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1 Case description

1.1 Premise

The valuable research conducted by Karle and Teichenthaler in their article "Collaborative BPM for Business Transformations in Telecommunications: The Case of '3'" (Jan vom Brocke, 2018) provides a foundational understanding of Three's Business Process Management Network (BPMN) environment. Their work, featured in the book "Business Process Management Cases: Digital Innovation and Business Transformation in Practice" edited by Jan vom Brocke and Jan Mendling, offered a crucial snapshot of Three's processes at that specific point in time.

However, the telecommunications industry is a dynamic landscape, constantly evolving alongside the rapid advancements in technology. Since the publication of Karle and Teichenthaler's research (Jan vom Brocke, 2018), significant changes may have occurred within Three's BPN environment. Additionally, the rise of powerful technologies like artificial intelligence (AI) presents exciting possibilities for optimizing existing processes.

Therefore, our project takes the initiative to bridge this gap. We aim to build upon the valuable baseline laid by previous research while recognizing the constantly changing technological landscape. Our focus is on a specific area within Three's complex BPM environment – the logistics macro process. By leveraging the power of AI, we believe we can significantly enhance its efficiency and effectiveness (Rehse, 2020).

1.2 Understanding Three

Three, a globally recognized brand, is owned by Hutchison 3G Enterprises S.A.R.L and operates in the telecommunications sector across diverse regions, including Ireland, the United Kingdom, Austria, Sweden, Denmark, Hong Kong, Macau, and Indonesia. With a customer base exceeding 110 million, Three focuses primarily on delivering cutting-edge enterprise solutions, IoT services, and private network infrastructure.

1.3 Challenges Faced by Three

Three has grown through strategic mergers and acquisitions, requiring the creation of strong operational frameworks that can handle the changing business environment. To address this, Three has implemented a comprehensive structure of processes to enhance organizational adaptability and resilience. This strategic approach ensures that Three remains agile and responsive amidst rapid industry changes, solidifying its position as a telecommunications leader.

1.4 Understanding the Current Environment

Mergers and acquisitions often entail significant changes in company processes, with the complexity varying based on the organization's size. To tackle these challenges, a well-established set of processes can streamline the merger process by facilitating the revision and readaptation of existing procedures. Research by Peter A. François, Marlon Kampmann, Ralf Plattfaut, and André Coners highlights the benefits of adhering to a systematic BPM lifecycle, particularly through the reuse of processes. Such benefits include faster implementation, higher software quality, and reduced maintenance efforts.

2 Organizational Chart

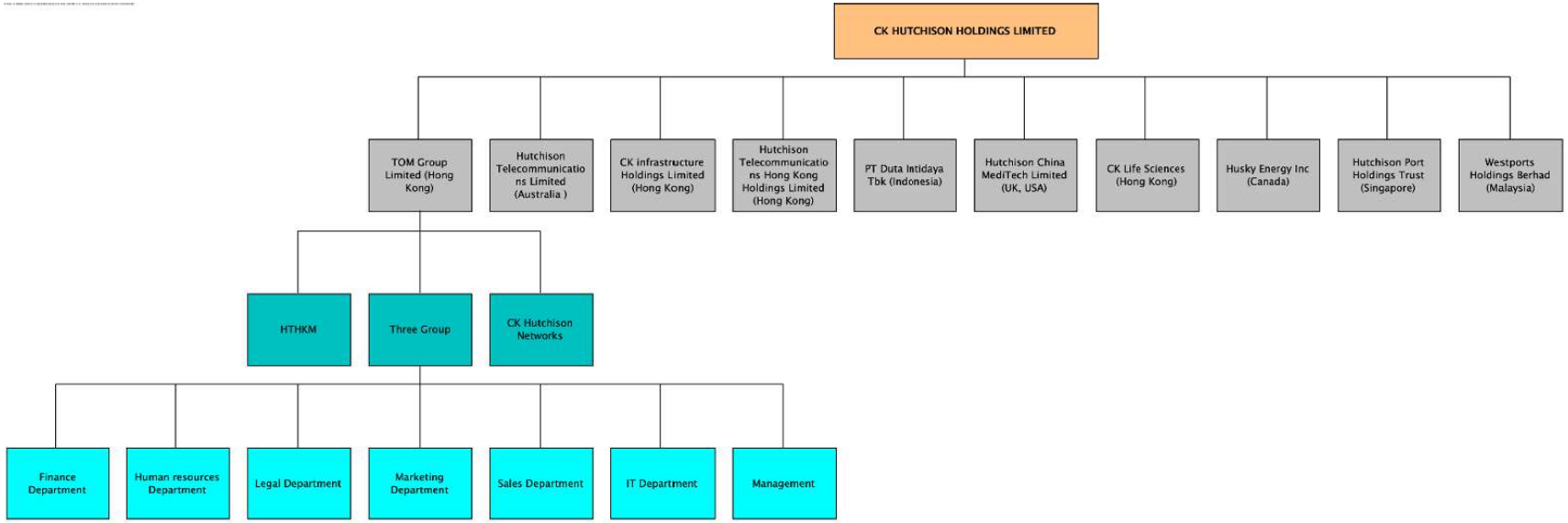

Figure: 1 Three Organizational Chart

2.1 Three's BPM Environment

Three has adopted a centralized ERP system, the Global Single Interface (GSI), to allow branches to operate and adapt to process changes simultaneously and in accordance with the latest standards. The GSI, based on the Oracle E-Business Suite, includes nine modules: Order Management, Inventory Management, Manufacturing, Purchasing, Receivables, Payables, Assets, Cash Management, and General Ledger.

2.2 Potential Areas of Improvement

Three's operations are complex, especially with the difficulties caused by mergers and acquisitions. Therefore, it is vital to keep improving its process environment. To address these challenges effectively, focusing on enhancing logistics processes through the adoption of Logistics and Inventory Management (LIM) systems is a logical next step. This targeted improvement initiative will concentrate on core processes within the logistics macro process, such as Manage Stock, Receive Orders, and Return Processing. These processes have been identified through research on Three's organizational structure and analysis of the Case Function matrix derived from the GSI.

Implementing an LIM system holds the potential to streamline logistics operations, optimize inventory management practices, and improve overall operational efficiency and responsiveness. By incorporating features like real-time tracking, enhanced forecasting capabilities, and automated inventory controls, Three can address risks associated with stockouts, overstocking, and logistical inefficiencies. Additionally, integrating virtual inventory components could enhance flexibility and agility in managing inventory across diverse operational regions.

2.3 Case Function Matrix

		Case Type					
		Private Customers			Business Customers		
		Mobile	Broadband	Sim Only	Connectivity Plans	Security & Controls	Service & Support
Logistics Department	Warehouse Team						
	Transportation Team						
	Distribution Team						
	Order Fullfilment Team						
	Procurement Team						
	Inventory Management						
Sales Department	Sales operation Tean						
	Administration Team						
	Customer relationship Team						
	Sales Support Team						
Finance Department	Payment Collecting Team						
	Payment Processing Team						
	Financial Analysis Team						
	Payroll Processing Team						
IT department	Product Support Team						
	Product implementation Team						
Management	Statisticical Analysis						
	Operations planner						
	Descisions Makers						
	Operational Coordination						

Figure: 2 Case Function Matrix (Forum, 2022)

Processes & Activities:	Processes & Activities:	Processes & Activities:	Processes & Activities:	Processes & Activities:
Logistics Department	IT department:	Sales Department:	Management:	Finance Department:
Manage Stock	Implement new system	Feedback from customers	Analyse statistics	Billing & Payment setup
Process Orders	CRM Maintenance	Initiate contact to customer	Supplier research	Bursting Email
Receive Orders	Status information about network	Marketing with feedback	Efficient routing	Refund processing
Fulfill Orders	SCM Software implementation	Delivery notifications	Quality Control	Invoice processing oracle apps
Stock Verification		External sales processing		Online Payment approval
Stock Acquisition				
Return Processing				

Figure: 3 Processes & Activities

3 Process Analysis

Optimizing Three's logistics processes requires a thorough examination of their current state. While our initial understanding may be limited, a comprehensive analysis is crucial to identify potential areas for improvement.

