

Exploring BigQuery and Google Cloud as A Cloud Solution:

Building a Data Pipeline with BigQuery and Google Cloud Storage

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## Table of Contents

<i>A. Schema Objects Creation in BigQuery .....</i>	<i>3</i>
1. Create the Required Schema Objects.....	6
1. Documentation of Database Code and Explanation of Components.....	6
<i>B. Populating the Database .....</i>	<i>12</i>
1. Inserting Transaction Records .....	13
2. Explanation of Insertion Code and Functions.....	15
<i>C. Queries.....</i>	<i>17</i>
1. List All Unique Customers.....	17
2. List All Items of One Customer's Shopping Cart .....	19
3. List the Total Purchase Amounts for all Customers in Descending Order .....	20
<i>D1. Resources (Code Used and Tutorials) .....</i>	<i>22</i>
<i>D2. References (In-Text Citations).....</i>	<i>23</i>

## A. Schema Objects Creation in BigQuery

This paper explores how Google Cloud and BigQuery can adequately create a database solution for Alliah's transaction records. Through this exploration, we seek to answer, "Can Alliah create a data pipeline utilizing the tools provided within the Google Cloud Platform?" The paper discusses the iterative steps of creating an automated data pipeline to an OLAP interface with querying features.

The creation of this data process and pipelines took two iterations, as explained in this paper. It is essential to discuss the iteration process because of limitations and issues that arise when establishing a cloud solution using sample data. Each iteration builds on the previous solution to address the challenges of creating a normalized, production-ready, automated data storage solution.

The first iteration involved data cleaning and transformation in a local Jupyter notebook before uploading the data directly into BigQuery for ingestion. BigQuery consists of a managed data warehouse and analytics service, so the most straightforward solution would be to upload the file directly into BigQuery. Figure 1 below shows the SQL code to create an empty table in BigQuery that follows the general JSON format of Alliah's transaction records. BigQuery's native support for JSON files has a caveat: it can automatically detect the schema for newline delimited JSON (JSONL) but has difficulty processing JSON payload formats—the JSON file needs to be reformatted into JSONL.

Additionally, there was an error when uploading the file to BigQuery after creating the schema (Figure 1) because the key 'vendor' had a trailing white space. The cleaning and transformation process involved fixing the 'vendor' key and reformatting the sample data file to JSONL with Python in a Jupyter Notebook environment (Figure 2).

