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**1. Introduction**

Efficient logistics management is crucial for B2B marketplaces, especially when handling a diverse array of products with varying logistical requirements. The **Enhanced Detailed Logistical Product Code (LPC) System**, integrated with a **Product Information Management (PIM) System**, provides a structured approach to classify products, compose shipments, assess compatibility, and determine optimal transportation methods. This comprehensive system ensures that even complex shipments with multiple, potentially incompatible products are managed effectively, enhancing operational efficiency and compliance.

**2. System Overview**

The **Enhanced LPC System** is structured into six primary layers to accommodate complex shipments:

1. **Product Classification Layer**
2. **Shipment Composition Layer**
3. **Compatibility Assessment Layer**
4. **Shipment Details Layer**
5. **Origin-Destination Shipment Matrix**
6. **Logistics Decision Matrix**
7. **Logistics Matching Layer**

Each layer serves a distinct purpose, ensuring that products are accurately classified, shipments are effectively composed, compatibility is assessed, and optimal logistics solutions are identified. The system is designed to handle both single-product and multi-product shipments, including cases where products have incompatible logistical requirements.

**3. Detailed System Components**

**3.1 Product Classification Layer**

**Purpose:**  
This layer categorizes each product using the LPC system, ensuring every product is assigned a unique LPC code reflecting its inherent logistical attributes.

**Components:**

* **LPC Code Generator:** Creates LPC codes based on product attributes.
* **Attribute Mapping:** Maps product attributes to LPC segments.
* **Validation Rules:** Ensures LPC codes adhere to predefined standards.

**Workflow:**

1. **Attribute Collection:** Collect relevant logistical attributes for each product.
2. **LPC Code Generation:** Generate the LPC code using the LPC Code Generator.
3. **Validation:** Ensure the LPC code is valid and conforms to system standards.
4. **Storage:** Store the LPC code in the Product Database within the PIM system.

**3.2 Shipment Composition Layer**

**Purpose:**  
Defines the composition of each shipment by listing the products included, their quantities, and associated LPC codes. This layer facilitates the aggregation of multiple products into a single shipment.

**Components:**

* **Shipment Identifier (SI):** Unique identifier for each shipment.
* **Product List:** Detailed list of products, quantities, and LPC codes included in the shipment.
* **Composition Interface:** Interface for adding or removing products from a shipment.

**Workflow:**

1. **Shipment Creation:** Create a new shipment and assign a unique SI.
2. **Product Addition:** Add products to the shipment by selecting from the PIM system.
3. **Quantity Specification:** Specify the quantity for each product in the shipment.
4. **Composition Storage:** Store the composition details linked to the SI.

**3.3 Compatibility Assessment Layer**

**Purpose:**  
Evaluates the compatibility of products within a shipment and identifies any logistical conflicts. This ensures that incompatible products are either separated or handled appropriately to prevent logistical issues.

**Components:**

* **Compatibility Rules Engine:** Defines rules for product compatibility based on LPC attributes.
* **Conflict Detection Module:** Identifies conflicts between products in a shipment.
* **Segmentation Strategies:** Strategies for separating incompatible products into different shipments if necessary.

**Workflow:**

1. **Input Retrieval:** Fetch LPC codes and attributes for all products in the shipment.
2. **Compatibility Evaluation:** Use the Compatibility Rules Engine to assess compatibility.
3. **Conflict Identification:** Detect any conflicts between products.
4. **Action Determination:** Decide whether to adjust the shipment composition or apply special handling measures.
5. **Segmentation (if needed):** Separate incompatible products into distinct shipments.

**3.4 Shipment Details Layer**

**Purpose:**  
Captures shipment-specific information such as total weight, total volume, route constraints, and destination type. This layer aggregates details necessary for logistics planning.

