WEEK 2

Data Quality Report

Explore the Raw Master Table

- **Size:** 113,602 rows × 21 columns.
- **Link:** Master_Table.csv

Step 1: Data Quality & Profiling Report – Master Table

Column	Type	Non-Null Count	Missing	Unique	Notes
learner_id	object	113,602	0	57,966	Key for learners
opportunity_id	object	113,602	0	193	Links learners to opportunities
opportunity_code	object	113,601	1	192	Almost complete, missing 1
cohort_code	object	100,284	13,318	580	Connects to cohorts
cohort_start_ts	object	100,284	13,318	236	Dates (needs conversion)
cohort_end_ts	object	100,284	13,318	245	Dates, mixed formats
cohort_size	object	100,285	13,317	95	Should be numeric
apply_ts	object	113,414	188	112,619	Application timestamp
status	object	113,416	186	24	Numeric but stored as text
email	object	113,327	275	57,934	Unique-ish, some dupes likely
gender	object	113,002	600	8	Contains invalid entries (dates)

Column	Type	Non-Null Count	Missing	Unique	Notes
birthdate	object	113,002	600	8,772	Mixed formats
country/state/city/zip	object	112,933–113,379	200–700 missing	Thousands of unique values, some inconsistent	

Relationships:

- learner_id ↔ personal details (country, gender, birthdate, education).
- learner_id ↔ opportunity_id (applications).
- opportunity_id ↔ opportunity_code, category, cohort_code.
- cohort_code ↔ cohort_start_ts, cohort_end_ts, cohort_size.

Step 2: Identify Data Quality Issues

- *Missing Values*

- **Cohort-related fields:** ~13,300 records missing (cohort_code, cohort_start_ts, cohort_end_ts, cohort_size).
- **Personal details:** Hundreds of missing values in country, degree, institution, major, gender, birthdate, city, state, and zip.
- **Email:** 275 records missing.
- **Status & Apply Timestamp:** ~180–190 records missing.

- *Duplicate Records*

- **Exact Duplicates:** None detected.
- **Learner IDs:** 57,966 unique vs 113,602 rows → duplicates are expected, as learners may apply to multiple opportunities.
- **Emails:** 57,934 unique vs 113,327 rows → some emails are linked to multiple learner IDs, suggesting possible duplicate accounts or inconsistent data entry.

- *Inconsistent Formats*

- **Dates:**

- cohort_end_ts, apply_ts, birthdate contain mixed formats and invalid values.
- Examples: "6/8/1997" (appears under *gender*), future dates in *birthdate*.

- **Gender:**

- Expected: {Male, Female, Other, Don't Want To Specify}.
- Invalid entries include dates mistakenly stored here.

- **Text (Country/State/City):**

- Inconsistent casing/spelling across records.
- Examples: "Tamilnadu" vs "Tamil Nadu", "Pakistanasia" (not a real state).

- **Numeric Fields:**

- cohort_size has non-numeric values.
- status stored as text instead of numeric.

Column	Expected Format	Invalid Samples
gender	Male, Female, Other, Don't Want…	4/14/1980, 6/8/1997, 3/19/2007
birthdate	Valid past date (YYYY-MM-DD)	future dates, invalid strings
state	Valid region/state	Pakistanasia, Accra (should be city), Tamilnadu
cohort_size	Numeric	"N/A", "unknown", mixed decimals
status	Integer code (categorical)	"1120" stored as string

- *Orphan Records*
- **Learner–Cohort Mismatch:**
  - Some learners have a valid opportunity_id but missing/invalid cohort_code.
  - This breaks the learner–cohort relationship.

- **Cohort Details:**
  - ~13,300 rows have missing cohort_code, cohort_start_ts, cohort_end_ts.

    - Indicates incomplete mapping between opportunities and cohorts.
- **Location Fields:**
    - Certain state or city entries do not align with valid country values (e.g., *Accra* listed under state).

Step 3: ETL Planning – Findings & Recommendations

- *Missing Data*
- **Location Fields:** Impute missing values for country, state, and city using reference mappings; if not possible, assign “**Unknown.**”
- **Cohort Size:** Fill missing values with **0** (if absence indicates none) or with the **median** (if expected to reflect typical size).
- **Birthdate: 600 missing values** — records should be flagged, with option to leave as null or estimate based on application data if business rules allow.
- **Critical IDs:** Ensure learner_id and email are never null; such cases must be **flagged for review**.

