GSCP Intern at San Disk – Milipitas

Analysis of Sample Supply chain Dataset provided by Tony on Interview reference

Dataset Contents

– Bill of Materials

- **BOMID**
- **Product ID**
- **Component ID**

– Forecast Actuals

- **Product ID**
- **Week**
- **Forecasted Demand**
- **Actual Demand**

– On-hand Inventory

- **Component ID**
- **On Hand Inventory**

– Product Information

- **Product ID**
- **ProductName**
- **Category**
- **Sales Price ($)**

– Supplier and Component Details

- **Component ID**
- **Supplier ID**
- **Lead Time (Days)**
- **Cost ($)**

1. Excel Analysis (Supplier Sample data – SD)

- **Forecast Accuracy**→ Demand Planning
  → Calculated error and accuracy % per product using Pivot Tables and visualized underperforming forecasts.
- **Inventory Risk** → Inventory Optimization
  → Exploded product forecasts to component-level demand using the BOM, then compared with on-hand inventory to flag stockout risks.
- **Supplier Risk**→ Supply Chain Resilience
  → Identified components with single suppliers and long lead times using COUNTIF and AVERAGEIF — key for supply continuity.
- **Build Cost**→ Supply Chain Resilience
  → Used MINIFS to select lowest-cost suppliers, summed total build cost per product, and compared against sales price to assess profitability.

2.Power BI Dashboard Analysis (Supplier Sample data – SD)

- **Forecast Accuracy Overview-** *Analyzes how accurately demand was forecasted per product.*
  - Visualizes **Avg Forecast Accuracy %**
  - Highlights products with **high forecast error**
  - KPI card shows **overall forecasting performance**
- **Inventory Risk Analysis-***Evaluates component-level inventory vs demand to spot shortages.*
  - Compares **Total Component Demand** vs **On-Hand Inventory**
  - Flags **Inventory Gaps** (shortages)
  - KPI shows **# of components at risk of stockout**
- **Supplier Risk Summary-***Assesses supply continuity risk based on lead times and supplier count.*
  - Shows **Avg Lead Time per component**
  - Donut chart splits **Single vs Multiple Suppliers**
  - Highlights components that are **dependent on only one supplier**
- **Build Cost & Profitability-** *Analyzes cost to build each product and compares it with sales price.*
  - Charts **Build Cost vs Sales Price**
  - Calculations **Profit per product,** KPI shows **Total Profit or Avg Profit Margin**

3.Data-Driven Supply Chain Optimization: Demand Forecasting, Shortage Prediction, and Supplier Risk Evaluation Using ML – Python/Collab

- **Forecast Accuracy Summary (Top 5 Products)**

Product ID	Forecasted Demand	Actual Demand	Forecast Error	Forecast Accuracy (%)
12	1547	1979	43.69	97.79%
13	1852	1822	40.77	97.76%
8	1809	1845	45.38	97.54%
5	1800	1807	45.15	97.50%
19	1455	1917	48.77	97.46%

- **Product Risk Summary (Top 5 by Shortage Risk or Low Inventory)**

Product ID	Forecasted Demand	On-Hand Inventory	Build Cost	Profit Per Unit	Shortage Risk
10	1544	4054	$39.00	–$18.40	1
14	1322	4504	$101.33	–$5.33	1
8	1809	5519	$50.17	–$10.47	0
6	1809	5643	$73.33	–$48.93	0
5	1800	5861	$31.67	–$6.67	0

- **Supplier Risk Summary (Top 5 High-Risk Components)**

Component ID	Number of Suppliers	Average Lead Time (days)	Average Cost	Risk Level
7	1	14.0	$6.00	High
24	1	14.0	$7.00	High
5	1	12.5	$7.00	High
16	1	7.0	$11.00	Low/Medium
4	1	6.0	$15.00	Low/Medium

Final Summary

Area	Key Takeaway
Forecast Accuracy	Excellent (>97%) forecasts highly reliable
Product Risk	Inventory healthy, but profit per unit is negative
Supplier Risk	3 components are single source with long lead time
Profit Prediction	Model captures loss trend, but has high error — needs tuning
Shortage Prediction	Model detects no-risk cases well, but misses real shortages

Tools Used:

- **Python in Google Colab**
- **Pandas, NumPy** – data handling
- **Matplotlib, Seaborn** – data visualization
- **Scikit-learn** – ML models and evaluation
- **XGBoost –** advanced regression model
- **Pipeline + ColumnTransformer** – for preprocessing and modeling

ML Methods Used:

Purpose	Method	Explanation
Demand Forecasting	**Linear Regression (Sklearn), XGBoost**	Predict actual demand using weekly & forecasted demand as inputs, For more accuracy
Feature Handling	**OneHotEncoding**	Converted Product IDs into numeric format
Model Evaluation	**Mean Squared Error, R^2 Score**	To assess model performance
Shortage Risk Prediction	**Binary label creation**	Compared total inventory vs demand forecast to flag shortage
Visualization	**Plotting actual vs predicted demand**	To show prediction accuracy and trend alignment

INPUTS for Project Proposal at San disk

1.My projects and Coursework related to San disk

Courses:

ISE 140: Operations Planning and Control

ISE 167: System Simulation

ISE 250: Leading the Six Sigma Improvement Project

ISE 230: Advanced Operations Research

ISE 235: Quality Assurance and Reliability

ISE 251: Managing the Lean Enterprise Improvement Program

ISE 245: Advanced Supply Chain Engineering

ISE 247: Logistics for Supply Chain – Ongoing currently

ISE 240: Analytics for Systems Engineering- Ongoing currently

ISE 244: AI Tools and Practice for Systems Engineering- Ongoing currently

Projects:

ISE 140: Operations Planning and Control – Dr Anil Kumar

- Used **Time Series**-**Exponential smoothing, FIT** model for demand forecasting with MAD validation.
- Developed **MRP** and **capacity plans** from BOM and production data.
- Built cost-efficient production schedules using level & chase strategies.
- Applied Pro-Model for simulation-based scheduling to minimize makespan.
- Focused on **forecasting, inventory control, and cycle time reduction** – directly relevant to SanDisk GSCP tasks.

