**Transforming Maintenance Operations at FutureEnergy with ERP and Industry 4.0 Technologies**

Enterprise Resource Management – INFS 5024

Submitted By: Saraf Rahman Khan

Table of Contents

[Executive Summary 3](#_Toc205819941)

[1.0 Introduction 4](#_Toc205819942)

[2.0 Business Process Context 5](#_Toc205819943)

[2.1 Company Overview 5](#_Toc205819944)

[2.2 Core Business Processes 5](#_Toc205819945)

[2.3 Focusing on Asset Management 6](#_Toc205819946)

[Business Continuity & Operational Reliability: 6](#_Toc205819947)

[Process Efficiency and Competitive Advantage: 6](#_Toc205819948)

[Regulatory Compliance: 6](#_Toc205819949)

[Growth and Innovation: 7](#_Toc205819950)

[2.4 Predictive Analytics for Maintenance and Strategic Significance 7](#_Toc205819951)

[3.0 Current Maintenance Process Overview 8](#_Toc205819952)

[3.1 Fragmented Maintenance Landscape 8](#_Toc205819953)

[3.2 Manual and Reactive Maintenance in Fossil Fuel Plants 8](#_Toc205819954)

[3.3 Sensor-Based, Yet Isolated, Maintenance in Renewable Plants 8](#_Toc205819955)

[3.4 Lack of Centralized Visibility and Coordination 8](#_Toc205819956)

[4.0 Problem Statement and Digital Transformation Drivers 9](#_Toc205819957)

[5.0 Industry 4.0 Integration 9](#_Toc205819958)

[5.1 Use of IIoT Sensors for Asset Data Collection 10](#_Toc205819959)

[5.2 Linking Sensor Data to Digital Twin Simulation 10](#_Toc205819960)

[5.3 Enabling Predictive Analytics for Proactive Intervention 10](#_Toc205819961)

[5.4 Supporting the Strategic Renewable Transition 10](#_Toc205819962)

[6.0 Introduction to ERP-Enabled Process Redesign 11](#_Toc205819963)

[7.0 SAP S/4HANA Modules 11](#_Toc205819964)

[7.1 SAP Plant Maintenance (PM) 11](#_Toc205819965)

[7.2 SAP Materials Management (MM) 12](#_Toc205819966)

[7.3 SAP Fiori (Mobile Interface) 12](#_Toc205819967)

[8.0 Pools, Lanes, and Responsibilities - System Architecture 12](#_Toc205819968)

[8.1 Pool 1: Data Collection System 12](#_Toc205819969)

[8.2 Pool 2 : Digital Twin Engine 13](#_Toc205819970)

[8.3 Pool 3: ERP SYSTEM (SAP S/4HANA) 13](#_Toc205819971)

[8.4 Pool 4: FutureEnergy Maintenance Team 14](#_Toc205819972)

[8.5 Summary Table of Pools and Lanes 14](#_Toc205819973)

[9.0 Re-Engineered TO-BE Process for Asset Maintenance 15](#_Toc205819974)

[9.1 Process Workflow 16](#_Toc205819975)

[10.0 Expected Business Benefits 18](#_Toc205819976)

[11.0 Limitations and Assumptions 20](#_Toc205819977)

[12.0 Recommendations for Implementing the New Predictive Maintenance Process 21](#_Toc205819978)

[13.0 Conclusion 23](#_Toc205819979)

[References 24](#_Toc205819980)

[Appendix A – TO-BE Process Diagram 0](#_Toc205819981)

# Executive Summary

The implementation plan outlines the use of a combination of SAP S/4HANA and Industry 4.0 technologies to re-engineer the current maintenance process at FutureEnergy. All the current business processes were enlisted and analysed to select the most influential process. Asset maintenance was categorially chosen as the business process because of the high associated costs of energy generation assets and business continuity. The current asset maintenance process and its drawbacks were analysed to develop a re-engineered process. Industry 4.0 technologies including IIoT sensors, Digital Twin Engines and Predictive Analysis were explored along with SAP S/4HANA along with main core modules in accordance to asset maintenance. The re-engineered process was mapped using BPMN which has been extensively discussed including all pools, lanes and a step-by-step process workflow. The expected benefits from the re-engineered process sets a foundation for cost optimisation, competitive advantage and business continuity for FutureEnergy. The limitations and assumptions of the implementation plan have been discussed to incorporate the possible shortcomings of the new process. Well weighted recommendations have been made based on analysing all the benefits and limitations for the most optimal and efficient implementation of the re-engineered process.

# 1.0 Introduction

Digital innovation, growing consumer expectations, and climate imperatives are all driving significant change in the global energy business (Li et al., 2023). Energy suppliers are under tremendous pressure as governments quicken their decarbonization efforts to update their operational and digital infrastructures in addition to switching to renewable energy sources. The South Australian government has mandated energy providers to shift to entirely renewable energy production by 2027, which is a major driver for the change within FutureEnergy. With more than 650,000 clients, FutureEnergy is a large-scale energy supplier in South Australia and is leading the charge on this issue. However presently it is limited by fragmented legacy systems, uneven asset management procedures, and compartmentalized operations across its wind, solar, coal, and gas generating facilities (Gavrikova et al., 2022).

This implementation plan suggests that FutureEnergy needs to strategically integrate Industry 4.0 technology with SAP S/4HANA to increase the efficiency of operations at FutureEnergy (Fernandez-Vidal et al., 2022). SAP S/4HANA is the ERP system selected for its strong ability to unify key business operations. Recent research and industry practices demonstrate that cloud-based ERP platforms, especially SAP S/4HANA, can integrate areas such as finance, procurement, human resources, and maintenance into a single digital backbone, enabling streamlined and efficient organisational processes (Abd Elmonem et al., 2016). Concurrently, the report illustrates digital technologies such as Digital Twins, IIoT-enabled sensors, real-time analytics facilitate data-driven operational management and predictive asset maintenance to minimize downtime and improve business continuity (Alhadi et al., 2025).

This Implementation Plan describes a thorough approach to transforming FutureEnergy from a fragmented IT environment to an intelligent, networked system that facilitates strategic expansion, operational agility, and predictive maintenance. The strategy is set up to direct the implementation of SAP ERP in all functional areas, integrating predictive technologies, managing organizational transformation, and guaranteeing alignment with FutureEnergy's long-term sustainability and innovation agenda. This will allow for enterprise-wide visibility, agility, and sustainable scaling (Hutter et al., 2023). An intelligent energy ecosystem that can not only adapt to the future but also lead it may be established by the company through the integration of ERP and Industry 4.0.

# 2.0 Business Process Context

## 2.1 Company Overview

FutureEnergy is a major electricity provider based in South Australia, supplying power to over 650,000 customers. The company was established in 2015 following the acquisition of two old companies and now manages a combination of fossil-fuel and renewable energy assets. Its portfolio includes a coal-fired power station in Port Augusta, a gas-fired power station in Port Bonython, a windfarm on the Eyre Peninsula, and a solar farm near Whyalla. These assets enable FutureEnergy to serve both residential and business customers and have positioned it as a key player in the state’s energy transition.

As the energy sector evolves the government mandated push for a shift to entirely renewables by 2027, FutureEnergy is faced with both opportunities and challenges. The company must maintain high service reliability and comply with environmental regulations while responding to increasing competition, need to modernize operational core, and continue business growth.

