Proactive and Automated Control for BMW

Problem Statement

Challenge

- BMW assembly processes integrate thousands of parts, sourced from a wide variety of suppliers, located around the world
- If these parts fail to arrive on time, costly delays and work stoppages follow
- Requires monitoring that is done manually by highly experienced supply chain professionals
- Tedious and expensive

Solution

- Improved data-driven algorithms, systems and processes
- Capture, analyze and exploit datasets to enable optimized and proactive materials control, optimize specialized human expertise, and reduce line stoppages due to missing parts
- Scalable

Statement of Work from Proposal

Phase 1: Data Collection and Development

- Data collection and analysis
- Develop models representing a wide range of data and interrelationships
- Identify subset of “easy to plan” parts, automate handling of these parts, suggest actions to take given a part’s status
- Evaluate path to full automation of low-risk parts

Phase 2: Proactive and Automated Reporting Integration

- Validate and enhance developed models and AI material planner
- Develop dashboards and reporting
- Reduce material planner’s efforts to increase efficiency
- Enhancement over current methods (SAP)

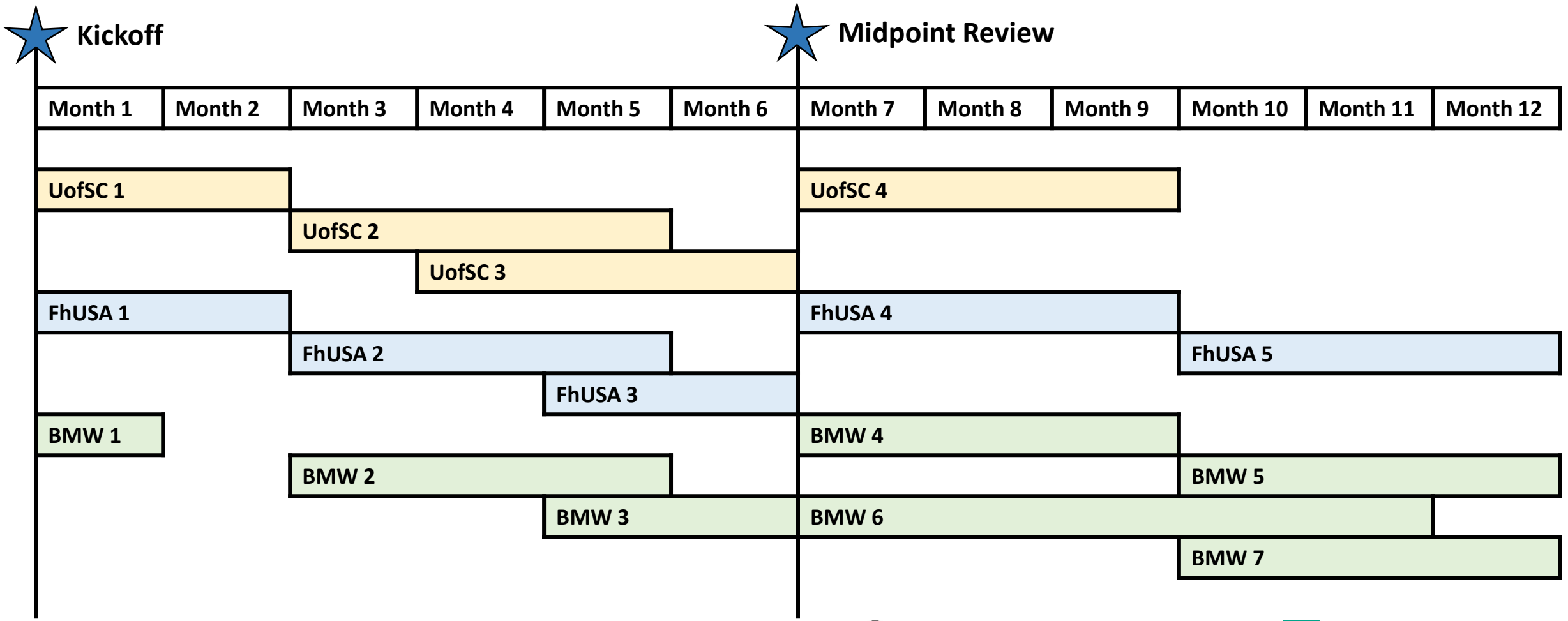
Tasks/Deliverables Listed in Proposal – Phase 1