ISE 167 – System Simulation – Dr Khaled Mbrouk

- Simulated **factory floor operations** to optimize **workforce and machine utilization**.
- Improved **throughput** and reduced bottlenecks using discrete-event simulation.
- Relevant to SanDisk for **capacity planning** and **digital twin applications**.

ISE 250 – Leading the Six Sigma Improvement Project -Dr Jacob Tsao – (Green belt)

- Applied **Six Sigma tools** (SPC, MSA, DMAIC) in a **manufacturing environment**.
- Used **Minitab** for statistical analysis and **process optimization**.
- Aligns with SanDisk goals in **quality improvement** and **data-driven decision making**.

ISE 251 – Managing the Lean Enterprise Improvement Program (GWAR)

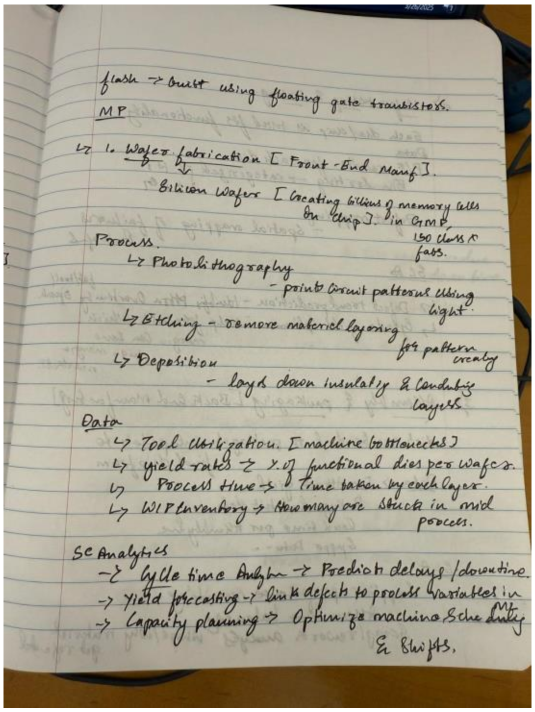
- Used **AHP, TOPSIS, and VSM** to evaluate and optimize **supplier selection strategies**.

ISE 230 – Advanced Operations Research

- Built and solved **LP/IP models** for optimizing logistics networks and inventory allocation.
- Applied **queuing theory**, **Little's Law**, and **Markov chains** for demand and throughput analysis, with robust model validation.

Understanding San Disk

2. Manufacturing Process at SD-Kioxia



flash -> Built using floating gate transistors.

MP

-> 1. Wafer fabrication [Front-End Manuf].

Silicon Wafer [Creating billions of memory cells on chip]. in GMP, 150 class K fabs.

Process.

-> Photolithography - print circuit patterns using light.

-> Etching - remove material layering for pattern creating

-> Deposition - lays down insulating & conducting layers.

Data

-> Tool utilization. [machine bottlenecks]

-> yield rates -> % of functional dies per wafer.

-> Process time -> time taken by each layer.

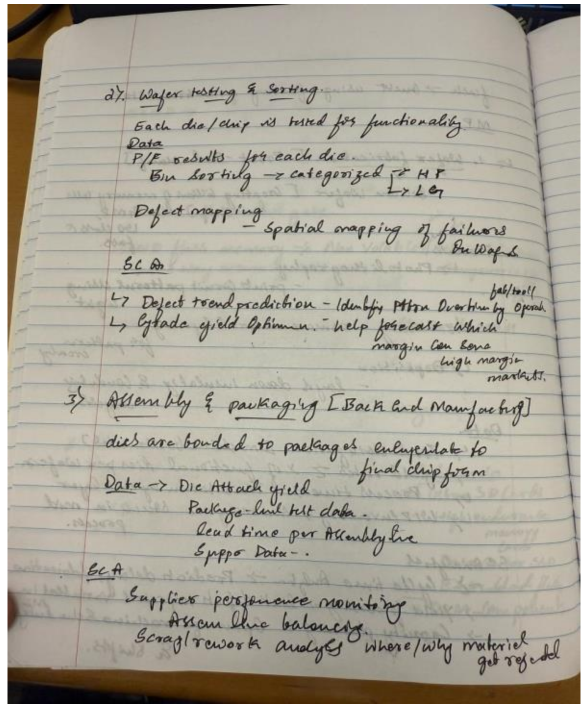
-> WIP inventory -> How many are stuck in mid process.

SC Analytics

-> Cycle time Analysis -> Predict delays / downtime.

-> Yield forecasting -> link defects to process variables in ML

-> Capacity planning -> Optimize machine schedule & shifts.



2). Wafer testing & Sorting.

Each die / chip is tested for functionality

Data

P/F results for each die.

Bin sorting -> categorized -> HP, -> LG

Defect mapping - Spatial mapping of failures on wafers.

SC An

-> Defect trend prediction - Identify pattern over time by fab/tool/ operator.

-> Grade yield Optimn. - help forecast which margin can serve high margin markets.

