

AI-powered recommendation tool: Supplementing ISE 519 (Database Applications in Industrial and Systems Engineering)

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1. Applications of SQL and Power BI in industry

Supply Chain Management

- Reorder Point Analysis: SQL retrieves sales, lead times, and current stock to calculate when new orders should be placed. Power BI automates alerts and dashboards for planners.
- Safety Stock Optimization: SQL models variability in demand and supply; Power BI visualizes safety stock trade-offs (cost vs. service levels).
- Forecast Accuracy Tracking: SQL compares forecasted demand with actual consumption. Power BI visualizes Mean Absolute Percentage Error (MAPE) trends across SKUs, plants, or regions.
- Obsolescence & Excess Stock: SQL flags low-demand SKUs, while Power BI highlights aging inventory and carrying cost implications for finance teams.
- Order Fulfillment Tracking: SQL queries retrieve order statuses from ERP systems, helping identify late shipments, backorders, and pending approvals. Power BI dashboards visualize fulfillment rates across regions or customer segments.
- Transportation & Logistics: SQL integrates shipment data (carrier performance, freight costs, delivery times). Power BI maps highlight route delays, carrier reliability, and opportunities for consolidation.
- Supplier Management: SQL enables monitoring of supplier lead times, defects, and pricing changes. Power BI dashboards generate supplier scorecards for vendor comparison and contract negotiations.
- Warehouse Operations: SQL queries on warehouse transactions (put-aways, picks, cycle counts) provide granular inventory visibility. Power BI highlights slow-moving vs. fast-moving SKUs, space utilization, and picking efficiency.

Manufacturing Operations

- Machine Utilization & Downtime: SQL queries from MES logs identify machine idle times, setup times, and breakdown frequencies. Power BI visualizes uptime vs. downtime by machine or line.
- Production Throughput: SQL aggregates production volumes per shift, operator, or machine. Power BI dashboards highlight throughput variance against targets.
- Quality Control: SQL queries extract defect logs, rework orders, and scrap counts. Power BI trends defect rates by process, product family, or operator.
- Predictive Maintenance: SQL stores IoT sensor data (temperature, vibration). Power BI visualizes anomalies, enabling proactive maintenance scheduling.
- Workforce Productivity: SQL consolidates labor hours per job or shift. Power BI visualizes operator efficiency, overtime trends, and labor cost contribution per unit.

Process Improvement & Lean Initiatives

- Bottleneck Identification: SQL merges process times from ERP. Power BI highlights which steps delay throughput, enabling line balancing.
- Cycle Time Reduction: SQL captures time stamps for production stages. Power BI visualizes process cycle times against takt time.
- Cost Analysis: SQL integrates raw material costs, scrap, and labor inputs. Power BI highlights cost overruns by department or product line.
- Six Sigma Projects: SQL supports data extraction for DMAIC phases. Power BI creates real-time dashboards to monitor defect reduction progress.
- Kaizen Tracking: SQL maintains continuous improvement logs. Power BI visualizes savings achieved, project timelines, and employee participation.

Executive Reporting

- Cross-Functional KPI Consolidation: SQL extracts KPIs from finance, supply chain, and production systems. Power BI presents a unified scorecard for executives.
- Financial & Operational Dashboards: SQL queries link cost data to operational metrics. Power BI enables CFOs to see cost per unit, ROI on capital assets, and budget adherence.
- Strategic Planning: SQL models historical trends in demand, capacity, and costs. Power BI helps executives simulate expansion scenarios or evaluate “what-if” cases.
- Regulatory & Compliance Reporting: SQL retrieves audit trails from ERP/WMS systems. Power BI generates compliance dashboards for ISO, OSHA, or industry-specific standards.
- Board-Level Storytelling: SQL feeds consolidated KPIs; Power BI turns them into executive-friendly visuals showing growth, risks, and strategic opportunities.

2. Industry Insights and Pain Points

To ensure the AI-powered recommendation tool is not only academically useful but also industry-relevant, research was conducted into common challenges and pain points faced by professionals and alumni when applying SQL and Power BI in real-world settings. This exploration helps bridge the gap between classroom learning and industry practice by identifying where students typically struggle once they enter the workforce.

By translating these pain points into targeted tool features such as providing practice datasets with formatting errors, duplicate entries, and missing values, offering optimized SQL query examples to process and clean the data efficiently, and providing ready-to-use KPI dashboard templates to visualize insights effectively, the AI tutor equips students to tackle the full data workflow encountered in professional environments. In this way, the tool transforms academic exercises into practical, hands-on learning experiences, helping

students develop the skills and confidence necessary to analyze, visualize, and draw actionable insights from real-world industrial data.

After researching SQL and Power BI applications in industry settings and gathering feedback from alumni working in supply chain, manufacturing, logistics, and consulting, several clear themes emerged. These insights highlight not only where these tools are applied but also the recurring challenges that limit their effectiveness in practice.

Below are the common pain points with using SQL in industry:

Time-Consuming Data Cleaning and Standardization

Across industries, SQL is heavily relied upon for cleaning and standardizing data from multiple systems, such as ERP, MES, WMS, and carrier platforms. Shipment records, supplier data, and production logs often come in inconsistent formats, making SQL the first step in ensuring data quality. Power BI then adds value by visualizing performance trends, such as carrier reliability, supplier defect rates, or production delays. The challenge lies in the significant time spent preparing and transforming data, which often overshadows the actual analysis and decision-making process.