To achieve this, we'll utilize 'why-why' diagrams. This methodical approach allows us to systematically dissect and analyze processes. By repeatedly asking 'why' for each identified bottleneck or inefficiency, we can uncover their root causes. This analysis will focus on three of the major processes that could potentially hinder the efficiency within the logistic process.

3.1 Manage Stock why and why diagram

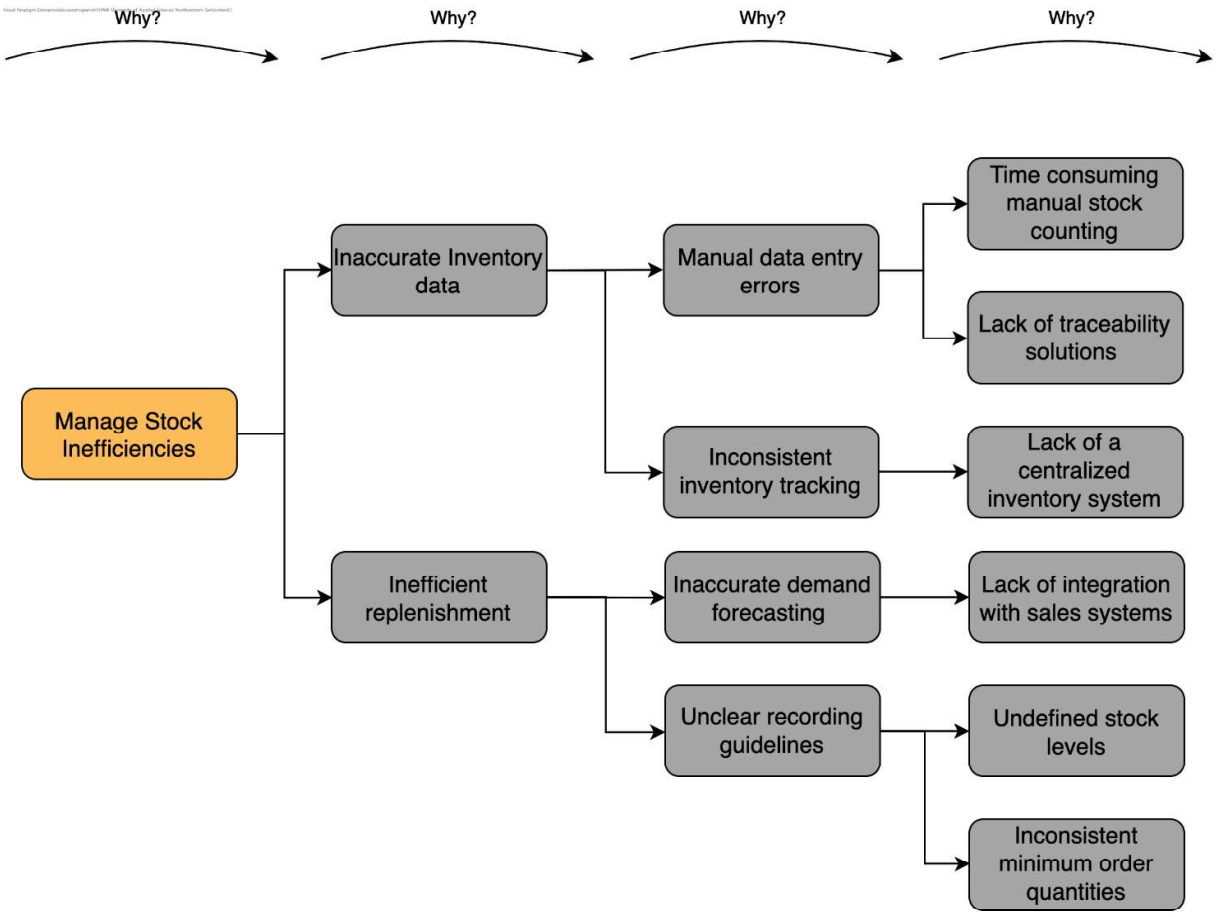

Figure: 4 Manage Stock why and why diagram

Inefficiencies in the Manage Stock process can have a significant negative impact on a business. Inaccurate inventory data and inefficient replenishment can lead to stockouts, which result in lost sales opportunities. Furthermore, excess inventory due to poor forecasting ties up capital and requires storage space, while rush orders for out-of-stock items incur additional costs. These inefficiencies also lower overall efficiency by spending time looking for lost inventory, correcting mistakes in data entry, and processing orders due to slow picking processes. Ultimately, all these problems can upset customers who face shortages and delays.

3.2 Receive Orders why and why diagram

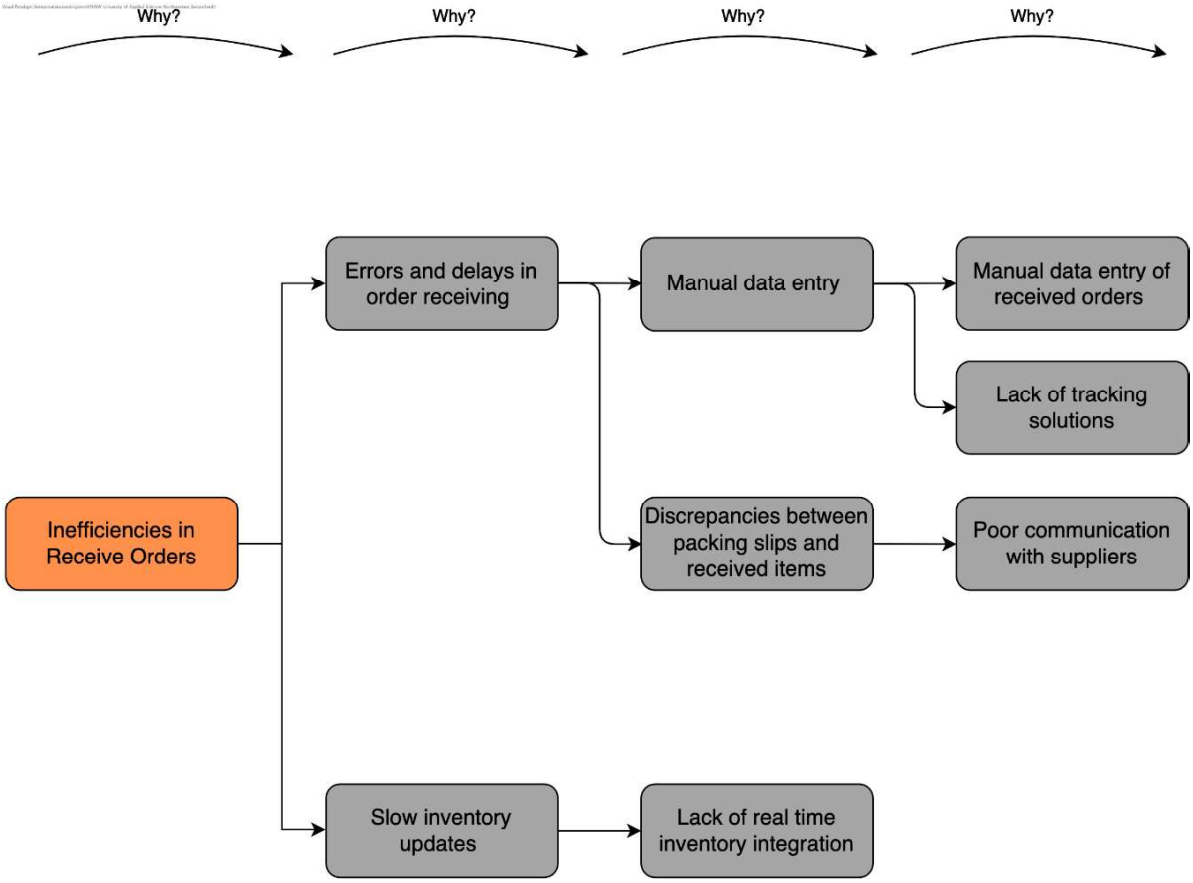

Figure: 5 Receive Orders why and why diagram

Manual data entry, lack of mobile capture devices, and poor communication with suppliers lead to errors and delays in receiving orders. These inefficiencies cause slow inventory updates, inaccurate stock levels, and ultimately hinder order fulfillment, impacting customer satisfaction and increasing costs.

