Strategic HR Analytics & Cleaning and Modeling Stage

From Raw Data to a Robust Star Schema Architecture

Project Context: Digital Egypt Pioneers Initiative (DEPI) - Graduation Project

Team Members:

- **Osama El-Sarsawy** (Team Lead)
- Mohamed El-Bastawiy
- Alaa Osama
- Mariam El-Badry
- Taha Khalifa

Project Roadmap

01

Project Scope & Vision

Why are we doing this?

02

The "Before" State

Assessing Data Chaos & Quality Issues.

03

Phase I: Data Cleaning & Preparation (ETL)

Transformation Logic & Quality Assurance.

04

Phase II: Advanced Data Modeling

Architecture & The "Reference Table" Strategy.

05

Feature Engineering

Creating Intelligence via DAX.

06

Technical Challenges & Solutions

Overcoming Complexity.

Transforming HR Data into Strategic Assets

- **Objective** To move beyond static reporting and build a dynamic BI Ecosystem capable of diagnosing Attrition, predicting Burnout, and evaluating Talent Performance. This allows for proactive decision-making rather than reactive responses.
- **The Dataset Scope**
  - **Demographics:** 1,470 Employees (Age, Gender, Education levels, Job Role, etc.).
  - **Transactions:** 6,000+ Historical Performance Reviews, including ratings and feedback over time.
  - **Lookups:** 4 Dimension Tables (Education Field, Satisfaction Level, Performance Ratings, Experience Levels) to provide context.
- **Technical Goal** Achieve a "Single Source of Truth" through a rigorous Star Schema model. This ensures data consistency, reduces redundancy, and simplifies query design for analysts.

Initial Data Assessment & Challenges

The "Before" State (Data Audit)

Fragmentation

Data existed in 5 disconnected CSV files (Employee.csv, PerformanceRating.csv, SalaryHistory.csv, etc.), making it impossible to get a holistic view of HR metrics without manual effort.

Ambiguity

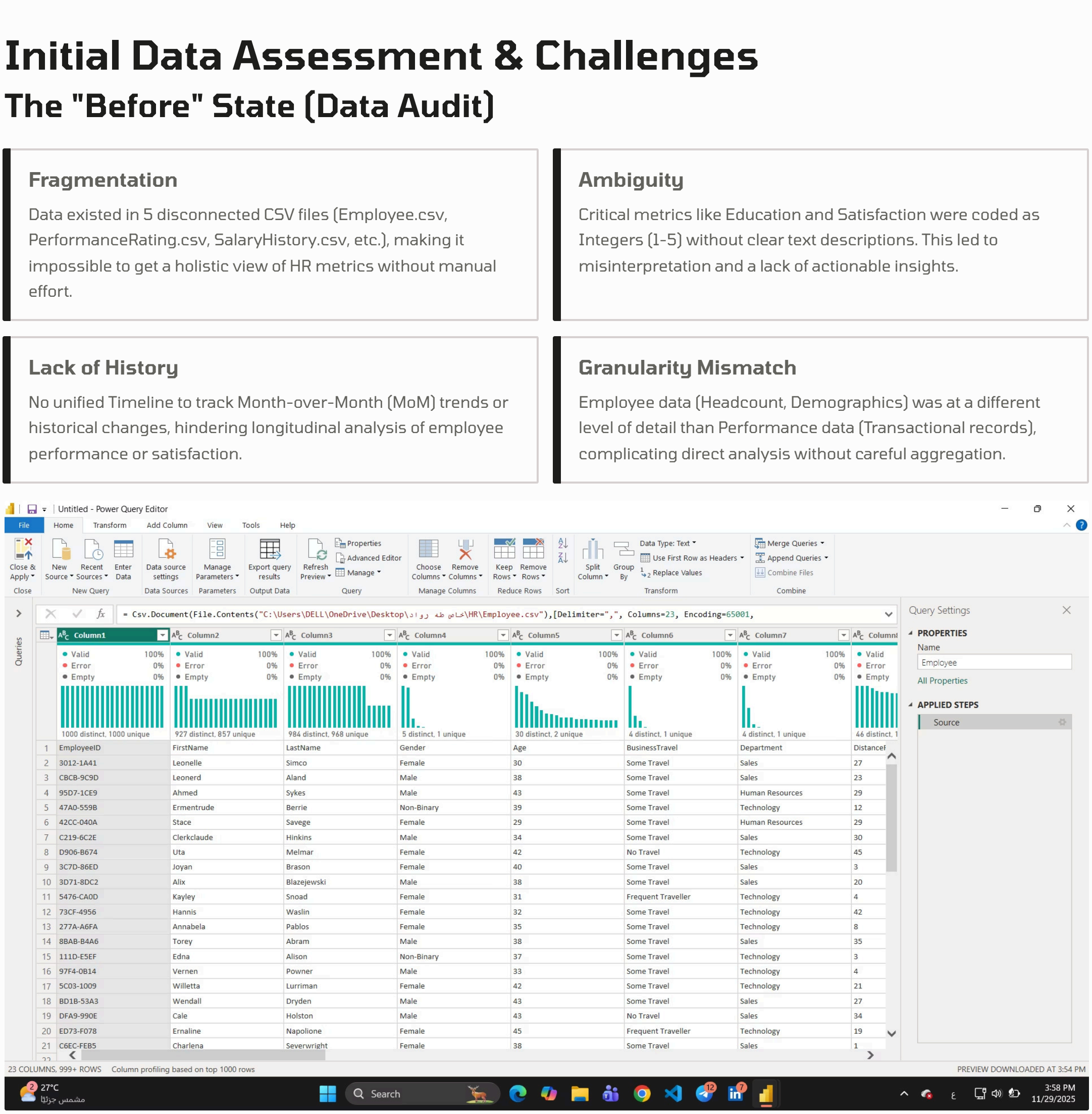
Critical metrics like Education and Satisfaction were coded as Integers (1-5) without clear text descriptions. This led to misinterpretation and a lack of actionable insights.