Incomplete or Messy Data

SQL is commonly used to extract consumption history, calculate reorder points, and determine safety stock levels. This structured approach supports better demand forecasting and replenishment planning. Power BI dashboards allow planners to visualize demand fluctuations and run “what-if” scenarios to balance inventory with service levels. However, real-world data is often incomplete, contains null values, or requires complex joins - issues that students rarely encounter in academic exercises but are routine in industry.

Complex Data Integration

In logistics, SQL supports the consolidation of shipment data and carrier invoices, enabling cost-per-mile calculations and transit time analysis. Power BI dashboards provide visibility into freight spend, delivery performance, and hidden cost drivers. These insights often lead to supplier negotiations or redesigned routing strategies. The difficulty lies in the technical complexity. Analysts need advanced SQL skills to handle joins across large transactional datasets and optimize queries for performance.

Fragmented Systems

SQL is widely applied to analyze shop-floor data, including downtime logs, defect counts, and machine utilization. Power BI dashboards are then used to track Overall Equipment Effectiveness (OEE), scrap and rework trends, and throughput by line or shift. Similarly, supplier quality data can be queried to identify high-defect sources and track parts-per-million (PPM) performance across plants. The recurring barrier here is the fragmentation of data across multiple systems, making integration into a single reporting view challenging.

Lack of Standardization

At the executive and consulting level, SQL and Power BI are central to building cross-functional scorecards and KPI dashboards. These tools are used to merge financial, operational, and customer data, providing leaders with actionable insights. Typical applications include supplier performance scorecards, freight cost optimization, predictive maintenance, and customer service analytics. The common challenges include lack of standardized KPI templates, limited proficiency in advanced Power BI (e.g., DAX formulas, drill-through analysis), and excessive reliance on manual data pulls.

3. Industry Scenarios and Typical KPIs

A central component of the AI-powered recommendation tool will be a curated repository containing realistic industry scenarios and typical KPI metrics. This repository will include examples from supply chain, manufacturing operations, and logistics. Each scenario will be paired with relevant SQL queries and Power BI visualizations, allowing students to explore how data is used to monitor performance and support decision-making. By providing structured, hands-on examples, the repository ensures that students can practice applying course concepts in contexts that mirror actual industry challenges.

Inventory Turnover Analysis

SQL Task: Query historical inventory and sales data to calculate turnover ratios.

Power BI KPI Metrics: Inventory Turns, Days of Inventory on Hand, Stockout Frequency, Safety Stock Levels.

On-Time Delivery Tracking

SQL Task: Extract shipment and order data, calculate delivery delays.

Power BI KPI Metrics: On-Time Delivery Rate (OTD), Average Transit Time, Late Shipment Count, Carrier Performance Score.

Demand vs. Supply Analysis

SQL Task: Combine historical demand data with production or supplier data.

Power BI KPI Metrics: Forecast Accuracy, Fill Rate, Backorder Levels, Lead Time Variability.

Overall Equipment Effectiveness (OEE) Monitoring

SQL Task: Aggregate machine uptime, downtime, and production output data.

Power BI KPI Metrics: OEE %, Machine Utilization, Downtime by Machine/Shift, Scrap Rate.

Defect and Quality Tracking

SQL Task: Query production logs to count defects, categorize by type or supplier.

Power BI KPI Metrics: Defect Rate, Parts Per Million (PPM), Supplier Defect Contribution, Rework Percentage.

Production Throughput Analysis

SQL Task: Analyze completed units over time, by production line or shift.

Power BI KPI Metrics: Units Produced per Hour, Cycle Time, Bottleneck Identification, Capacity Utilization.

Freight Cost Optimization

SQL Task: Consolidate carrier invoices, calculate cost-per-mile, identify outliers.

Power BI KPI Metrics: Average Freight Cost per Shipment, Cost Variance by Carrier, Accessorial Charge Frequency, Route Efficiency.

Warehouse Operations and Space Utilization

SQL Task: Extract WMS data on stock location, pick/pack/ship times.

Power BI KPI Metrics: Warehouse Utilization %, Order Picking Accuracy, Cycle Time, Inventory Accuracy.

Supplier Performance Scorecards

SQL Task: Combine supplier delivery, quality, and pricing data.

Power BI KPI Metrics: Supplier On-Time Delivery %, Defect Rate, Cost Variance, Lead Time Compliance.

4. Next Steps

AI Tool Design & Development

- Design an interactive OpenAI-powered tool accessible via a web interface.
- Program the tool to answer queries such as: “Where can I apply SQL in inventory management?”, “Show me how to build a dashboard to track on-time delivery.”, “Provide a sample data file to practice complex joins.”
- Ensure the tool provides clear, actionable steps, including code snippets, database structures, and Power BI dashboard examples.

Pilot Testing & Integration

- Pilot the AI tool with a selected group of ISE 519 students.
- Collect user feedback on usability, relevance, and practicality.
- Refine the tool’s recommendations and expand its database of scenarios.
- Develop clear integration guidelines for instructors to introduce the tool as a supplemental resource for coursework and projects.