PIM features

- Ability to create SKUs in bulk against a brand
- Ability to copy/paste sections of the PIM hierarchy – like categories and UPIDs which enable duplication and shortcut creation
- Vertical Industry and Market creation
- Application Groups and Applications
- Dynamic Category Creation and specification selection for category and subcategory
- types of UPID

Product Information Management (PIM) System with Hierarchical Data Management

---

Table of Contents

---

1. Entities and Their Definitions

Below are the key entities in the PIM system, each with a unique identifier and definition:

Entity Name	**Example Entity ID**	**Definition**
Industry	IND001	Represents the sector **Construction & Infrastructure** encompassing various markets.
Market	MKT001	Specific segments within the **Construction & Infrastructure** industry, e.g., Building Construction, Roads and Infrastructure, Industrial Construction.
Category	CAT001	High-level classification of products within a Market, e.g., Electrical, Plumbing.
Sub-Category	SUB001	More granular classification within a Category, e.g., Electrical Wiring under Electrical.
UPID (Product)	PRD001	Unique Product Identifier defined within the system, linked to one or multiple Categories.

SKU	SKU001	Stock Keeping Unit, a brand-specific product identifier linked directly to a UPID and Brand Vertical.
Brand	BRD001	Represents a manufacturer or brand name, e.g., Polycab.
Brand Vertical	BV001	Specific divisions within a Brand focusing on particular product lines, e.g., Polycab Fans.
Supplier	SUP001	Entities that supply SKUs to specific Brand Verticals in designated Regions, e.g., Supplier ABC.
Region	REG001	Geographic areas where Brand Verticals operate, e.g., Pune, Maharashtra, India.
Country	CNT001	Represents a nation, the highest level in the Region hierarchy, e.g., India.
Region_Hierarchy	RH001	Represents the hierarchical path of a Region using Materialized Paths.
Industry_Hierarchy	IH001	Represents the hierarchical path of an Industry using Materialized Paths.

---

2. Relationships Table

This table outlines how each primary entity relates to others within the system.

Primary Entity	Relationship Description	Related Entity	Relationship Type	Associative Table
Industry	Encompasses multiple Markets	**Market**	One-to-Many	N/A
Market	Linked to multiple Categories	**Category**	Many-to-Many	Category_Market
Category	Linked to multiple Industries	**Industry**	Many-to-Many	Category_Industry
Category	Contains multiple Sub-Categories	**Sub-Category**	One-to-Many	N/A
Sub-Category	Belongs to one Category	**Category**	Many-to-One	N/A
UPID (Product)	Linked to multiple Categories	**Category**	Many-to-Many	Product_Category
SKU	Linked directly to one UPID	**UPID (Product)**	Many-to-One	N/A

SKU	Linked directly to one Brand Vertical	**Brand Vertical**	Many-to-One	N/A
Brand Vertical	Operates in multiple Regions	**Region**	Many-to-Many	BrandVertical_Region
Brand Vertical	Belongs to one Brand	**Brand**	Many-to-One	N/A
Brand	Has multiple Brand Verticals	**Brand Vertical**	One-to-Many	N/A
Supplier	Supplies multiple SKUs in multiple Regions	**SKU** & **Region**	Many-to-Many-to-Many	Supplier_SKU_Region
Supplier	Linked to multiple Brand Verticals from Brands	**Brand Vertical**	Many-to-Many	Supplier_BrandVertical_Region
Region	May have hierarchical relationships (e.g., Parent Region)	**Region**	Many-to-One	N/A
Industry	May have hierarchical relationships (e.g., Parent Industry)	**Industry**	Many-to-One	N/A

---

3. Detailed Notes on Relationships

1. One-to-Many (1:N) Relationships

- **Industry → Market:**
    - **Description:** Each **Industry** encompasses multiple **Markets**, but each **Market** is associated with only one **Industry**.
    - **Example:** Construction & Infrastructure (IND001) → Building Construction (MKT001), Roads and Infrastructure (MKT002), Industrial Construction (MKT003).
- **Category → Sub-Category:**
    - **Description:** Each **Category** contains multiple **Sub-Categories**, but each **Sub-Category** belongs to only one **Category**.
    - **Example:** Electrical (CAT001) → Electrical Wiring (SUB001), Electrical Components (SUB002).
- **Brand → Brand Vertical:**
    - **Description:** Each **Brand** has multiple **Brand Verticals**, but each **Brand Vertical** is associated with only one **Brand**.