3.3 Return Processing why and why diagram

Return processing is the systematic handling and management of products that are returned by customers for various reasons, including defects, damages, or customer dissatisfaction.

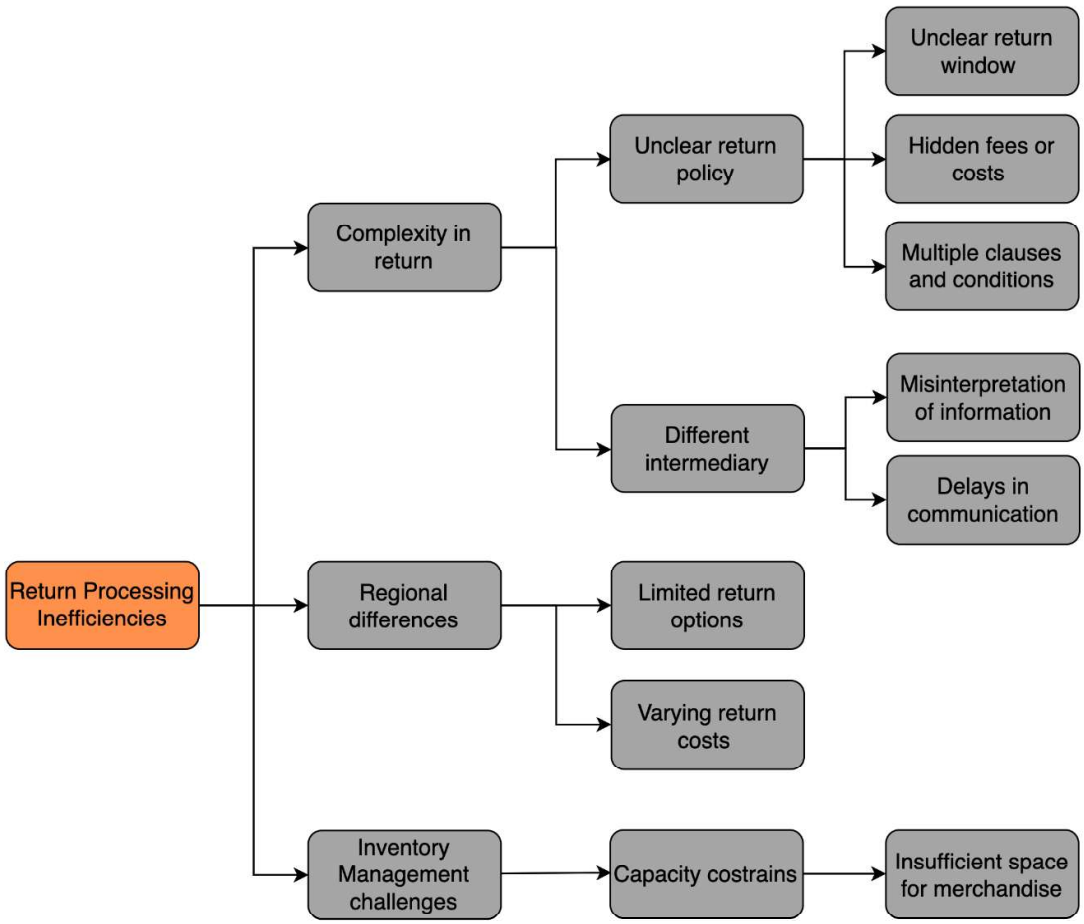

Figure: 6 Return Processing why and why diagram

4 Process Evaluation

Figure: 7 Pick Chart

ROI Score	Score assigned based on the potential return after the resolution of the issues within a process.
Effort Score	Score assigned based on the effort required to solve the issues within a process.

Table: 1 ROI and Effort Score

After analyzing the main issues with "Manage Stock," "Receive Orders," and "Return Processing" and their impact on the respective processes, an ROI/effort analysis was conducted. Each issue leads to different impacts, and if not addressed, there might be severe repercussions.

The "Manage Stock" process has a total ROI score of 30, which is significantly higher than the

"Receive Orders" 16 and relatively close to "Return Processing" 40.

The effort score for "Manage Stock" is 24, which is lower than the effort score for "Return Processing" 36 and at the same time higher than the "Return Processing" which has an effort score of 16.

Even though the potential ROI of “Return Processing” is high, it also requires a major number of resources and effort in order to address it in the appropriate way. “Manage Stock”, on the other hand, shows a slightly lower ROI; however, the effort required for implementation is significantly reduced.

The critical impacts associated with stock management issues further underscore its importance:

Impact	**Impact Score**
Increased risk of stockouts and overstocking	5
Errors in inventory records	4
Higher operational costs due to labor-intensive tasks	4
Compromised inventory accuracy	5
Increased likelihood of errors	5
Hindered ability to track inventory movement effectively	3
Suboptimal inventory levels	4
Affecting operational efficiency	4

Table: 2 Impact and Impact Score

In conclusion, focusing on the "Manage Stock Inefficiencies" process is the most strategic choice due to its high potential return on investment and moderate effort required for implementation. Addressing the critical issues within this process will significantly enhance inventory accuracy, reduce operational expenses, and improve overall efficiency. This prioritization aligns with the goal of maximizing benefits while maintaining a manageable level of resource allocation.

5 Process Models

This section further explores the "Manage Stock" process by focusing on some of its most important components. We identify areas for improvement and opportunities to leverage AI for increased efficiency. Each paragraph provides a comprehensive overview and demonstrates how traditional processes have been improved.

5.1 Stock Replenishment

Stock replenishment is a critical step for sustaining smooth operations and ensuring that customer demand is satisfied without interruption. By keeping inventory levels in line with actual demand, businesses may reduce the danger of stockouts, which can result in lost sales and dissatisfied consumers. It also helps to avoid overstocking, which ties up cash in surplus inventory and raises storage costs. Effective stock replenishment decreases inaccuracies in inventory records, resulting in more accurate and up-to-date information. This improves decision-making and operational efficiency. Furthermore, automating replenishment procedures reduces labor-intensive jobs, lowering operational costs and increasing overall efficiency.

To enhance the efficiency of the stock replenishment process, we developed a model representing the current stock replenishment workflow. We then identified components that could be improved by implementing an AI model. The area with the greatest potential for improvement involves partially substituting the "Inventory Management" intervention with an AI model that analyzes demand forecast data and decides on the necessity of replenishment for a given period. This improvement not only reduces the required amount of human resources but also decreases the likelihood of evaluation errors and avoids unnecessary controls, thereby saving time for the "Inventory Team."

5.2 Demand Forecast

Demand forecasting is vital for optimizing inventory levels and ensuring that resources are allocated efficiently to meet future consumer demands. Accurate demand projections help maintain a balance between supply and demand, reducing the risk of stockouts and overstocking. Demand forecasting also plays a crucial role in financial planning, enabling organizations to manage budgets, allocate resources effectively, and set realistic sales targets.