Lack of History

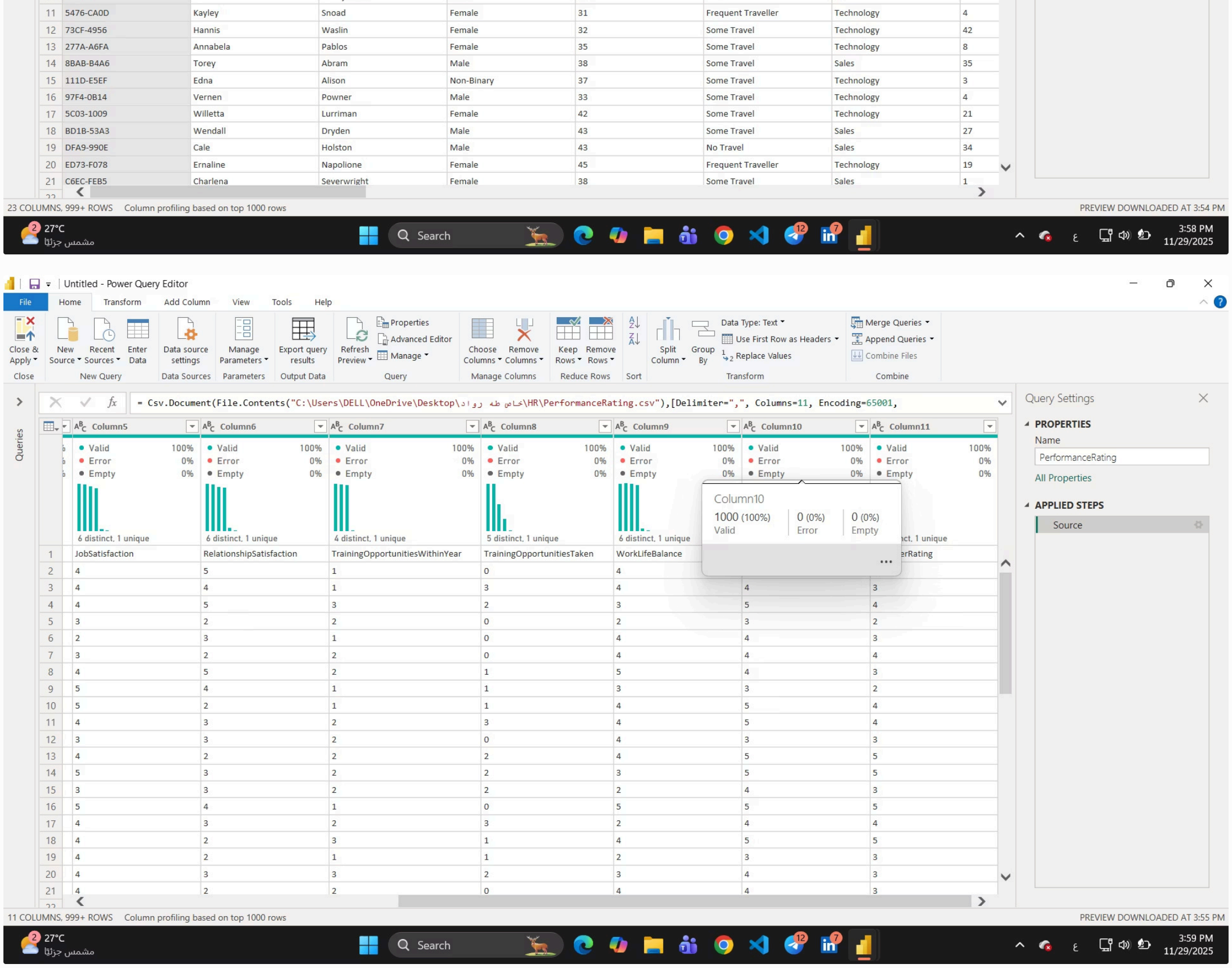
No unified Timeline to track Month-over-Month (MoM) trends or historical changes, hindering longitudinal analysis of employee performance or satisfaction.