3) Assembly & packaging [Back end Manufacturing]

dies are bonded to packages encapsulate to final chip form

Data -> Die Attach yield

Package-level test data.

lead time per Assembly line

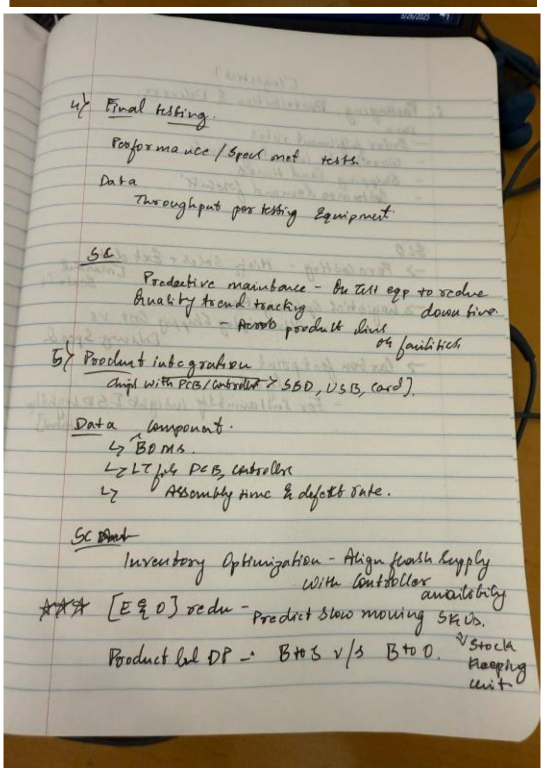
Supplier Data.

SCA

Supplier performance monitoring

Assem line balancing.

Scrap/rework analysis where/why material get rejected



4) Final testing.

Performance / Spec met tests.

Data

Throughput per testing Equipment

SC

Predictive maintenance - on test eqp to reduce down time.

Quality trend tracking - Across product lines or facilities.

5) Product integration

chips with PCB/Controller -> SSD, USB, card].

Data

-> BOMs. (component)

-> LT for PCB, controllers

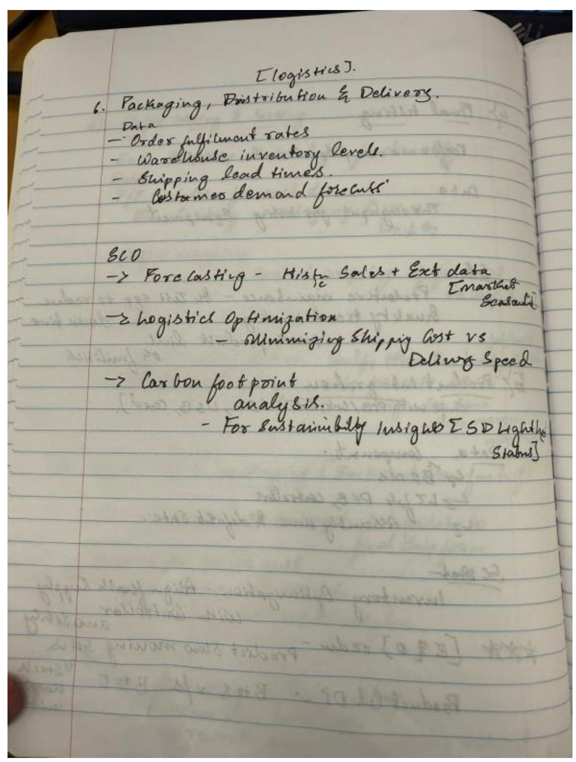
-> Assembly time & defect rate.

SC ~~Anal~~

Inventory Optimization - Align flash supply with controller availability

*** [E & O] redn - Predict slow moving SKUs. (Stock Keeping unit)

Product lvl DP - BTS v/s BTO.



[logistics].

6. Packaging, Distribution & Delivery.

Data

- Order fulfilment rates
- Warehouse inventory levels.
- Shipping lead times.
- Customer demand forecasts

SCO

-> Forecasting - Historic Sales + Ext data [market Seasonality]

-> Logistics Optimization - Minimizing shipping cost vs Delivery Speed

-> Carbon footprint analysis. - For sustainability insights [SD Lighthouse Status]

SanDisk Manufacturing Process

1. Wafer Fabrication (Front-End)

- Silicon wafers used to create memory cells using floating gate transistors.
- Processes include photolithography, etching, and deposition for layer creation.

2. Wafer Testing & Sorting

- Each die is tested for functionality (P/F results), then sorted (e.g., HP/LG).
- Defect mapping and spatial failure analysis support yield tracking.

3. Assembly & Packaging (Back-End)

- Dies are bonded to packages to form final chips.
- Data includes die attach yield, package hit rate, and assembly lead time.

4. Final Testing

- Performance/speed testing per device.
- Data collected: throughput per equipment.

5. Product Integration

- Assembled with PCB/controllers to form SSDs, USBs, etc.
- BOMs, assembly time, and defect rates tracked.
- Absolutely! Here's the table in plain text format, easy to copy into Word:

Supply Chain Data and KPIs by Manufacturing Process Step

Manufacturing Step	Relevant SC Data / KPIs
1. Wafer Fabrication	Tool utilization, machine bottlenecks, yield rate (functional dies per wafer), process time, WIP inventory
2. Wafer Testing & Sorting	P/F results, bin sorting, defect mapping (spatial), defect trend prediction, yield forecasting
3. Assembly & Packaging	Die attach yield, package hit rate, lead time, supplier data, scrap/root cause analysis
4. Final Testing	Throughput per test equipment, speed and performance metrics
5. Product Integration	BOMs, lead time for PCB/controllers, assembly time, defect rate, E&O reduction, slow-moving SKU tracking

MP-SC perspective - Key KPIs

Stage	KPIs	Use in SCP Methodology
Demand Forecasting	Forecast Accuracy (MAPE, WAPE), Service Level	Time series forecasting, planning alignment
Wafer Fabrication	Tool Utilization, WIP Inventory, Fab Yield %	Capacity optimization, bottleneck analysis
Wafer Testing	Bin Yield %, Scrap Rate, Test Throughput	Product mix planning, predictive quality analysis
Assembly & Packaging	Assembly Lead Time, First Pass Yield, Defect Rate	Inventory optimization, supply-demand balancing
Final Integration	Product Pass Rate, Integration Time, Rework %	Allocation models, backlog analysis
Distribution & Fulfillment	OTIF, Inventory Turns, Backlog	Network optimization, customer service improvement

Key Supply Chain & Analytics Applications wrt MP

- Inventory Optimization – Sync flash supply with controller availability.
- Cycle Time Analysis – Predict delays and downtime.
- Yield Forecasting – Link process variables to defect trends.
- Capacity Planning – Optimize machine scheduling and labor shifts.
- Supplier Monitoring & Line Balancing – Scrap/root cause analysis for rejections.