Task #	Description	Deliverable	Time Range
BMW 1	Gather and provide the partners with historical BMW data	Historical BMW data delivered to partners	Months 0-1
UofSC 1	Exploration of historical BMW and extraneous data for forecasting part deliveries	Document: Key figures from historical data, rich/poor areas, supplier ranking	Months 0-2
FhUSA 1	Stakeholder interviews to identify how material planners approach problems	Prototype ER model, Presentation to stake holders	Months 0-2
UofSC 2	Data formatting and interrogation to identify relationships in data and capabilities of forecasting model	Key capabilities for part-forecasting model and prepared data for model creation	Months 2-5
BMW 2	Assist in AI material planner development	Active support and reviews	Months 2-5
FhUSA 2	Create AI Material Planner Assistant Prototype	Software: AI model material planner prototype. Workshops with partners to prepare integration	Months 2-5
UofSC 3	Develop parts forecasting model	Software: AI model prototyping forecasting capabilities	Months 4-6
FhUSA 3	AI assistant model validation	Tutorial on AI model, signals and patterns. Updated AI Model	Months 5-6
BMW 3	Perform model validation and testing	Active support and reviews	Months 5-6
Midterm Review – Demonstration of AI parts forecasting model and AI planning assistant prototypes			

Tasks/Deliverables Listed in Proposal – Phase 2

Task #	Description	Deliverable	Time Range
UofSC 4	Parts forecasting model validation	Software: Validated AI model	Months 7-9
FhUSA 4	Integrate forecasting model with AI Material Planner	AI Material planner framework with integrated AI forecasting model	Months 7-9
BMW 4	Systems of record integration		Months 7-9
FhUSA 5	AI Material Planner with alerting and human readable steps created	Workshops: status updates, alerting functionalities, human readable action steps. Software: Alerting functionality, human readable action steps. Software support: support BMW with integration of system at BMW. Correction calibration of system	Months 9-12
BMW 5	Integration of combined parts forecasting model and AI material planner		Months 9-12
BMW 6	Visualization, dashboard and reporting		Months 7-11
BMW 7	Feasibility study and testing	Document: Feasibility study report, final report	Months 10-12

Initial Timeline



Objective and Solutions

Broad Objective: How can we reduce material planner efforts?

- The user dashboard can integrate all needed data and analysis into one location for the planner.
  - Various widgets
    - Parts Ranking, Live Material Location during Transportation, KPIs like exceptions
    - Requires meetings with BMW to identify the KPIs of interest
- Parts Health Status Model
- Provide Key Performance Indicators (KPIs) on dashboard that could guide material planner to reduce their daily efforts.
- Recommend best practices for the material planner.
  - Recommendation engine is one tool that is used to achieve this objective

Dashboard

- Provide Key Performance Indicator (KPIs) on dashboard that could guide material planner to reduce their daily efforts.
- KPIs
  - Health Status (KPI # 1)
  - Part Ranking (KPI # 2)
- Questions to be investigated:
  - What are the KPIs for the material planner to reduce their daily efforts?
  - What are fields/columns in datasets to generate these KPIs?
  - What can be an Application logic/Algorithm to derive these KPIs?
  - What are use case scenarios/test cases scenarios to validate the results?

Decision Tree for KPIs

Algorithm, Application Logic, Rulesets

Exception
Exception ID (PK)
Exception Msg

Supply
Purchase Order #
Trailer ID
Source of Shipment
Dest. of Shipment
ETA to Dest.
Supply TS
Weather
Traffic
…

AL

Stock DoS (number, in Days)

First Receipt DoS (number, in Days)

Exception

AL

KPI # 1

Health Status (number, 0-100)

Material Config.
Safety Stock
Planning Time Fence
Safety Time
Planning Calendar
…

