BUSINESS INTELLIGENCE SOLUTION FOR DOG SHELTER OPERATIONS

Using Data Analytics to Improve Adoption Outcomes and Support Smarter Decisions

ISM 6255 – Knowledge Management & Business Intelligence
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1. Introduction

Dog shelters face the constant challenge of managing large amounts of information, from tracking each dog's background to monitoring adoptions, veterinary visits, and volunteer efforts. When this data is scattered across different sources and difficult to analyze, it becomes harder to make decisions that improve operations and save more lives.

Many dogs spend weeks or even months waiting in shelters. In overcrowded facilities, prolonged stays can mean running out of time, and some dogs are euthanized when space or foster care ends without an adopter. This reality highlights the urgent need for tools that help shelters place dogs faster and with the right families.

The goal of this project was to transform raw, fragmented shelter data into a format that staff and decision-makers can use to identify patterns and act on them. Using SQL Server Analysis Services (SSAS), the operational database was cleaned, structured, and built into a cube that allows quick, multi-angle analysis. Custom measures were designed to track key metrics such as adoption rates, veterinary costs, and foster conversion, while hierarchies were created to make trends easier to explore.

The final deliverables include a cube for in-depth analysis and an Excel dashboard with clear visualizations. This solution enables shelters to see their data in a way that supports smarter, faster, and more compassionate decisions, giving more dogs a better chance at finding a home.

2. Business Problem and Objectives

Animal shelters manage a variety of operations, from dog intake to medical treatment and adoption, but most of this information is stored in separate systems or spreadsheets. Without integration, staff members lack the ability to easily see how factors like breed, shelter location, or foster history affect adoption outcomes. This lack of visibility limits the ability to make data-driven decisions that could improve adoption rates and resource allocation.

The business problem focuses on the need for a single, reliable source of information that combines data from adoptions, fosters, veterinary visits, and volunteer activities. When

information is fragmented, critical questions remain unanswered. How long do dogs of certain breeds stay in care? Which shelters face the most overcrowding? Are there patterns in volunteer contributions that could improve support where it is needed most?

The objective of this project was to create a solution that addresses these gaps by:

- Centralizing shelter data into a clean, analyzable structure
- Building a data mart and cube that enables quick exploration of adoption, foster, veterinary, and volunteer trends
- Defining meaningful metrics such as adoption rates, veterinary costs per dog, and average foster duration to support better decision-making
- Providing clear visualizations through Excel PivotTables and Pivot Charts that allow staff to easily identify patterns

By meeting these objectives, the project delivers a tool that enhances operational insight and supports the shelter's ultimate mission of helping more dogs find permanent, loving homes.

3. Data Source and Preparation

The project began with an operational database built in Microsoft Access that stored information on adoptions, dogs, shelters, foster homes, rescue organizations, veterinary visits, and volunteer activity. While the data was comprehensive, it was not structured for analysis. Relationships were inconsistent, date fields were not standardized, and duplicate or unnecessary attributes were present.

To prepare the data for analysis, the database was reviewed and cleaned. Primary and foreign keys were verified to ensure proper relationships between tables. Fields were adjusted to enforce data integrity, such as defining field sizes, setting validation rules, and formatting dates consistently. Several redundant columns were removed to prevent confusion during cube development.

A key part of the preparation involved handling dates. Since multiple tables contained date fields (adoption dates, foster start and end dates, veterinary visit dates, and volunteer activity dates), a Date Dimension was created. This dimension served as a centralized calendar, supporting time-based analysis across all facts. However, the use of the Full Date attribute as both a key and a hierarchy level initially caused conflicts. To resolve this, the hierarchy was simplified and duplicate levels were removed, while the Date Dimension remained usable across all tables.

The cleaned Access database was then exported to SQL Server, where it became the foundation for building a data warehouse. From there, SQL Server Analysis Services (SSAS) was used to create a multidimensional cube. During this process, role-playing dimensions were implemented to handle multiple date relationships, and fact tables were connected to the appropriate dimensions to allow flexible slicing of data. This preparation phase ensured that the data model was robust, consistent, and ready to support meaningful analysis.