The demand forecasting process for Three involves several key activities. It begins with collecting and cleansing historical data on service usage, followed by analyzing this data to identify patterns and segment it based on various criteria. Next, appropriate forecasting models are selected and applied to develop demand forecasts. These forecasts are then validated against actual usage data and adjusted as necessary. The finalized forecasts are communicated to relevant stakeholders and implemented into operational plans. The process concludes with continuous monitoring of performance against forecasts and regular reviews to improve the forecasting process.

Implementing AI can streamline the BPM process into four main activities. First, AI can automate the collection of historical data by efficiently defining data requirements, identifying sources, collecting data using various methods, and organizing it for storage. Second, AI-powered algorithms can automate data cleansing and validation tasks, including removing duplicates, handling missing data, correcting errors, and standardizing formats, ensuring accuracy and completeness. Third, AI can swiftly identify patterns and trends in the data through advanced analytics techniques such as descriptive statistics, time series analysis, correlation analysis, visualization, and hypothesis testing. Finally, AI can segment the data effectively by defining segmentation criteria, conducting cluster analysis to identify natural groupings, profiling segments, validating their consistency, and documenting the segmentation process for future reference. This streamlined approach to BPM with AI reduces manual effort, accelerates data processing, and enhances the reliability of insights derived from the data.

5.3 Supplier Management

Supplier management ensures the quality and reliability of the supply chain. Effective supplier management involves strategic planning and execution of sourcing, procurement, and collaboration activities, which are crucial for maintaining product quality and integrity. By developing strong relationships with suppliers, businesses can negotiate favorable terms, manage procurement costs, and mitigate risks such as supply chain disruptions and price volatility.

The supplier management process involves several key activities to effectively identify, onboard, monitor, and improve relationships with suppliers. Initially, potential suppliers are identified based on predefined criteria and evaluated for suitability through analysis of historical performance and financial health. Selected suppliers are then onboarded through the drafting and review of contracts. Subsequently, supplier performance is monitored, compliance with contracts is reviewed, and any issues are promptly addressed. Relationship management is prioritized through regular reviews, communication of expectations, and continuous improvement initiatives to enhance col-

laboration and efficiency. Additionally, risk management strategies are implemented by identifying potential risks and developing contingency plans. Finally, the process undergoes periodic review and improvement cycles to continually optimize supplier management practices.

By leveraging AI, the subprocess for monitoring supplier performance can be streamlined into three main activities: defining performance metrics, data collection, and data processing and analysis. Firstly, AI can automate the identification and formulation of KPIs by analyzing business objectives and industry standards, eliminating the need for extensive manual collaboration. Secondly, AI can directly extract relevant data from current supplier reports, bypassing the need for manual determination of data collection methods and tools. Lastly, AI can handle the entire data processing and analysis phase, including data compilation, organization, statistical analysis, trend identification, and report generation, significantly reducing manual effort. This approach ensures efficient and accurate evaluation of supplier performance while optimizing resource utilization and expediting decision-making processes.

6 Intelligent Process automation

In this part of the paper, we would like to shift the focus towards AI and discuss how the implementation of AI could affect our case. As in the previous parts, we want to narrow it down to the logistics section, although some of the upcoming aspects can be applied to different processes. We think that AI can offer predictive analytics that can greatly enhance the efficiency of the logistics processes. Furthermore, by implementing AI into business processes, valuable experience is gained that can form the basis for advanced ABPMNS (AI-augmented Business Process Management Systems) (Dumas, 2023).

6.1 Use of AI

Supplier Management

The objective of this process is to utilise the AI as an analytical tool. This entails analysing the performance of suppliers and comparing it to industry standards. Performance metrics can be derived from industry standards and adjusted to align with the business's needs. For instance, the "delivery time" metric may be set at a higher or lower level depending on the urgency. The AI then generates a performance report, which is employed to address any issues that may arise. The report also incorporates predictive analytics, which assist in the avoidance of future issues such as bottlenecks or delays. This stage can be further enhanced by implementing a notification system that compares certain key parameters from the supplier reports with predefined values. When these values are exceeded, the Operations Planner will be notified about severe issues. This automation enhances and accelerates decision making.

Demand Forecast

We also chose to implement AI for this step as a predictive analytics tool. This would enable us to collect useful information and also assist in making choices. In the following chapter, a prototypical Python script is described, which uses an AI integration of the demand forecast process. (Kolková & Ključnikov, 2022, S. 4)

7 Process Simulation

7.1 Python script to optimize Logistics process

We used ChatGPT to generate Python code which could be used to improve the processes in managing stock. We explained the method in the preceding section, and we will present the results in the next section.

We also created a JupyterLite notebook with the execution of the code.

7.1.1 ChatGPT prompt

```
Create a working prototypical python script which creates 2 Arrays one called device_demand and one called sim_demand, with each 100 elements, use sklearn to create a regressional model from the data in a graph
```

7.1.2 Demand data

We started by generating demand data:

```
# Generate demand data for mobile devices

device_demand = np.array([...])

# Generate demand data for SIM cards

sim_demand = np.array([...])
```

We filled the array with fictional data from ChatGPT for demand and sim cards:

```
Device demand:
120, 122, 121, 125, 127, 130, 128, 135, 137, 138,
140, 142, 145, 143, 148, 150, 152, 155, 158, 160,
162, 165, 168, 170, 172, 175, 178, 180, 183, 185,
188, 190, 193, 195, 198, 200, 203, 205, 208, 210,
213, 215, 218, 220, 223, 225, 228, 230, 233, 235,
238, 240, 243, 245, 248, 250, 253, 255, 258, 260,
263, 265, 268, 270, 273, 275, 278, 280, 283, 285,
288, 290, 293, 295, 298, 300, 303, 305, 308, 310,
313, 315, 318, 320, 323, 325, 328, 330, 333, 335,
338, 340, 343, 345, 348, 350

Sim demand:
80, 82, 81, 85, 87, 90, 88, 95, 97, 98,
100, 102, 105, 103, 108, 110, 112, 115, 118, 120,
122, 125, 128, 130, 132, 135, 138, 140, 143, 145,
148, 150, 153, 155, 158, 160, 163, 165, 168, 170,
173, 175, 178, 180, 183, 185, 188, 190, 193, 195,
198, 200, 203, 205, 208, 210, 213, 215, 218, 220,
223, 225, 228, 230, 233, 235, 238, 240, 243, 245,
248, 250, 253, 255, 258, 260, 263, 265, 268, 270,
273, 275, 278, 280, 283, 285, 288, 290, 293, 295,
298, 300, 303, 305, 308, 310, 313, 315, 318, 320
```

Two “numpy” (np) arrays are built in this section to represent the demand data for SIM cards and mobile devices. Sample data points that mimic the demand over time are loaded into these arrays. The demand data for SIM cards (“sim_demand”) and mobile devices (“device_demand”) are used to train linear regression models and show patterns over time.

7.1.3 Creating time axis size

```
# Time indices
X = np.arange(1, len(device_demand) + 1).reshape(-1, 1)
```

The time indices for the demand data are represented by an array X in this instance. An array of consecutive numbers is created by the “np.arange” function, ranging from 1 to the “device_demand” array's length. This array is transformed into a two-dimensional array with a single column using the “reshape(-1, 1)” method, which is the necessary input shape for the linear regression model.

7.1.4 Building the linear regression model

```
# Fit linear regression model for mobile devices
device_model = LinearRegression()
device_model.fit(X, device_demand)
device_predictions = device_model.predict(X)

# Fit linear regression model for SIM cards
sim_model = LinearRegression()
sim_model.fit(X, sim_demand)
sim_predictions = sim_model.predict(X)
```

This part uses the scikit-learn LinearRegression class (Oleksandr Zaitsev, 2022) to generate and train two linear regression models. Simulated demand data is used to train the “sim_model”, while “device_demand” data is used to train the “device_model”. The prediction technique forecasts demand values based on the trained model, whereas the fit method finds the best-fit line for the data to train the model.