Material Transaction (MD04)
Demand Date
MRP Element
Change Qty
Total Qty
…

KPI # 2

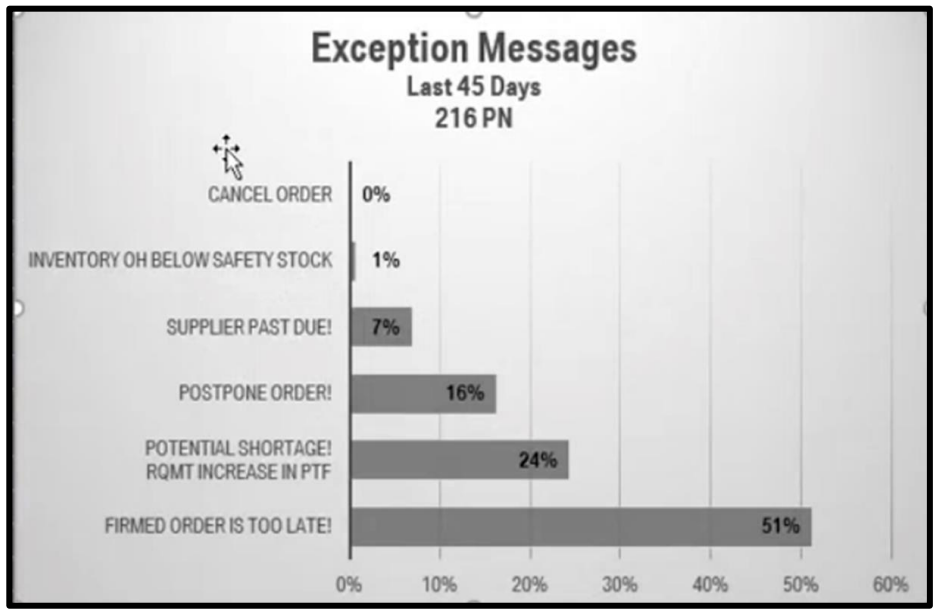
Part Ranking Algorithm

Part Ranking

Data Legend
- No Issues in Accessing Data
- Data is Accessible but Questions Exit
- Data Not Available

Capturing Best Practices – Exception Handling

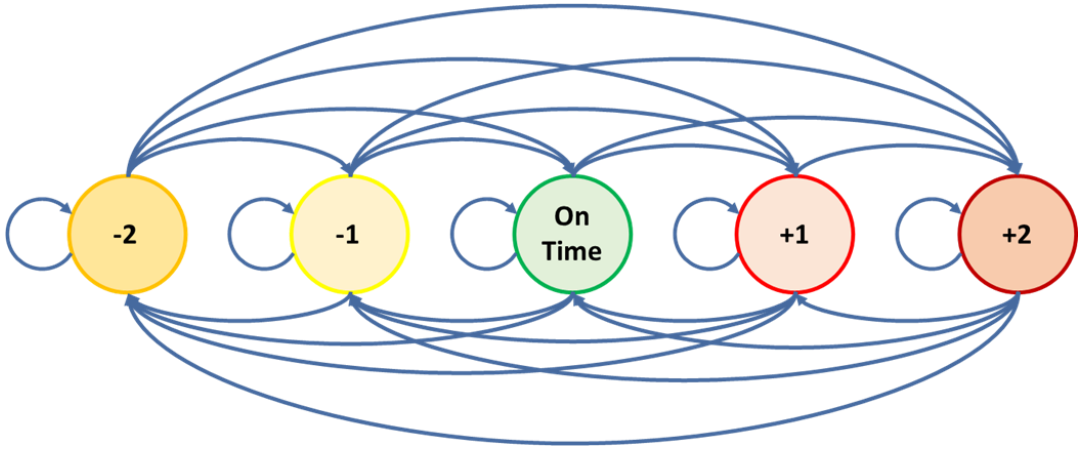
- Material Planner spends a significant amount of his/her daily time in reviewing exception messages.
- Improve quality of decisions made by reducing overall number of exceptions



- The team will investigate exception message related data to identify root causes of exceptions and recommendations for reducing the overall number.
- During testing, feedback from material planners will be collected on how to address exceptions
- Deliverable: Document detailing best practices for handling exception messages
- Access to exception message data is required.