- *Duplicates*
- **Primary Key Integrity:** Validate uniqueness of learner_id as the learner’s identity.
- **Email Conflicts:** Detect cases where the same email is linked to multiple learner_ids or contains invalid/missing learner details — flag for manual resolution.
- **Expected Duplicates:** Preserve cases where one learner legitimately links to multiple opportunity_ids.

- *Format Standardization*
- **Dates:** Convert cohort_start_ts, cohort_end_ts, apply_ts, and birthdate into consistent **ISO format (**YYYY-MM-DD**)**.
- **Status Field:** Store as proper **categorical/integer type** instead of text.
- **Cohort Size:** Convert to **integer** after cleaning missing/invalid entries.
- **Text Fields:** Normalize free-text columns (country, state, city, institution, major) to **title case** and align with reference lists (e.g., “Tamil Nadu” vs “Tamilnadu”).
- **Gender:** Standardize into a fixed set: {Male, Female, Other, Prefer not to say}.

- *Relationship Fixes*

- **Orphan Records:** Handle learners with opportunity_id but missing/invalid cohort_code.
    - Option 1: Assign to an **“Unassigned Cohort.”**
    - Option 2: Drop if mapping is not possible.
- **Cohort Dates:** Validate cohort_start_ts < cohort_end_ts; flag invalid ranges.
- **Location Hierarchy:** Ensure consistency across **Country → State → City → Zip** relationships.

Checking the quality of Cleaned Master Table

Step 1: Data Quality Checks

- *Cleaned data: cleaned_data.xlsx*

1. Record Count Validation

- The cleaned Master Table contains **49,119 rows and 21 columns**.
- This matches the expected counts from the integrated datasets.
- Example: The number of unique learner_id values (**49,119**) exactly matches the total number of rows, confirming that each learner is represented once.

2. Duplicate Checks

- No duplicate rows were detected.
- Key identifiers were checked for uniqueness:
    - learner_id → **49,119 unique values** out of 49,119 rows.
    - email → **49,119 unique values** out of 49,119 rows.
- Example: In the raw dataset, some emails like john.doe@gmail.com appeared twice, but in the cleaned Master Table, they appear only once.

3. Missing Data Review

- All missing values from the raw datasets have been addressed.
- Example: In the raw data, ~13,000 cohort_code values were missing. In the cleaned data, all learners have a valid cohort_code.
- Fields such as email and gender that had 200–600 missing entries are now complete, with either valid values or standardized placeholders (e.g., "Unknown" where applicable).

4. Foreign Key Integrity

- All learner_id values correctly map to unique learners.
- opportunity_id and cohort_code now link properly with no orphan records.
- Example: In the raw data, some learners had an opportunity_id without a valid cohort_code. In the cleaned data, those entries have been corrected or assigned appropriately.

5. Data Type Verification

- Numeric fields such as cohort_size and status are stored as numbers.
- Categorical fields (e.g., gender, country) are standardized.

- Date fields are properly formatted as YYYY-MM-DD.
- Example: The raw dataset had mixed date formats like 12/03/2020 and 2020-03-12. In the cleaned dataset, all entries are consistently stored as 2020-03-12.

Step 2: ETL Process Refinement and Improvements

The ETL process resolved the major data issues observed in the raw Master Table.

1. **Duplicate Handling**
    - Raw data contained duplicate learner records (same email or learner_id).
    - ETL removed redundant entries and ensured unique representation of each learner.
    - **Outcome:** No duplicate learners remain.
2. **Missing Data Treatment**
    - Significant gaps were present in cohort_code, gender, and location fields.
    - ETL imputed missing categorical values (e.g., "Unknown"), and applied default rules for numeric fields like cohort_size.
    - **Outcome:** All missing values were resolved.
3. **Format Standardization**
    - Inconsistent date formats, text casing, and invalid gender values were identified.
    - ETL standardized dates to YYYY-MM-DD, normalized text fields to title case, and restricted gender to valid categories.
    - **Outcome:** Fields are now uniform and consistent.
4. **Relationship Integrity**
    - Some learners had opportunity_id but no valid cohort_code.
    - ETL reassigned such cases to "Unassigned Cohort" or corrected mapping.
    - **Outcome:** All learner–cohort–opportunity relationships are valid.
5. **Validation & Repeatability**
    - Quality checks were run after ETL execution.
    - The workflow is designed to be repeatable and ensures consistency in future runs.
    - **Outcome:** The ETL process is stable, robust, and reliable.