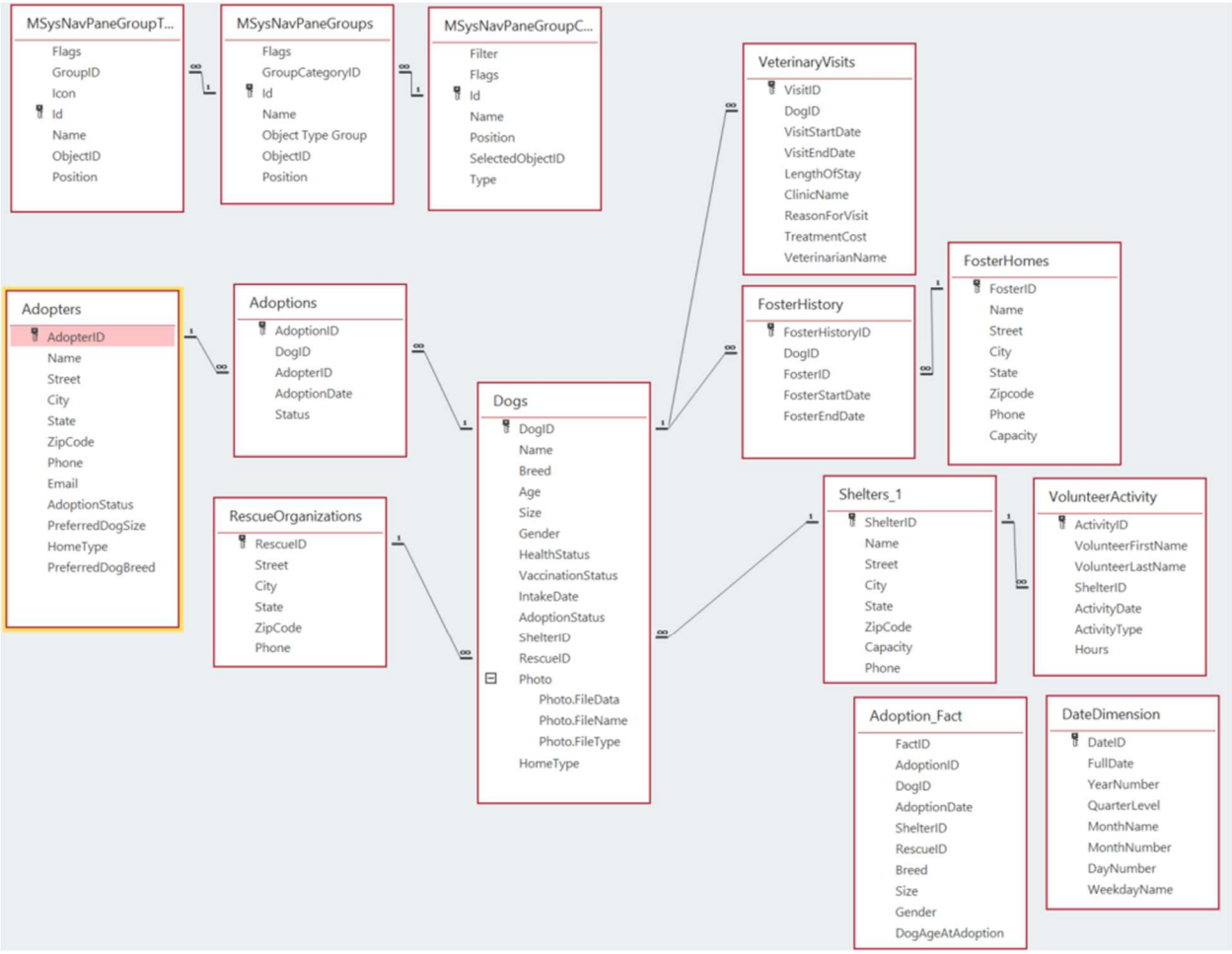


Figure 1. Microsoft Access Operational Database

4. Cube Design (Data Mart)

The data mart was designed to organize shelter data in a structure that supports multidimensional analysis. A star schema was implemented, placing the main fact tables at the center and surrounding them with descriptive dimensions. This approach made it possible to examine adoption activity, foster history, veterinary visits, and volunteer efforts from multiple perspectives.

The cube contained four measure groups, each tied to one of the fact tables, Adoption Fact, Foster History, Veterinary Visits, and Volunteer Activity. These groups captured measurable events such as the number of adoptions, length of veterinary stays, and total volunteer hours. Dimension tables, including Dogs, Adopters, Shelters, Foster Homes, Rescue Organizations, and Date Dimension, were linked to these fact tables through foreign keys to allow flexible filtering and grouping.