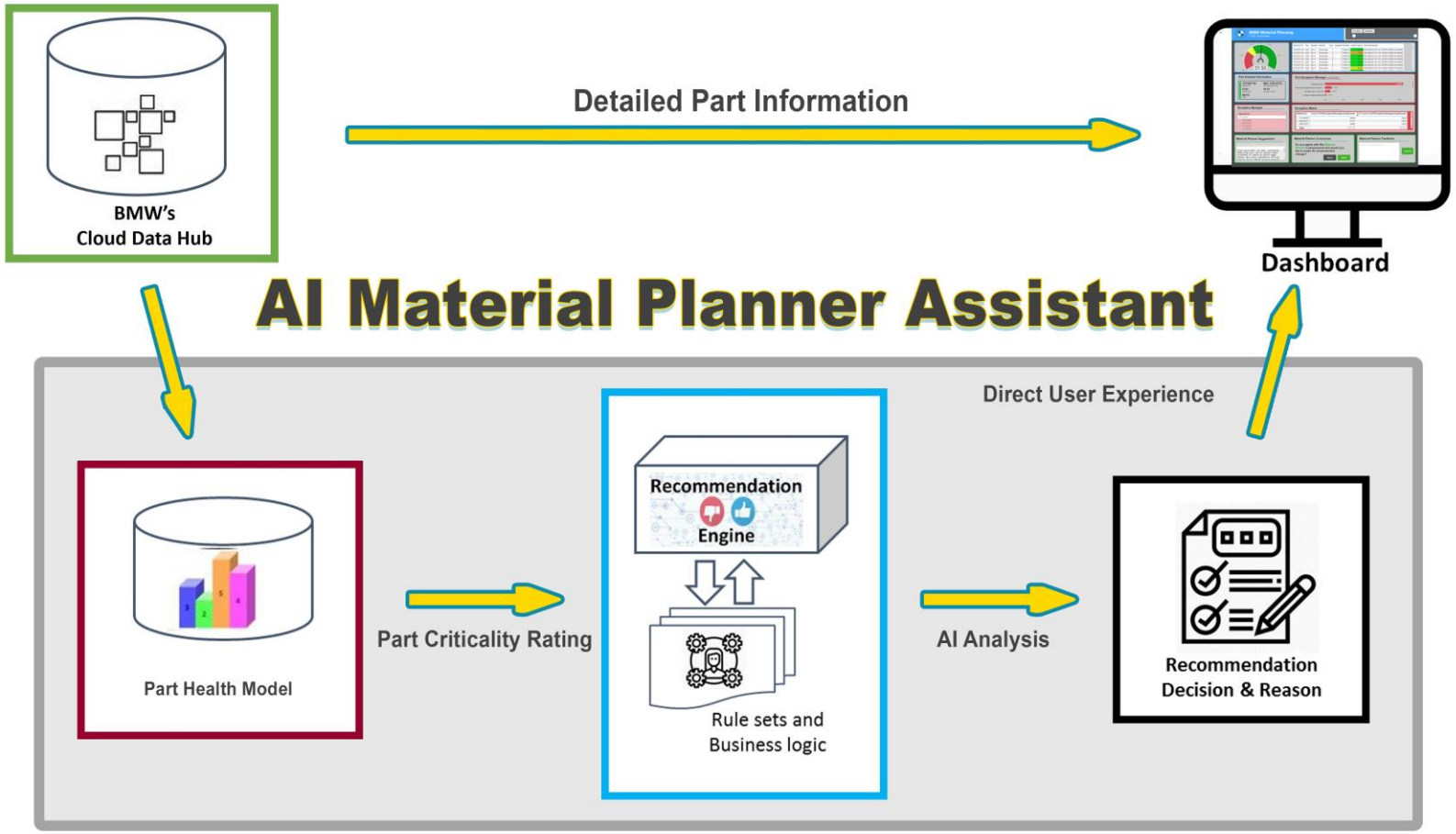
Capturing Best Practices – Parts Ranking

- Utilizing Markov Chain and historical data, this model will predict the likelihood of a part arriving early, on time, or late.
- Improve quality of decisions by identifying root cause of underperforming parts and the cause for delays allowing planners to take early action to prevent this from happening