3.San Disk Products

Category	Product Types	Use Case / Segment
Consumer Storage	USB flash drives, SD/microSD cards, portable SSDs	Cameras, smartphones, file transfers
Solid State Drives (SSDs)	Internal SSDs (SATA, NVMe), External SSDs	Laptops, desktops, creative workflows
Mobile Storage	iXpand flash drives (iPhone), dual USB-C drives	Mobile backup, cross-device transfer
Gaming Storage	WD_BLACK SN series, SanDisk microSD for Nintendo Switch	Console and PC gaming
Professional Storage	SanDisk Professional (G-Drive, G-Raid, G-Speed)	Photography, videography, media
Embedded Flash	eMMC, iNAND, UFS chips	Smartphones, tablets, automotive
Memory Cards	Extreme PRO SD/microSD, Ultra series	Photography, drone, surveillance
Cloud & Data Center Flash	U.2, U.3, E1.S enterprise SSDs, OpenFlex NVMe-oF platforms	Data centers, cloud infrastructure

Upcoming Products 2025 Road map

BiCS6 & BiCS8 NAND	218-layer and beyond 3D NAND flash developed in JV with Kioxia (higher density, faster speeds)
PCIe Gen 5 NVMe SSDs	For high-performance computing, gaming, and enterprise use
AI + Edge Storage	New SSDs and flash solutions optimized for edge computing and AI workloads
Sustainability in Flash	Eco-friendly packaging, energy-efficient drives, longer lifecycle support
i-NAND Smart SLC	Advanced NAND for automotive and industrial IoT markets
Automated Supply Chain	Integration of AI/ML tools for planning, inventory, and factory forecasting

Core Planning Methods

Methodology	**Use Case**		**Tools**
Forecasting (Time Series, ML)	Demand prediction, material consumption		Python, Power BI,ARIMA,LSTM
Optimization (Linear, Integer)	Capacity planning, production scheduling		Gurobi, FICO, Excel Solver
Simulation	What-if analysis on fab/assembly delays		Python, Arena (if applicable)
Inventory Analysis (EOQ, Safety Stock)	Stock level balancing across global locations		Excel, SQL
Data Visualization	KPI dashboards for executive and operations teams		Power BI, Tableau
Root Cause Analysis	Identifying delay, quality, or yield issues		Python, 5-Why, Fishbone Diagram

4. SanDisk Flash Business Landscape /Market Trends– 2025

1. Market Downturn & Production Cuts

- NAND market faces oversupply and weak demand (smartphones, laptops, SSDs).
- SanDisk, Micron, Samsung, SK hynix cutting production via lower fab utilization.
- Chinese competitors expanding rapidly.
- Long-term: Industry moving toward consolidation and innovation-driven survival.

2. SanDisk Price Increase – April 2025

- >10% NAND price hike planned from April 1, 2025.
- Driven by:
  - Expected supply-demand recovery in H2 2025.
  - Rising tariffs and cost pressure.
- SanDisk is positioning early for market rebound.

3. Spin-Off & High-Bandwidth Flash (HBF) Innovation

- SanDisk separated from Western Digital in Feb 2025; continues JV with Kioxia.
- Focused on 112/162-layer BiCS NAND vs. competitors' 218-layer.
- Developing High-Bandwidth Flash (HBF) as a next-gen NAND alternative to HBM.
  - 8–16x capacity of HBM at similar cost.
  - Could redefine supply chain architecture for advanced memory systems.

Fab Locations

Location	Function
Yokkaichi (Japan)	NAND wafer fabrication (Kioxia+WD JV)
Asia (Malaysia, China)	Assembly, testing, packaging
Milpitas (USA)	Global planning, R&D, logistics, SCM
Customer regions	Distribution and final delivery

SD-locations worldwide

Region	Site Name	Role	Ownership
Japan	Yokkaichi (Fabs 1–7)	Wafer fabrication (NAND)	JV w/ Kioxia
Japan	Kitakami	Expansion fab site (3D NAND)	Kioxia-led, WD-partner
Malaysia	Penang	Assembly, packaging, and testing	WD-owned
China	Shanghai, Shenzhen	ATP + Logistics	WD-owned
USA (CA)	Milpitas	HQ, Supply Chain Planning, R&D	WD-owned
India	Bangalore	R&D, Engineering	WD-owned

Tools currently used in SD for SC Demand forecasting

Category	Tools / Models Used
Forecasting Models	ARIMA, SARIMA, SARIMAX, Facebook Prophet, NeuralProphet
Machine Learning Models	XGBoost, LightGBM, Random Forest, Gradient Boosted Trees
Deep Learning Models	RNN, LSTM, GRU, Temporal Fusion Transformer (TFT)
AI/ML Platforms	SAP IBP, Blue Yonder (JDA), Kinaxis RapidResponse, Anaplan
Data Processing	Python (Pandas, NumPy), Spark, Kafka, SQL
Visualization & Reporting	Power BI, Tableau, Excel, Explainable AI Dashboards
Model Evaluation Metrics	MAPE, RMSE, MAE, Forecast Value Add (FVA), Service Level Impact, Inventory Turns
Real-time Forecasting Tools	Demand Sensing Engines, Streaming Analytics, Real-time POS/Market Data Integration
Simulation & Optimization	What-if Scenario Simulations, Gurobi, Linear Programming
AI Assistants & GenAI	Generative AI Copilots, LLM-based Forecast Summary Tools