- **Example:** Polycab (BRD001) → Polycab Fans (BV001), Polycab Lights (BV002).

- **SKU → UPID (Product):**
  - **Description:** Each **SKU** is associated with one **UPID (Product)**, but a **UPID (Product)** can have multiple **SKUs**.
  - **Example:** SKU001 → PRD001 (Mild Steel Flat Plate).
- **SKU → Brand Vertical:**
  - **Description:** Each **SKU** is linked to one **Brand Vertical**, but a **Brand Vertical** can have multiple **SKUs**.
  - **Example:** SKU001 → BV001 (Polycab Fans).

2. Many-to-Many (M:N) Relationships

- **Market ↔ Category:**
  - **Description:** A **Market** can include multiple **Categories**, and a **Category** can span multiple **Markets**.
  - **Associative Table:** Category_Market.
  - **Example:** Building Construction (MKT001) ↔ Electrical (CAT001), Plumbing (CAT002); Roads and Infrastructure (MKT002) ↔ Electrical (CAT001).
- **Category ↔ Industry:**
  - **Description:** A **Category** can be associated with multiple **Industries**, and an **Industry** can have multiple **Categories**.
  - **Associative Table:** Category_Industry.
  - **Example:** Electrical (CAT001) ↔ Construction & Infrastructure (IND001), Manufacturing (IND002).
- **Brand Vertical ↔ Region:**
  - **Description:** A **Brand Vertical** operates in multiple **Regions**, and a **Region** can host multiple **Brand Verticals**.
  - **Associative Table:** BrandVertical_Region.
  - **Example:** Polycab Fans (BV001) ↔ Pune (REG001), Mumbai (REG002); Polycab Lights (BV002) ↔ Pune (REG001), Bangalore (REG003).
- **Supplier ↔ Brand Vertical:**
  - **Description:** A **Supplier** can be linked to multiple **Brand Verticals**, and a **Brand Vertical** can have multiple **Suppliers**.
  - **Associative Table:** Supplier_BrandVertical_Region.

- **Example:** Supplier ABC (SUP001) ↔ Polycab Fans (BV001) in Pune (REG001), Polycab Lights (BV002) in Pune (REG001); Supplier XYZ (SUP002) ↔ Polycab Fans (BV001) in Mumbai (REG002), Polycab Lights (BV002) in Bangalore (REG003).

3. Many-to-Many-to-Many (M:N:N) Relationships

- **Supplier ↔ SKU ↔ Region:**
  - **Description: Suppliers** can supply multiple **SKUs** in multiple **Regions**, and each **SKU** can be supplied by multiple **Suppliers** across multiple **Regions**.
  - **Associative Table:** Supplier_SKU_Region.
  - **Example:** Supplier ABC (SUP001) supplies SKU001 (Fe TMT Rebar Steel Bar) in Pune (REG001) and SKU002 (AAC Block Adhesive) in Mumbai (REG002); Supplier XYZ (SUP002) supplies SKU003 (LED Ceiling Fan) in Bangalore (REG003).

4. Self-Referencing Relationships

- **Region ↔ Region:**
  - **Description:** Allows for hierarchical structuring of geographic areas, such as a city within a state or a state within a country.
  - **Example:** Pune (REG001) → Maharashtra (REG002) → India (CNT001).
- **Industry ↔ Industry:**
  - **Description:** Allows for hierarchical structuring within industries if applicable (e.g., Sub-Industries).
  - **Note:** In your current structure, there are no sub-industries, so this relationship is optional based on future requirements.