## 2.2 Core Business Processes

FutureEnergy’s ability to provide reliable and sustainable electricity depends on several critical business processes. Some of the main processes integral to the business are outlined below.

Core Business Processes and Current Practices at FutureEnergy

|  |  |
| --- | --- |
| Process | Current Practice at FutureEnergy |
| Power Generation | FutureEnergy operates coal, gas, wind, and solar power plants across South Australia, with each type of plant managed independently and using separate systems. Currently there is no integration between the fossil fuel and renewable energy plants. |
| Procurement & Supply Chain | The company manages procurement and supply chain activities using a proprietary, in-house Supply Chain Management (SCM) system called OnDemand. This system is not integrated with other business platforms. Vendor selection is based on price, quality, and delivery frequency for long-term contracts, such as coal supply, but there is no evidence of digital tendering or company-wide, real-time inventory tracking. |
| Customer Management & Billing | Customer service operations are divided between private and business clients. The Customer Relationship Management (CRM) department works closely with SA Power Networks for outage management. Billing processes use digital meters for solar and business customers, while 90% of residential customers still rely on manual meter readings every three months. |
| Energy Distribution | Energy distribution is facilitated through the SA Power Networks grid. FutureEnergy has also invested in electric vehicle charging infrastructure in partnership with other local organizations, with most charging stations currently operating in the Adelaide CBD and nearby regions. |
| Asset Management & Maintenance | Maintenance for coal and gas power stations is mainly manual and scheduled, relying on local logs and plant-specific procedures. Wind and solar sites employ sensor monitoring systems with remote access, but these systems are not integrated with head office platforms and are managed independently. There is no unified, company-wide asset management system in place. |
| HR & Workforce Planning | Recruitment at FutureEnergy is managed using a cloud-based tool (HireNow), while ongoing employee data is maintained in a separate internal system (MyStaff). These two systems are not integrated, which complicates workforce planning and hinders the efficient transfer of information from hiring to employment management. |

## 2.3 Focusing on Asset Management

Although all business processes contribute to the success of the company, we focus on transforming Asset Management as it is a strategic priority for several reasons.

Business Continuity & Operational Reliability: Effective maintenance emphasizes uptime and service continuity. Robust asset management not only maximizes equipment availability but also strengthens FutureEnergy’s ability to respond to unforeseen disruptions. Poor practices raise the risk of outages, failures, and regulatory breaches affecting financial performance, reputation, and customer trust. Proactive maintenance can also be directly linked to improved business continuity.

Process Efficiency and Competitive Advantage:The new process will automate workflows, standardizing processes, eliminating redundancies, and enabling data-driven decisions. Such transformation streamlines communication and collaboration between departments and enhances real-time visibility of operations. This will also reduce downtime and keeps FutureEnergy competitive as the industry evolves.

Regulatory Compliance: To meet the 2027 renewables mandate, efficient and transparent asset maintenance is essential. Advanced monitoring and automated reporting through ERP systems help ensure consistent regulatory compliance and reduce operational risk. Regulatory bodies are increasingly requiring detailed audit trails and accountability, making automated and integrated reporting not just beneficial, but essential for energy providers.

Growth and Innovation: Expanding renewable assets require increased maintenance and integrating industry 4.0 technologies like Digital Twins will enable predictive, condition-based maintenance. This will help anticipate failures while optimizing resources and scale as new technologies are deployed (Rojas et al., 2025). Innovations not only improve asset performance but also support scalable, sustainable business growth by enabling organizations to adapt quickly to technological change and market demands.

Overall, prioritizing asset management transformation is not only fundamental to operational reliability and compliance but also to driving efficiency, fostering innovation, and ensuring the company’s long-term competitiveness in a dynamic and challenging energy sector.

## 2.4 Predictive Analytics for Maintenance and Strategic Significance

Predictive maintenance is a forward-looking strategy that leverages real-time data, advanced analytics, IIoT sensors, and digital twin technology to anticipate and address potential equipment failures before they impact operations. By implementing predictive maintenance at FutureEnergy, the company can achieve:

1. Business Continuity Focus: Continuous, company-wide monitoring of asset health using IIoT devices and digital twins enables early detection of issues, which reduces downtime, lowers repair costs, extends asset life, and ensures uninterrupted business operations.
2. Maintenance only when needed: Data-driven predictions allow teams to intervene precisely when necessary, minimizing unnecessary maintenance and reducing wasted resources (Magnus Okechukwu Kanu 2025).
3. Shared Best Practices and Data across Business Units: Centralized digital platforms ensure that maintenance insights, solutions, and lessons learned are accessible to all teams, supporting continuous improvement and standardized performance company-wide.

Modernizing the maintenance process—moving from reactive, siloed approaches to a unified, predictive system—will support FutureEnergy’s transition to renewables, improve operational reliability, and enable scalable growth (Rana;, 2025). This focus not only addresses regulatory and competitive challenges but also positions FutureEnergy as a leader in digital transformation within Australia’s energy sector.

# 3.0 Current Maintenance Process Overview

## 3.1 Fragmented Maintenance Landscape

FutureEnergy operates several types of power plants across South Australia, including coal, gas, wind, and solar. Although the company covers both traditional and renewable energy sources, maintenance and asset management are handled very differently at each site. Coal and gas plants rely on legacy, manual routines, while wind and solar sites are managed with sensors. Importantly, these approaches are not linked, so each plant follows its own maintenance process, making coordination difficult and limiting overall visibility across the company.

## 3.2 Manual and Reactive Maintenance in Fossil Fuel Plants

Maintenance at the coal and gas power stations is organized at the plant level according to established routines. The coal plant is under a long-term decommissioning plan and receives coal supplies via contracts negotiated on price, quality, and delivery frequency. The gas plant was modernized in 2010 with sensor technology to support monitoring. Overall, maintenance activities for fossil fuel plants remain local, with no integration between plants or with company headquarters.

## 3.3 Sensor-Based, Yet Isolated, Maintenance in Renewable Plants

Wind and solar farms are equipped with state-of-the-art sensors and can be operated remotely. Maintenance at the windfarm involves manual inspections every six months, while solar panels require regular cleaning every six to twelve months and occasional replacement. Monitoring and maintenance are managed within each plant, with no integration or data sharing across sites.

## 3.4 Lack of Centralized Visibility and Coordination

There is no mention of FutureEnergy using a unified platform for asset management. Fossil fuel and renewable operations are managed separately, with maintenance records, schedules, and processes kept at each site. There is no aggregation or sharing of maintenance data, which limits company-wide visibility, coordination, and informed decision-making.

# 4.0 Problem Statement and Digital Transformation Drivers

FutureEnergy’s current maintenance model is both fragmented and outdated. The company relies on disjointed systems and manual workflows that hinder operational efficiency. While FutureEnergy has outlined strategic goals focused on expanding its renewable energy portfolio, the supporting maintenance and asset management practices remain inconsistent and siloed (Zhan et al., 2025).

The organization operates a diverse mix of coal, gas, wind, and solar generation assets, each managed independently using distinct tools and protocols. Asset management for fossil fuel stations (coal and gas) still relies on manual inspections and fixed-interval servicing. In contrast, wind and solar plants are equipped with modern, sensor-based monitoring systems that support remote diagnostics. However, despite these technological disparities, no centralized platform exists to integrate maintenance operations or provide enterprise-wide asset visibility.