7.1.5 Plotting data and creating regression lines

```
# Plot the data and the linear regression lines
plt.figure(figsize=(10, 6))

plt.scatter(X, device_demand, color='blue', label='Device Demand')
plt.plot(X, device_predictions, color='red', linewidth=2, label='Device Regression')

plt.scatter(X, sim_demand, color='green', label='SIM Demand')
plt.plot(X, sim_predictions, color='orange', linewidth=2, label='SIM Regression')

plt.title('Demand Forecasting with Linear Regression')
plt.xlabel('Time')
plt.ylabel('Demand')
plt.legend()
plt.grid(True)
plt.show()
```

The script's last section uses “matplotlib.pyplot” to depict the demand data and the associated linear regression lines. The real demand data points for mobile devices and SIM cards are plotted using scatter plots on a figure of a predetermined size. The lines on the graph show the predicted demand values based on the linear regression models. For clarity, the plot is enhanced by labels, a title, and a legend. The grid approach enhances readability by including a grid in the plot. The plot is finally displayed using the show technique. Understanding demand trends and the accuracy of linear regression models in predicting future demand is made easier with the aid of this depiction.

7.1.6 Result of this prototype

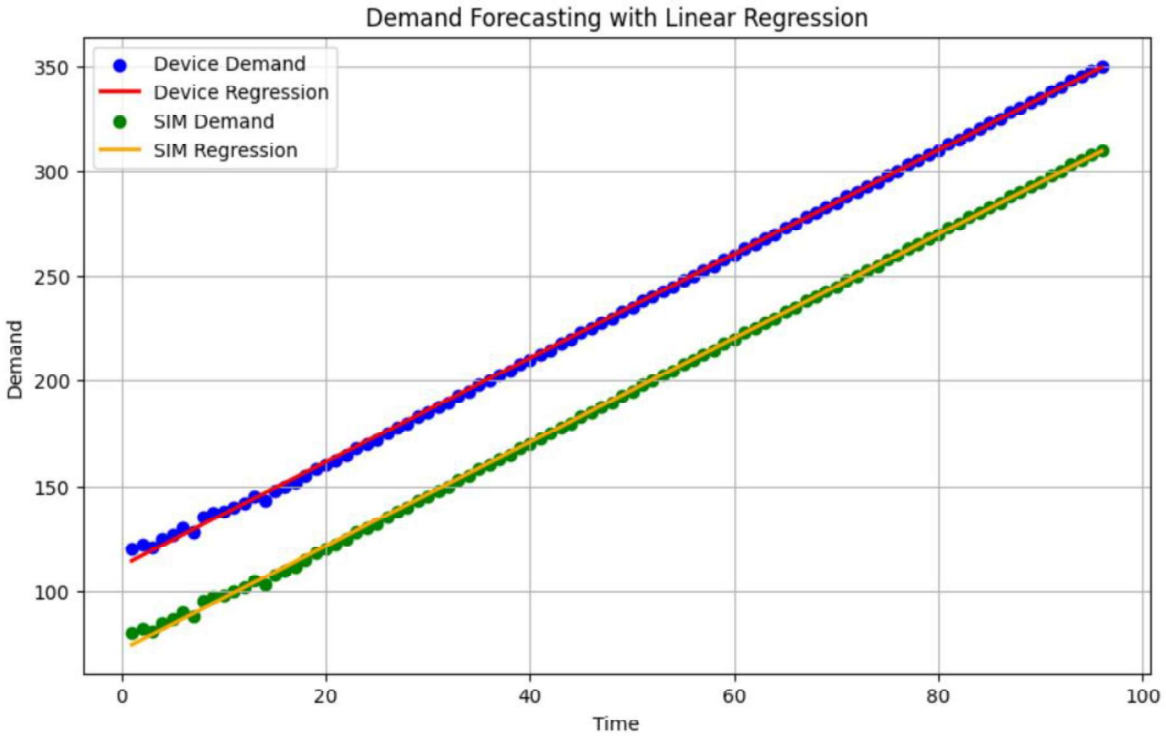

Figure: 8 Demand Forecasting diagram

8 Conclusion

This project aimed to enhance Three's logistics macroprocess with artificial intelligence, especially by implementing a Logistics and Inventory Management (LIM) system. The "Manage Stock," "Receive Orders," and "Return Processing" procedures at Three were found to have significant inefficiencies through a detailed examination of the company's present Business Process Management (BPM) environment.

According to our methodical analysis, the "Manage Stock" process's inefficiencies can yield the maximum possible return on investment given the amount of work involved. Three can lower operating expenses, increase overall efficiency, and dramatically improve inventory accuracy by concentrating on this process. The significant difficulties that have been found impact customer satisfaction and operational efficiency. These issues include impaired inventory accuracy, inaccuracies in inventory records, and an increased risk of stockouts and overstocking.

We suggested integrating a LIM system with cutting-edge features like automated inventory controls, improved forecasting capabilities, and real-time tracking in order to overcome these difficulties. The aforementioned features are intended to enhance overall responsiveness and flexibility, simplify inventory management procedures, and expedite logistics operations.

Moreover, Three can anticipate and reduce possible bottlenecks and delays by integrating Artificial Intelligence for predictive analytics in supplier management and demand forecasting, which improves decision-making procedures. The demand forecasting prototype Python script showed how AI may be used to improve logistics procedures and offer useful insights.

To sum up, our study not only expands on the basic research done by Karle and Teichenthaler (Jan vom Brocke, 2018), but it also makes adjustments to fit the ever-changing technological environment of the telecommunications sector. Three has a strong advantage in a dynamic industry, ensuring high performance and consistent expansion, by focusing on the macroprocess of logistics and adopting solutions powered by AI. Three's objective of optimizing benefits and efficiently allocating resources is in line with this strategic approach, which strengthens Three's position as the industry leader in telecommunications.

9 References

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List of aids

Aid	Usage	Affected areas
Private proofreading	Spell check	Entire work
DeepL Write	Optimization of individual text passages according to feedback from proofreading.	Entire Chapter 2
Quillbot	Optimization of individual text passages according to feedback from proofreading.	Chapter 8, paragraph 2 Entire Chapter 3 Entire Chapter 5
ChatGPT	ChatGPT to create executable python scripts for our prototype.	Chapter 6 pages 16-18
Jupyter Notebook	Creating a notebook and execute the python script to create a plot.	Chapter 6 page 18 (plot)