SC Keywords for project reference

Term	Meaning
Lead Time	Total time from order placement to delivery.
Cycle Time	Time taken to complete one unit of production.
Throughput	Number of units produced or moved through a system in a given time.
Inventory Turnover	How often inventory is sold and replaced over a period.
Stockout	When demand cannot be met due to no inventory.
Safety Stock	Extra inventory kept to prevent stockouts.
Order Quantity (EOQ)	Optimal amount to order to minimize cost.
Bullwhip Effect	Demand fluctuations amplified upstream in the supply chain.
Just-In-Time (JIT)	Inventory system aimed at reducing waste by receiving goods only as needed.
Kanban	Visual scheduling system to manage workflow and inventory.
Capacity Planning	Ensuring production can meet current and future demand.
Demand Forecasting	Predicting future customer demand using historical data.
Supply Chain Visibility	Ability to track products/components across the supply chain in real time.
Logistics	Coordination of moving goods, services, and information.
Warehouse Management	Efficient handling and storage of goods within a warehouse.

My Project Proposal (driven by above inputs)

"Next-Gen GSCP Framework: AI-Powered Demand-Lead Synchronization & Unified Planning Model for SanDisk's High-Bandwidth Flash Supply Chain"

Problem Context – Real-World Challenges at SanDisk HQ (Milpitas, 2025)

As of Q2 2025, SanDisk is navigating a **fragile recovery** in the NAND flash market. The **Milpitas HQ**, being the central node for global supply planning, is experiencing severe pressure due to:

- **Volatile consumer demand** (smartphones, SSDs, AI servers) → inaccurate forecasts
- **Overcapacity → reduced fab utilization** → underutilized assets
- **Pricing shifts** → SanDisk has announced a >10% NAND price hike (April 2025)
- **Transition to High-Bandwidth Flash (HBF)** → newer SKUs, complex BOMs, and supply bottlenecks – No product historic data
- **Disruption in ocean freight and silicon availability**
- **Split from Western Digital** → reconfiguration of planning systems, data integration, and team workflows

Current planning tools (Excel + i2 (Blue Yonder) /SAP + dashboards) lack:

- Real-time AI inference
- Predictive risk classification
- Connected visibility between demand, inventory, fab/test capacity, and logistics

This project proposes a next-gen AI-powered GSCP model — grounded in **SC 5.0** — to address these issues head-on.

A **Unified Demand Model** is a comprehensive framework that consolidates all forms of demand signals across the supply chain — from customers, channels, markets, and internal sources — into **a single, coherent model** that supports **end-to-end planning and synchronization** - supports **S&OP**, **MPS**, **MRP**, and **ATP** in a consistent way.

Project Goal:

To build a **prototype of Next Gen GSCP framework system** using advanced analytics, ML, and optimization to solve real-world planning inefficiencies across SanDisk's Milpitas operations, specifically tuned to 2025's flash business landscape.

Core Modules (Current vs. Future (with Tech References)

1. Demand Forecasting + Market Signal Integration

- **Current State at Milpitas**: Time-series based planning using SAP i2 & Excel; limited external signal input.
- **Proposed Upgrade**:
    - ML Models: Prophet, LSTM, XGBoost (Amazon Forecast, Google Vertex AI)
    - External signal fusion: import electronics market indices, tariffs, AI server shipment forecasts
    - Rolling horizon forecast with **auto-tuning based on MAPE**
    - **SAP IBP Copilot (SAP Joule)** to analyze transactional deltas + suggest forecast overrides

- Inspired by Amazon's Sage Maker + Adidas case study; Google's Wayfair deployment (Vertex AI pipelines).

2. Unified Data Model (UDM) & Master Data Layer

- **Current State**: Siloed BOMs, planning inputs, lead times; manual extraction from SAP tables
- **Proposed Upgrade**:
    - UDM built on Python + SQL layer mimicking SAP's digital core
    - Sync BOM, routing, lead times, production cycles into a real-time model
    - Foundation for optimization engines to "see" true constraints

-Inspired by SAP Digital Core, Siemens Xcelerator architecture, and IBM Sterling's master data governance.

3. Capacity + Inventory Optimization (Pyomo + Gurobi)

- **Current State**: Capacity planning manually driven through i2 & Excel simulations

- **Proposed Upgrade**:
  - MILP models to dynamically optimize lot sizes, wafer allocation, and test scheduling
  - Integrates constraints like fab downtime, forecasted demand, and holding/backorder costs

-NVIDIA uses similar AI planning for silicon wafer alignment across their fabs.

4. Shortage & Supplier Risk Prediction (ML Classifier)

- **Current State**: Shortage risk is reactionary — flagged only after issue
- **Proposed Upgrade**:
  - Random Forest + XGBoost models to classify parts with single sourcing + long lead time
  - Input BOM exploded at component level → alert for at-risk SKUs
  - Automate weekly exception dashboards via Power BI

-Intel's predictive risk analytics and Lenovo's IBM-powered visibility inspired this.

5. Logistics Network Optimization Using AI

- **Current State**: Static routing via TMS; no proactive exception detection
- **Proposed Upgrade**:
  - Use **AI-based network design** (AWS/Amazon's last-mile and OTD strategy) to optimize:
    - Ocean vs. air freight prioritization
    - Supplier consolidation routes
    - Predictive lead time classification
  - KPI focus: OTIF (On Time In Full), backlog %, delivery window adherence

-DHL's AI-driven robotics + IBM's scope 3 emissions reduction via TMS data used as blueprints.