This lack of integration results in inefficient scheduling, limited data-driven decision-making, and increased operational risk. Recognizing this, FutureEnergy is exploring the consolidation of all asset maintenance under a unified ERP platform. This transformation is proposed to standardize operations, improve uptime, and support long-term growth.

Externally, the South Australian Government has mandated a complete shift to renewable energy generation by 2027, adding urgency to FutureEnergy’s modernization efforts (Mahmood et al., 2024). In parallel, industry competitors such as AGL and SimplyEnergy are advancing rapidly with digital tools and integrated operations by highlighting the need for FutureEnergy to accelerate its own transformation to remain competitive. These internal limitations and external pressures form the foundation for FutureEnergy’s proposal to pursue a digital transformation strategy. The following section outlines the rationale for selecting specific Industry 4.0 technologies to support this strategic initiative.

# 5.0 Industry 4.0 Integration

There is a need to adapt and implement Industry 4.0 technologies like namely IIoT-enabled sensors, Digital Twin simulation engines, and predictive analytics (Mohd et al., 2023). These technologies can act as a critical enabler of FutureEnergy’s transition toward unified, predictive asset maintenance. These technologies directly address the company’s operational bottlenecks and align with its strategic direction, particularly the shift toward renewable energy.

## 5.1 Use of IIoT Sensors for Asset Data Collection

The current inconsistency in maintenance approaches across asset types—manual for fossil fuel stations and sensor-based for renewables has led to fragmented oversights along with providing limited strategic coordination. By equipping assets with standardized IIoT sensors, FutureEnergy can capture real-time data such as temperature, vibration, pressure, and electrical load (Dilshad Ansari et al., 2024). This enables consistent and centralized monitoring across the entire generation portfolio, enhancing situational awareness and responsiveness.

## 5.2 Linking Sensor Data to Digital Twin Simulation

While IIoT sensors provide visibility, the actual benefit will come when linked to a Digital Twin simulation engine. The Digital Twin will utilize the historical data as well as the real-time data to create dynamic models of FutureEnergy's physical assets. The simulations will then forecast future degradations, estimate component stress across various conditions, and forecast remaining useful life (RUL) (Yan et al., 2021). Integrating real-time IIoT streams with the simulation engine gives timely updates, and predictions become accurate and timely.

For example, a temperature spike in an IIoT sensor-monitored gas turbine can be fed into the Digital Twin to simulate expected bearing failure. If the expected stress curve exceeds safe limits, the maintenance alert is issued even before any real damage occurs (Hu et al., 2023).

## 5.3 Enabling Predictive Analytics for Proactive Intervention

The simultaneous output of IIoT data and Digital Twin simulation will form the foundation for predictive analytics. Once an asset simulated conditions exceeds set levels of risk or operational thresholds, predictive algorithms will generate an advanced maintenance schedule (Aivaliotis et al., 2019). The generated schedule will take into account risk severity, operational impact, and historical performance to trigger condition-based interventions.

This mechanism replaces manual, calendar-based servicing with a more targeted and predictive approach, ensuring maintenance resources are deployed only when and where they are needed. It also enables FutureEnergy to concentrate on high-risk assets and prevent avoidable downtime without over-maintaining lower-risk components and hence resulting in optimal use of resources and operational excellence.

## 5.4 Supporting the Strategic Renewable Transition

As FutureEnergy increases its reliance on renewable energy sources, operational agility and asset reliability become critical. A predictive maintenance framework reduces unplanned outages, optimizes maintenance costs, and supports scalable operations, all necessary to meet the 2027 renewable energy mandate. The ability to simulate asset condition over a distributed infrastructure provides a strategic advantage in managing broad-scale, dispersed plants (Zhan et al., 2025)

Generally, the integration of IIoT, Digital Twin, and predictive analytics is a holistic strategy for FutureEnergy's digitalization. It integrates data collection, simulation, and decision-making into a closed loop that can continually improve asset performance and management. This proposal positions FutureEnergy not just in a position to learn from regulatory change, but to lead operational excellence within Australia's energy industry.

# 6.0 Introduction to ERP-Enabled Process Redesign

Building on the strategic rationale and enabling technologies outlined above, implementation of an enterprise-wide ERP system using SAP S/4HANA is being proposed.  This ERP-enabled redesign will mark a shift from isolated, plant-specific systems toward a centralized, intelligent maintenance architecture at FutureEnergy. The new process aims to establish a seamless integration between real-time asset monitoring, advanced simulation, and condition-based maintenance execution. SAP S/4HANA is being positioned as the digital nerve centre that integrates asset data streams, automates decision-making, and supports scalable field operations throughout the company (Shaik, 2023).

The process begins with operational data received from IIoT sensors being sent and collected into a Unified Data Hub. This centralized system standardizes into a plant-wise dataset, which is then transmitted to the Digital Twin simulation engine, which models equipment degradation and estimates component-level risk based on current and historical data. If thresholds are breached, the engine outputs structured, SAP-compatible maintenance alerts and insights.

These insights are passed to SAP Plant Maintenance (PM), which automatically generates a work order. SAP Materials Management (MM) simultaneously checks the inventory status of required spare parts (Crespo Márquez, 2022). The Maintenance Coordinator reviews the auto-generated work order and dispatches it through SAP Fiori to a Field Technician’s mobile device for the actual maintenance task to be executed. This design enables FutureEnergy to operationalize predictive maintenance on a daily basis, breaking free from the inefficiencies of static planning and manual triage (Toulan et al.).

# 7.0 SAP S/4HANA Modules

The re-engineered predictive maintenance framework relies on several key SAP modules and integrated system components to orchestrate the end-to-end process. The various SAP modules being used for this process are:

## 7.1 SAP Plant Maintenance (PM)

The PM module is the primary engine for creating, managing, and closing maintenance work orders. When the Digital Twin engine identifies a prospective maintenance or high-risk condition, it generates a maintenance alert with structured maintenance insights that include data like equipment ID, fault type, urgency, etc (Wu et al., 2025). These insights are directly formatted for SAP PM, enabling the creation of maintenance schedules and work orders. PM also maintains historical records of each asset, including repair history, inspection logs, and task outcomes. This data helps improve future simulations and supports compliance reporting.

## 7.2 SAP Materials Management (MM)

Once a work order is generated and it requires spare parts, MM performs an automatic check for spare part availability based on the bill of materials (BOM) linked to the affected asset. If parts are available, they are reserved; if not, a purchase requisition is triggered. This ensures maintenance tasks are not delayed by material shortages (Chaves et al., 2023). MM is also responsible for vendor management and procurement lifecycle, which will be critical when scaling predictive maintenance across multiple regions in the future.

## 7.3 SAP Fiori (Mobile Interface)

Fiori provides a mobile/tablet optimized user interface for coordinators and technicians in the field. Assigned tasks are sent to the technician’s device, complete with asset location, repair instructions, safety protocols, and an option to submit post-maintenance notes and evidence like photos, test results, etc, which will be used to create a final completion log and reference to close the work order.