Table: 3 List of Aids

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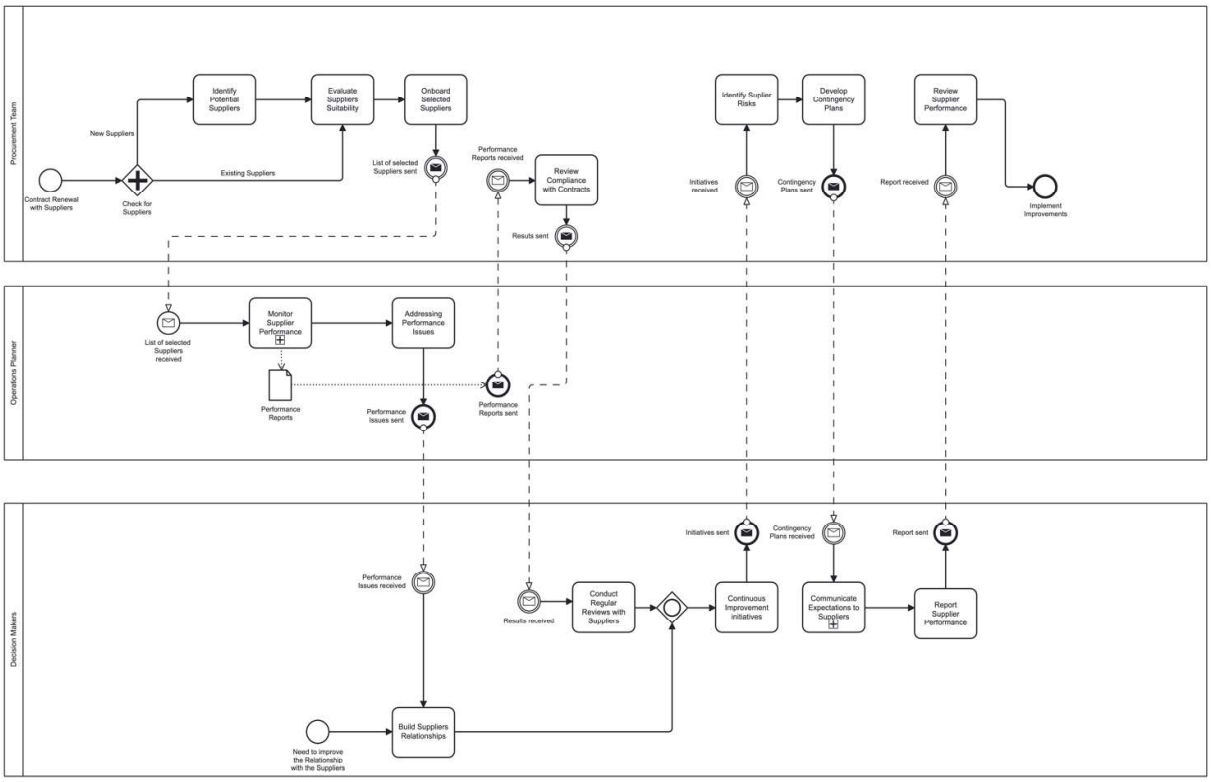
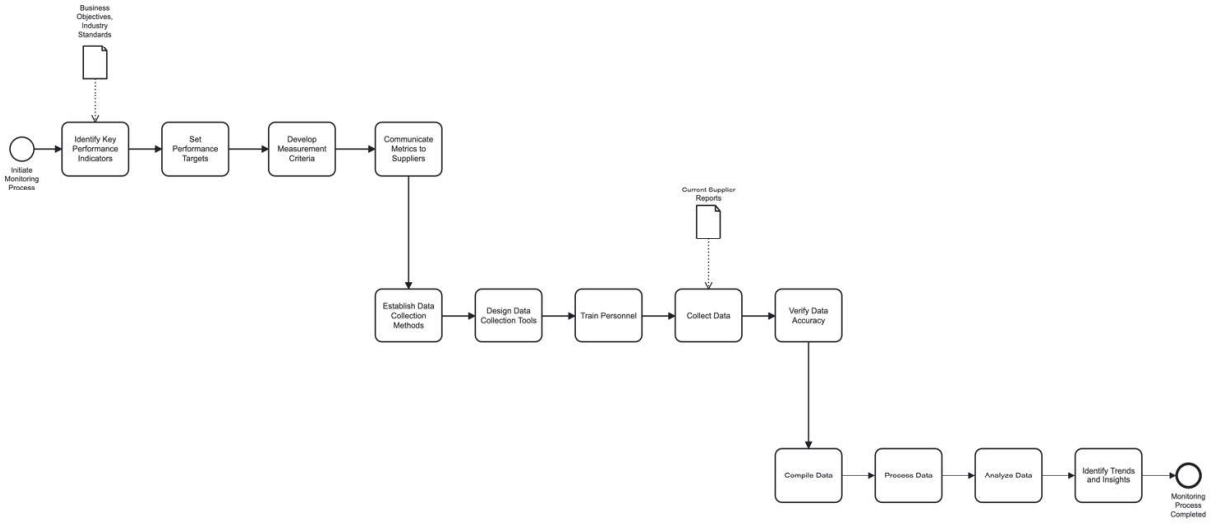
Appendix

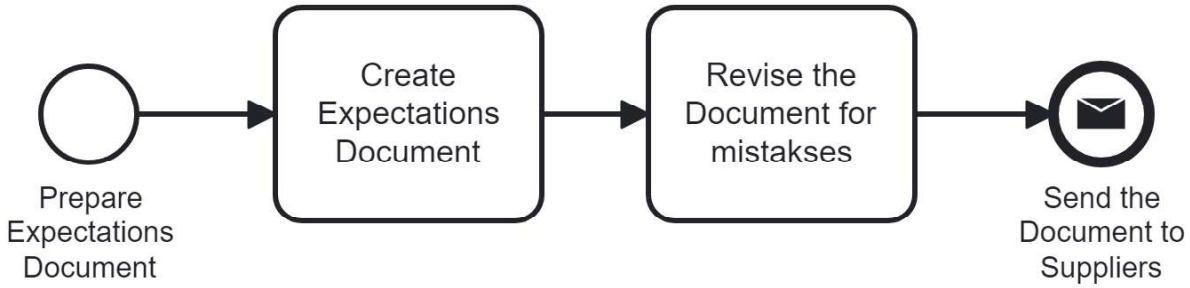
Supplier Management traditional



Appendix: 1 Supplier Management traditional Process

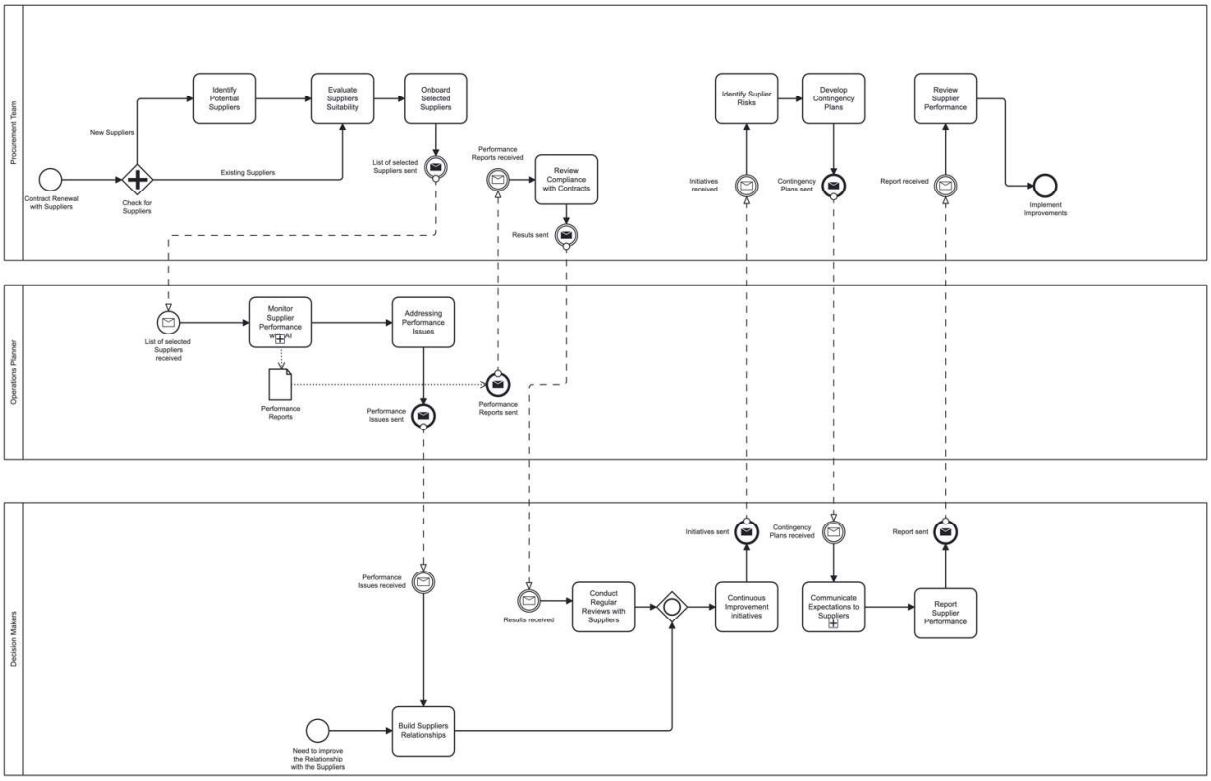


Appendix: 2 Supplier Management traditional subprocess: Monitor Supplier Performance