Key Supply Chain 5.0 Features Incorporated (with Real-World Inspiration)

SC 5.0 Feature	Real-World Implementation
Human-AI Collaboration	**SAP Joule Copilot** – AI-generated insights for planners
Sustainability & Emissions	**IBM + DHL** – Scope 3 emissions using TMS + smart transport
Unified Decision Models	**Siemens + SAP** – Xcelerator + Control Tower UDM
Cognitive Automation	**Deloitte Cognitive SC** – AI assistants for predictive planning
Digital Twins	**NVIDIA Omniverse** – Real-time fab simulation and capacity bottleneck prediction
Pattern-Based Forecasting	**Amazon Forecast** – External market signal injection
ERP-to-AI Integration	**SAP IBP + Vertex AI** – linking transactional data with optimization engines

Expected Results by August 2025 (Q2 End):

Challenge	Solved By	Outcome
Inaccurate NAND/HBF demand plans	ML-based forecast + SAP Joule overrides	↑ Fill Rate, ↓ Inventory obsolescence
Fab/test bottlenecks & underutilization	MILP optimization	↑ Capacity Utilization, ↓ Backorders
SKU-level shortages	ML-based risk classification	Proactive alerts → ↓ Expedited costs
Ocean freight/logistics risk	AI-driven routing	↑ OTIF, ↓ Transit cost variance
Manual reporting inefficiencies	Power BI + SAP CoPilot	↓ Planner effort by 40%
Strategic agility vs. Samsung	Pattern-driven forecasts + sustainability KPI	Competitive edge in cost + carbon footprint

Industry 4.0 vs 5.0 at Japan Plants: Current & Proposed Digital Foundation

Current State (Industry 4.0)

- MES + SAP i2 used
- Basic sensor data + fab control systems
- No live digital twin or AI-enabled decision support

Proposed Shift (Industry 5.0)

- Use Digital Twin (via Python or NVIDIA Omniverse model)
  - Simulate fab output vs. forecast error → real-time feedback
  - Integrate fab downtimes into optimization models
- SAP IBP Copilot layer for Gen AI planning
- Real-time inventory tracking via ML models + IOT feed

Recommended Tools & Technologies for Next-Gen GSCP at SanDisk

Category	**Purpose & Use Case**	**Tools / Models Used**
Forecasting Models	Handle volatility in NAND/HBF demand across global markets	- **Facebook Prophet, Neural Prophet** (quick deployment) - **ARIMA, SARIMA, SARIMAX** (short-term forecast tuning) - **Temporal Fusion Transformer (TFT)** – time series with attention for HBF ramp-up
Machine Learning Models	Shortage risk classification, lead time prediction, demand-supply mismatch detection	- **XG Boost, Light GBM, Random Forest** (fast + interpretable) - **Gradient Boosted Trees** for feature interaction modeling
Deep Learning Models	Detect hidden patterns in demand + capacity fluctuations	- **LSTM, GRU, RNN** – long-sequence memory - **Transformer-based models** for multi-variate time series
AI/ML Platforms	End-to-end AI-powered planning platforms for real-time planning	- **SAP IBP + SAP Joule Copilot** (existing at SanDisk) - **Kinaxis Rapid Response** (event-based, demand-supply alignment) - **Blue Yonder (JDA)** (used by Western Digital before split) - **Anaplan** (scenario modeling for exec-level S&OP)

Category	Purpose & Use Case	Tools / Models Used
Digital Twin + Simulation	Simulate fab/test output and bottlenecks, model impact of Kioxia capacity shifts	- **NVIDIA Omniverse** (visual + ML-enabled twins) - **Any Logic** (discrete + agent-based SCM sim) - **Flex Sim / Promodel** (plant-level what-if analysis)
Supply Chain Optimization	Optimize lot sizing, fab utilization, test/burn-in balancing	- **Gurobi, CPLEX, Pyomo** (MILP/LP for inventory-capacity balancing) - **What-if Scenario Planners** (SAP IBP, Anaplan embedded)
Real-time Forecasting / Demand Sensing	Ingest POS, eComm, ODM order signals for short-term planning	- **Streaming analytics** via **Kafka, Spark Structured Streaming** - **Demand sensing engines** from **Kinaxis / SAP** - **AWS Forecast or Google Cloud Vertex AI pipelines**
Data Processing + ETL	Clean, enrich, and merge master data from SAP, Kioxia feeds, and planning teams	- **Python (Pandas, NumPy)** - **SQL (Oracle, SAP HANA)** - **Apache Spark**, **Airflow** for scheduling - **Data Lake connectors (AWS Glue, GCP DataPrep)**
Visualization & Reporting	Planner-facing dashboards, shortage alerts, capacity trend views	- **Power BI** (used by SanDisk) - **Tableau** (for rapid dashboard builds) - **Explainable AI Dashboards** (SHAP, LIME) for model transparency
Model Evaluation Metrics	Validate models for reliability + cost impact	- **MAPE, RMSE, MAE** (forecast accuracy) - **Forecast Value Add (FVA)** – planner vs. model ROI - **Service Level Impact, Inventory Turns, Fill Rate**
AI Assistants & Gen AI	Planning copilots, summary generation, forecast commentary	- **SAP Joule (GenAI Copilot for IBP)** - **LLM-based tools for "Why forecast changed?"** - **ChatGPT / Vertex AI Gen Apps** (summarizing exception reports)

How this Project Strengthens GSCP Under the Kioxia JV

#	Challenge	Your Project's Solution	Strategic Impact
1	Limited fab data visibility	Build a **digital twin** using inferred fab metrics (cycle times, yield, downtime)	Simulate and anticipate fab-side delays; better planning accuracy
2	Inaccurate forecast commitments – due to internal MP changes	Use **ML models** (Prophet, LSTM, XGBoost) with internal + external signals	Improves demand commit accuracy; reduces over/under allocation from JV
3	No proactive shortage alerts	Develop **risk classification model** for at-risk SKUs (lead time, BOM, sourcing)	Enables early mitigation and alternate sourcing
4	Capacity mismatch risk	Optimize production with **MILP (Gurobi, Pyomo)** considering fab constraints	Balances wafer supply vs. demand and reduces scrap/backorders
5	Disconnected planning collaboration	Automate insights with **Power BI + SAP Joule** copilots	Real-time visibility, faster decisions, fewer manual errors
6	Competitor edge (e.g., Samsung's vertical integration)	Integrate AI + digital tools to **match or exceed** SC responsiveness	Builds a smarter, agile GSCP despite shared manufacturing model