Granularity Mismatch

Employee data (Headcount, Demographics) was at a different level of detail than Performance data (Transactional records), complicating direct analysis without careful aggregation.



	EmployeeID	FirstName	LastName	Gender	Age	BusinessTravel	Department	DistanceF
2	3012-1A41	Leonelle	Simco	Female	30	Some Travel	Sales	27
3	CBCB-9C9D	Leonerd	Aland	Male	38	Some Travel	Sales	23
4	95D7-1CE9	Ahmed	Sykes	Male	43	Some Travel	Human Resources	29
5	47A0-559B	Ermentrude	Berrie	Non-Binary	39	Some Travel	Technology	12
6	42CC-040A	Stace	Savege	Female	29	Some Travel	Human Resources	29
7	C219-6C2E	Clerkclaude	Hinkins	Male	34	Some Travel	Sales	30
8	D906-B674	Uta	Melmar	Female	42	No Travel	Technology	45
9	3C7D-86ED	Joyan	Brason	Female	40	Some Travel	Sales	3
10	3D71-8DC2	Alix	Blazejewski	Male	38	Some Travel	Sales	20
11	5476-CA0D	Kayley	Snoad	Female	31	Frequent Traveller	Technology	4
12	73CF-4956	Hannis	Waslin	Female	32	Some Travel	Technology	42
13	277A-A6FA	Annabela	Pablos	Female	35	Some Travel	Technology	8
14	8BAB-B4A6	Torey	Abram	Male	38	Some Travel	Sales	35
15	111D-E5EF	Edna	Alison	Non-Binary	37	Some Travel	Technology	3
16	97F4-0B14	Vernen	Powner	Male	33	Some Travel	Technology	4
17	5C03-1009	Willetta	Lurriman	Female	42	Some Travel	Technology	21
18	BD1B-53A3	Wendall	Dryden	Male	43	Some Travel	Sales	27
19	DFA9-990E	Cale	Holston	Male	43	No Travel	Sales	34
20	ED73-F078	Ernaline	Napolione	Female	45	Frequent Traveller	Technology	19
21	C6EC-FEB5	Charlena	Severwright	Female	38	Some Travel	Sales	1



	JobSatisfaction	RelationshipSatisfaction	TrainingOpportunitiesWithinYear	TrainingOpportunitiesTaken	WorkLifeBalance		
2	4	5	1	0	4		
3	4	4	1	3	4	4	3
4	4	5	3	2	3	5	4
5	3	2	2	0	2	3	2
6	2	3	1	0	4	4	3
7	3	2	2	0	4	4	4
8	4	5	2	1	5	4	3
9	5	4	1	1	3	3	2
10	5	2	1	1	4	5	4
11	4	3	2	3	4	5	4
12	3	3	2	0	4	3	3
13	4	2	2	2	4	5	5
14	5	3	2	2	3	5	5
15	3	3	2	2	2	4	3
16	5	4	1	0	5	5	5
17	4	3	2	3	2	4	4
18	4	2	3	1	4	5	5
19	4	2	1	1	2	3	3
20	4	3	3	2	3	4	3
21	4	2	2	0	4	4	3

ETL Strategy & Data Quality Assurance

Phase I - Data Cleaning & Preparation (ETL)

→ Strict Type Casting

Enforced specific data types (Dates vs. Text vs. Int64) across all columns to prevent calculation errors and ensure data integrity within the model.