---

4. Associative (Junction) Tables Overview

To effectively manage many-to-many and complex relationships, the following associative tables are employed:

Associative Table	**Primary Keys**	**Foreign Keys**
Category_Market	Category ID, Market ID	Category ID → Category, Market ID → Market
Category_Industry	Category ID, Industry ID	Category ID → Category, Industry ID → Industry
Product_Category	UPID (Product) ID, Category ID	UPID (Product) ID → UPID (Product), Category ID → Category
BrandVertical_Region	Brand Vertical ID, Region ID	Brand Vertical ID → Brand Vertical, Region ID → Region

Supplier_SKU_Region	Supplier ID, SKU ID, Region ID	Supplier ID → Supplier, SKU ID → SKU (UPID), Region ID → Region
Supplier_BrandVertical_Region	Supplier ID, Brand Vertical ID, Region ID	Supplier ID → Supplier, Brand Vertical ID → Brand Vertical, Region ID → Region

---

5. Hierarchical Data Management

Efficient management of hierarchical relationships is crucial for scalability, particularly within the **Region** and **Industry** entities. This prototype employs **Materialized Paths** to handle hierarchies effectively.

a. Materialized Paths Implementation

Materialized Paths involve storing the full path of a node within the hierarchy in a single column, enabling efficient querying of hierarchical data without the need for recursive joins.

Examples:

- **Region Hierarchy:**
    - **Hierarchy Path for Pune:**
        - Path: /India/Maharashtra/Pune
- **Industry Hierarchy:**
    - **Hierarchy Path for Construction & Infrastructure:**
        - Path: /Construction & Infrastructure

b. Hierarchy Tables

To implement Materialized Paths, an additional column is introduced in the **Region** and **Industry** tables to store the hierarchical paths.

i. Region Table with Materialized Paths

The **Region** table includes a Path column to store the hierarchy path.

Region ID	Region Name	Region Type	Parent Region ID	Path
REG001	Pune	City	REG002	/India/Maharashtra/Pune
REG002	Maharashtra	State	CNT001	/India/Maharashtra
REG003	Mumbai	City	REG002	/India/Maharashtra/Mumbai
REG004	Bangalore	City	REG005	/India/Karnataka/Bangalore
REG005	Karnataka	State	CNT001	/India/Karnataka
CNT001	India	Country	NULL	/India

ii. Industry Table with Materialized Paths

Similarly, the **Industry** table includes a Path column to manage hierarchical relationships.

Industry ID	Industry Name	Parent Industry ID	Path
IND001	Construction & Infrastructure	NULL	/Construction & Infrastructure
IND002	Manufacturing	NULL	/Manufacturing

Entity Definition:

Entity Name	Entity ID	Definition
Region_Hierarchy	RH001	Represents the hierarchical path of a Region using Materialized Paths.
Industry_Hierarchy	IH001	Represents the hierarchical path of an Industry using Materialized Paths.

Note: The Path column is included directly in the **Region** and **Industry** tables, eliminating the need for separate hierarchy tables unless additional metadata is required.

c. Benefits of Materialized Paths

- **Efficient Queries:** Fetching all descendants or ancestors of a node can be done using simple LIKE or prefix matching queries.
- **Reduced Complexity:** Avoids the need for recursive queries, which can be performance-intensive.
- **Flexibility:** Easily supports dynamic changes in the hierarchy, such as adding or moving nodes.

d. Example Queries Using Materialized Paths

- **Retrieve All Cities in Maharashtra:**

sql

Copy code

```
SELECT * FROM Region
WHERE Path LIKE '/India/Maharashtra/%' AND Region_Type = 'City';
```

- **Find the Hierarchical Path of Pune:**

sql

Copy code

```
SELECT Path FROM Region
WHERE Region_ID = 'REG001';
```

- **Retrieve All Categories under Building Construction Market:**

sql

Copy code

```
SELECT Category.*
FROM Category
JOIN Category_Market ON Category.Category_ID = Category_Market.Category_ID
WHERE Category_Market.Market_ID = 'MKT001';
```

- **Find All SKUs under Electrical Category in Manufacturing Industry:**

```
sql
Copy code
SELECT SKU.*
FROM SKU
JOIN UPID ON SKU.Product_ID = UPID.Product_ID
JOIN Product_Category ON UPID.Product_ID = Product_Category.Product_ID
JOIN Category ON Product_Category.Category_ID = Category.Category_ID
JOIN Category_Industry ON Category.Category_ID = Category_Industry.Category_ID
JOIN Industry ON Category_Industry.Industry_ID = Industry.Industry_ID
WHERE Category.Category_Name = 'Electrical' AND Industry.Path = '/Manufacturing';
```

---

6. Example Scenario Incorporating the Relationships

Scenario: Polycab's Regional Supply Chain Management

Objective: Efficiently manage and track the supply chain for Polycab's diverse product lines across multiple regions and industries, ensuring scalability and high performance.