SanDisk Supply Chain: Upstream vs. Downstream

Flow	Example Companies / Partners	Push / Pull System	Where this Project Helps
Upstream (Suppliers)	- **Kioxia** (JV fab partner)- **ASE** (assembly & test)- **Tokyo Electron** (fab equipment)- **Wafer/material vendors** (e.g., SUMCO, Shin-Etsu)	**Push System**(SanDisk forecasts → suppliers push inventory)	- Predict fab lead times using ML- Simulate wafer delays via digital twin- Classify BOM parts with supplier risk- Optimize upstream buffer levels using MILP
Downstream (Customers & Distribution)	- **OEMs** (e.g., Dell, Lenovo)- **Retailers** (e.g., Best Buy, Amazon)- **Channel distributors** (e.g., Ingram Micro)- **eCommerce** (WD/SanDisk.com)	**Pull System**(Customer demand pulls inventory from DCs/factories)	- Forecast demand using LSTM/XGBoost models- Allocate supply based on market/channel trends- Visualize stockouts & OTIF risk in Power BI

Push vs. Pull in SanDisk's Next-Gen Product Strategy (HBF, BiCS NAND)

Stage	Push or Pull?	Role of ATO & MRP	My Project's Strategy
Wafer Fabrication (Kioxia JV)	**Push**	Based on **forecasted wafer demand**, SanDisk places fab orders in advance using long-term capacity planning. MRP schedules wafer input based on future assembly needs.	- ML-based **demand forecasting** (Prophet, LSTM)- Simulate fab constraints with **digital twin**- MILP to optimize fab output by layer node (e.g., 112L, 162L)- Risk classification for wafer supply shortage
Component Procurement (Controllers, Substrates)	**Push**	Purchased in anticipation of final assembly needs. MRP explodes demand from planned finished goods.	- Use BOM explosion to forecast sub-component needs- Classify risky parts (e.g., single-source) using ML- Optimize buffer inventory based on shortage risk
Assembly & Packaging	**Pull (ATO)**	SanDisk operates on an **Assemble-to-Order** basis: products are assembled after customer demand is known, based on pre-positioned wafers and components. MRP ensures sub-assemblies are staged ahead of time.	- Align **MRP with ML forecasts** for better staging- Visualize real-time inventory vs. demand match in Power BI- Forecast SKU-level demand using market signals- Gen AI to suggest schedule overrides
Order Fulfillment & Logistics	**Pull**	Orders are fulfilled post-assembly based on demand from OEMs or retail. Planning here is demand-driven and sensitive to delivery performance (OTIF).	- Predict OTIF risk and logistics delays using AI- Route optimization (logistics network AI)- KPI dashboards to track customer service metrics

Bullwhip Effect at SanDisk – Summary & Project Mitigation

Aspect	Explanation
What is the Bullwhip Effect?	A supply chain phenomenon where small changes in customer demand cause increasingly larger demand fluctuations upstream (e.g., fab, suppliers), leading to inefficiencies.

SanDisk-Specific Bullwhip Scenarios & Project Solutions

Supply Chain Layer	Bullwhip Scenario at SanDisk	My Project's Solution
Retail / OEM Demand	Sudden spike in SSD demand (e.g., AI laptops) leads to aggressive OEM ordering	ML forecasting (LSTM, XGBoost) reduces forecast error and overreaction
Assembly & Packaging	Excess build orders for BiCS NAND or controllers based on outdated demand	Unified Data Model aligns real-time demand with component planning
Wafer Fab (Kioxia JV)	Overordering wafers for older node (e.g., 112L) while demand shifts to 162L	Digital twin simulates fab output + MILP optimizes wafer allocation
Raw Material Suppliers	Excess raw material orders from perceived shortages upstream	Supplier risk model + lead time prediction avoids panic ordering

Overall Project Impact

Result	Benefit to SanDisk GSCP
↓ Demand Amplification	More stable ordering across supply chain tiers
↓ Inventory Costs	Avoids overstock and obsolete inventory
↑ Service Levels	Better product availability for customers
↑ Planning Accuracy	Less rework, smoother fab-to-assembly flow

SanDisk Supply Chain Planning Intern – 2025 Action Plan Summary

Objective	**Action**	**Value to SanDisk**	**Trends Impacting This Area**
1. Analyze Supply Chain Data	Extract and analyze demand, inventory, and production data for flash memory	Identify inefficiencies and improve visibility during volatile market shifts	Shift from overproduction to lean planning due to **global NAND oversupply** and **tariff pressures**
2. Improve Demand Forecasting	Build or support forecasting models using time series or ML	Enhance forecast accuracy to align production with real-world demand	Recovery in **NAND pricing**, volatile **consumer electronics demand**, **AI workload growth**
3. Optimize Inventory & Capacity	Use LP/IP models to suggest optimal fab utilization and inventory levels	Balance cost, capacity, and revenue across BiCS node layers	Production focus shifting to **112/162-layer optimization**, fab cuts, and **price stabilization goals**
4. Automate & Visualize Processes	Build KPI dashboards, automate reporting workflows	Enable real-time decision-making and reduce manual effort	Increased need for **agile dashboards** and **data-driven ops** in response to industry volatility
5. Support Strategic Projects	Research competitor trends, contribute to planning for HBF adoption and fab node strategies	Provide actionable insights to strengthen SanDisk's competitive edge	Rise of **High-Bandwidth Flash (HBF)**, pressure to innovate against **218+ layer competition**

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- **LLMs – 4.0 model to give final formatted data.**