→ Data Profiling

Achieved 100% Column Quality (0 Errors, 0 Empty values) across Primary Keys and critical attributes, ensuring a reliable foundation for analysis.

→ Standardization

Renamed inconsistent columns (e.g., EmpID to EmployeeID) to enable seamless auto-relationship detection and improve readability for future users.

→ Result

A clean, error-free dataset that serves as a robust and reliable source for advanced analytics and reporting, reducing the time spent on data preparation.

The Architecture: Building the Star Schema

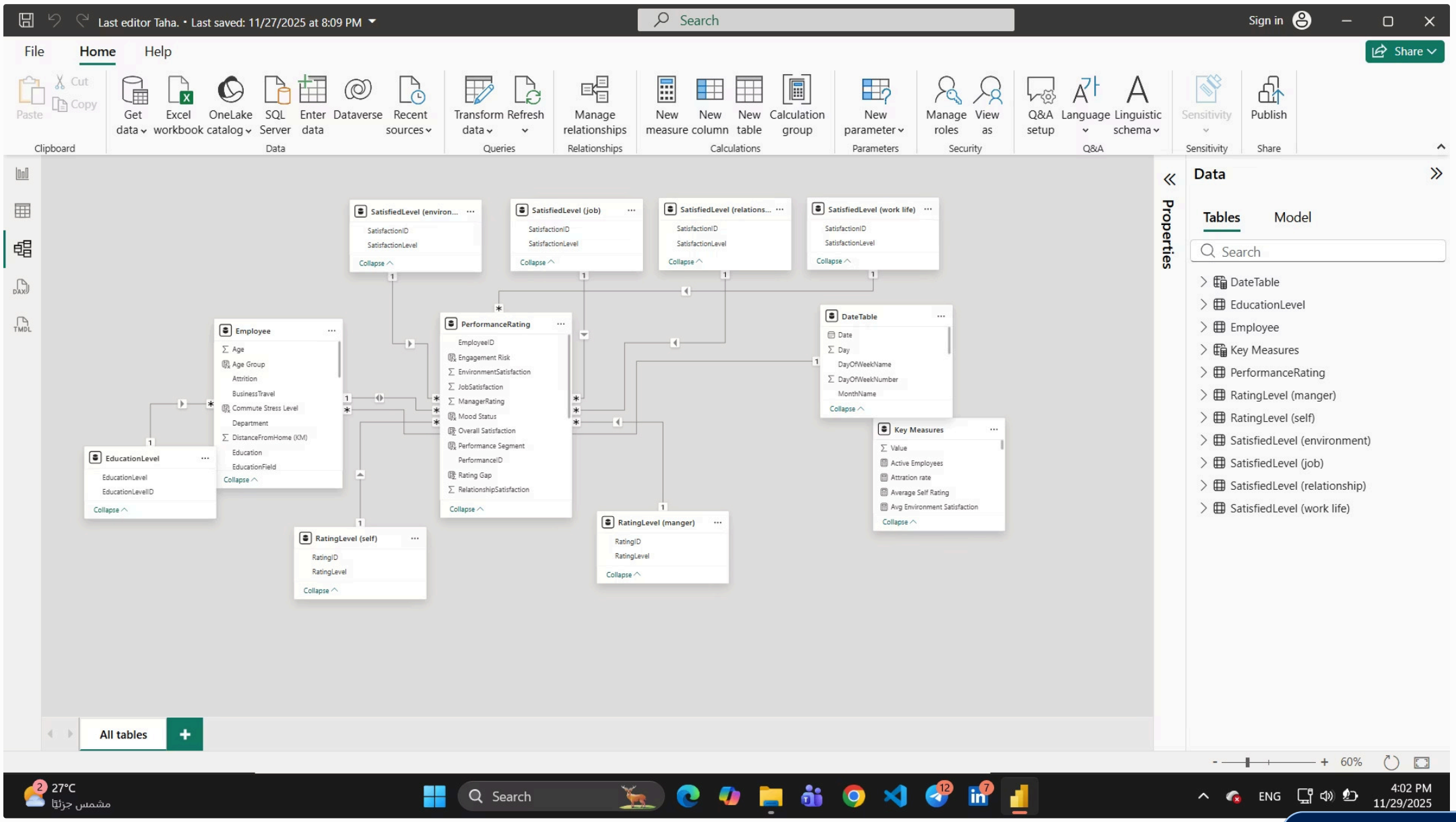
Phase II - Advanced Data Modeling

Model Overview

- **Fact Table:** PerformanceRating (The central transactional table containing performance metrics and review dates).
- **Dimension Tables:** Employee (SCD Type 1 for slowly changing attributes like job title), DateTable (for temporal analysis), Education, and Rating (for descriptive attributes).

The Logic

- Established One-to-Many (1:*) relationships between dimension and fact tables to ensure data integrity and accurate aggregation.
- Enforced Single Direction filtering from dimension to fact tables to prevent ambiguity and circular dependencies, ensuring predictable data behavior.



Solving the "Role-Playing Dimension" Challenge

Technical Highlight - The "Reference Table" Strategy

1

The Challenge

The PerformanceRating table contained 4 separate satisfaction columns (Environment, Job, Relationship, WorkLifeBalance), each requiring a descriptive lookup. We only had one lookup table: SatisfiedLevel.csv.