# 8.0 Pools, Lanes, and Responsibilities - System Architecture

The TO-BE BPMN diagram of FutureEnergy’s predictive maintenance process is logically structured across three key **pools**, each representing a different dimension of the business process—digital systems, ERP execution, and human operations. Each **lane** within these pools defines a specialized role or module, ensuring clear segregation of responsibility and enabling scalable integration (Skouti et al., 2024). Below is the refined system architecture based strictly on the submitted BPMN model.

## 8.1 Pool 1: Data Collection System

This pool captures and articulates the collection, preparing and normalisation of data to be sent to the Digital Twin Engine for simulation. The data collection is done from all the different plants from various touch points such as sensors and previous historical data.

The Data Collection System Pool has the following lanes: -

1. **Unified Data Hub** – The lane where all the collection and orchestration of the data happens from various plants. After all the collection a unified digital repository is made which acts as the source for the Digital Twin Engine to run simulation.
2. **Wind and Solar Plant** – The Wind and Solar plants will gather data from IIoT sensors installed at each asset and provide all the data to the Unified Data Hub.
3. **Gas Plant** – The gas plant unlike the wind and solar plants does not have advanced IIoT sensors as it is not viable to spend on advancements of plants which are going out of commission soon. The collection of data at the plant is partially done via sensors and partially via historical data of assets maintained at the plant. We are not inclined to invest in IIoT sensors as this plant will be decommissioned in the near future.
4. **Coal Plant** – The coal plant unlike all the other plants don’t have any sensors so all the data collection relies on historical data. We again are not inclined to invest in IIoT sensors at this plant because it is supposed to be decommissioned.

## 8.2 Pool 2 : Digital Twin Engine

The Digital Twin Engine is a separate pool in the re-engineered process that will run real-time analysis of data being provided as the digital repository. The digital twin engine will create virtual scenarios of the current assets to run predictive analysis and generate insights (Abd Wahab et al., 2024). These insights will also be normalised for integration with SAP S/4HANA.

## 8.3 Pool 3: ERP SYSTEM (SAP S/4HANA)

This pool consolidates execution-level activities and orchestrates condition-based maintenance using core SAP modules. Each module has been shown as a lane to show the internal interactions of SAP modules. The following core SAP S/4HANA modules have been used:-

1. **Plant Maintenance (SAP PM) –** The SAP PM module receives the maintenance alerts from the Digital Twin Engine, create and draft a schedule for asset maintenance. This module will facilitate the creation and closure of the work order to document the whole maintenance lifecycle closure.
2. **Materials Management (SAP MM) –** Materials Management is the SAP module that manages the stock reservation and readiness of materials for any maintenance task. The SAP MM validates the spare parts via the Bill of Materials. The SAP MM will also facilitate the ordering of goods if certain spare parts are not currently available, finally SAP MM will update the final inventory when the maintenance has been done (Lin & Ghodrati).
3. **Fiori App ( SAP Fiori) –** SAP Fiori is the user interface which the workforce will interact. FutureEnergy has planned a rollout of phones and tablets for empowering their workforce to interact with the new integrated system (Beselga & Alturas, 2019). SAP Fiori has been inculcated with the motive of helping and being a tool that will be used across the organisation by almost all areas of operations.

## 8.4 Pool 4: FutureEnergy Maintenance Team

This pool depicts the maintenance team which includes the Maintenance Coordinator and the Field Technician. Both of them collectively interact with the ERP system to facilitate and record the maintenance task in hand.

1. **Maintenance Coordinator** – Manages and validates the maintenance tasks in hand. The coordinator reviews the work order to assign the tasks based on availability of technicians. Once the task is done, the coordinator also checks the completion and gives the final confirmation of completion. All this two and frow is done through SAP Fiori.
2. **Field Technician** – The field technician are the people who are responsible for the actual facilitation of the maintenance task. They check work order and task allocated to them by interacting with the Fiori interface. They conduct all the manual tasks and log the completion of maintenance by closing the task again in the Fiori interface.

## 8.5 Summary Table of Pools and Lanes

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Pool** | **Lane** | **Role** | **Key Responsibilities** | **Justification** |
| **Data Collection System** | Unified Data Hub | Data Orchestrator | Collect, cleanse, and structure incoming data from all plant types | Acts as the first system touchpoint and for generation of simulation-ready input |
| Wind & Solar Plant | Data Source for Wind and Solar Plants | Stream real-time IIoT telemetry to the Unified Data Hub (Geldenhuys et al., 2021) | Enables predictive maintenance from modern assets |
| Gas Plant | Data Source for Gas Plant | Provide partial sensor data and historical data to Unified Data Hub | Provides integrative data for older assets with some technological advancements |
| Coal Plant | Data Source for Coal Plant | Send historical logs to Unified Hub | Ensures legacy asset inclusion without sensor upgrades |
| **Digital Twin Engine** | NA | Predictive Simulation Engine | Simulate asset behaviour, estimate RUL, trigger alerts for future maintenance (van Dinter et al., 2022) | Drives proactive ERP execution based on digital diagnostics and predictive analytics |
| **ERP SYSTEM (SAP S/4HANA)** | SAP PM | Maintenance Workflow Manager | Create work orders from alerts, manages scheduling, logging completion and storage of completed logs. | Automates the full maintenance lifecycle based on predicted asset health |
| SAP MM | Inventory & BOM Specialist | Validates BOM, checks availability and procures if necessary | Ensures task readiness through real-time material coordination and manages inventory replenishment |
| SAP Fiori App | Mobile Interaction Interface | Send tasks to users, collect technician input and closure logs by providing user-friendly interface | Enables mobile-first field execution and real-time system syncing. Helps in easy and fast processing of tasks |
| **Maintenance Team** | Maintenance Coordinator | Scheduler & Validator | Review work orders, assign tasks, confirm completion via Fiori interface | Adds human judgement and oversight in task distribution |
| Field Technician | Maintenance Executor | Perform maintenance and close tasks using Fiori interface | Completes the physical operation and logs completion digitally |

# 9.0 Re-Engineered TO-BE Process for Asset Maintenance

The re-engineered process for asset maintenance using predictive analytics for FutureEnergy has been curated by utilising industry 4.0 technologies including IIoT, Digital Twin Engine and predictive analytics. These new age technologies have been integrated with an enterprise-wide ERP based on SAP S/4HANA to drive the strategic shift of FutureEnergy towards an integrated information system that brings all functioning and operations under one roof (Zheng et al., 2020)

The **Figure 1 - TO-BE Process** models a logical and granular view of the new process which inculcates all the pools and lanes as mentioned in Pools, Lanes, and Responsibilities. Unlike previous maintenance approach of reactive and time-based maintenance scheduling, the new TO-BE process uses insights from IIoT sensors that depict the real-time information, digital twin engine and predictive analysis to assess the asset metrics including RUL, break-point, etc, to manage early and timely intervention and textbook maintenance of the assets (Carvalho et al., 2022). Each activity is tightly coupled with SAP system modules, ensuring real-time coordination of alerts, materials, schedules, and technician workflows.

The following breakdown outlines the full operational workflow of the re-engineered process from initial data collection to maintenance execution and system update, aligning human roles with intelligent systems for optimal efficiency and reliability.