Special consideration was applied to the Date Dimension, as it needed to support several date fields across multiple tables. Role-playing dimensions were created for each date context, such as Adoption Date, Foster Start Date, Foster End Date, Visit Start Date, Visit End Date, and Volunteer Activity Date. This allowed the same calendar structure to be reused without creating conflicts.

Hierarchies were built to enhance analysis. For example, the Date Dimension contained a hierarchy that drilled down from Year to Quarter, Month, and Day, enabling time-based trends to be visualized easily. Additional hierarchies were developed for Dogs (Breed to Size to Gender) and Shelters (State to City to Shelter Name) to support deeper exploration.

During cube development, challenges like duplicate attributes, conflicting keys, and incorrect aggregations were resolved through careful adjustments. Redundant attributes were disabled, the Date Dimension was restructured to avoid hierarchy duplication, and calculated measures were defined to handle averages that could not be aggregated correctly. The final cube

structure was clean, efficient, and optimized for use with Excel PivotTables, forming the foundation for insightful reporting.

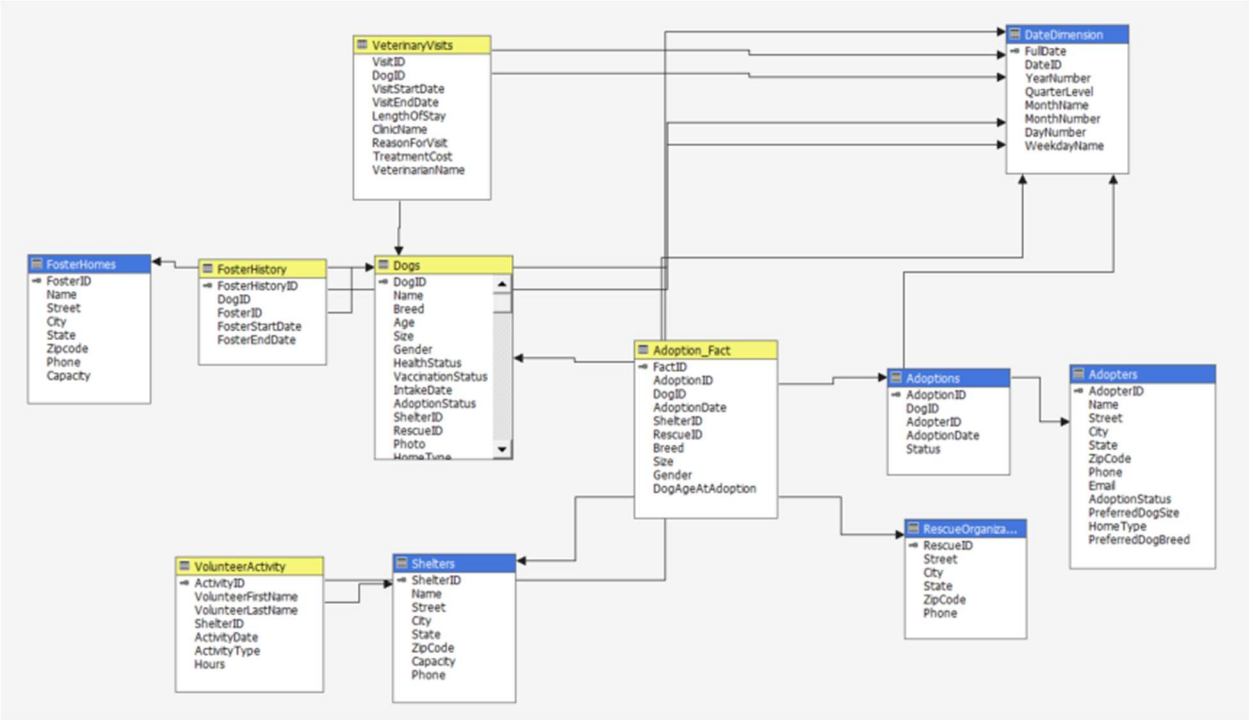


Figure 2. Cube Structure

5. Measures and Calculations

To deliver meaningful insights, the cube incorporated both standard measures and custom calculations. Standard measures, such as counts of adoptions, fosters, veterinary visits, and volunteer activities, were included automatically based on the fact tables. However, additional calculated measures were necessary to answer more complex questions and provide actionable metrics.

