IoT to Business Intelligence: End-to-End Data Pipeline Research Roadmap

A comprehensive plan for Research Session #2, connecting IoT sensor data to business intelligence dashboards through a complete data pipeline.

Session Start: Resource Allocation & Goal Setting

Power BI Learning Track (PL-300)

- Watch 1-2 PL-300 preparation videos
- Study guide section review
- Document questions and interests

Mind Mapping

- Create structured knowledge map
- Use Miro, Whimsical, or paper
- Identify knowledge gaps

Set Clear Objectives

Build a complete proof-of-concept pipeline that transforms IoT sensor data into actionable business intelligence

Starting with focused learning objectives helps ensure your technical implementation meets real business requirements.

Mind Mapping Your Power BI Knowledge

Data Sources

SQL Server, Excel, web APIs, IoT streams

Power Query

Transformations, cleaning, merging

Data Model

Relationships, hierarchies, star schema

DAX

Measures, calculated columns, time intelligence

Visualization

Chart types, formatting, interactive features

Publishing

Workspace, apps, sharing, security

This structured approach ensures comprehensive coverage of Power BI concepts needed for your end-to-end implementation.

Knowledge Capture Strategy

Content Creation

Develop Gamma slide decks for each key concept, focusing on:

- Core principles with visual examples
- Implementation considerations
- Integration points with other components

These artifacts will serve as teaching tools and documentation for your project.

AI-Assisted Learning

Use AI tools to enhance your learning:

- Feed complex concepts to Gemini/ChatGPT
- Generate concise learning notes
- Create technical summaries for documentation
- Identify potential implementation challenges

Documenting as you learn ensures knowledge retention and creates shareable assets for your team.

Dataset Development Strategy

Micro Scale (Arduino)

Begin with simulated sensor data from Arduino - temperature, pressure, or vibration readings at regular intervals

Data Pipeline

Develop ETL process to move sensor data into structured database with appropriate schema design

Macro Scale (Automotive)

Scale to manufacturing context with shipments, driver data, factory metrics, and logistics information

This approach demonstrates both technical proof-of-concept and real-world business application in manufacturing analytics.

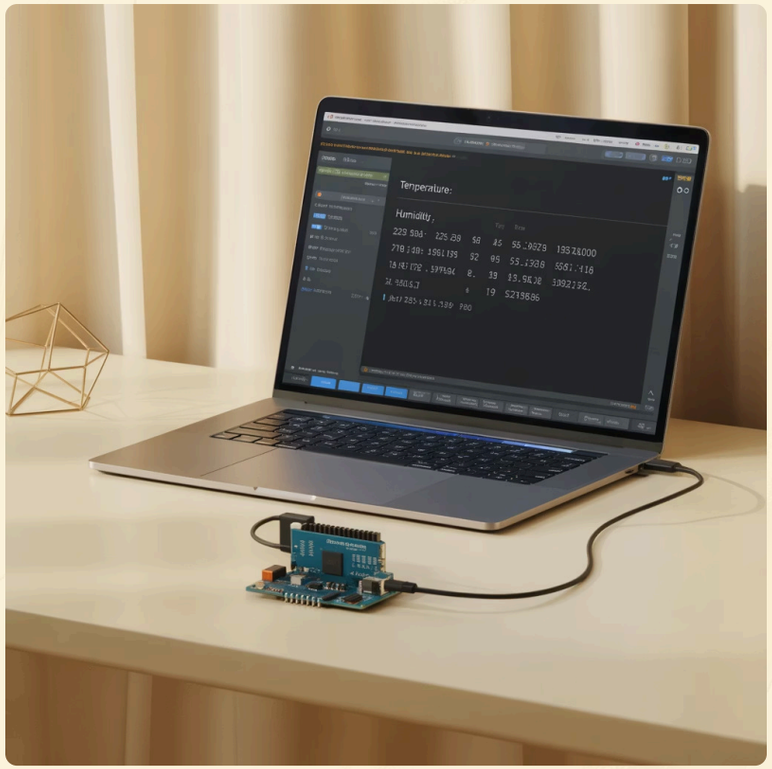
Deep Dive Exploration: Building the Pipeline