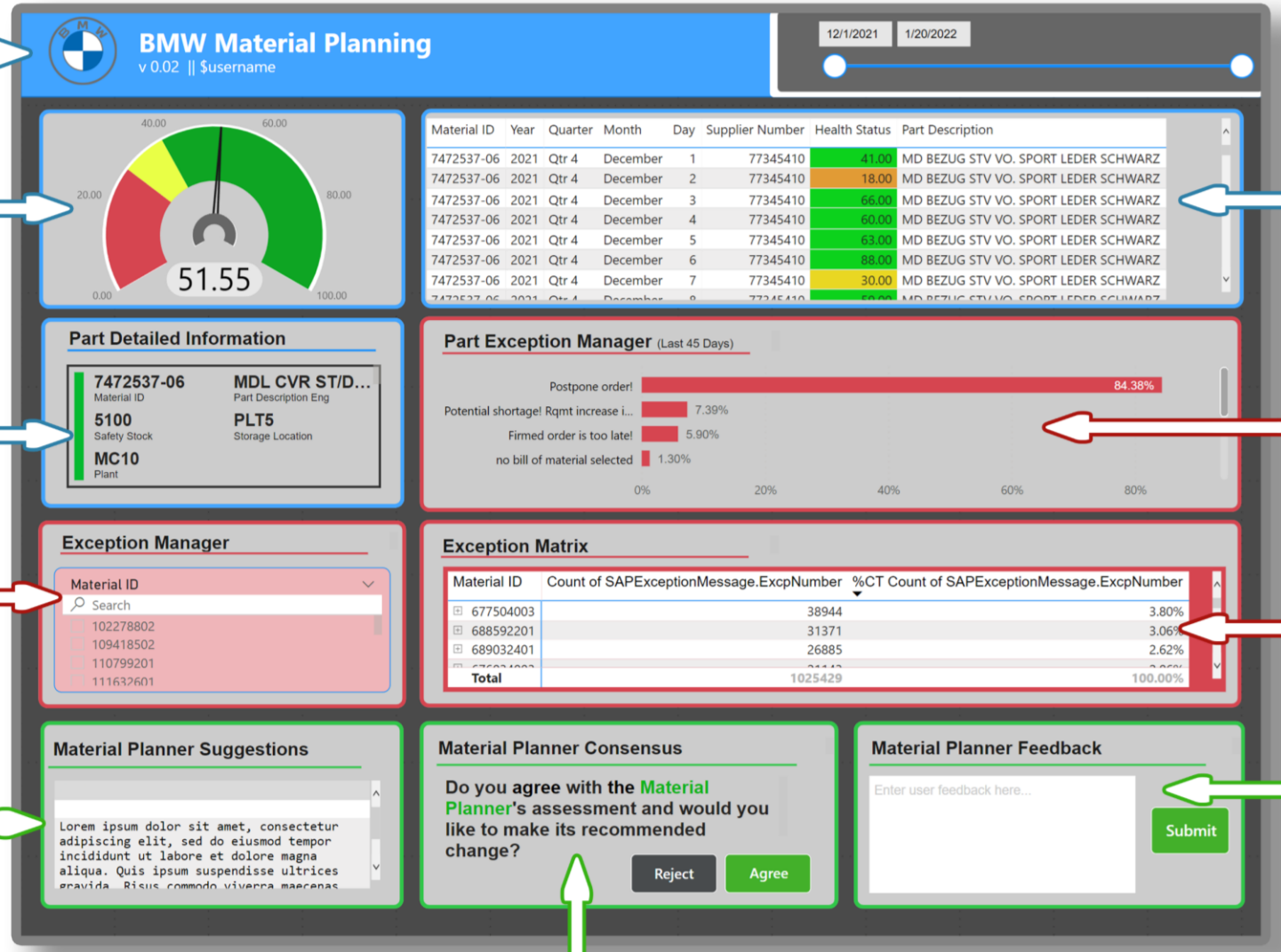


- The team will investigate supplier and material related data to predict arrival times and identify root causes of delays
- During testing, feedback from material planners will be collected on how to address problems
- Deliverable: Document detailing best practices for handling material delays
- Access to historical shipping data is needed.