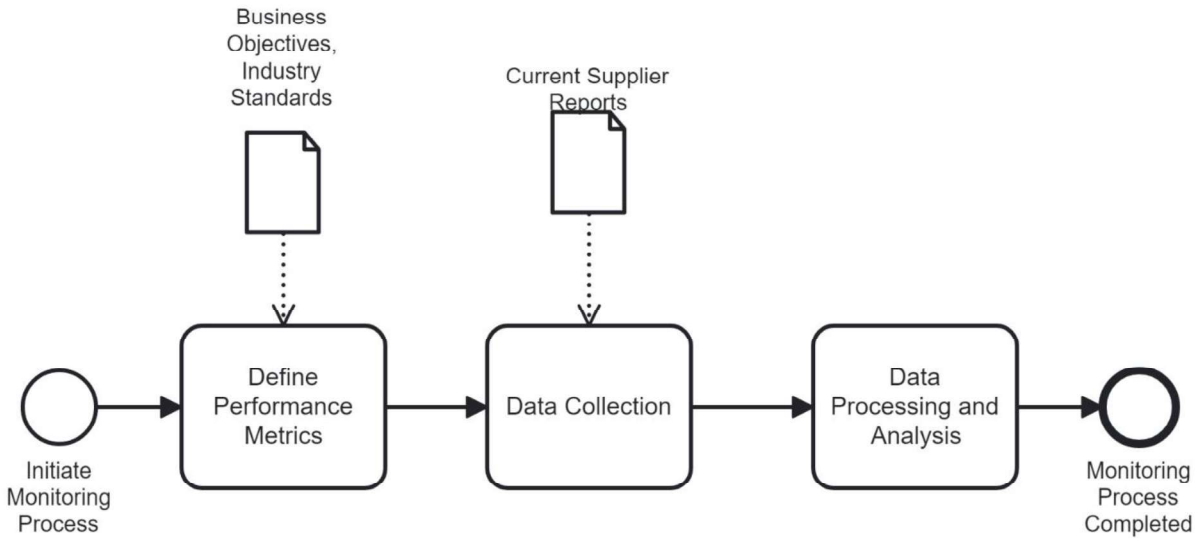


Appendix: 3 Supplier Management traditional subprocess: Communicate Expectations to Suppliers

Supplier Management with AI

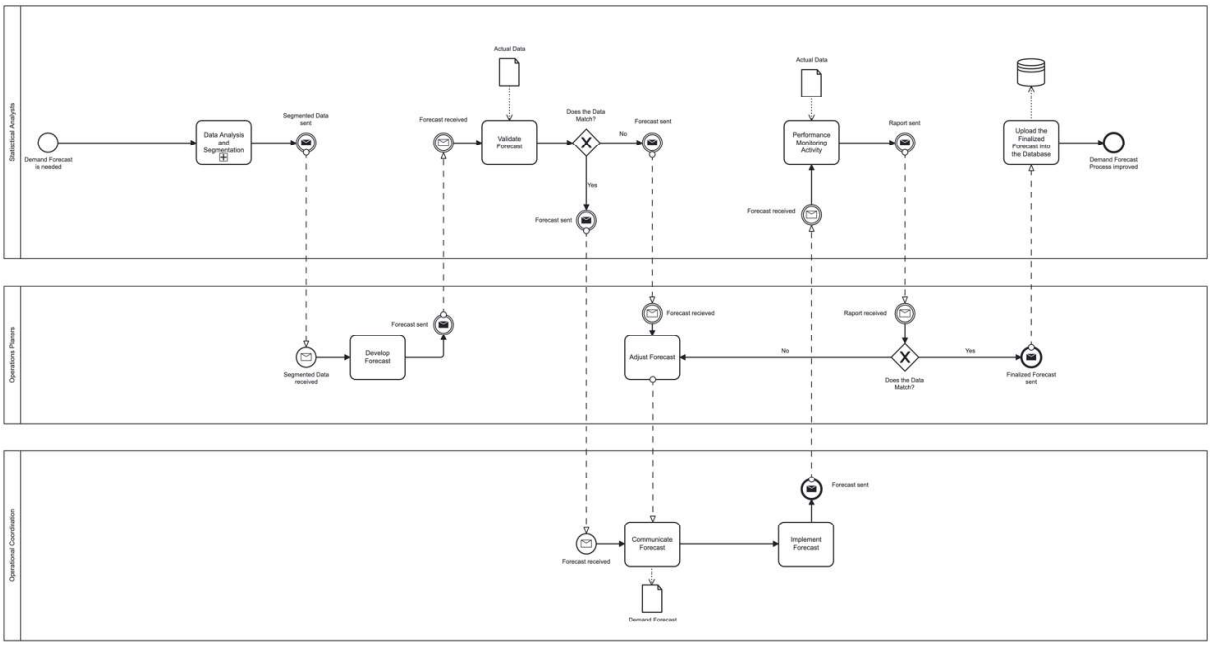


Appendix: 4 Supplier Management Process with AI integration

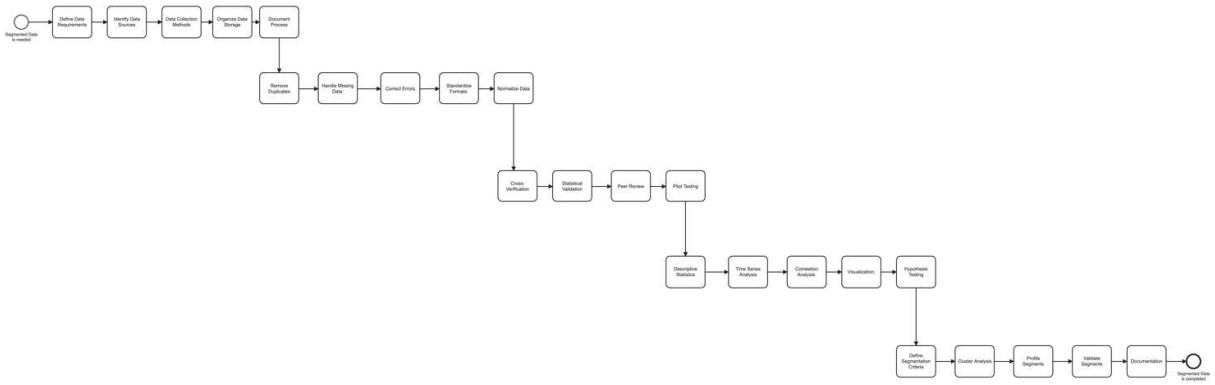


Appendix: 5 Supplier Management subprocess with AI integration: Monitor Supplier Performance