**Components:**

* **Shipment Identifier (SI):** Unique identifier linking to the Shipment Composition Layer.
* **Total Weight (TW):** Cumulative weight of all products in the shipment.
* **Total Volume (TV):** Cumulative volume of all products in the shipment.
* **Route Constraints (RC):** Specific constraints related to the transportation route.
* **Destination Type (DT):** Specifies whether the shipment is domestic or international.
* **Shipment Date (SD):** Scheduled date for the shipment.
* **Origin and Destination Details:** Specific locations for pickup and delivery.

**Workflow:**

1. **Data Aggregation:** Calculate total weight and volume based on shipment composition.
2. **Constraint Specification:** Define route constraints and destination type.
3. **Details Storage:** Store all shipment details linked to the SI.

**3.5 Origin-Destination Shipment Matrix**

**Purpose:**  
Determines the appropriate mode of transport based on the origin and destination areas. This matrix assesses whether the shipment is domestic, international, or requires multimodal transport solutions.

**Components:**

* **Origin-Destination Pairs:** Defined pairs of geographic locations.
* **Mode of Transport Options:** Available transport modes such as Road, Sea, Rail, Air.
* **Selection Criteria:** Criteria for selecting the mode based on distance, cost, speed, and other factors.

**Workflow:**

1. **Input Retrieval:** Fetch origin and destination locations from the Shipment Details Layer.
2. **Matrix Consultation:** Refer to the Origin-Destination Shipment Matrix to determine suitable transport modes.
3. **Mode Selection:** Choose the optimal mode(s) of transport based on matrix outcomes.
4. **Mode Combination Determination:** Decide if a combination of transport modes is necessary (e.g., Road + Sea).

**3.6 Logistics Decision Matrix**

**Purpose:**  
Selects the specific type of transport within the chosen mode(s) based on shipment composition inputs such as weight, volume, and product attributes. This matrix ensures the selection of the most appropriate vehicle type and logistics solutions.

**Components:**

* **Weight Classes:** Diverse classifications of shipment weight.
* **Volume Classes:** Diverse classifications of shipment volume.
* **Product Attributes:** Considerations such as hazard classification, temperature sensitivity, packaging type.
* **Transport Mode Specifics:** Detailed options within each transport mode (e.g., types of trucks for road transport).

**Workflow:**

1. **Input Retrieval:** Use total weight, total volume, and product attributes from the Shipment Details and Compatibility Assessment Layers.
2. **Mode-Specific Decision:** Within the selected transport mode(s), refer to the Logistics Decision Matrix to select the appropriate vehicle type and logistics solutions.
3. **Optimization:** Ensure the selected transport type meets all shipment requirements efficiently.
4. **Recommendation Generation:** Generate recommendations for transport mode and vehicle type.

**3.7 Logistics Matching Layer**

**Purpose:**  
Utilizes information from all preceding layers to determine the optimal transportation mode and vehicle type, ensuring all logistical requirements and compatibility issues are addressed.

**Components:**

* **Matching Algorithms:** Algorithms that process shipment details and matrices to provide recommendations.
* **Transport Mode Definitions:** Detailed definitions and specifications for each transport mode.
* **Vehicle Specifications:** Detailed specifications for each vehicle type within transport modes.
* **Compliance Database:** Database of regulatory requirements and permits.
* **Decision Support Tools:** Tools to assist in making informed logistics decisions.

**Workflow:**

1. **Data Aggregation:** Compile all relevant data from Product Classification, Shipment Composition, Compatibility Assessment, Shipment Details, Origin-Destination Shipment Matrix, and Logistics Decision Matrix.
2. **Algorithm Processing:** Run matching algorithms to evaluate and recommend optimal transport modes and vehicle types.
3. **Compliance Check:** Ensure all recommendations comply with regulatory requirements and necessary permits are obtained.
4. **Recommendation Delivery:** Provide a comprehensive logistics plan based on the analysis.

**4. Logistics Decision Matrix**

The **Logistics Decision Matrix** is a critical component that determines the specific type of transport within the chosen mode(s) based on various shipment parameters. It ensures that shipments are transported using the most suitable vehicles and methods, optimizing for cost, efficiency, and compliance.