IoT → Database → Business Intelligence

Arduino Sensor Setup

The foundation of your data pipeline starts with Arduino-generated data:

- Generates random values (1-100) every 5 seconds
- Outputs via serial connection
- Simulates real-world sensor readings
- Pre-configured code ready for implementation



This hardware setup forms the data origination point that will feed your entire pipeline.

Python ETL Component

1

Serial Port Reading

Configure Python script to read from Arduino's serial port (COM3 or /dev/ttyACM0)

```
import serial
arduino = serial.Serial('COM3', 9600, timeout=1)
raw_data = arduino.readline().decode('utf-8').strip()
```

2

Data Processing

Parse incoming data and prepare for database insertion

```
timestamp = datetime.now()
value = int(raw_data) if raw_data.isdigit() else None
```

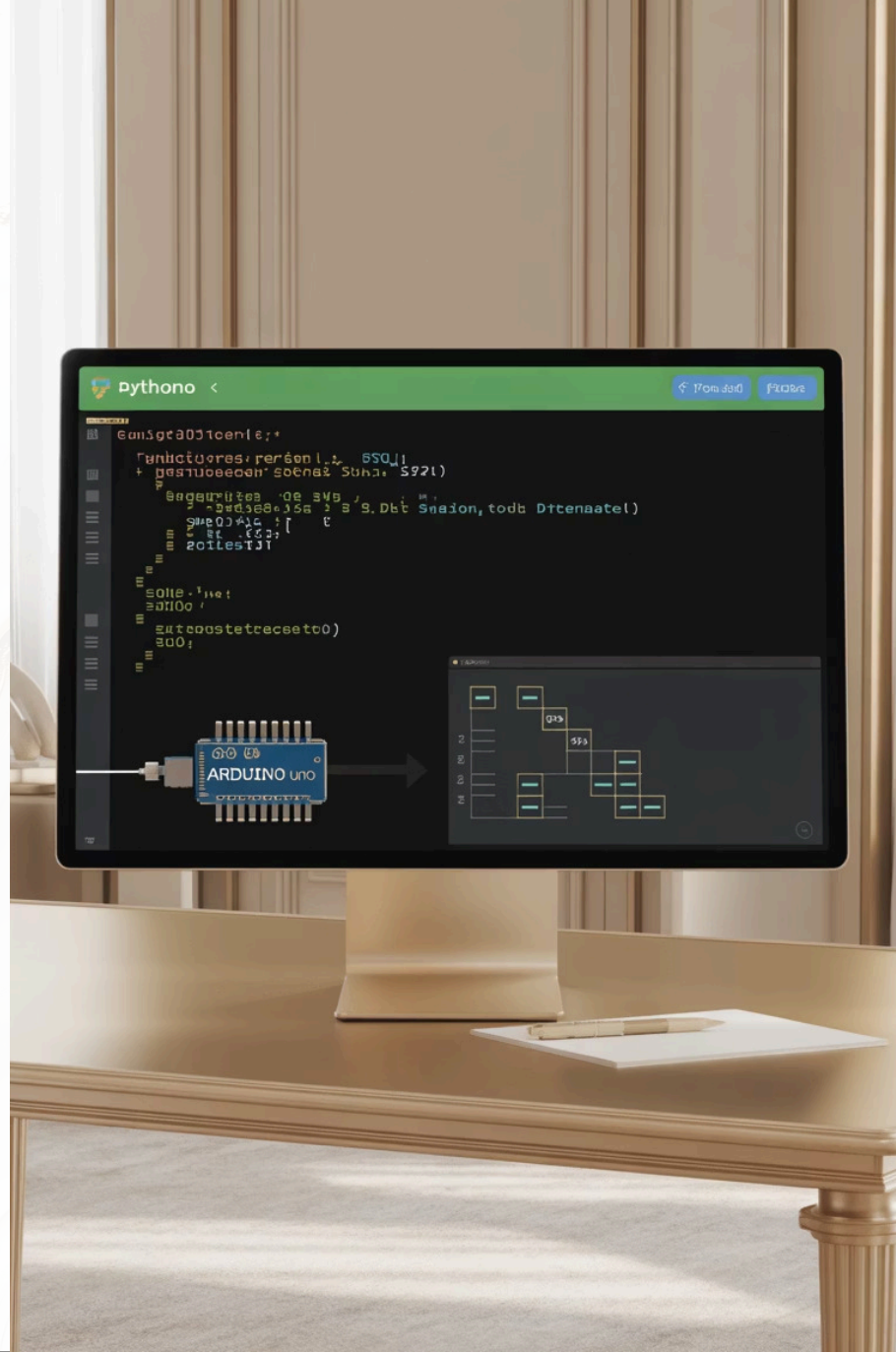
3

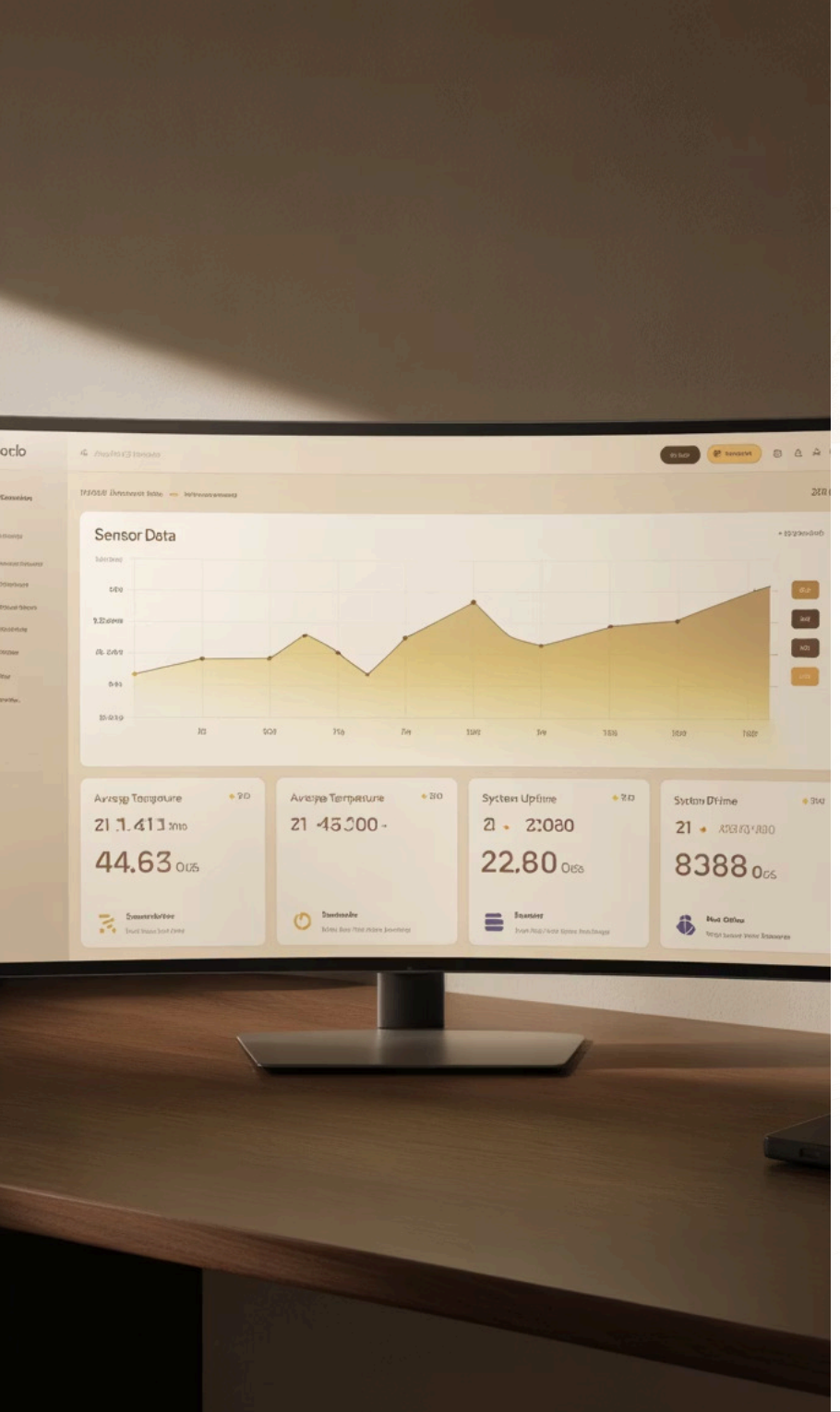
SQL Server Insertion

Connect to database and insert processed records

```
cursor.execute("""
INSERT INTO SensorData (Timestamp, Value)
VALUES (?, ?)""", (timestamp, value))
```

This Python component bridges the physical sensor world with your data storage layer.