Key calculated measures included:

- **Adoption Rate (%)**

This measure compared the number of adoptions to the total number of dogs in the database. It provided a clear percentage that allowed staff to evaluate how effectively dogs were being placed into homes over time.

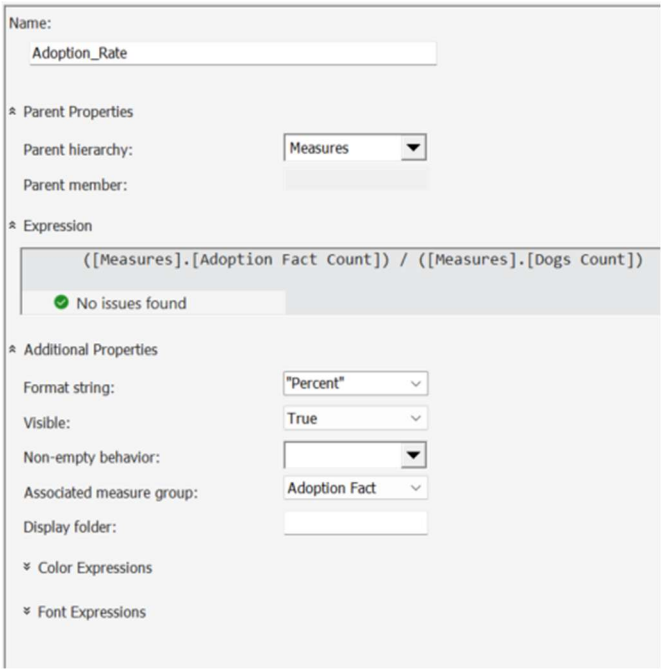


Figure 3. Adoption Rate

- **Average Dog Age at Adoption (Through Excel)**

Because the raw dog age measure aggregated as a sum, a calculated measure was created to divide the total dog age at adoption by the count of adoption records. This provided a true average, enabling analysis by breed, shelter, or time period.

- **Average Foster Duration**

For foster history, a measure was developed to calculate the length of each foster stay by subtracting the start date from the end date. The cube then averaged this value, helping identify whether certain dogs or locations experienced longer foster periods.

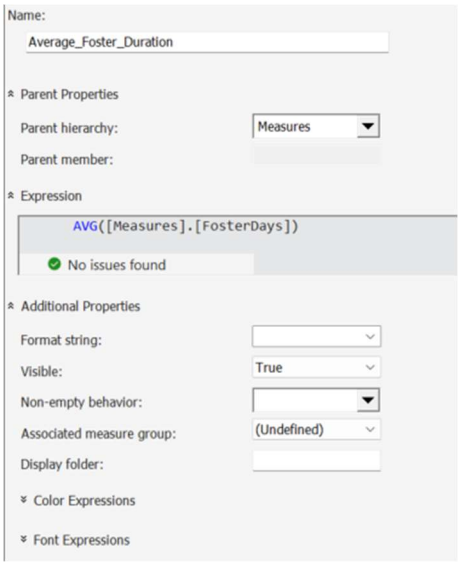


Figure 4. Average Foster Duration

- **Veterinary Cost per Dog**

This measure divided total treatment costs by the number of dogs receiving care, allowing shelters to understand the average medical expenses associated with each animal.

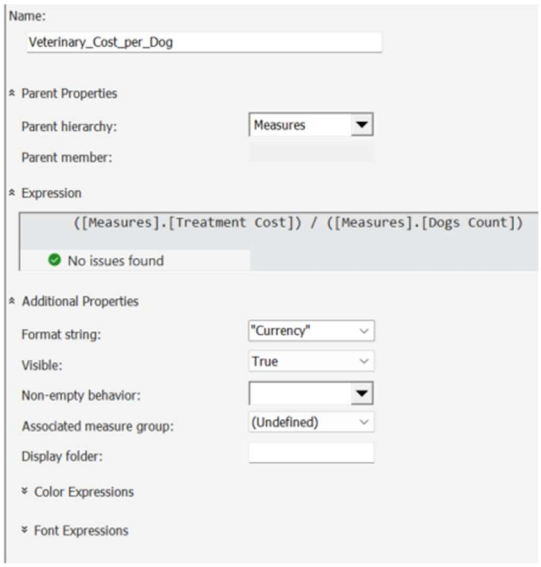


Figure 5. Veterinary Cost per Dog

- **Volunteer Contribution Ratio (%)**

This calculation showed how much each shelter benefited from volunteer hours compared to the total hours contributed across all shelters. It highlighted where volunteer engagement was strongest and where additional support might be needed.