**4.1 Weight Classes**

|  |  |  |
| --- | --- | --- |
| **Weight Class** | **Description** | **Range (kg)** |
| W001 | Very Light | 0 - 500 |
| W002 | Light | 501 - 2,000 |
| W003 | Moderate | 2,001 - 5,000 |
| W004 | Heavy | 5,001 - 10,000 |
| W005 | Very Heavy | 10,001 - 20,000 |
| W006 | Ultra Heavy | 20,001 - 50,000 |
| W007 | Extra Heavy | 50,001 - 100,000 |
| W008 | Super Heavy | 100,001 - 200,000 |
| W009 | Mega Heavy | 200,001 - 500,000 |
| W010 | Giga Heavy | 500,001+ |

**4.2 Volume Classes**

|  |  |  |
| --- | --- | --- |
| **Volume Class** | **Description** | **Range (m³)** |
| V001 | Very Small | 0 - 0.5 |
| V002 | Small | 0.6 - 2 |
| V003 | Moderate | 2.1 - 5 |
| V004 | Large | 5.1 - 10 |
| V005 | Very Large | 10.1 - 20 |
| V006 | Extra Large | 20.1 - 50 |
| V007 | Super Large | 50.1 - 100 |
| V008 | Ultra Large | 100.1 - 200 |
| V009 | Mega Large | 200.1 - 500 |
| V010 | Giga Large | 500.1+ |

**4.3 Product Attributes Considerations**

* **Hazard Classification (HC):** Determines if special handling or vehicles are required.
* **Temperature Sensitivity (TS):** Requires temperature-controlled environments.
* **Packaging Type (PT):** Influences the type of vehicle (e.g., open vs. closed).
* **Special Handling Requirements (SHR):** Necessitates specific equipment or vehicle modifications.
* **Compliance/Permit Requirement (CPR):** May restrict transport modes or vehicle types.

**4.4 Transport Mode Specifics**

**Road Transport**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Vehicle Type** | **Description** | **Weight Capacity (kg)** | **Volume Capacity (m³)** | **Ideal For** |
| Small Pickup Truck | Compact truck for light shipments | 0 - 2,000 | 0 - 2 | Very Light, Small Volumes |
| Light Commercial Vehicle | Versatile for light to moderate shipments | 2,001 - 5,000 | 2.1 - 5 | Light to Moderate Loads |
| Medium Truck | Suitable for moderate to heavy shipments | 5,001 - 10,000 | 5.1 - 10 | Heavy Loads, Larger Volumes |
| Flatbed Truck | Open platform for oversized or bulky items | 10,001 - 20,000 | 10.1 - 20 | Oversized, Bulky Items |
| Refrigerated Truck | Temperature-controlled transport | 2,001 - 10,000 | 2.1 - 10 | Temperature Sensitive Goods |
| Flat Rack Trailer | Open trailer for large, heavy, or awkward loads | 20,001 - 50,000 | 20.1 - 50 | Extremely Heavy, Oversized Loads |
| Multi-Axle Trailer | Enhanced capacity for ultra-heavy shipments | 50,001+ | 50.1+ | Giga Heavy, Mega Heavy Loads |

**Sea Transport**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Ship Type** | **Description** | **Weight Capacity (kg)** | **Volume Capacity (m³)** | **Ideal For** |
| Container Ship (20 ft) | Standard container for general goods | 21,000 - 25,000 | 33 - 37 | General International Shipments |
| Container Ship (40 ft) | Larger container for substantial volumes | 27,000 - 30,000 | 67 - 76 | Large International Shipments |
| Bulk Carrier | Ships designed for transporting unpackaged bulk cargo | 100,000 - 500,000 | 500 - 1,000 | Bulk Commodities (e.g., cement, grains) |
| Roll-on/Roll-off (RoRo) Ship | Ships designed for wheeled cargo like vehicles | 50,000 - 200,000 | 200 - 800 | Vehicles, Heavy Machinery |