## 9.1 Process Workflow

1. The predictive maintenance process is triggered to run a predictive maintenance cycle.
2. Each plant begins sending data to the **Unified Data Hub**
   * **Wind and Solar plants** send real-time IIoT sensor data.
   * **Gas plant** send a mix of sensor data and historical logs.
   * **Coal plant** provides historical maintenance data.
   * Each of these tasks will generate a respective document that will create a **dataset** (Wind Plant Dataset, Solar Plant Dataset, Gas Plant Dataset & Coal Plant Dataset). All the historical data for the gas and coal plant will be extracted from their relevant **databases**. (Asset Database for Gas Plant and Asset Database for Coal Plant).
3. The Unified Data Hub receives all inputs(datasets) and compiles a single, normalized maintenance dataset by the name of **Digital Asset Repository**. This digital repository normalizes all the data from all plants by assigning a unique key to each asset. The **Digital Asset Repository** is then sent to the **Digital Twin Engine** for running simulations.
4. The **Digital Twin Engine** simulates current conditions and degradation trends for all the assets. The **Digital Twin Engine** forecasts **future insights** based on the data fed and calculates various metrics like Remaining Useful Life (RUL) (Yan et al., 2021), identifies high-risk components, and generates predictive maintenance alerts.
5. The maintenance alerts are normalized and formatted for SAP compatibility by generating a document - **Maintenance Insights**, which is then transmitted to the SAP PM (Plant Maintenance) module in SAP S/4HANA.
6. Upon receiving the **Maintenance Insights**, SAP PM generates a forecasted maintenance schedule based on the **Maintenance Insights.** A Work Order is then generated, which includes asset details, urgency level, and task type.
7. After generation of the Work Order in SAP PM, it is checked to assess if a BOM is required or not by assessing the components section of the Work Order?
   * If yes, the **BOM** is attached to the **Work Order** and sent to **SAP MM**.
   * If not, the status of the Work Order is updated to **Ready for Execution** and sent to **SAP Fiori**.
8. **SAP MM** retrieves the **Bill of Materials** (BOM) corresponding to the asset mentioned in the Work Order. A stock check is performed:
   * If parts are in stock, the inventory is reserved against the Work Order.
   * If parts are out of stock, **procurement** is initiated to replenish items which has been depicted as a **sub-process**.
   * When the referenced parts are in-stock either by originally being in stock or procurement these parts are then reserved against the Work Order. The **Work Order** status is updated to **Ready for Execution**.
9. Once parts have been validated, the updated Work Order is sent to SAP Fiori which then receives and uploads the Work Order. Fiori serves as the mobile interface for both the Maintenance Coordinator and Field Technicians.
10. The Maintenance Coordinator receives the notification on SAP Fiori when the uploading of Work Order is completed. The Maintenance Coordinator then reviews the Work Order details. Based on the skills required for the task and availability, the task is assigned to a Field Technician via SAP Fiori.
11. SAP Fiori receives all the inputs from the Maintenance Coordinator. It then creates, assigns and notifies the relevant Field Technician about the created task.
12. The Field Technician receives the assigned task on their remote device via SAP Fiori, along with instructions and a checklist derived from the Work Order.
13. The technician visits the warehouse and collects the reserved parts or apparatus.
14. Maintenance is performed on-site. Once completed, the Field Technician logs the task completion in SAP Fiori, including remarks or irregularities.
15. The Maintenance Coordinator is notified of completion, they review the final update. Once verified, the coordinator confirms closure of the task through SAP Fiori which generate a **Completion Log** and also store in in the **Completion Log Database**. SAP Fiori then marks the task status as completed.
16. SAP Fiori then sends the Completion Log to SAP PM for updating the Work Order status and SAP MM to update/confirm actual material consumption.
17. SAP PM updates the status of the Work Order to Completed/Closed and logs the updated maintenance history for the asset in the **Asset Maintenance Database**.
18. SAP MM cross-checks actual material usage against reserved inventory and adjusts stock levels accordingly.
19. The final updates are looped back to the Unified Data Hub, refreshing the **Digital Repository** with post-maintenance insights for future simulations and predictive maintenance cycle.
20. The process concludes with full traceability, up-to-date records, and improved readiness for the next maintenance cycle.

A table of all data objects and databases have been mentioned below for traceability of all documents and their storage throughout the process.

|  |  |  |  |
| --- | --- | --- | --- |
| Name | Type | Created/Used By | Purpose |
| Solar Dataset | Data Object | Wind & Solar Plant | Raw IIoT telemetry data from solar panels. |
| Wind Dataset | Data Object | Wind & Solar Plant | Raw IIoT telemetry data from wind turbines. |
| Gas Dataset | Data Object | Gas Plant | Sensor + historical asset data from gas assets. |
| Coal Dataset | Data Object | Coal Plant | Historical data from legacy coal assets. |
| Digital Repository | Data Object | Unified Data Hub | Normalized asset data sent to Digital Twin for simulation. |
| Maintenance Insights | Data Object | Digital Twin Engine | Predictive alerts and condition insights for SAP integration. |
| Forecasted Maintenance Schedule | Data Object | SAP PM | Schedule of tasks derived from predictive alerts. |
| Work Orders | Data Object | SAP PM / SAP Fiori | Full task specification sent to field team via SAP Fiori. |
| BOM (Bill of Materials) | Data Object | SAP MM | Part list linked to the work order for facilitation of maintenance. |
| Completion Log | Data Object | Field Technician / SAP Fiori | Post-maintenance evidence and remarks for closure. |
| Asset Database for Gas Plant | Data Store | Gas Plant | Stores historical data used for simulation input. |
| Asset Database for Coal Plant | Data Store | Coal Plant | Stores legacy data to simulate old equipment behaviour. |
| Asset Maintenance Database | Data Store | Global for FutureEnergy | Stores complete asset maintenance history for compliance and future use. |
| Completion Log Database | Data Store | SAP Fiori / SAP PM | Repository for all post-maintenance logs and evidence. |

# 10.0 Expected Business Benefits

The integration of SAP S/4 HANA with Industry 4.0 technologies is expected to strategic and operational benefits for FutureEnergy across multiple dimensions of business performance and market positioning. This analysis examines the anticipated business value creation through ERP implementation.