2

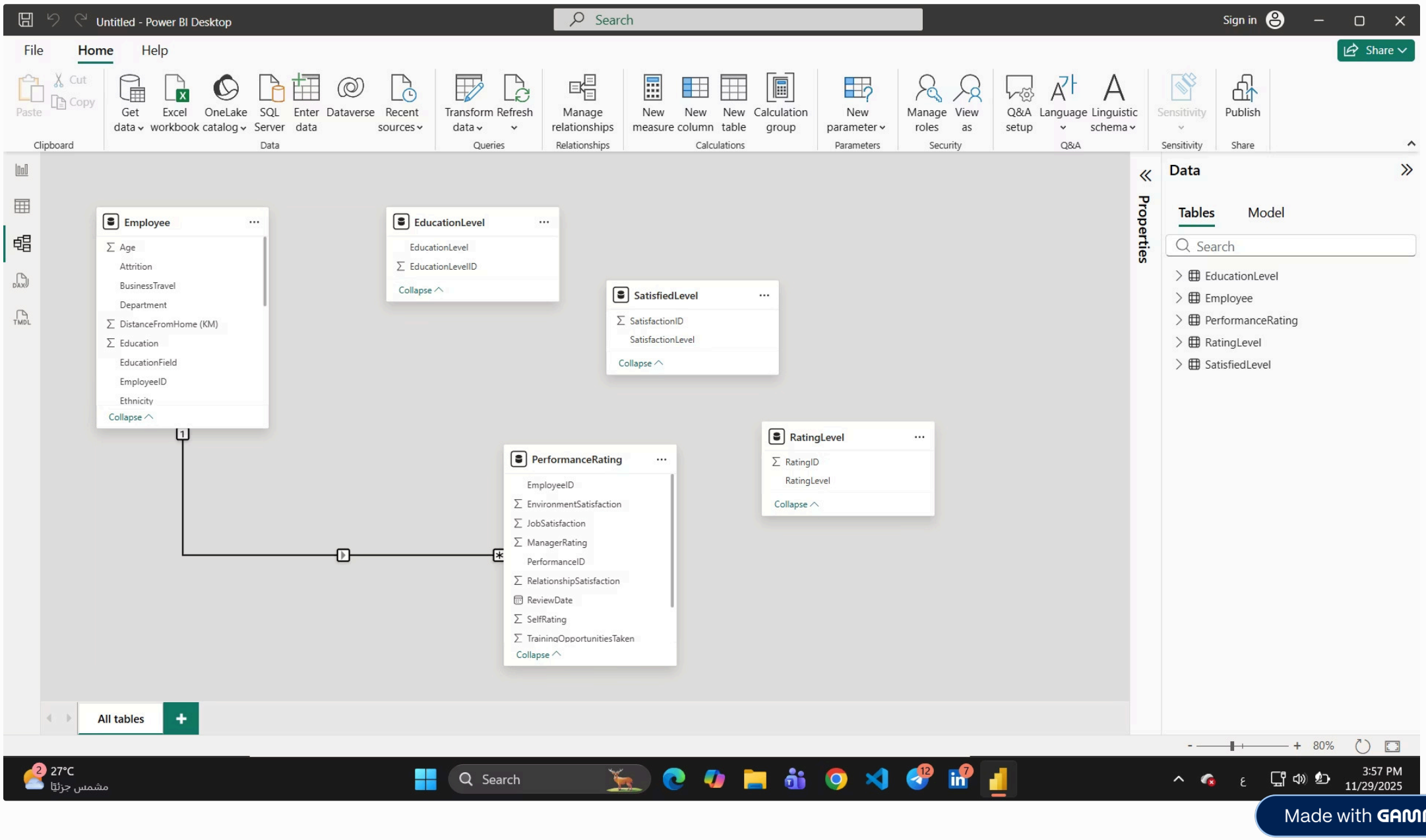
The "Pro" Solution

Instead of merging text 4 times (which bloats file size and reduces performance), we imported SatisfiedLevel as a Reference Table. We then created 4 Active Relationships (or virtual copies) to filter each satisfaction metric independently.

3

Impact

This strategy significantly optimized model performance and allowed for complex slicing and dicing (e.g., Filtering by "Low Job Satisfaction" without affecting "Environment Satisfaction"), providing granular insights.



The Date Table & Temporal Analysis

Time Intelligence Infrastructure

The Problem

Raw data lacked a continuous and comprehensive timeline, making it challenging to perform time-based analyses such as trends, period-over-period comparisons, or year-to-date calculations.

The Solution

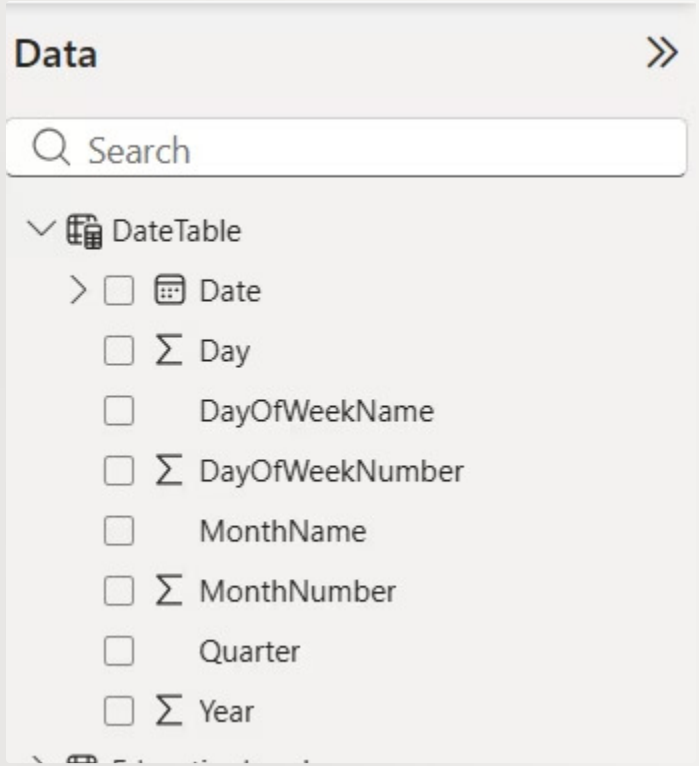
We engineered a dynamic Date Table using DAX, populating it with a full range of dates and associated attributes like year, quarter, month, and day of week.

Relationships

- **Active Link:** To PerformanceRating[ReviewDate] (for analyzing performance trends over time).
- **Inactive Link:** To Employee[HireDate] (activated via USERELATIONSHIP for recruitment analysis and tenure calculations).

Enabled Analysis

This infrastructure enabled robust Month-over-Month (MoM) Growth calculations, Year-to-Date (YTD) analyses, and detailed Seasonality checks, providing deeper insights into HR dynamics.



Creating Intelligence: Advanced Calculated Columns

Feature Engineering (Smart Columns)

Concept: We didn't just use the data; we enriched it.

Highlight 1: The "Real Promotion" Logic

Problem: New hires often had "0 Years Since Promotion", mimicking recently promoted staff, leading to misinterpretation.

Solution: We developed a complex DAX query: `Real Promotion Year = IF(YearsSincePromotion < YearsAtCompany, Year - YearsSincePromotion, BLANK())`. This accurately identifies actual promotions versus new employment.