**Rail Transport**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Rail Car Type** | **Description** | **Weight Capacity (kg)** | **Volume Capacity (m³)** | **Ideal For** |
| Boxcar | Enclosed car for general goods | 20,000 - 25,000 | 50 - 60 | General Bulk Shipments |
| Flat Rack Rail Car | Open rail car for oversized or bulky items | 30,000 - 50,000 | 100 - 150 | Oversized, Bulky Items |
| Tank Car | Specialized rail car for liquids and gases | 25,000 - 40,000 | 70 - 100 | Hazardous Materials, Liquids |
| Hopper Car | Rail car for bulk commodities like grains or cement | 40,000 - 100,000 | 300 - 400 | Bulk Commodities (e.g., cement, ores) |
| Refrigerated Rail Car | Temperature-controlled rail car | 20,000 - 30,000 | 60 - 80 | Temperature Sensitive Goods |

**5. Origin-Destination Shipment Matrix**

The **Origin-Destination Shipment Matrix** determines the appropriate mode of transport based on the geographic areas involved in the shipment. This matrix considers factors such as distance, accessibility, cost, and speed to select the most suitable transport mode or combination of modes.

**5.1 Matrix Structure**

|  |  |  |  |
| --- | --- | --- | --- |
| **Origin Area** | **Destination Area** | **Distance Range (km)** | **Recommended Mode(s) of Transport** |
| Local | Local | 0 - 100 | Road |
| Local | Regional | 101 - 500 | Road, Rail |
| Local | National | 501 - 1,500 | Road, Rail |
| Regional | Regional | 0 - 300 | Road, Rail |
| Regional | National | 301 - 2,000 | Road, Rail |
| National | National | 0 - 3,000 | Road, Rail |
| National | International | 3,001 - 10,000 | Sea, Air |
| International | International | >10,000 | Sea, Air |
| Multimodal Needs | Any | Any | Combination of Road, Rail, Sea, Air |

**5.2 Mode Selection Criteria**

* **Road:** Flexible, door-to-door service; suitable for short to medium distances.
* **Rail:** Cost-effective for bulk and heavy goods over medium to long distances; limited to rail network.
* **Sea:** Ideal for international shipments; high capacity but slower transit times.
* **Air:** Fastest mode; suitable for high-value or time-sensitive goods; higher cost.
* **Multimodal:** Combination of modes to leverage strengths (e.g., Road + Sea for international).

**6. Workflow and Interactions**

**6.1 Individual Layer Workflow Diagrams**

**6.1.1 Product Classification Layer Workflow**

sql

Copy code

+------------------------------+

| Product Classification |

| Layer |

+------------------------------+

|

| Fetch Product Attributes

v

+------------------------------+

| LPC Code Generator |

| - Generates LPC based on |

| attributes |

+------------------------------+

|

| Generate LPC Code

v

+------------------------------+

| Validation Rules |

| - Ensure LPC adheres to |

| standards |

+------------------------------+

|

| Valid LPC Code

v

+------------------------------+

| Store LPC in PIM Database |

+------------------------------+

**6.1.2 Shipment Composition Layer Workflow**

sql

Copy code

+------------------------------+

| Shipment Composition |

| Layer |

+------------------------------+

|

| Create Shipment (Assign SI)

v

+------------------------------+

| Add Products to Shipment |

| - Select from PIM |

| - Specify Quantities |

+------------------------------+

|

| Compile Product List with LPCs

v

+------------------------------+

| Store Composition Details |

| (Linked to SI) |

+------------------------------+

**6.1.3 Compatibility Assessment Layer Workflow**

sql

Copy code

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| Compatibility Assessment |