* **Re-Engineered and predictive Maintenance**: By shifting from reactive to predictive operations, the ERP shows how customer data, production records, financial information, and staff details will connect properly. With a predictive maintenance process each plant will send real time data to the Unified Data Hub, with IIoT sensors as providing based on the historical logs (Abd Wahab et al., 2024) creating dataset for most significant operational improvement, with anticipated reductions in unexpected equipment failures. The Digital Twin simulation will help identify problems and forecast inefficiencies before they develop, providing accuracy for real-time visibility shifting from costly reactive repairs to proactive condition-based interventions.
* **Maintenance Cost Optimization Through Predictive Analytics:** Combining the SAP S/ 4HANA systems will enable better combination across departments and all plant types, generating immediate cost savings by shifting from reactive repairs to condition-based interventions. According to McKinsey & Company's analysis of industrial IIoT applications, predictive maintenance strategies can reduce maintenance costs by 10-40% while improving equipment uptime by 10-20% (Mckinsey&Company, 2015). The implementation of predictive maintenance will provide with significant cost reduction opportunities. This proactive approach to asset management represents a fundamental shift from traditional time-based maintenance schedules toward data-driven maintenance optimization strategies.
* **Inventory Management and Working Capital Optimization:** The new system will handle FutureEnergy’s expansion goals much better than the current patchwork of systems. SAP MM module will demonstrate optimizing inventory capability management process. Research by (Shang & Seddon, 2002) identified inventory reduction as one of the primary operational benefits of ERP implementation, for interstate energy exports, partners will expect coordinated and real-time operational data and reliability metrics that only a unified system can provide consistently and real-time tracking of spare parts usage and automatically optimize inventory across plants.
* **Competitive differentiation**: With better operational efficiency FutureEnergy will enhance a comprehensive approach providing advantage against AGL and SimplyEnergy which are also investing in digital tools. The integrated customer management capabilities will support lower costs, competitive pricing and better service delivery, helping retain customers enhancing revenue optimization opportunities. SAP Fiori will enhance field technician productivity and enable real-time data capture (Treibitz et al., 2015).
* **Workforce Development and Operational Agility:** The implementation will strengthen workforce capabilities with modern digital tools and intuitive mobile interfaces. Enhanced data visibility will improve decision-making at all organization levels, from field operations to executive strategy. Enabling flexible work arrangements to access critical operational data, supporting future expansion objectives. Mobile ERP systems significantly speed up task completion while improving real-time data accuracy (Malladi & Krishnan, 2012). Mobile technology integration will enable field technicians to access critical system information, update work orders, and collaborate with remote experts in real-time.
* **Regulatory compliance**: With the 2027 renewable South Australian Government mandate approaching (Australia, 2024), FutureEnergy must strengthen its documentation and reporting processes. SAP system will streamline compliance by automatically maintaining detailed maintenance records, significantly reducing the need for manual data compilation. This is particularly important as environmental regulations become stricter, the system’s ability to optimize renewable asset performance will maximize clean energy generation efficiency. FutureEnergy’s remains committed to environmental sustainability while ensuring reliability throughout the energy transition. The ability to generate comprehensive operational reports and maintain complete audit trails represents significant value in regulated environments.

# 11.0 Limitations and Assumptions

The success of FutureEnergy’s implementation depends on several critical assumptions, each of which may face challenges during execution. Integrating legacy systems with modern digital infrastructure for coal and gas plants with modern IIoT assumes a level of compatibility that may not exist in practice, potentially limiting the Digital Twin engine’s initial accuracy. Furthermore, the assumption that existing IT infrastructure can support the increasing data processing and storage. In the implementation, this may require unplanned investment and network capacity and resources.

**Data Quality Integration**: SAP implementation assumes several things that might go wrong. An assumption is that historical data from coal plants can work as real-time sensors data for predictive maintenance. The gap in data quality probably cause a conflict due to incomplete or inconsistent records. The Digital Twin accuracy may be compromised for aging assets and may result in poor maintenance decisions during a critical transition period.

**Technology dependencies:** The success of predictive maintenance relies on stable network connectivity across all sites from remote wind farms to coal plants in industrial areas. The assumption of existing infrastructure can handle increased data loads might be inaccurate. Internet connectivity issues or system downtime could disrupt the entire predictive maintenance workflow, leading to operational vulnerabilities.

**Financial and Regulatory Assumptions:** The system assumes continued regulatory support for renewable energy transition and stable government policies through 2027. Changes in government could impact the strategic relevance of the system and ROI projections. The project assumes sufficient capital allocation for the full implementation while maintaining high operational performance during the transition and scalability.

**Workforce Readiness and Skills Gap Challenges:** FutureEnergy faces a significant organizational challenge due to its limited SAP experience—only four IT staff members possess direct knowledge of the system. This knowledge gap poses a substantial risk to successful implementation. The expectation that 1,500 employees can seamlessly adopt new digital processes while sustaining operational performance may underestimate the scope of cultural and training hurdles. In particular, resistance to change among seasoned technicians accustomed to manual workflows could hinder adoption and diminish early system effectiveness—especially during the pivotal transition to renewable energy.

# 12.0 Recommendations for Implementing the New Predictive Maintenance Process

**Adopt a Phased Rollout Approach:** We recommend piloting SAP S/4HANA at both the windfarm and the solar farm to compare outcomes and identify best practices in different renewable environments. Lessons learned from these pilots should guide the subsequent rollout to coal and gas plants. This phased approach minimizes disruption, manages risk, and enables smoother change management across all facilities (Madathala et al.).

**Leverage Digital Twin and Predictive Analytics:** Implementing a Digital Twin platform will allow FutureEnergy to model asset behavior, forecast failures, and optimize maintenance interventions (Firas Basim et al., 2024) By combining live and historical data, predictive analytics can automate the creation of work orders and optimize maintenance schedules. This approach supports proactive, data-driven decision-making and enables management to prioritize resources based on risk and operational impact.

**Prioritize Renewables—Wind and Solar:** Given FutureEnergy’s commitment to going entirely renewable energy based power generation by 2027, we strongly recommend prioritizing the implementation and optimization of predictive maintenance at the windfarm and solar farm. By focusing on these assets, FutureEnergy can ensure operational excellence in the renewable segment, build on early success to inform the transition away from fossil fuels, and demonstrate leadership in sustainability to stakeholders and regulators. Early wins in the renewable space will also provide valuable insights to refine the broader company-wide transformation.

**Invest in Workforce Training and Change Management:** A successful transformation depends on people as much as technology. We advise the board to invest in comprehensive staff training, emphasizing new digital workflows, proper use of SAP interfaces, and the importance of accurate, timely data entry. Change management initiatives—such as regular communication, active involvement of key stakeholders, and demonstration of quick wins during the pilot—will be essential to reduce resistance (Sanusi et al., 2025). Establishing a robust support network, including helpdesks and designated SAP champions within teams, will further smooth the transition and encourage user adoption.

**Strengthen Data Governance and Security:** To protect the value of new systems and ensure regulatory compliance, we recommend defining clear data governance policies and roles (Pahune et al., 2025). These should address data quality, integrity, security, and privacy, with ongoing monitoring to support reliable analytics and reporting. Assigning dedicated data stewards will help maintain high standards and support continuous improvement.

# 13.0 Conclusion

FutureEnergy proposed implementation with Industry 4.0 dynamic integration represents a key strategic improvement to transform operational capabilities and strength competitive advantage in South Australia’s evolving energy sector. This end-to-end digital transformation directly addresses operational inefficiencies while positioning the organization for sustainable and strategic growth.

The integration of predictive maintenance capabilities through SAP S/4HANA, IIoT sensors, and Digital Twin technology will establish and modernize field operations while supporting the company’s planned expansion through infrastructure and investment. Bringing benefits as lower maintenance cost, reliable assets and improved compliance, addressing core operational inefficiencies while building digital infrastructure required for long-term growth and renewable energy competitiveness, allowing maintenance teams to implement preventive measures that preserve business continuity while maintaining the reliability standards essential for competitive market positioning.

This transformation aligns with key external pressures, including the South Australian Government’s 2027 renewable energy mandate and growing competition from digitally advanced market players, by creating an integration of disparate legacy interconnected systems across coal, gas, wind, and solar plants that will deliver enhanced operational visibility, strategic scalability and smooth transition that can provide FutureEnergy the visibility and agility needed to lead and innovate.