Power BI Dashboard Development

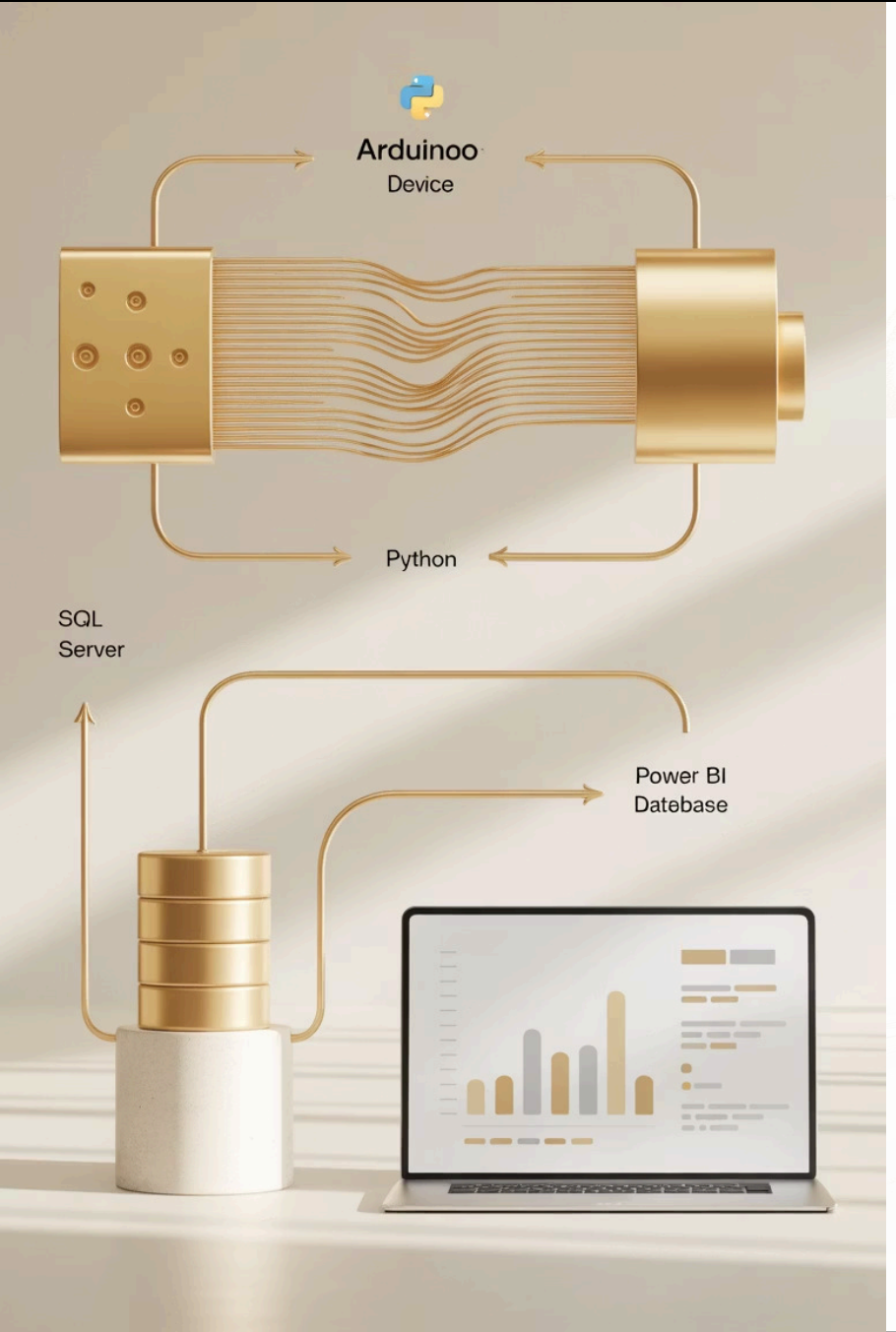
Database Connection

- Connect to SQL Server instance
- Configure data refresh settings:
  - DirectQuery for real-time monitoring
  - Scheduled refresh for historical analysis
- Apply transformations in Power Query if needed

Dashboard Elements

- Real-time line chart showing sensor values over time
- KPI cards displaying:
  - Current value
  - Average over last hour
  - Min/max readings
- Alert indicators for values outside thresholds

This completes your proof-of-concept: a full IoT → DB → BI pipeline with real-time visualization.



Complete Architecture Overview

Data Generation

Arduino generates simulated sensor data (temperature, pressure, etc.) and transmits via serial connection

ETL Layer

Python script reads serial data, processes values, and inserts records into SQL Server database

Data Storage

SQL Server hosts SensorData table with Id (PK), Timestamp, and Value columns in normalized schema

Visualization

Power BI connects to SQL Server to create interactive, real-time dashboards for monitoring and analysis

This architecture provides a blueprint for industrial IoT implementations that can scale to enterprise needs.

Documentation & Deliverables

Project Tutorial Components

Gamma Slide Deck

- Visual step-by-step implementation guide
- Architecture diagrams and screenshots
- Troubleshooting section for common issues

GitHub Repository

- Arduino sketch file (.ino)
- Python ETL script (.py)
- SQL setup scripts for table creation
- Power BI template file (.pbit)

Medium Article

- Narrative tutorial with implementation context
- Business value explanation
- Extension opportunities for real-world use

Copiloters Notes

- Concise step-by-step instructions
- Command reference for quick implementation
- Debugging tips for common errors

These tutorial components ensure your project is accessible to various technical audiences.