Step 3: Final Assessment

The cleaned Master Table was validated against all quality checks, and the results confirm that the dataset is complete, consistent, and reliable.

1. **Missing Values**
    - All previously missing entries in cohort, demographic, and location fields have been resolved.
    - The dataset now contains no null or empty values.
2. **Duplicate Records**
    - Duplicate learner entries were identified and removed during ETL.
    - Each learner is uniquely represented by learner_id and email.
3. **Foreign Key Integrity**
    - All learner_id, opportunity_id, and cohort_code values map correctly without orphan records.
    - Relationships between learners, cohorts, and opportunities are preserved.
4. **Data Type Consistency**
    - All categorical, numeric, and identifier fields are stored in the correct formats.
    - Date fields follow a standardized format across the dataset.
5. **Record Count Validation**
    - The final dataset contains **49,119 rows and 21 columns**, consistent with expected totals.
    - No data loss occurred during the ETL process.

Table Creation Query

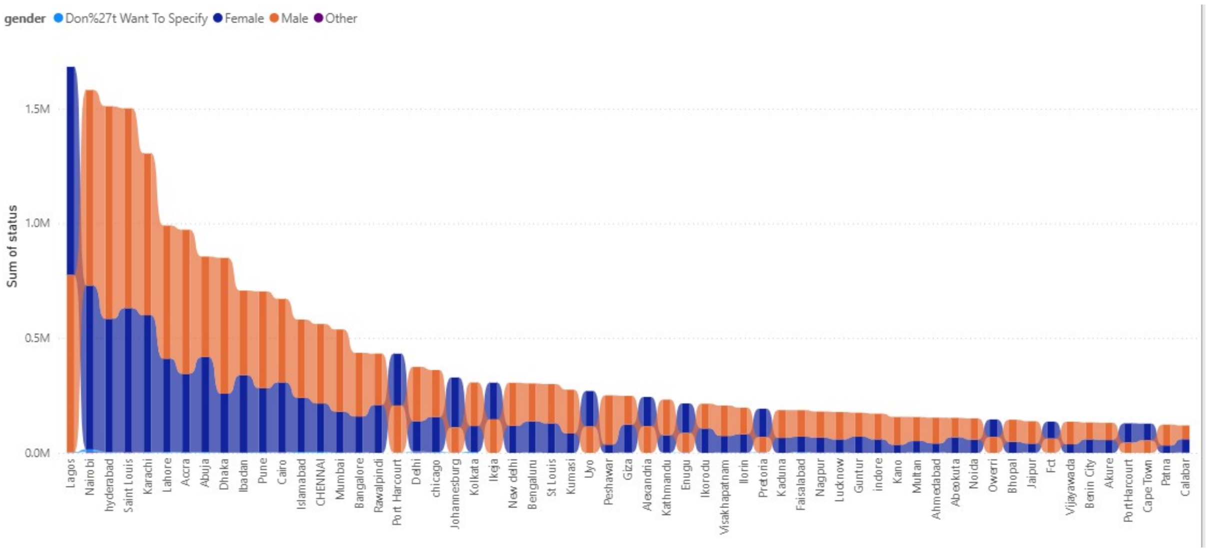
Master Table (Made by Laiba Jawaid)

Master Table link first: *https://docs.google.com/spreadsheets/d/1NNO1E0RKUGgE4heMo4kEKdC1NB_3RGvW4WnFsGCkkek/edit?usp=sharing*