| Layer |

+------------------------------+

|

| Retrieve LPCs from Composition

v

+------------------------------+

| Compatibility Rules Engine |

| - Check for conflicting |

| attributes |

+------------------------------+

|

| Identify Conflicts

v

+------------------------------+

| Conflict Resolution |

| - Adjust Shipment Composition|

| (e.g., separate shipments) |

+------------------------------+

|

| Updated Shipment Composition

v

+------------------------------+

| Store Compatibility Results|

+------------------------------+

**6.1.4 Shipment Details Layer Workflow**

sql

Copy code

+------------------------------+

| Shipment Details |

| Layer |

+------------------------------+

|

| Aggregate Weight & Volume

v

+------------------------------+

| Calculate Total Weight |

| and Total Volume |

+------------------------------+

|

| Define Route Constraints

v

+------------------------------+

| Define Route Constraints |

| and Destination Type |

+------------------------------+

|

| Store Shipment Details

v

+------------------------------+

| Store Details Linked to SI |

+------------------------------+

**6.1.5 Origin-Destination Shipment Matrix Workflow**

sql

Copy code

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| Origin-Destination Matrix |

| Layer |

+------------------------------+

|

| Retrieve Origin & Destination

v

+------------------------------+

| Determine Distance Range |

+------------------------------+

|

| Refer to Matrix for Transport Mode

v

+------------------------------+

| Select Mode(s) of Transport|

+------------------------------+

|

| Recommend Transport Mode

v

+------------------------------+

| Store Mode Selection |

+------------------------------+

**6.1.6 Logistics Decision Matrix Workflow**

sql

Copy code

+------------------------------+

| Logistics Decision Matrix |

| Layer |

+------------------------------+

|

| Retrieve Shipment Weight, Volume, and Product Attributes

v

+------------------------------+

| Determine Weight Class |

| and Volume Class |

+------------------------------+

|

| Refer to Logistics Decision Matrix

v

+------------------------------+

| Select Vehicle Type |

| and Specific Transport |

| Solutions |

+------------------------------+

|

| Recommend Vehicle and Transport Solutions

v

+------------------------------+

| Store Logistics Decision |

+------------------------------+

**6.1.7 Logistics Matching Layer Workflow**

sql

Copy code

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| Logistics Matching Layer |

+------------------------------+

|

| Aggregate Data from All Layers

v

+------------------------------+

| Run Matching Algorithms |

| - Consider all Constraints|

+------------------------------+

|

| Generate Logistics Plan

v

+------------------------------+

| Output Logistics Plan |

+------------------------------+

**6.2 Combined Detailed System Workflow Diagram**

Below is a **text-based combined workflow diagram** illustrating how all layers interact to process a shipment from product classification to logistics matching.

sql

Copy code

+------------------------------+

| Product Classification |

| Layer |

+------------------------------+

|

| Fetch LPC Codes

v

+------------------------------+

| Shipment Composition |

| Layer |

+------------------------------+

|

| Compile Product List with LPCs

v

+------------------------------+

| Compatibility Assessment |

| Layer |

+------------------------------+

|

| Check for Conflicts

v

+------------------------------+

| Shipment Details |

| Layer |

+------------------------------+

|

| Aggregate Weight & Volume

v

+------------------------------+

| Origin-Destination Matrix |

| Layer |

+------------------------------+

|

| Select Mode(s) of Transport

v

+------------------------------+

| Logistics Decision Matrix |

| Layer |

+------------------------------+

|

| Select Vehicle Type & Transport Solutions

v

+------------------------------+

| Logistics Matching Layer |

+------------------------------+

|

| Generate Logistics Plan

v

+------------------------------+

| Execution & Tracking |

| Layer |

+------------------------------+

**6.3 Handling Edge Cases**

**Edge Case 1: Incompatible Packaging Types**

* **Scenario:** A shipment contains both open-packaged (e.g., flatbed) and closed-packaged (e.g., containerized) products.
* **Solution:** Use separate vehicle compartments or different vehicles to prevent cross-contamination and ensure appropriate handling.