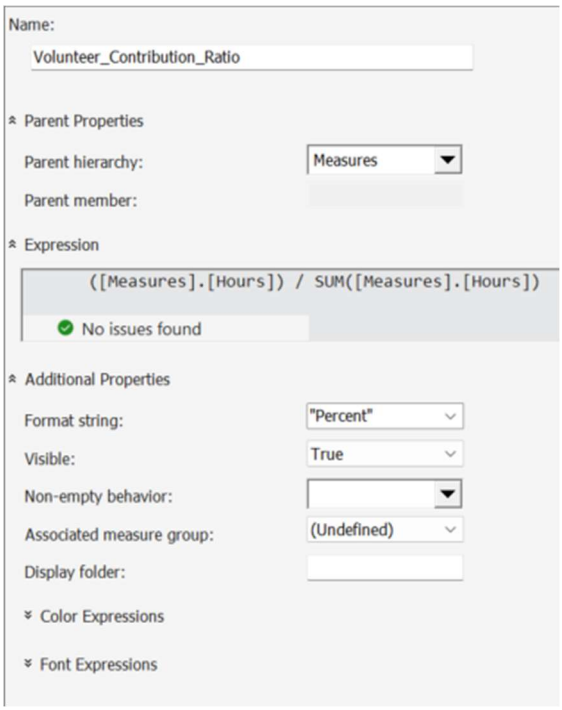


Figure 6. Volunteer Contribution Ratio

Creating these measures required careful configuration in SSAS. Some averages, such as the average age at adoption, initially produced incorrect results because of aggregation issues. Attempts to resolve this involved defining calculations that used sums divided by counts rather than relying on default aggregation, but the results were not always consistent when pulling the values into PivotCharts. This inconsistency indicates that further refinement is needed to ensure the calculations work correctly in every context.

In cases where the cube could not provide accurate averages, Excel formulas were used as a supplementary method to display correct values. While this approach allowed the analysis to move forward, it also highlighted an area for improvement in future iterations of the project. Fixing these calculation errors within SSAS remains an ongoing task to ensure that all measures behave as expected directly in the cube.

Even with these challenges, the calculated measures already implemented transformed the cube from a simple data store into a decision-support tool. They allowed shelter staff to interpret complex patterns, spot trends, and make informed decisions based on reliable data.

6. Hierarchies and Dimensions

The cube relied on dimensions and hierarchies that allowed users to drill down and view data from multiple perspectives. Each dimension was carefully structured to enhance analysis without overwhelming users with unnecessary attributes.

The Date Dimension played a central role in time-based analysis. It contained a user-defined hierarchy moving from Year to Quarter, Month, and Day. This structure allowed staff to quickly explore adoption or foster trends across different time frames. Initially, using Full Date as both a key and a hierarchy level created duplication errors, which were resolved by simplifying the hierarchy and renaming the final level to avoid conflicts. The Date Dimension was also used as multiple role-playing dimensions to handle different date contexts, such as adoption dates, foster start and end dates, and veterinary and volunteer activity dates.

The Dogs Dimension provided attributes such as breed, size, and gender. These were organized into a hierarchy from Breed to Size to Gender, enabling analysis of patterns such as which breeds are adopted faster or whether certain sizes tend to stay longer in care.

The Shelters Dimension included state, city, and shelter name, arranged in a hierarchy that supported geographical analysis of operations. This made it easy to compare performance across locations and identify areas needing additional resources.

Other dimensions, including Adopters, Foster Homes, and Rescue Organizations, added descriptive context to the facts without creating excessive complexity. Each was linked appropriately to the fact tables to enable filtering and grouping.

By structuring the dimensions in this way, the cube supported clear navigation and meaningful drill-down capabilities. Users could start with a high-level view and move step by step into detailed data, whether they were examining adoption trends over time, foster

activity by location, or volunteer contributions by shelter. This careful design ensured that insights could be discovered quickly and acted upon effectively.