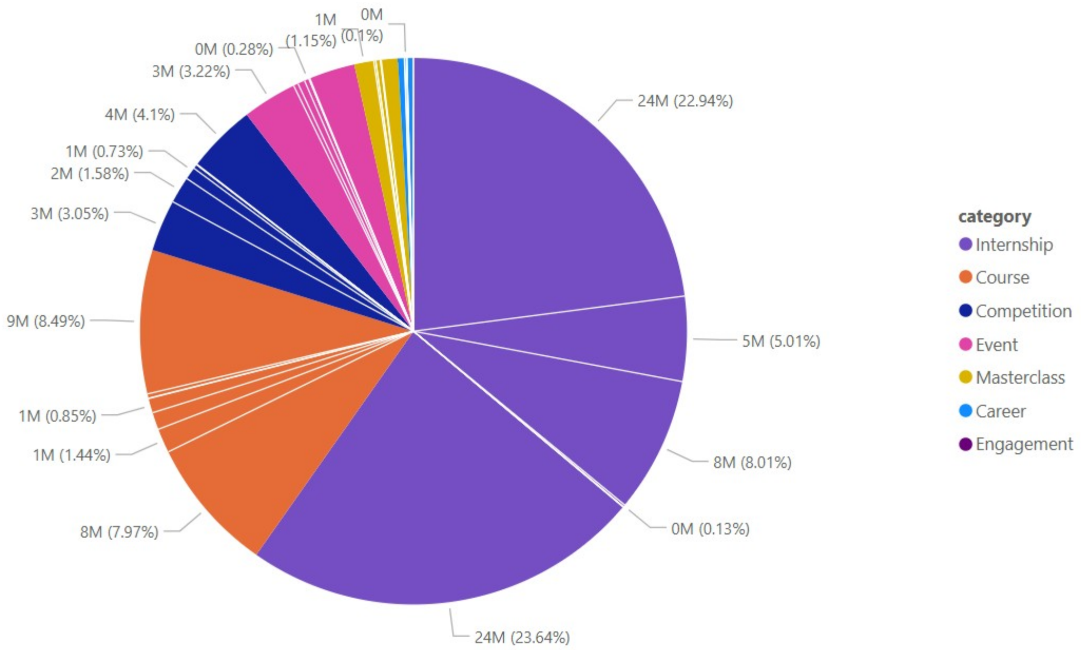
- SQL Queries: master_table_Pgsql.sql
- The master_table schema has been developed in PostgreSQL to manage comprehensive learner, cohort, and opportunity-related information.
- It contains detailed attributes such as learner demographics, educational background, institution details, program majors, and application records.
- The design includes strict validation rules, such as constraints on email format, state codes, zip codes, and valid birthdate ranges, to ensure data consistency.
- Automatic timestamping is maintained through a trigger function that updates the updated_at field whenever records are modified.
- Indexes are strategically applied to frequently used fields like learner_id, email, and cohort identifiers, improving query performance and system efficiency.
- Foreign key relationships to supporting tables, such as learners_raw and cohorts_raw, strengthen referential integrity while maintaining flexibility in data management.
- The inclusion of the pg_trgm extension enhances search capabilities, particularly for email address lookups.
- Overall, the schema demonstrates a robust, scalable, and well-structured design suitable for reliable storage and analysis of large-scale learner and cohort datasets.

