

TITLE

Design and Evaluation of Prompts for an AI-Based Smart Manufacturing Automation System

AIM

To design prompts for different **prompt types** (Comparative Analysis, Experiential Perspective, Everyday Functioning, Universal Prompt Structures, Prompt Refinements, and Prompt Size Limitations) using a **manufacturing automation use case**, compare responses across different AI tools, and evaluate the prompts using a **Rubrics-based evaluation method**.

EXPLANATION

This experiment focuses on designing effective prompts for an **AI-powered manufacturing automation system** using concepts from **Unit 2 (Prompt Types)** and applying them to a **Unit 5 use case (AI + IoT in Manufacturing)**.

The prompts are tested on different AI tools such as **ChatGPT, Google Gemini, and Microsoft Copilot**, and their responses are evaluated based on **clarity, relevance, technical accuracy, and usefulness**.

PROCEDURE

Scenario:

The manufacturing industry aims to reduce manual monitoring and increase operational efficiency through **automation**. The system uses **IoT sensors, embedded controllers, and AI models** to automate equipment, monitor machine health, and enable predictive maintenance.

Target Audience:

Manufacturing companies in:

- Automotive
- Electronics
- Food Processing

Main Objectives:

- Improve production efficiency by **30%**
- Reduce machinery downtime using **predictive maintenance**

- Enable **real-time monitoring and remote control**
- Reduce **energy consumption** through optimized operations

Selected Use Case:

👉 **AI-based Predictive Maintenance and Smart Manufacturing Automation**

1. Comparative Analysis Prompt

Prompt:

“Compare traditional manual machine monitoring systems with AI-driven IoT-based predictive maintenance systems in manufacturing industries. Analyze them in terms of efficiency, cost, downtime, scalability, and energy consumption.”

Purpose:

To highlight differences between **conventional monitoring** and **AI-powered automation**.

2. Experiential Perspective Prompt

Prompt:

“As a manufacturing plant manager, explain your experience using AI-enabled IoT systems for predictive maintenance. How has automation improved productivity, reduced downtime, and enhanced energy efficiency in your plant?”

Purpose:

To capture insights from a **real-world professional perspective**.

3. Everyday Functioning Prompt

Prompt:

“Explain how AI-based predictive maintenance in factories is similar to how smartphones notify users about battery health or app performance issues in daily life.”

Purpose:

To relate **industrial AI concepts** to **everyday technology** for better understanding.

4. Universal Prompt Structures

a) Simple Explanation with Example

Prompt:

“Explain AI-based predictive maintenance in simple terms with an example from a manufacturing plant.”

b) Step-by-Step Process

Prompt:

“Explain the process of smart manufacturing automation using IoT sensors and AI step by step.”

Purpose:

To ensure clarity, structure, and beginner-friendly explanations.

5. Prompt Refinement

Initial Prompt (Broad):

“Explain AI in manufacturing.”

Refined Prompt:

“Explain how AI combined with IoT improves predictive maintenance and energy efficiency in manufacturing industries, with a real-time example.”

Purpose:

To improve **specificity, relevance, and output quality**.

6. Prompt Size Limitations

Large Prompt Issue:

“Generate a detailed 5000-word report on AI-based smart manufacturing systems.”

Refined Prompt (Chunking):

- *“Generate a 1000-word introduction on AI-based smart manufacturing.”*
- *“Now explain IoT integration and predictive maintenance in 1000 words.”*

Purpose:

To manage **token limits** and improve response coherence.

AI Tool	Strengths	Limitations
ChatGPT	Structured, detailed explanations, technical depth	Slightly verbose
Google Gemini	Concise and fast	Less technical depth
Microsoft Copilot	Business-oriented responses	Limited academic explanation

Criteria	ChatGPT	Gemini	Copilot
Clarity (5)	5	4	4
Relevance (5)	5	4	4
Technical Accuracy (5)	5	3	4
Structure & Organization (5)	5	4	3
Practical Usefulness (5)	5	4	4
Total (25)	25	19	19

RESULT / OBSERVATION

- Well-structured prompts significantly improve AI output quality.
- **Comparative and Experiential prompts** provide deeper insights.
- **Prompt refinement and size management** are essential for handling complex tasks.
- ChatGPT performed best based on the evaluation rubric.

CONCLUSION

This experiment demonstrates that **effective prompt engineering** plays a critical role in designing AI systems for **smart manufacturing automation**. Using structured prompt types from Unit 2 enables better idea generation, clearer explanations, and more reliable outputs. Proper evaluation using rubrics ensures objective comparison across AI tools and helps select the most suitable system for industrial applications.