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Original Article

Global Parts Management through Data and AI Leveraging Structured and Unstructured Data

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Abstract: *In today's complex global manufacturing and consumer service landscape, effective parts management is crucial for maintaining operational efficiency and competitive advantage. This paper presents an innovative approach to parts management that integrates both structured and unstructured data sources. I propose a hybrid system that combines traditional database management with advanced natural language processing, generative AI and machine learning techniques to extract valuable insights from diverse data types. My research demonstrates how this integrated approach can significantly improve field parts search, inventory management, and supply chain optimization in a global manufacturing context. I present a case study of a multinational escalator and elevator manufacturer that implemented this system for field and factory operating units, resulting in a 25% reduction in overall parts spend and 20% improvement in parts search by field mechanics. The findings highlight the potential of leveraging both structured and unstructured data for enhanced decision-making and operational efficiency in manufacturing enterprises focused on both factory and field operations.*

Keywords: *Parts Management, Global Manufacturing, Structured Data, Unstructured Data, Data Engineering, Machine Learning, Document and Image Processing.*

I. INTRODUCTION

Global manufacturing enterprises face significant challenges in managing their vast and complex parts inventories across multiple locations and supply chains. Traditional parts management systems rely heavily on structured data stored in relational databases. However, a wealth of valuable information often resides in unstructured formats such as images, parts leaflets [1]. This paper proposes an innovative approach to parts management that integrates both structured and unstructured data sources. By leveraging data engineering with natural language processing (NLP), machine learning (ML) and generative AI, manufacturers can extract valuable insights from diverse data types, leading to more effective parts management strategies [2].

II. MAIN BODY

A. Challenges In Global Parts Management:

1. Data Silos: Information about parts is often scattered across various factories, part centres and third party managed warehouses.
2. Data Diversity: Parts data exists in multiple formats, both structured (e.g. relational databases) and unstructured (e.g. leaflets, images).
3. Global Complexity: Managing parts across different geographic locations, regulatory environments, and supplier networks adds layers of complexity.
4. Duplicate Parts: Same parts carrying different part numbers across regions and factories with very limited information on parts attributes.

B. Global Parts Master

I propose building a consolidated global parts master database which combines both structured and unstructured data.

1. Define data model: Define core parts attributes that are essential to uniquely identify a part. Attributes such as part number, part technical family, part description, parts length, height, width etc.
2. Core departments: Identify key enterprise departments that directly contribute and consume parts attributes. Eg: Engineering, Factory, Field
3. Structured data processing: Extract data elements from structured parts data sources that provide parts attributes based on defined data model.

4. Unstructured data processing: Extract parts attributes through image recognition and document processing using combination of natural language processing and generative AI as per defined data model.
5. Rationalize parts: Combine part attributes gathered through structured data processing with attributes gathered through unstructured data processing, identify duplicate parts.
6. Regional data consolidation: Combine parts attributes, rationalize parts at regional level depending enterprise operating areas. Eg: Americas, EMEA, APAC
7. Global data consolidation: Use native capabilities available in today's large distributed data processing platforms to share regional parts master data and create consolidated global parts master table.

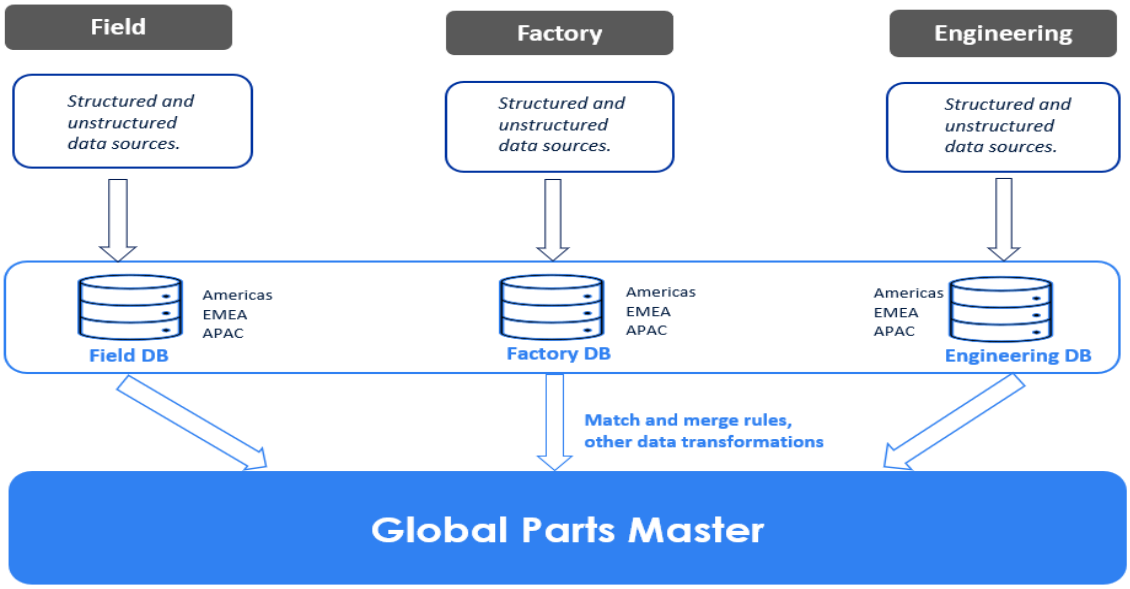

Figure 1: Conceptual Data Flow

III. IMPLEMENTATION METHODOLOGY

- **Data Architecture**: Build end to end data architecture defining data flow, technology stack, governance mechanism and access control mechanism.
- **Data Sources**: Identify relevant data sources, understand their data model. Map out required part attributes based on defined parts master data model.
- **Data Preparation**: Build data ingestion pipelines to ingest data from data sources to enterprise data platform. Apply data engineering principles to cleanse and transform data with applicable match and merge rules.