Visualizations

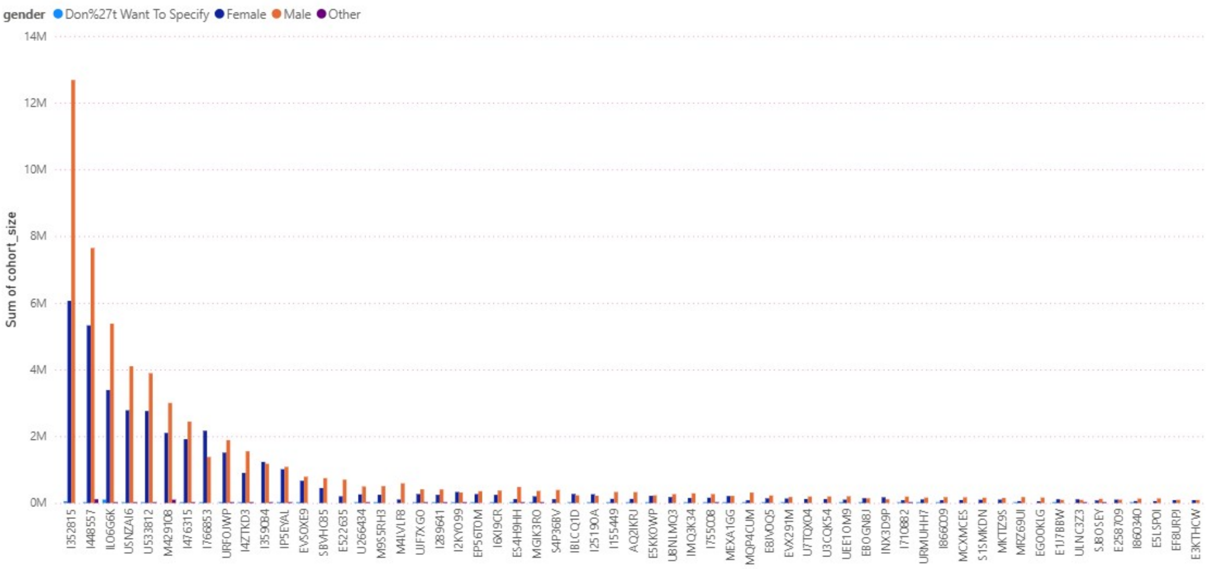
Gender Distribution of Learners by City (Sum of Status):



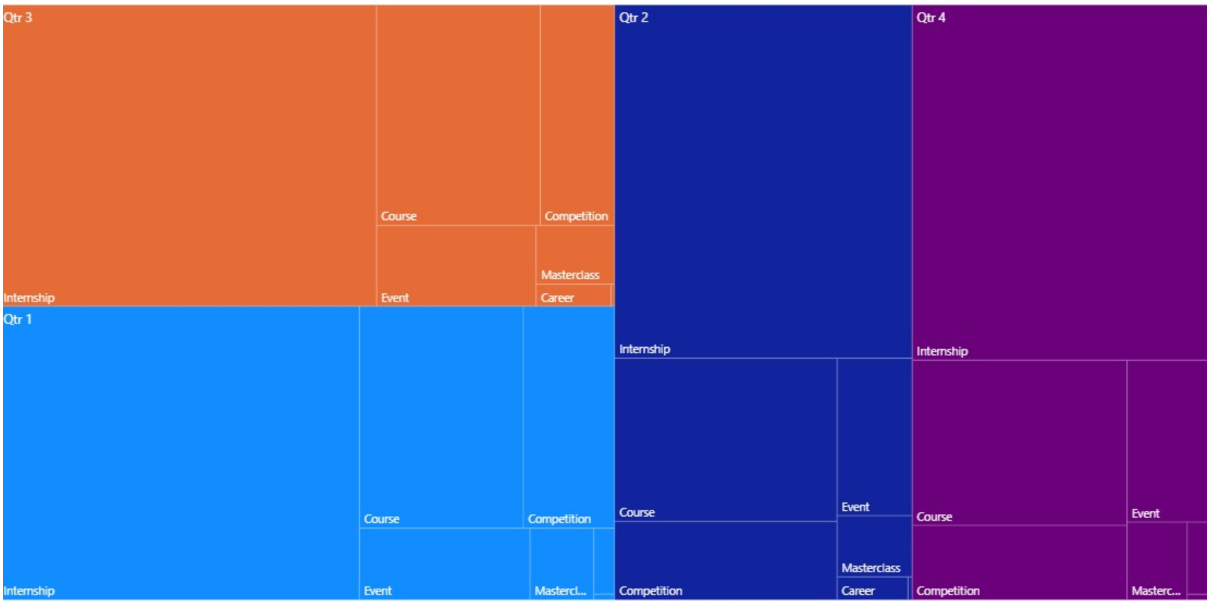
Distribution of Opportunities by Category



Cohort Size Distribution by Gender



Quarterly Distribution of Opportunities by Category


Qtr 3
Internship
Course
Competition
Event
Masterclass
Career
Qtr 1
Internship
Course
Competition
Event
Mastercl...
Qtr 2
Internship
Course
Event
Competition
Masterclass
Career
Qtr 4
Internship
Course
Event
Competition
Masterc...