Figure 7. Adopter Hierarchy

Figure 8. Dog Type Hierarchy

Figure 9. Shelter Hierarchy

Figure 10. Date Hierarchy

Figure 11. FosterHomes Hierarchy

7. PivotTable and Insights

Once the cube was built and processed, Excel became the tool to bring the data to life. By connecting directly to the cube, PivotTables and Pivot Charts could pull insights instantly, allowing users to explore the information without needing to write queries or manually combine spreadsheets.

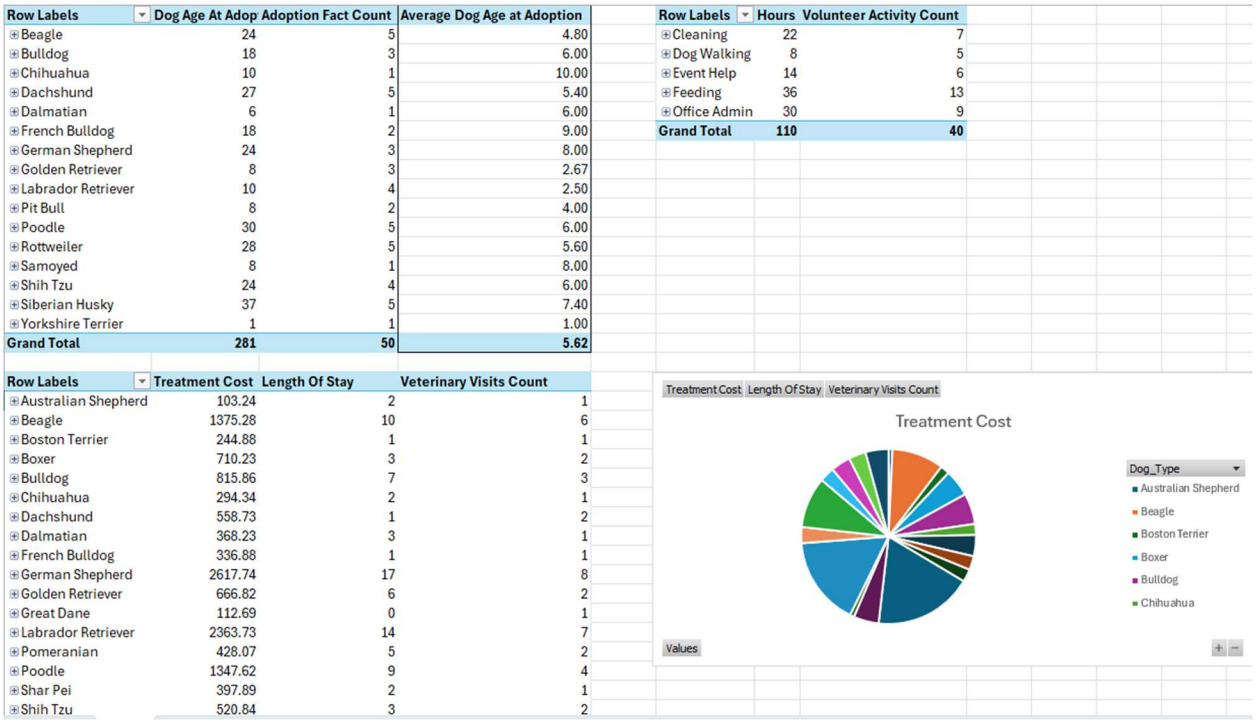
The Excel reports included several key analyses. Adoption trends over time were visualized using a line chart connected to the Date Dimension hierarchy. This revealed seasonal patterns in adoptions and highlighted periods where adoption rates slowed down, signaling when shelters might need more outreach.

The analysis of average dog age at adoption used a bar chart that broke down results by breed and size. This made it easy to see which breeds stayed longer in shelters and which ones were adopted quickly. Even though calculating averages was challenging in SSAS due to aggregation issues, careful workarounds ensured that the numbers reflected true averages rather than sums.

For volunteer contributions, a column and pie chart showed how many hours were contributed at each shelter. This visualization quickly identified which shelters had strong volunteer support and which might need more help. Similarly, veterinary data was turned into a cost per dog metric, providing a clear picture of medical expenses and helping prioritize where resources should be allocated.