**Edge Case 2: Hazardous and Non-Hazardous Materials Together**

* **Scenario:** A shipment includes both hazardous (e.g., adhesives) and non-hazardous products.
* **Solution:** Separate hazardous materials into specialized vehicles or compartments within the same vehicle to comply with safety regulations.

**Edge Case 3: Mixed Temperature Requirements**

* **Scenario:** A shipment contains temperature-sensitive products requiring refrigeration and non-temperature-sensitive products.
* **Solution:** Utilize temperature-controlled vehicles for the entire shipment if feasible, or segregate temperature-sensitive products into separate transport units.

**Edge Case 4: Oversized and Standard-Sized Products**

* **Scenario:** A shipment includes both oversized products (requiring flatbed trucks) and standard-sized products.
* **Solution:** Split the shipment into separate consignments or use vehicles with adaptable platforms to accommodate both product types without compromising safety.

**Edge Case 5: Multiple Origin and Destination Points**

* **Scenario:** Products in a shipment originate from different locations and are destined for multiple destinations.
* **Solution:** Optimize routing by consolidating products with similar origin and destination points, or utilize hub-and-spoke logistics models to streamline transport.

**Edge Case 6: High-Value and Bulk Items Together**

* **Scenario:** A shipment includes both high-value items (requiring secure transport) and bulk items (requiring large-volume vehicles).
* **Solution:** Separate high-value items into secure transport units while transporting bulk items in appropriate bulk vehicles, ensuring both security and efficiency.

**5. Example of a Shipment**

**5.1 Scenario Overview**

**Objective:**  
Transport a shipment containing **TMT Rebars**, **Cement Bags**, and **Adhesives** domestically with specific logistical requirements, including incompatible packaging types and hazardous material handling.

**5.2 Step-by-Step Process**

**Step 1: Product Classification Layer**

* **Products:**
  1. **TMT Rebars**
     + **LPC Code:** STE-T00-E00-H00-P11-S02-C01-U04-S03
  2. **Cement Bags**
     + **LPC Code:** BRI-T00-E01-H00-P04-S00-C00-U02-S02
  3. **Adhesives**
     + **LPC Code:** ADH-T01-E00-H01-P07-S00-C02-U00-S02

**Step 2: Shipment Composition Layer**

* **Shipment Identifier (SI):** SHP-004
* **Composition:**
  + **TMT Rebars:** 200 metric tons, STE-T00-E00-H00-P11-S02-C01-U04-S03
  + **Cement Bags:** 10,000 bags, BRI-T00-E01-H00-P04-S00-C00-U02-S02
  + **Adhesives:** 5,000 boxes, ADH-T01-E00-H01-P07-S00-C02-U00-S02

**Step 3: Compatibility Assessment Layer**

* **Compatibility Rules Evaluation:**
  + **TMT Rebars** (P11: Straight Bundled) require flatbed open trolleys.
  + **Cement Bags** (P04: Bagged) require closed trucks.
  + **Adhesives** (H01: Flammable) require specialized hazardous material transport.
* **Conflict Identification:**
  + **Incompatible Packaging Types:** Open flatbed required for TMT Rebars vs. closed trucks required for Cement Bags.
  + **Hazardous Material:** Adhesives cannot be transported with non-hazardous materials in the same vehicle.
* **Action Determination:**
  + **Segregate TMT Rebars and Cement Bags** into separate shipments.
  + **Adhesives** must be transported in a separate, specialized vehicle.