Material Planner Assistant



User Dashboards



0 Header

1 Part Health Status

2 Part Lookup

3 Part Detailed Description

4 Part Exception Manager

5 Part Exception Matrix

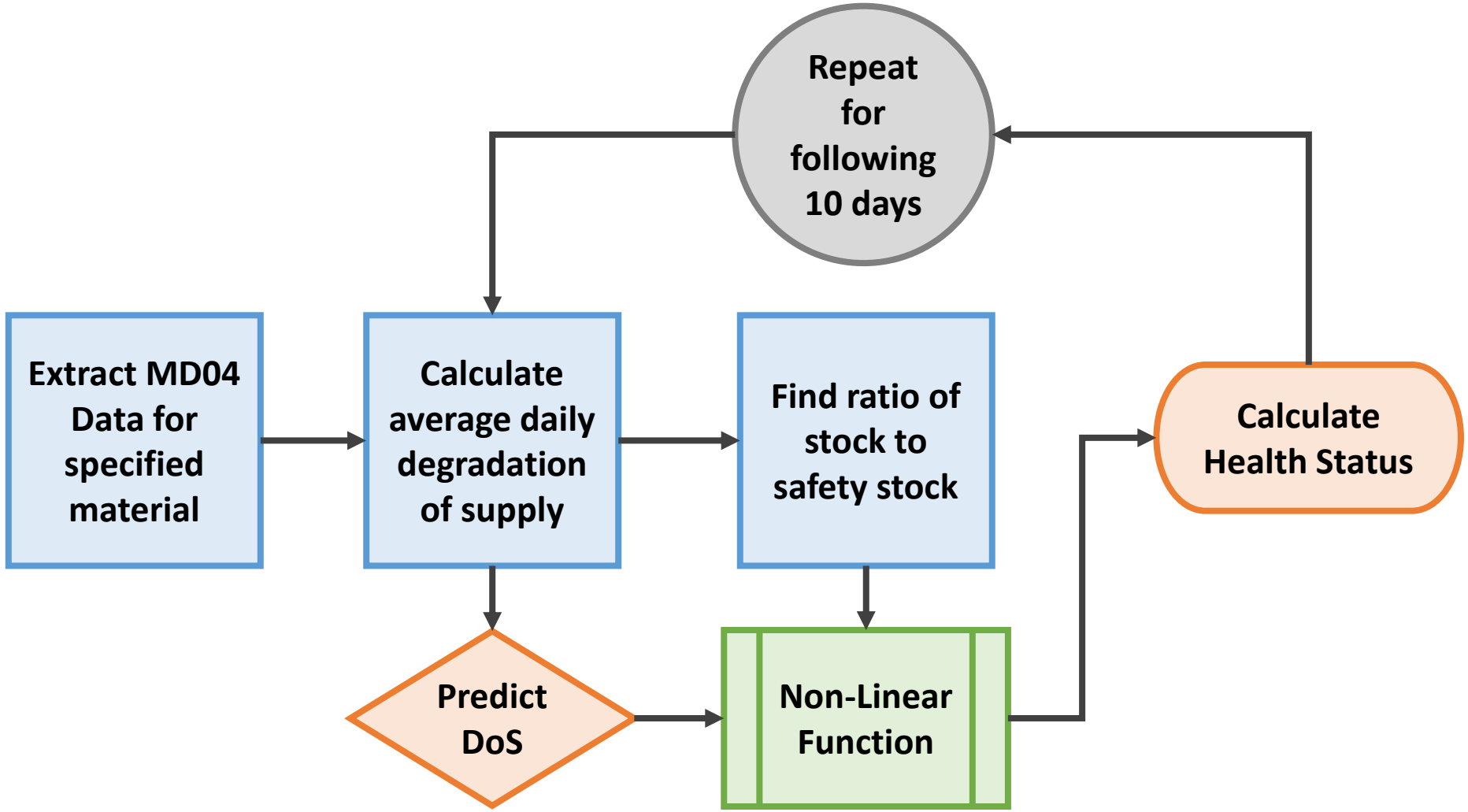
6 Part Exception Manager

7 Material Planner Suggestion

8 Material Planner Response

9 Material Planner Reasoning

Health Score Model



Phase 2

- Additional data fields explored
- Enhanced with machine learning techniques
- Further validation and refinement

Part Ranking Algorithm

Based on historical data, we will be able to calculate the probability that an order will be early or late and by how many days for the next delivery.