These PivotTables were enhanced with slicers and filters, allowing users to click through breeds, shelters, and dates to tailor the analysis. Instead of static charts, the dashboards became interactive tools where shelter staff could ask questions and get answers immediately.

Through these Excel reports, the data finally became easy to understand and act upon. Patterns that were hidden in scattered spreadsheets were now visible at a glance, giving decision-makers the information they need to improve operations and, help more dogs find homes.



Row Labels	Dog Age At Adop	Adoption Fact Count	Average Dog Age at Adoption
Beagle	24	5	4.80
Bulldog	18	3	6.00
Chihuahua	10	1	10.00
Dachshund	27	5	5.40
Dalmatian	6	1	6.00
French Bulldog	18	2	9.00
German Shepherd	24	3	8.00
Golden Retriever	8	3	2.67
Labrador Retriever	10	4	2.50
Pit Bull	8	2	4.00
Poodle	30	5	6.00
Rottweiler	28	5	5.60
Samoyed	8	1	8.00
Shih Tzu	24	4	6.00
Siberian Husky	37	5	7.40
Yorkshire Terrier	1	1	1.00
Grand Total	**281**	**50**	**5.62**

Row Labels	Hours	Volunteer Activity Count
Cleaning	22	7
Dog Walking	8	5
Event Help	14	6
Feeding	36	13
Office Admin	30	9
Grand Total	**110**	**40**

Row Labels	Treatment Cost	Length Of Stay	Veterinary Visits Count
Australian Shepherd	103.24	2	1
Beagle	1375.28	10	6
Boston Terrier	244.88	1	1
Boxer	710.23	3	2
Bulldog	815.86	7	3
Chihuahua	294.34	2	1
Dachshund	558.73	1	2
Dalmatian	368.23	3	1
French Bulldog	336.88	1	1
German Shepherd	2617.74	17	8
Golden Retriever	666.82	6	2
Great Dane	112.69	0	1
Labrador Retriever	2363.73	14	7
Pomeranian	428.07	5	2
Poodle	1347.62	9	4
Shar Pei	397.89	2	1
Shih Tzu	520.84	3	2

Figure 12. Pivot Charts and Tables

8. Lesson Learned (3Ws)

What went well

The project successfully transformed raw shelter data into a structured model that supports meaningful analysis. The cube design worked well with its clear fact and dimension tables, enabling smooth integration with Excel. Role-playing date dimensions allowed for accurate time-based analysis across multiple date fields. The final dashboard was intuitive, providing quick insights into adoption patterns, volunteer efforts, veterinary costs, and foster outcomes.

What did not go well

Some challenges occurred during development. Using Full Date as both the primary key and a hierarchy level caused repeated deployment errors that required troubleshooting. Average calculations, such as average age at adoption, did not behave as expected in SSAS and required additional formulas to correct aggregation behavior. There were also issues with duplicate attributes, hierarchy conflicts, and key settings that took time to resolve.

What would be done differently next time

Future iterations would start by defining surrogate keys, such as DateID, from the beginning to prevent hierarchy and key conflicts. More calculated measures would be created directly in SSAS to reduce the need for Excel workarounds. Additionally, preparing the Date Dimension with clean attribute relationships early on would save significant debugging time. These adjustments would make the process smoother and help deliver an even cleaner analytical model.

9. Conclusion

This project demonstrated how transforming operational shelter data into a well-structured business intelligence solution can make a real difference. By cleaning and organizing the data, creating a robust cube in SQL Server Analysis Services, and connecting it to interactive Excel dashboards, the project turned scattered records into actionable insights.

The final solution allows shelter staff to explore adoption trends, monitor volunteer activity, track veterinary costs, and evaluate foster care effectiveness with ease. Patterns that were once hidden are now visible, helping decision-makers act quickly and with confidence. For example, identifying breeds that remain in shelters longer or spotting shelters with limited volunteer hours can guide where to focus resources and outreach.

Beyond meeting the technical requirements of the course, the project reflects the shelter's mission to save lives. Every data point in the system represents a dog waiting for a home, and the insights gained can help shorten that wait. By enabling smarter, faster, and more compassionate decisions, this solution has the potential to improve operations and ultimately help more dogs find loving families.