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**

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**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\_Brand Vertical\_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\_Brand Vertical\_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 2.5mm²)
  + PRD006 (LED Ceiling Fan)
  + PRD007 (Smart LED Light)
* **SKUs:**
  + SKU001 (Fe TMT Rebar Steel Bar)
  + SKU005 (Copper Electrical Wiring 2.5mm²)
  + 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 2.5mm²** (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 2.5mm²** 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 2.5mm²) 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.