Entities Involved:

- **Brand:** Polycab (BRD001)
- **Brand Verticals:**
  - Polycab Fans (BV001)
  - Polycab Lights (BV002)
- **Suppliers:**
  - Supplier ABC (SUP001)
  - Supplier XYZ (SUP002)
- **Regions:**
  - Pune (REG001)
  - Mumbai (REG003)

    - Bangalore (REG004)
    - Maharashtra (REG002)
    - Karnataka (REG005)
    - India (CNT001)
- **Industries:**
    - Construction & Infrastructure (IND001)
    - Manufacturing (IND002)
- **Markets:**
    - Building Construction (MKT001)
    - Roads and Infrastructure (MKT002)
    - Industrial Construction (MKT003)
- **Categories:**
    - Electrical (CAT001)
    - Plumbing (CAT002)
- **Sub-Categories:**
    - Electrical Wiring (SUB001)
    - Plumbing Fixtures (SUB002)
- **UPIDs (Products):**
    - PRD001 (Mild Steel Flat Plate)
    - PRD004 (Electrical Wiring 2.5mm^2)
    - PRD006 (LED Ceiling Fan)
    - PRD007 (Smart LED Light)
- **SKUs:**
    - SKU001 (Fe TMT Rebar Steel Bar)
    - SKU005 (Copper Electrical Wiring 2.5mm^2)
    - SKU006 (LED Ceiling Fan)
    - SKU007 (Smart LED Light)

Data Flow:

1. **Industry and Market Associations:**

- **Construction & Infrastructure** (IND001) encompasses the **Building Construction** (MKT001), **Roads and Infrastructure** (MKT002), and **Industrial Construction** (MKT003) **Markets**.
- **Manufacturing** (IND002) encompasses the **Electrical Components** (MKT004) **Market** *(Assuming a new market for Electrical Components under Manufacturing)*.

2. **Category Associations:**
   - **Electrical** (CAT001) is linked to **Building Construction** (MKT001) and **Roads and Infrastructure** (MKT002).
   - **Plumbing** (CAT002) is linked to **Building Construction** (MKT001) and **Industrial Construction** (MKT003).
   - **Electrical Wiring** (SUB001) is a **Sub-Category** under **Electrical** (CAT001).
   - **Plumbing Fixtures** (SUB002) is a **Sub-Category** under **Plumbing** (CAT002).
3. **Product Classification:**
   - **Mild Steel Flat Plate** (PRD001) is a **UPID** linked to **Electrical** (CAT001).
   - **Electrical Wiring 2.5mm^2** (PRD004) is a **UPID** linked to **Electrical** (CAT001).
   - **LED Ceiling Fan** (PRD006) is a **UPID** linked to **Electrical** (CAT001).
   - **Smart LED Light** (PRD007) is a **UPID** linked to **Electrical** (CAT001).
4. **SKU Assignments:**
   - **SKU001** is a **Fe TMT Rebar Steel Bar** linked to **PRD001** and **Polycab Fans** (BV001).
   - **SKU005** is a **Copper Electrical Wiring 2.5mm^2** linked to **PRD004** and **Polycab Lights** (BV002).
   - **SKU006** is an **LED Ceiling Fan** linked to **PRD006** and **Polycab Fans** (BV001).
   - **SKU007** is a **Smart LED Light** linked to **PRD007** and **Polycab Lights** (BV002).
5. **Supplier Associations:**
   - **Supplier ABC** (SUP001) supplies:
     - **Polycab Fans** (BV001) in **Pune** (REG001)
     - **Polycab Lights** (BV002) in **Pune** (REG001)
   - **Supplier XYZ** (SUP002) supplies:
     - **Polycab Fans** (BV001) in **Mumbai** (REG003)
     - **Polycab Lights** (BV002) in **Bangalore** (REG004)
   - These linkages are managed via the Supplier_BrandVertical_Region associative table.
6. **Hierarchical Structures:**
   - **Regions:**