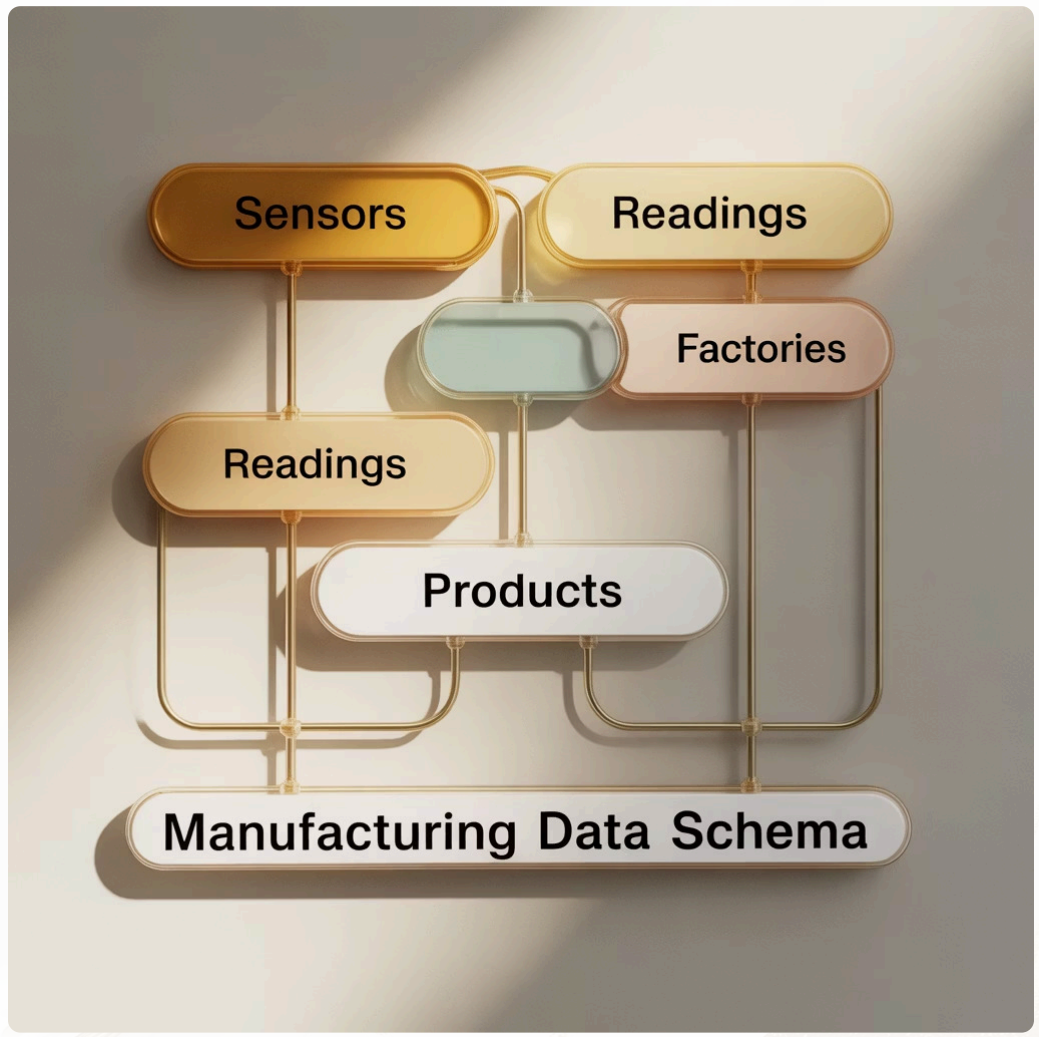
Research Documentation Plan

Formal Research Paper

Structure for OSF/Zenodo publication:

- **Abstract:** Overview of IoT-to-BI workflow
- **Methods:** Hardware setup, pipeline architecture, database design
- **Results:** Performance metrics, dashboard capabilities
- **Discussion:** Manufacturing digital transformation implications
- **Conclusion:** Future work and scaling considerations

Technical Diagrams



Create comprehensive technical documentation:

- ER diagram of complete SQL schema
- Data flow architecture diagrams
- Component interaction maps
- Setup instructions in README.md

Formal research documentation establishes credibility and enables others to build on your work.

Social Media Content Strategy

LinkedIn

Professional post highlighting technical implementation and business value, with project summary and key insights for manufacturing data practitioners

Instagram/TikTok

Short 15-30 second clips showing Arduino sensor in action and real-time dashboard updates, with technical overlay captions explaining the process

YouTube

Comprehensive 5-10 minute tutorial walking through complete implementation from hardware setup to dashboard creation, with narrated explanation

Facebook

Broader community post featuring slide deck screenshots, implementation photos, and discussion of manufacturing analytics applications

Tailoring content to each platform maximizes engagement and reaches different segments of the technical community.