Figure 1

### *BigQuery Empty Table Generation and Upload Error*

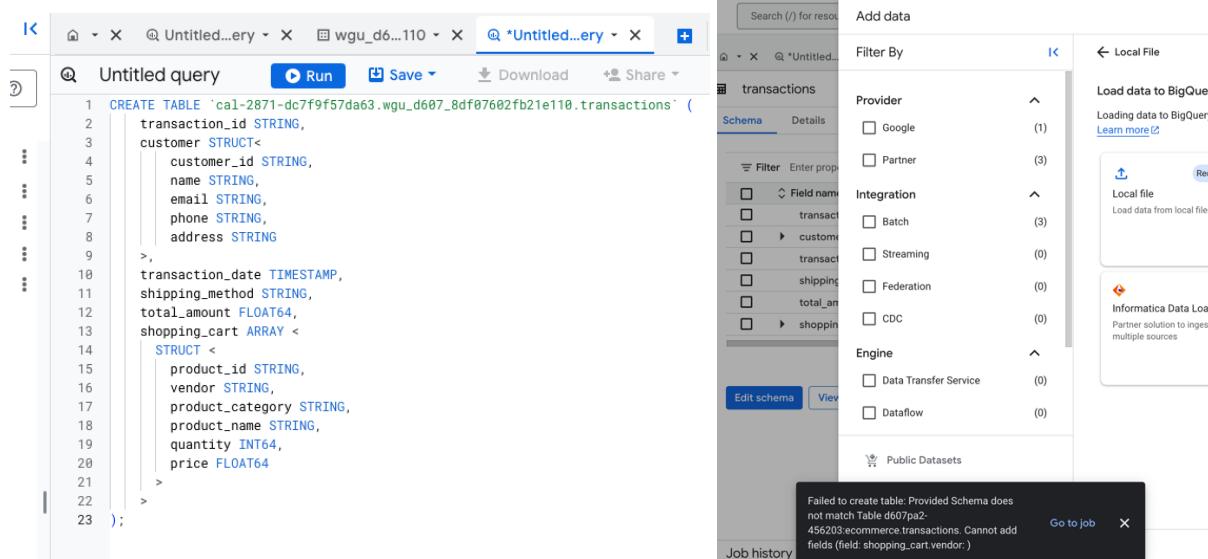


Figure 2

### *Data Cleaning and Transformation – Jupyter Notebook*

```

import os
import json

os.chdir('/Users/joanne/Desktop/WGU/D607/Resources')
os.getcwd()

'/Users/joanne/Desktop/WGU/D607/Resources'

# Generate sample data of 20 records from transaction data
with open('TransactionData.json') as f:
    data = json.load(f)

sample_data = data[0:20]

print(len(sample_data))

20

# Make new file for the twenty records
with open("json_20.json", "w") as file:
    json.dump(sample_data, file, indent=4)

```

```

# Clean vendor key issue
def rename_vendor_keys(obj):
    """ Recursively rename keys in the JSON object.
    Arguments:
    obj -- The JSON object to be processed.
    """
    if isinstance(obj, dict):
        return {
            key.replace("vendor:", "vendor"): rename_vendor_keys(value)
            for key, value in obj.items()
        }
    elif isinstance(obj, list):
        return [rename_vendor_keys(item) for item in obj]
    return obj

cleaned_data = [rename_vendor_keys(item) for item in sample_data]
print(len(cleaned_data))
20

# Make newline-delimited json file
with open('processed_twenty.jsonl', 'w') as outfile:
    if isinstance(cleaned_data, list):
        for obj in cleaned_data:
            json.dump(obj, outfile)
            outfile.write('\n')
    elif isinstance(cleaned_data, dict):
        json.dump(cleaned_data, outfile)
        outfile.write('\n')

```

The first screenshot in Figure 2 shows the code that opens the TransactionData.json file

and extracts twenty records from the array, storing them in a variable called sample\_data and

then writing that list of sample data into its own JSON file. This will be the test data moving forward. The second screenshot shows how a helper function ran inside a for-loop to clean the ‘vendor’ key. A newline delimited JSON file with the cleaned data was written and saved. From here, the BigQuery console had features to manually upload the data file into the empty table (Figure 3).

Figure 3

*JSON File Upload into Empty BigQuery Table and Data Preview*

The screenshot shows the BigQuery 'Create table' interface and a 'Table Explorer' preview.

**Create table** (Left Panel):

- Source:** 'processed\_twenty.jsonl' (File format: JSONL (Newline delimited JSON))
- Destination:** Project: 'd607pa2-456203', Dataset: 'ecommerce', Table: 'transactions'
- Schema:** Auto detect

**Table Explorer (Right Panel):**

Row	transaction_id	customer.customer_id	customer.name	customer.email	customer.phone
1	8810c3f3-059b-4450-adff-1c54...	0566d2f9-9700-4c77-a595-6d...	Eric Hinton	jlstevens@example.org	(940)654-8170
2	69749120-e03-4344-87d3-6...	f068720b-f99c-4f55-9e03-7952...	Vincent Koch	mitchellsheila@example.com	(850)675-6467
3	412b8ad1-56fe-453e-b1b4-d1b...	5024044c-e689-4d62-b003-12...	Nicholas Hansen	rosshannah@example.net	(582)300-3282
4	e0are43a-9b32-4fdc-b5be-50b...	cb4ef4b2-9114-461c-97cf-2d8...	Alexandra Young	philipale@example.net	576.791.5701

This process is highly inefficient for two main reasons. First, the BigQuery table does not reflect the schema developed in Task 1, which highlights normalized tables to minimize data redundancy. Second, the process involves a lot of manual modifications, which could result in

