2021 – November 2022.

Reviewing Precautions against the Negative Impact of Improvement

Solution (prevention/reduction) of potentially arising negative impacts.

a) Making IK (Work Instructions) Solar *Cell Booster treatment*.
b) Making a periodic Solar Booster maintenance checklist.
c) Making Management of Change (MOC) documents as a step to publish information on changes in PC2000-8 to the owner who in this case is PT BIB. Innovating the progress or regression of evaluation results.

4. Conclusion

Installing upgraded solar cells on PC2000-8 units has made a big difference in overcoming the problem of unscheduled electrical system breakdowns that often hamper operations. By reducing crash events from 55 to 0, we eliminated costly glitches and significantly improved operational efficiency. In addition, by eliminating potential loss costs of IDR 529,968,602.98 and threatened production costs, we have reduced financial risks that previously became a burden for the company. This step increases the reliability of the PC2000-8 units and demonstrates our commitment to innovation and long-term cost savings.

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