Multilingual Technical Vocabulary Development

Deutsch (German)

- Die Datenbank - database
- Der Sensor - sensor
- Die Visualisierung - visualization
- Das Dashboard - dashboard

Svenska (Swedish)

- Databas - database
- Givare - sensor
- Tillverkning - manufacturing
- Instrumentpanel - dashboard

中文 (Chinese)

- 数据库 (shùjùkù) - database
- 传感器 (chuángǎnqì) - sensor
- 制造 (zhìzào) - manufacturing
- 仪表板 (yíbiǎobǎn) - dashboard

日本語 (Japanese)

- データベース (dētabēsu) - database
- センサー (sensā) - sensor
- 製造 (seizō) - manufacturing
- ダッシュボード (dasshubōdo) - dashboard

Interleaving language learning with technical work creates valuable cross-disciplinary skills for global manufacturing contexts.

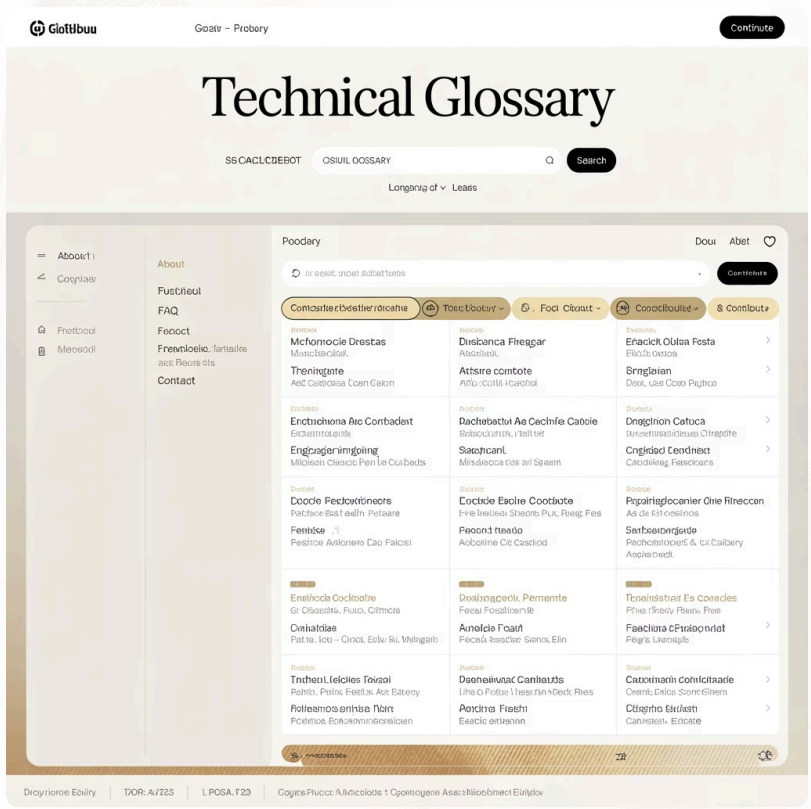
Project Outcomes & Next Steps

Deliverables Checklist

- ✅ Functioning Arduino → SQL → Power BI prototype
- ✅ Complete documentation suite:
  - Gamma slides for visual reference
  - GitHub repo with all code components
  - Medium article explaining implementation
- ✅ Research paper draft for academic publication
- ✅ Social media content package prepared
- ✅ Multilingual technical glossary in GitHub repo

Idea: Multilingual Documentation

Create a GitHub repository with common IoT and BI terminology in all four languages (English, German, Swedish, Chinese, Japanese) to support international implementations.



By session completion, you'll have a functioning proof-of-concept demonstrating the entire IoT → BI pipeline, comprehensive documentation, and multilingual resources to support global implementation.