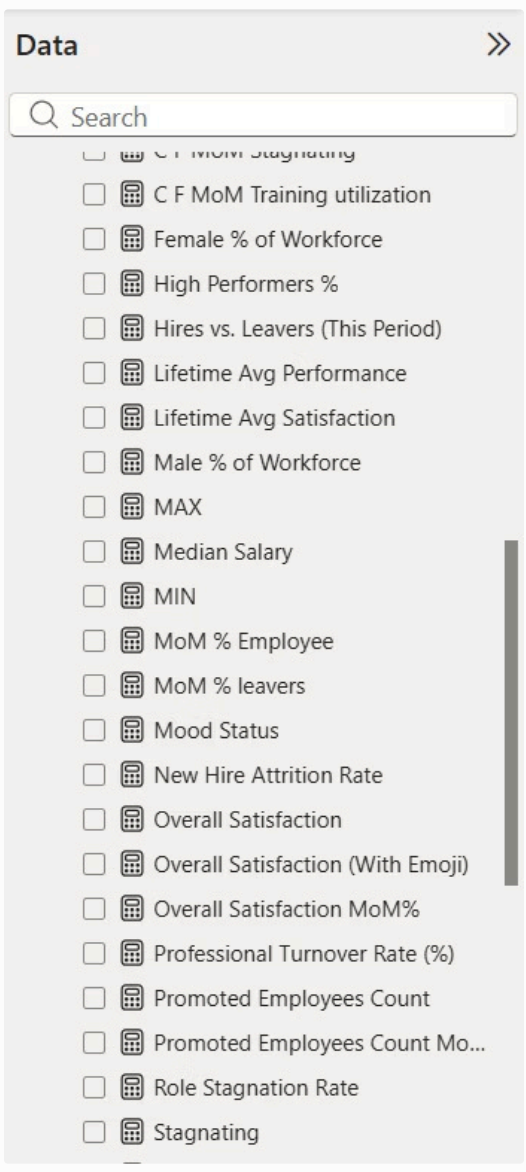
Highlight 2: The "Exit Reason Classifier"

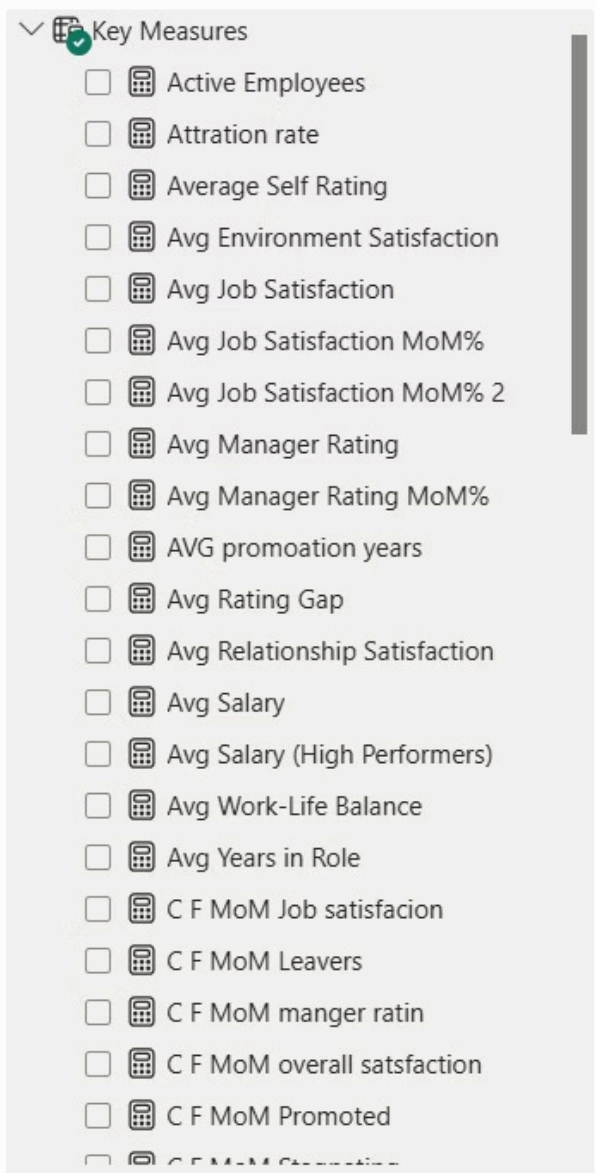
Concept: A logic-based column that intelligently classifies leavers based on their performance and satisfaction data.