Concept	Definition & Use	Formulas / Methods	Key Variables	Application to SanDisk SCP Intern Role
Demand Forecasting	Estimating future product demand based on historical data and trends.	- Moving Average: $F = \frac{D_1+D_2+...+D_n}{n}$ - Exponential Smoothing: $F_t = \alpha D_{t-1} + (1-\alpha)F_{t-1}$ - Linear Regression: $Y = a + bX$	D: Demand F: Forecast α: Smoothing constant	Improve forecast accuracy for Flash memory demand using Python, Excel, or ML models to optimize production and avoid over/understocking.
Aggregate Planning (APP)	Medium-term (6–18 months) balancing production rate, inventory, and workforce levels.	Chase, Level, Hybrid strategies	N/A	Align capacity and inventory at SanDisk's fabs in Milpitas based on market forecasts and global supply trends.
Master Production Scheduling (MPS)	Weekly schedule to produce finished goods as per forecast and demand.	Outputs: Weekly planned production	- MPS - Forecast - Inventory levels	Supports translating demand forecasts into weekly fab production plans for NAND wafers or SSDs.
Material Requirements Planning (MRP)	Determines raw material and component needs based on BOM and lead time.	Inputs: MPS, BOM Output: Planned order schedule	- Lead Time - Inventory status - BOM	Helps ensure timely supply of critical components for Flash memory manufacturing.

	levels.			global supply trends.
Master Production Scheduling (MPS)	Weekly schedule to produce finished goods as per forecast and demand.	Outputs: Weekly planned production	- MPS - Forecast - Inventory levels	Supports translating demand forecasts into weekly fab production plans for NAND wafers or SSDs.
Material Requirements Planning (MRP)	Determines raw material and component needs based on BOM and lead time.	Inputs: MPS, BOM Output: Planned order schedule	- Lead Time - Inventory status - BOM	Helps ensure timely supply of critical components for Flash memory manufacturing.
Lot Sizing / EOQ	Decides how much to order to minimize inventory cost.	EOQ: $\sqrt{\frac{2DS}{H}}$ Total Cost: $DC + \frac{D}{Q}S + \frac{Q}{2}H$	D: Demand S: Setup/order cost H: Holding cost Q: Order qty	Minimize holding/ordering cost of inventory at SanDisk's supply chain nodes (e.g., fabs or logistics hubs).
Reorder Point (ROP)	Inventory level at which to reorder to avoid stockouts.	ROP: $d \times L$	d: Daily demand L: Lead time	Set smart reorder thresholds for critical raw materials in volatile demand scenarios.
Total Inventory Cost	Sum of all inventory-related costs.	$TC = DC + \frac{D}{Q}S + \frac{Q}{2}H$	Same as EOQ variables	Supports evaluating cost impact of inventory strategies, helping to optimize warehouse use.
Capacity Planning	Ensures sufficient resources (labor/machines/time) to meet demand.	Utilization = $\frac{\text{Actual Output}}{\text{Capacity}} \times 100\%$	Output, Capacity, Time	Help adjust capacity planning models during production slowdowns or demand surges.
ABC Analysis	Prioritizes items in inventory based on usage value.	A = High control B = Med[illegible] C = Low	Item cost & consumption	Identify high-value NAND components or SKUs requiring tighter inventory management

📘 ISE 230 Concepts with Formulas & SanDisk Application

Topic	Key Concept & Formula	Variables	Application to SanDisk GSCP
Linear Programming (LP)	Maximize or Minimize: $Z = c_1x_1 + c_2x_2 + \cdots + c_nx_n$ Subject to: $a_{11}x_1 + a_{12}x_2 + \cdots \leq b_1$ $x_i \geq 0$	Z: Objective (e.g., cost, profit) x_i: Decision variables c_i: Coefficients a_{ij}: Constraint coefficients b_i: RHS	Optimize production plans across multiple fabs and products to minimize cost or maximize throughput.
Sensitivity Analysis	Shadow Price: Change in Z per unit increase in RHS. Allowable range = stable zone for objective coefficients.	RHS: Right-hand side of constraint Shadow price: Dual value	Helps understand how much capacity or demand can vary before your supply chain plan becomes suboptimal.
Transportation Problem	Minimize: $\sum_{i=1}^{m}\sum_{j=1}^{n} c_{ij}x_{ij}$ Subject to: $\sum_j x_{ij} = a_i$, supply $\sum_i x_{ij} = b_j$, demand	c_{ij}: Cost from source i to destination j x_{ij}: Units shipped a_i, b_j: Supply & demand	Optimize shipping of NAND wafers from fabs to global DCs to reduce cost & lead time.
Integer Programming	Same as LP, but with $x_i \in \mathbb{Z}$ or $x_i \in \{0, 1\}$	Binary: 0/1 (Yes/No) decisions	Solve supplier selection problems or production facility location decisions where partial assignments aren't allowed.

Markov Chains	Transition Matrix: P Steady state: $\pi P = \pi$, with $\sum \pi_i = 1$	π: Steady-state probabilities P: Transition probabilities	Model product lifecycle transitions (e.g., Intro → Growth → Maturity) or machine reliability in fabs.
Queuing Theory (M/M/1)	Utilization: $\rho = \frac{\lambda}{\mu}$ Avg # in system: $L = \frac{\lambda}{\mu - \lambda}$ Avg wait time: $W = \frac{1}{\mu - \lambda}$	λ: Arrival rate μ: Service rate ρ: Utilization	Model wafer test station usage to avoid bottlenecks and reduce fab cycle time.
Poisson Distribution	$P(X = k) = \frac{(\lambda t)^k e^{-\lambda t}}{k!}$	λ: Event rate t: Time window k: # of events	Model arrival of customer orders, breakdowns, or late shipments.
Project Management (CPM)	Critical Path = longest duration path in the network Slack = Latest Start - Earliest Start	Activities, durations, dependencies	Optimize global product launch plans (e.g., BiCS layer transitions or SSD ramp-ups).