        - **Pune** (REG001) is a **City** within **Maharashtra** (REG002), which is a **State** in **India** (CNT001).
        - **Mumbai** (REG003) is a **City** within **Maharashtra** (REG002), which is a **State** in **India** (CNT001).
        - **Bangalore** (REG004) is a **City** within **Karnataka** (REG005), which is a **State** in **India** (CNT001).
    - **Industries:**
        - **Construction & Infrastructure** (IND001) is a top-level industry without sub-industries.
        - **Manufacturing** (IND002) is a separate top-level industry without sub-industries.
7. **Data Hierarchy Implementation:**
    - **Region Hierarchy:**
        - **Pune** (REG001) Path: /India/Maharashtra/Pune
        - **Mumbai** (REG003) Path: /India/Maharashtra/Mumbai
        - **Bangalore** (REG004) Path: /India/Karnataka/Bangalore
    - **Industry Hierarchy:**
        - **Construction & Infrastructure** (IND001) Path: /Construction & Infrastructure
        - **Manufacturing** (IND002) Path: /Manufacturing
8. **Operational Flow:**
    - **Product Management:**
        - **PRD001** (Mild Steel Flat Plate) is managed under **Electrical** (CAT001) within the **Building Construction** (MKT001) **Market** of the **Construction & Infrastructure** (IND001) **Industry**.
        - **PRD004**, **PRD006**, and **PRD007** are managed under **Electrical** (CAT001) within the **Building Construction** (MKT001) and **Roads and Infrastructure** (MKT002) **Markets**, spanning the **Construction & Infrastructure** (IND001) **Industry**.
    - **Supply Chain Management:**
        - **Supplier ABC** (SUP001) is responsible for supplying **Polycab Fans** and **Polycab Lights** in the **Pune** (REG001) **Region**.
        - **Supplier XYZ** (SUP002) handles supplies in **Mumbai** (REG003) and **Bangalore** (REG004), covering different geographical areas.
    - **Product Availability:**
        - **SKU001** (Fe TMT Rebar Steel Bar) is available in **Pune** (REG001) through **Supplier ABC** (SUP001).

- **SKU005** (Copper Electrical Wiring 2.5mm^2) is available in **Pune** (REG001) through **Supplier ABC** (SUP001), and in **Mumbai** (REG003) and **Bangalore** (REG004) through **Supplier XYZ** (SUP002).
- **SKU006** (LED Ceiling Fan) and **SKU007** (Smart LED Light) are available in respective regions as per supplier assignments.

Logical Flow Explanation:

1. **Hierarchical Associations:**
    - **Industry Hierarchy:** Defines the structure from broad sectors like **Construction & Infrastructure** and **Manufacturing** down to specific markets and categories.
    - **Region Hierarchy:** Organizes geographical areas from the national level (**India**) down to specific cities like **Pune**, **Mumbai**, and **Bangalore**.
2. **Market and Category Integration:**
    - **Markets** are defined within **Industries**, allowing **Categories** to be associated directly with their respective **Markets**.
    - **Categories** further classify products into specific groups like **Electrical** and **Plumbing**.
3. **Product and SKU Management:**
    - **UPIDs (Products)** are linked to multiple **Categories**, enabling flexible product classification.
    - **SKUs** are specific to **UPIDs** and **Brand Verticals**, ensuring precise tracking of product variations across different brand divisions.
4. **Supplier and Regional Supply Chain:**
    - **Suppliers** are associated with specific **Brand Verticals** and **Regions**, allowing precise control over where and how products are supplied.
    - **Associative Tables** like Supplier_BrandVertical_Region manage these complex relationships, ensuring that each supplier's capabilities are accurately reflected in the system.
5. **Data Retrieval and Reporting:**
    - Using **Materialized Paths**, the system can efficiently query hierarchical data. For example:
        - To find all SKUs under **Electrical** Category in **Building Construction** Market, the system can traverse the **Industry** and **Region** hierarchies using the Path columns.
        - Reports can be generated to show product availability, supplier performance, and regional sales based on these hierarchies.