Demand Forecast traditional

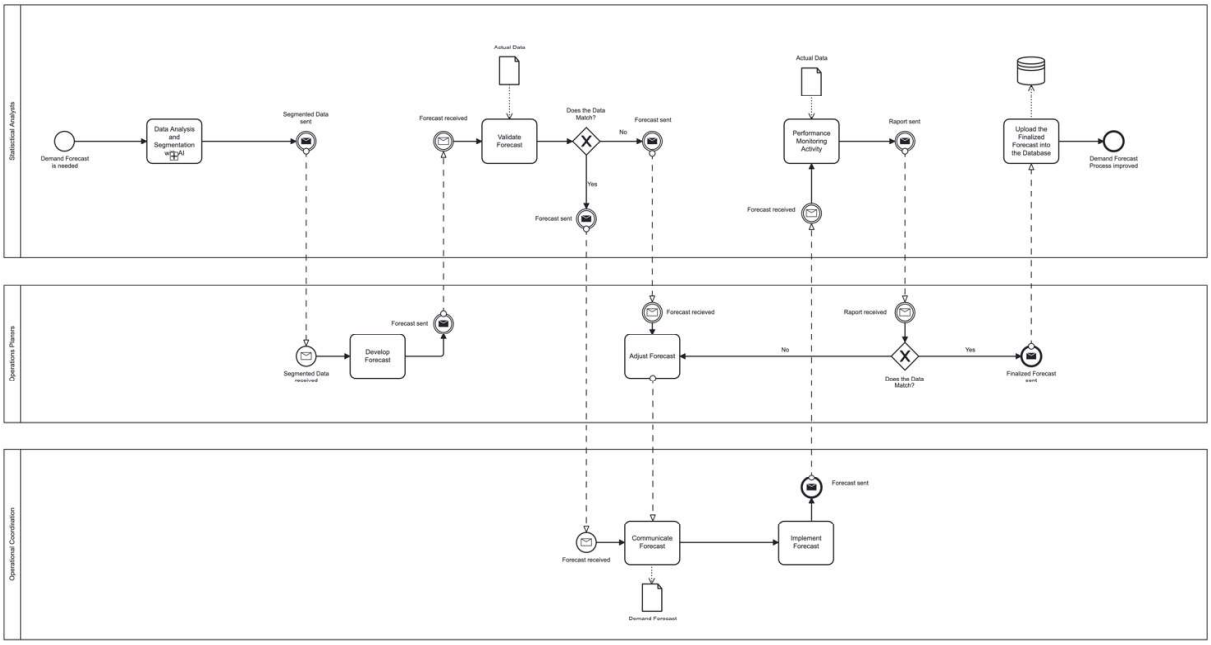


Appendix: 6 Demand Forecast traditional Process

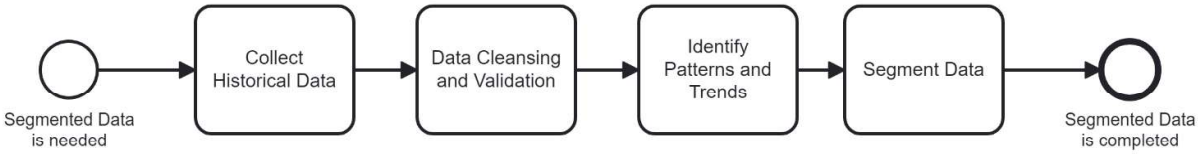


Appendix: 7 Demand Forecast traditional subprocess: Data Analysis and Segmentation

Demand Forecast with AI

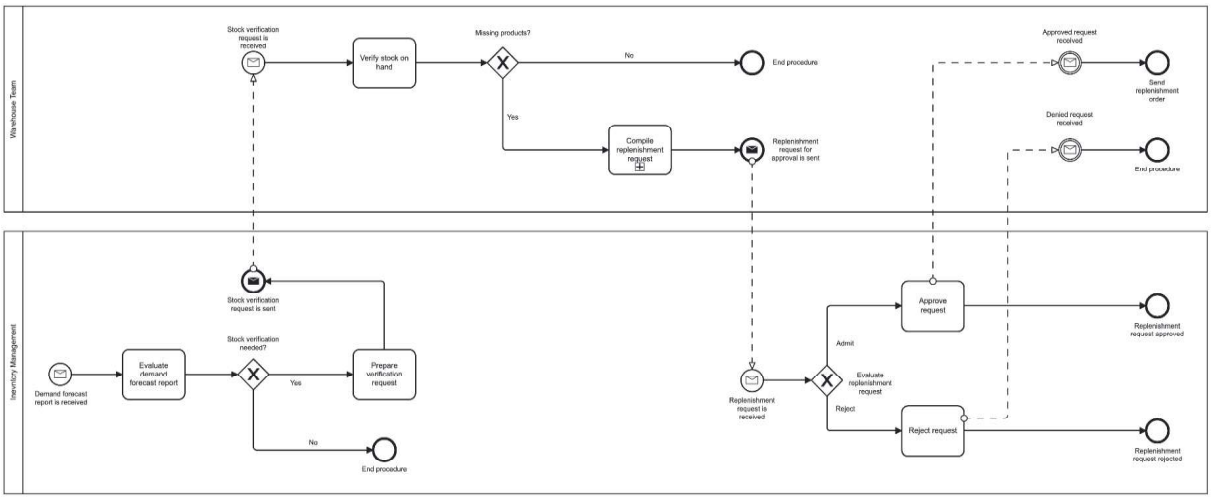


Appendix: 8 Demand Forecast Process with AI integration



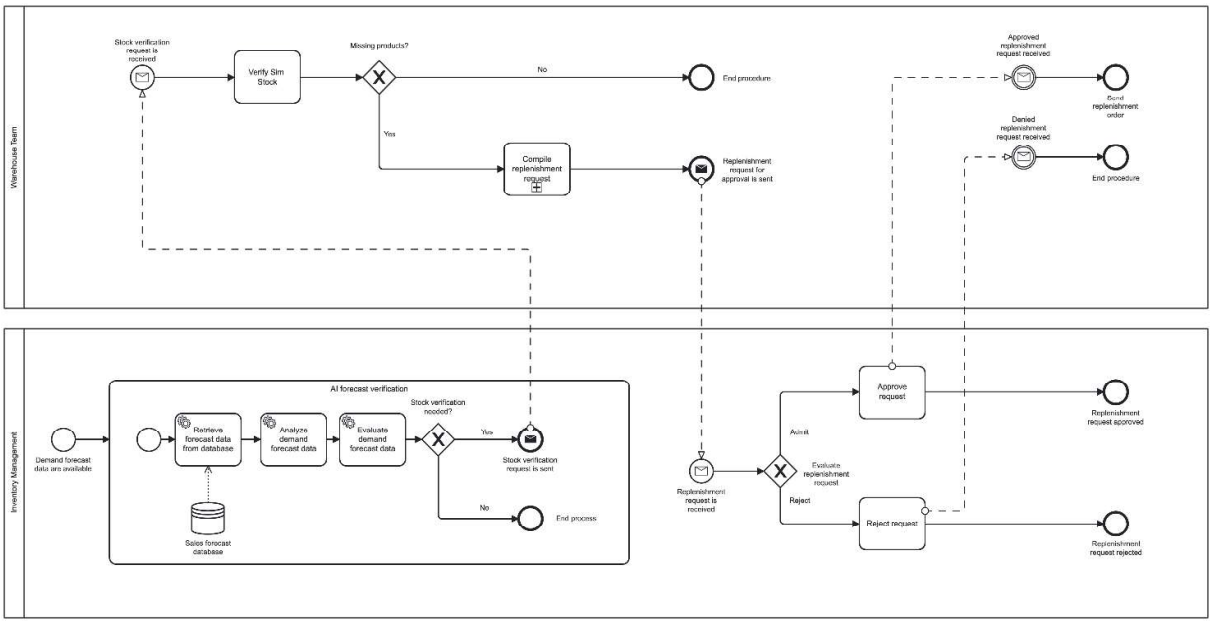
Appendix: 9 Demand Forecast subprocess with AI integration: Data Analysis and Segmentation

Stock Replenishment traditional



Appendix: 10 Stock Replenishment traditional Process

Stock replenishment with AI forecast verification



Appendix: 11 Stock Replenishment Process with AI integration