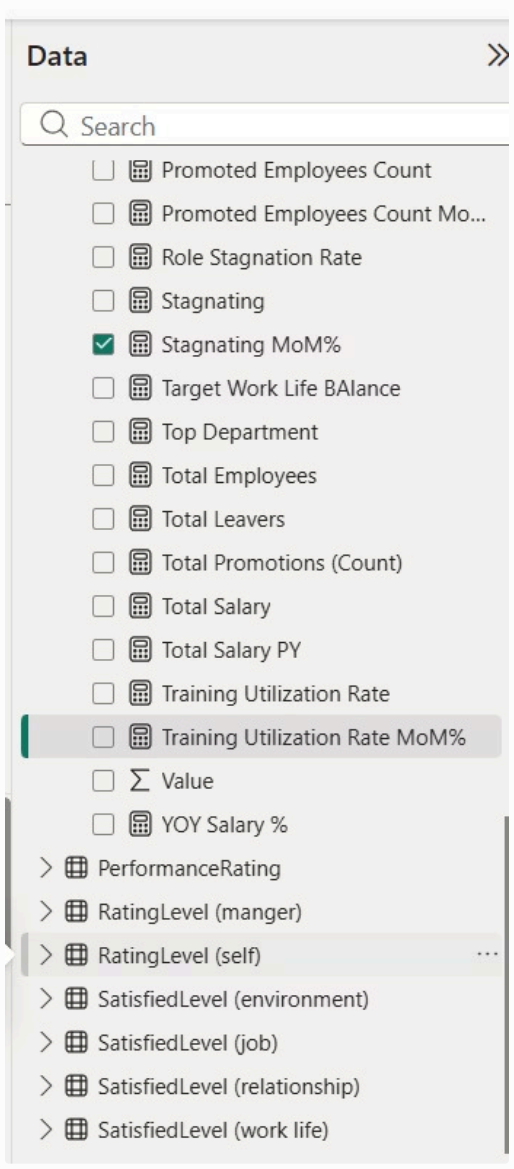
- **Burnout:** High Performance / Low Satisfaction
- **Salary Churn:** High Performance / High Satisfaction (suggesting external offers)
- **Involuntary:** Low Performance / Any Satisfaction (indicating performance-based exits)

These engineered features provide a richer, more nuanced understanding of HR dynamics, moving beyond raw data to actionable intelligence.

```dax
Professional Turnover Rate (%) =
VAR TotalLeavers =
    CALCULATE(
        [Total Leavers],
        ALLSELECTED('DateTable')
    )
VAR CumulativeEmployees =
    CALCULATE(
        SUMX(
            'Employee',
            1
        ),
        FILTER(
            ALL('Employee'),
            'Employee'[HireDate] <= MAX('DateTable'[Date])
        )
    )
VAR TurnoverRate = DIVIDE(TotalLeavers, CumulativeEmployees, 0)
RETURN
FORMAT(TurnoverRate, "0%")
```







Overcoming Data Complexity

Technical Challenges & Solutions

1

Challenge 1: Granularity Mismatch

Issue: Trying to analyze "Employee Attributes" (one row per person) against "Historical Reviews" (multiple rows per person) directly could lead to incorrect aggregations.

Solution: Utilized DAX Context Transition to calculate "Lifetime Averages" for every employee, ensuring accurate metrics across different granularities.

2

Challenge 2: Many-to-Many Traps

Issue: Connecting a single EducationLevel dimension to multiple fact tables (e.g., performance and hiring data) could create ambiguous or incorrect relationships.

Solution: Implemented Bridge Tables and distinct Reference Tables to keep the schema clean, maintain data integrity, and ensure filtering works as intended without circular dependencies.

Final Deliverable: An Enterprise-Ready Model

Status

The Data Model is fully optimized, validated, and meticulously documented, ready for deployment and immediate use by HR analysts and leadership.

Scalability

The architecture supports adding future data sources (e.g., Attendance, Payroll, Training Records) without breaking existing logic, ensuring long-term utility.

Next Step

This robust model is now the foundational layer for our 6 Strategic Dashboards covering Workforce Dynamics, Performance Management, Employee Well-being, and more.