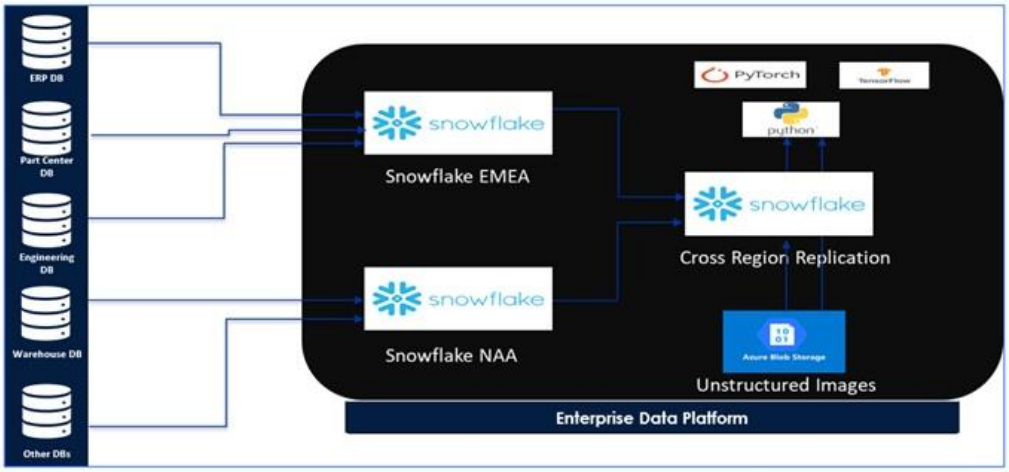

Figure 2: Sample Data Flow Diagram with Technology Stack

Table 1: Sample Transformation Rules Where Part Attributes are Pulled From Oracle JDE Source

Source Table	Source Columns	Data Type	Transformation Type	Transformation Rule	Target Table	Target Columns	Target Data Type
F4101	IMLITM	String	Direct	DISTINCT(TRIM(IMLITM)) If it exists ignore else insert	Global_Parts_Master	OTIS_PART_NB	VARCHAR(16777216)
F4101	IMDSC1, IMDSC2	String	Direct	COALESCE(IMDSC1, IMDSC2) if PART_DESC is null	Global_Parts_Master	PART_DESC	VARCHAR(16777216)
F4104	IVCITM	String	Direct	Join with F4101, IMLITM=IVLITM, pull IVCITM if SUPPLIER_PART_NB is null	Global_Parts_Master	SUPPLIER_PART_NB	VARCHAR(16777216)
F4101	IMPDGR	String	Direct	Pull it from IMPDGR if PART_PRODUCT_GP is null	Global_Parts_Master	PART_PRODUCT_GP	VARCHAR(16777216)
F4101	IMCDCD	String	Direct	Pull it from IMCDCD if COMMODITY_CD is null	Global_Parts_Master	COMMODITY_CD	VARCHAR(16777216)
F4101	IMPRP2	String	Direct	Pull it from IMPRP2 if COMMODITY_DESC is null	Global_Parts_Master	COMMODITY_DESC	VARCHAR(16777216)

Figure 3: Sample Variation in Parts Number and Description across Countries

- Proof of concept: select a specific factory or part center to implement parts master, verify the results with parts SMEs.
- Full scale implementation: Upon successful completion of proof of concept extend the implementation effort to all the factories, part centers and regions. Validate consolidated global parts master data with all key stakeholders.
- Production deployment: Deploy the solution in production. Follow change management procedures; align with upstream and downstream consumers on contributing and consuming parts master data.

IV. CASE STUDY

A. **Background**:

A large escalator and elevator manufacturing company struggled with inefficiency and high cost due to fragmented parts management.

B. Implementation:

Company implemented global parts master table which served as single source of truth with following key features:

- Data ingestion was done from various parts data sources across regions into a central data platform encompassing both structured and unstructured data.
- Machine learning models were executed on unstructured data to extract key part attributes along with data engineering processes to extract part attributes from structured datasets.
- A consolidated global parts master table was built with more than 20 million parts and more than 250 part attributes to uniquely identify the part across global regions.

C. Results:

Implementation of global parts master resulted in

- 25% decrease in total parts spends due to elimination of duplicate parts and optimized supplier spend. Company had total parts spend of ~$3.8B across field and factory.
- 20% improvement in parts search within enterprise mobile and web application catering field parts for mechanics, reducing turnaround time in escalator repairs and installations.

V. CONCLUSION

Effective parts management in global manufacturing enterprises requires a holistic approach that leverages both structured and unstructured data. By integrating diverse data sources and applying advanced analytics techniques, manufacturers can achieve significant cost savings on parts spend across suppliers and regions, decommission duplicate parts, improve operational efficiency and reduce turnaround time in field service to consumers. The proposed framework demonstrates the potential for combining traditional parts management systems with insights derived from unstructured data sources. The case study results highlight the tangible benefits of this approach, including cost reductions and improved operational efficiency

As global manufacturing continues to evolve, the ability to effectively manage parts using both structured and unstructured data will become increasingly critical for maintaining competitiveness and operational excellence. The global parts master approach presented in this paper provides a foundation for manufacturers to address current challenges and prepare for future developments in the industry.

VI. REFERENCES

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