The modernised predictive maintenance process highlights how digital systems can coordinate and digitalise complex operations across ageing assets and next-generation renewable infrastructure. The use of this approach will support better decision-making at all levels of the business with strong governance, infrastructure and flexible field operations while improving operational practices that require comprehensive training and robust project management frameworks.

Success in this implementation will establish FutureEnergy as digital leader in the Australian energy sector. The investment in predictive maintenance capabilities and integrated operations management systems will create sustainable competitive advantages that support the company’s vision of becoming a premier renewable energy provider. With the right execution, FutureEnergy will be positions to lead South Australia’s energy transition, delivering reliable and modern service while building innovation, resilience and operational excellence.

# References

Abd Elmonem, M. A., Nasr, E. S., & Geith, M. H. (2016). Benefits and challenges of cloud ERP systems – A systematic literature review. *Future Computing and Informatics Journal*, *1*(1-2), 1-9. <https://doi.org/10.1016/j.fcij.2017.03.003>

Abd Wahab, N. H., Hasikin, K., Wee Lai, K., Xia, K., Bei, L., Huang, K., & Wu, X. (2024). Systematic review of predictive maintenance and digital twin technologies challenges, opportunities, and best practices. *PeerJ. Computer science*, *10*, e1943-e1943. <https://doi.org/10.7717/peerj-cs.1943>

Aivaliotis, P., Georgoulias, K., & Chryssolouris, G. (2019). The use of Digital Twin for predictive maintenance in manufacturing. *International journal of computer integrated manufacturing*, *32*(11), 1067-1080. <https://doi.org/10.1080/0951192X.2019.1686173>

Alhadi, A., Dr Tom, B., & Yacine, R. (2025). Enhancing asset management: Integrating digital twins for continuous permitting and compliance - A systematic literature review. *Journal of Building Engineering*, *99*, 111515. <https://doi.org/10.1016/j.jobe.2024.111515>

Australia, G. o. S. (2024).

Beselga, D., & Alturas, B. (2019). *Using the Technology Acceptance Model (TAM) in SAP Fiori*. <https://doi.org/10.1007/978-3-030-16181-1_54>

Carvalho, L. P., Cappelli, C., & Santoro, F. M. (2022). BPMN pra GERAL: a framework to translate BPMN to a citizen language. *Business process management journal*, *28*(2), 508-531. <https://doi.org/10.1108/BPMJ-04-2020-0150>

Chaves, J., Loures, E. F. R., Santos, E. A. P., G. Trentin, M., Gouvêa da Costa, S. E., Deschamps, F., & Pinheiro de Lima, E. (2023). Prioritization of Spare Parts Purchase Orders Based on Asset Criticality in Manufacturing. In (pp. 400-407). Springer. <https://doi.org/10.1007/9783031361210_50>

Crespo Márquez, A. (2022). *Digital Maintenance Management : Guiding Digital Transformation in Maintenance* (1st 2022. ed.). Springer International Publishing. <https://doi.org/10.1007/978-3-030-97660-6>

Dilshad Ansari, M., Singh, N., Birla, S., & Shukla, N. K. (2024). An Overview of Predictive Maintenance and Load Forecasting. In. John Wiley & Sons, Incorporated. <https://doi.org/10.1002/9781394227990.ch11>

Firas Basim, I., Hussein, A.-F., Hasril, H., Ammar, A.-B., & Hussein, A. K. (2024). A comprehensive review of the dynamic applications of the digital twin technology across diverse energy sectors A comprehensive review of the dynamic applications of the digital twin technology across diverse energy sectors. *Energy strategy reviews*, *52*, 101334.

Gavrikova, E., Volkova, I., & Burda, Y. (2022). Implementing asset data management in power companies. *The International journal of quality & reliability management*, *39*(2), 588-611. <https://doi.org/10.1108/IJQRM-10-2020-0346>

Geldenhuys, M. K., Will, J., Pfister, B. J. J., Haug, M., Scharmann, A., & Thamsen, L. (2021). Dependable IoT Data Stream Processing for Monitoring and Control of Urban Infrastructures. In. Ithaca: Cornell University Library, arXiv.org.

Hu, M., He, Y., Lin, X., Lu, Z., Jiang, Z., & Ma, B. (2023). Digital twin model of gas turbine and its application in warning of performance fault. *Chinese journal of aeronautics*, *36*(3), 449-470. <https://doi.org/10.1016/j.cja.2022.07.021>

Hutter, K., Brendgens, F.-M., Gauster, S. P., & Matzler, K. (2023). Scaling organizational agility: key insights from an incumbent firm's agile transformation. *Management decision*. <https://doi.org/10.1108/MD-05-2022-0650>

Li, X., Lepour, D., Heymann, F., & Maréchal, F. (2023). Electrification and digitalization effects on sectoral energy demand and consumption: A prospective study towards 2050. *Energy (Oxford)*, *279*, 127992. <https://doi.org/10.1016/j.energy.2023.127992>

Lin, J., & Ghodrati, B. (2011). Maintenance spares inventory management: performance measurement using a HOMM.

Madathala, H., Yeturi, G., Mane, V., & Muneshwar, P. D. (2025). Navigating SAP ERP Implementation: Identifying Success Drivers and Pitfalls.

Magnus Okechukwu Kanu , E. O., Peter Ifechukwude Egbumokei , Wags Numoipiri Digitemie4, Ikiomoworio Nicholas Dienagha5. (2025). Enhancing Asset Management in Gas Distribution Predictive Maintenance and Data-Driven Decision Making.

Mahmood, S., Dheyaa Jasim, K., Mohamed, S., Firas Mohammed, T., Ammar Sabri, M., & Ali Jawad, A. (2024). Investigating and predicting the role of photovoltaic, wind, and hydrogen energies in sustainable global energy evolution Investigating and predicting the role of photovoltaic, wind, and hydrogen energies in sustainable global energy evolution. *Global Energy Interconnection*, *7*(4), 429-445.

Malladi, S., & Krishnan, M. S. (2012). Does Software-as-a-Service (SaaS) has a role in IT-enabled innovation? - An empirical analysis. *18th Americas Conference on Information Systems 2012, AMCIS 2012*, *1*, 474-483.

Mckinsey&Company. (2015).

Mohd, J., Abid, H., & Rajiv, S. (2023). Digital Twin applications toward Industry 4.0: A Review Digital Twin applications toward Industry 4.0: A Review. *Cognitive robotics*, *3*, 71-92.

Pahune, S., Akhtar, Z., Mandapati, V., & Siddique, K. (2025). The Importance of AI Data Governance in Large Language Models. *Big Data and Cognitive Computing*, *9*, 147. <https://doi.org/10.3390/bdcc9060147>

Rana;, M. N. S. (2025). IOT-ENABLED CONDITION MONITORING IN POWER DISTRIBUTION SYSTEMS: A REVIEW OF SCADA-BASED AUTOMATION, REAL-TIME DATA ANALYTICS, AND CYBER-PHYSICAL SECURITY CHALLENGES.

Rojas, L., Peña, Á., & Garcia, J. (2025). AI-Driven Predictive Maintenance in Mining: A Systematic Literature Review on Fault Detection, Digital Twins, and Intelligent Asset Management. *Applied sciences*, *15*(6), 3337. <https://doi.org/10.3390/app15063337>

Sanusi, A., Husseni, A., & Samuel, A. (2025). Exploring the Opportunities and Challenges of Data Analysis with SAP: A Review of ERP Software Effectiveness.