**Step 4: Shipment Details Layer**

* **Total Weight (TW):**
  + **TMT Rebars:** 200 metric tons = 200,000 kg
  + **Cement Bags:** 10,000 bags × 50 kg = 500,000 kg
  + **Adhesives:** 5,000 boxes × 2 kg = 10,000 kg
  + **Total Weight:** 200,000 kg + 500,000 kg + 10,000 kg = **710,000 kg (710 tons)**
* **Total Volume (TV):**
  + **TMT Rebars:** 15 m³
  + **Cement Bags:** 8 m³
  + **Adhesives:** 5 m³
  + **Total Volume:** 15 + 8 + 5 = **28 m³**
* **Route Constraints (RC):** A02 (Requires off-road capability)
* **Destination Type (DT):** D01 (Domestic)
* **Shipment Date (SD):** 2024-08-20
* **Origin:** Mixed Origins (Factory, Cement Plant, Adhesive Warehouse)
* **Destination:** Mixed Destinations (Construction Site, Storage Facility)

**Step 5: Origin-Destination Shipment Matrix**

* **Origin Area:** National
* **Destination Area:** National
* **Distance Range:** 0 - 3,000 km
* **Recommended Mode(s) of Transport:** Road, Rail

**Step 6: Logistics Decision Matrix**

* **Shipment Segments:**
  1. **TMT Rebars:**
     + **Weight:** 200,000 kg (W008)
     + **Volume:** 15 m³ (V005)
     + **Hazard Classification:** Non-hazardous
     + **Packaging Type:** Straight Bundled (P11)
  2. **Cement Bags:**
     + **Weight:** 500,000 kg (W010)
     + **Volume:** 8 m³ (V004)
     + **Hazard Classification:** Non-hazardous
     + **Packaging Type:** Bagged (P04)
  3. **Adhesives:**
     + **Weight:** 10,000 kg (W005)
     + **Volume:** 5 m³ (V003)
     + **Hazard Classification:** Flammable (H01)
     + **Packaging Type:** Boxed (P07)
* **Mode Selection:**
  1. **TMT Rebars and Cement Bags:** Road Transport
  2. **Adhesives:** Road Transport (Specialized Hazardous Material Vehicle)
* **Vehicle Selection:**
  1. **TMT Rebars:**
     + **Vehicle Type:** Flat Rack Trailer (Road)
     + **Reason:** Requires open flatbed for oversized, straight bundled products.
  2. **Cement Bags:**
     + **Vehicle Type:** Closed Truck (Road)
     + **Reason:** Requires closed truck for bagged products.
  3. **Adhesives:**
     + **Vehicle Type:** Specialized Hazardous Material Truck (Road)
     + **Reason:** Flammable materials require separate, compliant transport.

**Step 7: Logistics Matching Layer**

* **TMT Rebars:**
  + **Transport Mode:** Road
  + **Vehicle Type:** Flat Rack Trailer
  + **Required Equipment:** Cranes for loading/unloading
  + **Permits:** Oversized load permit (C01)
  + **Route:** Off-road capable paths (A02)
* **Cement Bags:**
  + **Transport Mode:** Road
  + **Vehicle Type:** Closed Truck
  + **Required Equipment:** Forklifts for unloading
  + **Permits:** None required (C00)
  + **Route:** Standard road routes (A02)
* **Adhesives:**
  + **Transport Mode:** Road
  + **Vehicle Type:** Specialized Hazardous Material Truck
  + **Required Equipment:** Safety equipment for handling flammable materials
  + **Permits:** Hazardous material transport permit (C02)
  + **Route:** Off-road capable paths (A02)

**Step 8: Generate Logistics Plan**

* **TMT Rebars:**

Transport Mode: Road

Vehicle Type: Flat Rack Trailer

Required Equipment: Cranes for loading/unloading

Permits: Oversized load permit (C01)

Route: Off-road capable paths (A02)

* **Cement Bags:**

Transport Mode: Road

Vehicle Type: Closed Truck

Required Equipment: Forklifts for unloading

Permits: None required (C00)

Route: Standard road routes (A02)

* **Adhesives:**

Transport Mode: Road

Vehicle Type: Specialized Hazardous Material Truck

Required Equipment: Safety equipment for handling flammable materials

Permits: Hazardous material transport permit (C02)

Route: Off-road capable paths (A02)