Vendor/Supplier	Material #	Material Description	Expected by Date	Actual Receipt Date	Days Late
19184810	7214653-09	LH SEALING BODYSIDE	**8/16/2021**	8/16/2021	**0**
19184810	7214653-09	LH SEALING BODYSIDE	**8/16/2021**	8/17/2021	**-1**
19184810	7214653-09	LH SEALING BODYSIDE	**8/19/2021**	8/18/2021	**1**
19184810	7214653-09	LH SEALING BODYSIDE	**8/19/2021**	8/19/2021	**0**
19184810	7214653-09	LH SEALING BODYSIDE	**8/19/2021**	8/20/2021	**-1**
19184810	7214653-09	LH SEALING BODYSIDE	**8/19/2021**	8/21/2021	**-2**
19184810	**7214653-09**	**LH SEALING BODYSIDE**	**8/22/2021**	**8/22/2021**	**0**

	1	0	-1	-2
1	0	1	0	0
0	0	0	1	0
-1	0.5	0	0	0.5
-2	0	1	0	0
	π(1)	**π(0)**	**π(-1)**	**π(-2)**
	0.166667	0.333333	0.333333	0.166667
	0.166667	0.333333	0.5	

	Ideal state
	Acceptable state
	Unacceptable state

Task 1: Dashboard Development

- **Duration: Jan-May 2022* (Months 7-12)**
- **Deliverable: Dashboard that integrate outputs from Parts Forecasting model and recommendation engine and other widgets**
- **Aim: Refine and validate dashboard developed in Phase 1**
- **Sub activities:**
  - Identify suitable technology stack to develop dashboard
  - Refine and validate dashboard developed in Phase 1
  - Deploy dashboard
- **Milestone: *March 31, 2022**; Refined dashboard ready for evaluation**
- **What is needed from BMW:**
  - KPIs (e.g., health score, exception manager. etc.) to be developed into dashboard
  - Suitable datasets to develop KPIs
- **What is needed from Fraunhofer:**
  - Recommendation engine APIs to be called from Dashboard
  - Database APIs/Database server to extract data from BMW cloud

***Dates to be determined**

Task 2: Forecasting Model

- **Duration: Jan-May 2022* (Months 7-12)**
- **Deliverable: Parts forecasting model ready to be integrated into AI MPA**
- **Aim: Refine, test and validate parts forecasting model developed in Phase 1**
- **Sub activities: (preliminary list)**
  - Test and validate parts forecasting with historical data
  - Test and validate optimized parameters for parts ordering
  - Refine model as needed
- **Milestone 1: *March 31, 2022**; Refined forecasting model ready for user testing**
- **Milestone 2: *May 31, 2022**; Refined and validated forecasting model based on user feedback**
- **What is needed from BMW:**
  - Suitable datasets and APIs (e.g., part delivery location etc.)
  - Deployment plan to deploy our Forecasting model
  - Scope of the forecasting model (e.g., our model will work for parts at MC10 plant, material parts considered for the model)
- **What is needed from Fraunhofer:**
  - Database APIs/Database server to extract data from BMW cloud

***Dates to be determined**

Areas for Discussion/Clarification

- Dashboard Development
  - Functional Dashboard vs Production Ready Dashboard - work with Suzanne's team to Develop
    - Responsibility of development / support
    - How will the dashboard be deployed and accessed by users
  - Most important KPIs for dashboard
  - Study of existing dashboards for material planning at BMW
- Data
  - How available are other data sources like transportation/shipping
- Scope and End Users
  - Phase 2 will be focused first on a subset of parts (parts monitored by the 4 planners interviewed)
- Deliverable
  - Dashboard tool that connects data and analysis, document outline best practices, troubleshooting/user manual for tool
- End Date – 7/29/21