Shaik, M. (2023). SAP - ERP Software’s Pivotal Role in Shaping Industry 4.0: Transforming the Future of Enterprise Operations. *Computer Science and Engineering*, *13*, 1-7. <https://doi.org/10.5923/j.computer.20231301.02>

Shang, S., & Seddon, P. B. (2002). Assessing and managing the benefits of enterprise systems: the business manager's perspective. *Information systems journal (Oxford, England)*, *12*(4), 271-299. <https://doi.org/10.1046/j.1365-2575.2002.00132.x>

Skouti, T., Seiger, R., Furrer, F. J., & Strahringer, S. (2024). RBPMN: the value of roles for business process modeling. *Software and systems modeling*, *23*(6), 1375-1406. <https://doi.org/10.1007/s10270-024-01202-z>

Toulan, M., Nafeh, A., & Arafa, S. (2024). Improvement of Induction Motors Reliability in Fertilizers Plants Using IOT and Enterprise Resource Planning.

Treibitz, T., Neal, B. P., Kline, D. I., Beijbom, O., Roberts, P. L. D., Mitchell, B. G., & Kriegman, D. (2015). Wide Field-of-View Fluorescence Imaging of Coral Reefs. *Scientific reports*, *5*(1), 7694-7694. <https://doi.org/10.1038/srep07694>

van Dinter, R., Tekinerdogan, B., & Catal, C. (2022). Predictive maintenance using digital twins: A systematic literature review. *Information and software technology*, *151*, 107008. <https://doi.org/10.1016/j.infsof.2022.107008>

Wu, D., Zheng, A., Yu, W., Cao, H., Ling, Q., Liu, J., & Zhou, D. (2025). Digital Twin Technology in Transportation Infrastructure: A Comprehensive Survey of Current Applications, Challenges, and Future Directions. *Applied sciences*, *15*(4), 1911. <https://doi.org/10.3390/app15041911>

Yan, T., Lei, Y., Li, N., Wang, B., & Wang, W. (2021). Degradation modeling and remaining useful life prediction for dependent competing failure processes. *Reliability engineering & system safety*, *212*, 107638. <https://doi.org/10.1016/j.ress.2021.107638>

Zhan, H., Hwang, B. G., & Krishnankutty, P. (2025). Embracing digital transformation for sustainable development: Barriers to adopting digital twin in asset management within Singapore's energy and chemicals industry. *Sustainable development (Bradford, West Yorkshire, England)*, *33*(2), 2864-2887. <https://doi.org/10.1002/sd.3270>

Zheng, H., Paiva, A. R., & Gurciullo, C. S. (2020). Advancing from Predictive Maintenance to Intelligent Maintenance with AI and IIoT. <https://doi.org/10.48550/arxiv.2009.00351>

# Appendix A – TO-BE Process Diagram

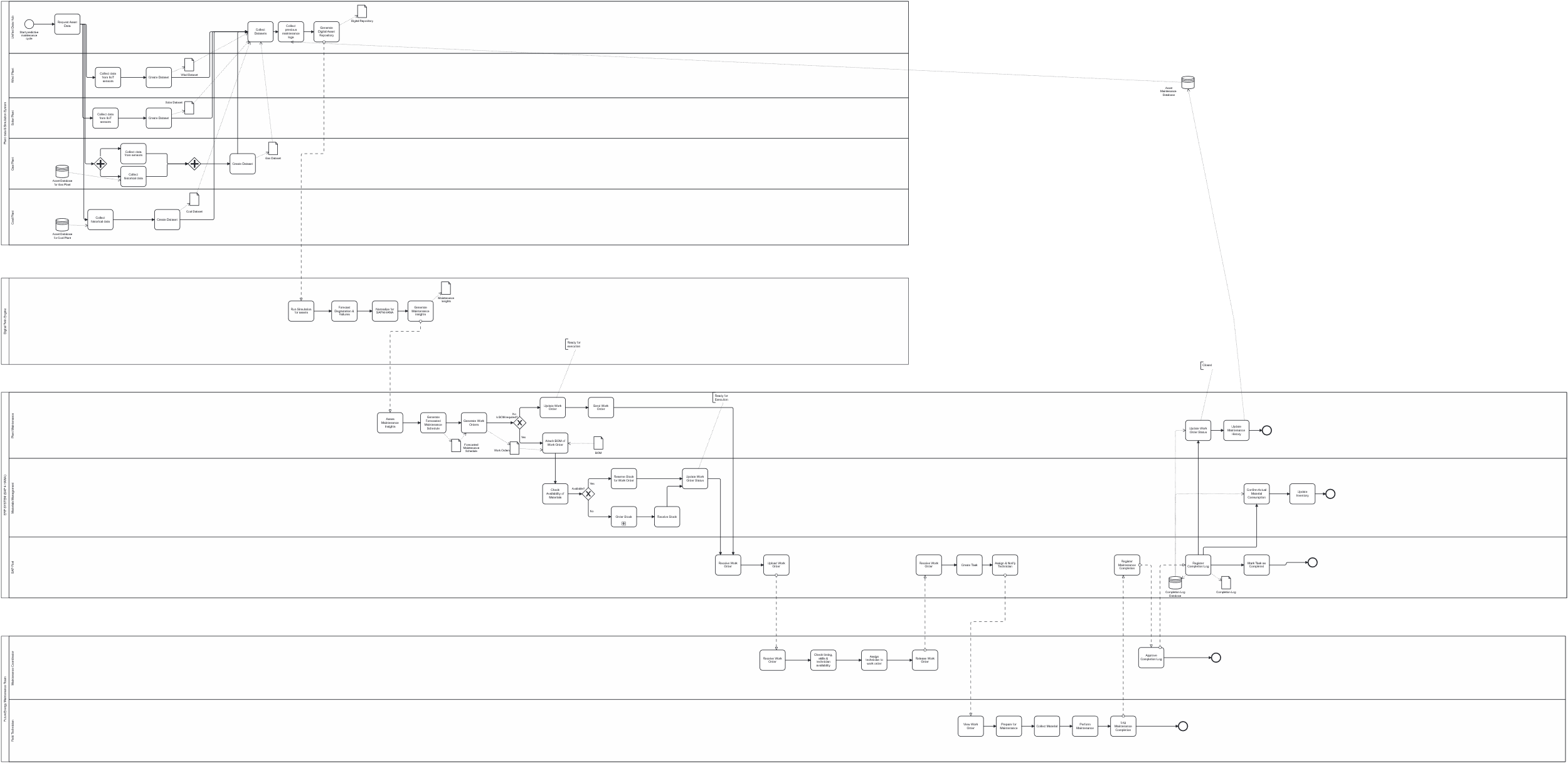
Link to the diagram - [Group 8 TO-BE Diagram.bpmn](https://mymailunisaedu-my.sharepoint.com/:u:/g/personal/sabay023_mymail_unisa_edu_au/EcG6vOI8gBRNkawtfgRH-fQBMosY1vbx_qp8r0Q3UeLhQg?e=8p5Mv6)

Figure - TO-BE Process