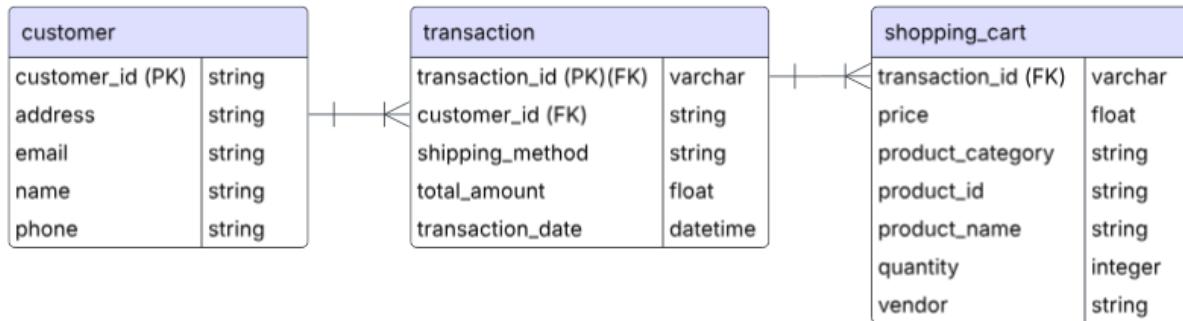
multiple errors. A company such as Alliah will need to process their data into a normalized form for their OLAP needs so that teams only query the needed data. Axel Thevenot (2025) states, “the advantage of this kind of structure resides in the way that each table answers a specific entity.” Additionally, there is no data duplication or redundancy, which lets users update one specific data in one table (Thevenot, 2025).

## 1. Create the Required Schema Objects

The tables in BigQuery need to reflect the proposed schema from Task 1. Thus, the CREATE TABLE code was refactored to reflect the normalized schema in Figure 4. Figure 5 shows the updated code that reflects the creation of three tables to normalize the data.

Figure 4

*Proposed ERD*



## 1. Documentation of Database Code and Explanation of Components

Figure 5

*Refactored CREATE TABLE Code*

```

1 CREATE TABLE ecommerce.customer (
2   customer_id STRING NOT NULL,
3   name STRING NOT NULL,
4   email STRING,
5   phone STRING,
6   address STRING,
7   PRIMARY KEY (customer_id) NOT ENFORCED
8 );
9
10 CREATE TABLE ecommerce.transaction (
11   transaction_id STRING NOT NULL,
12   customer_id STRING NOT NULL,
13   transaction_date TIMESTAMP,
14   shipping_method STRING,
15   total_amount FLOAT64,
16   PRIMARY KEY (transaction_id) NOT ENFORCED,
17   FOREIGN KEY (customer_id) REFERENCES ecommerce.customer(customer_id) NOT ENFORCED
18 );
19
20 CREATE TABLE ecommerce.shopping_cart (
21   transaction_id STRING NOT NULL,
22   product_id STRING NOT NULL,
23   vendor STRING,
24   product_category STRING,
25   product_name STRING NOT NULL,
26   quantity INT64,
27   price FLOAT64,
28   FOREIGN KEY (transaction_id) REFERENCES ecommerce.transaction(transaction_id) NOT ENFORCED
29 );

```

All results

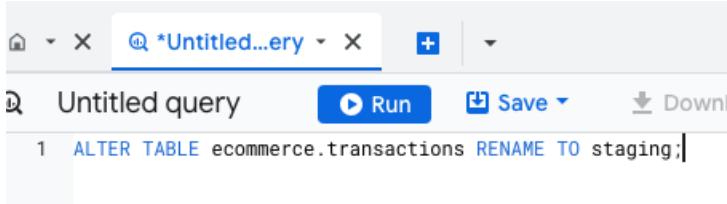
Elapsed time	Statements processed
1 sec	3

Status	End time	SQL
✓	3:20 PM [1:1]	CREATE TABLE ecommerce.customer (
✓	3:20 PM [10:1]	CREATE TABLE ecommerce.transaction (
✓	3:20 PM [20:1]	CREATE TABLE ecommerce.shopping_cart (

BigQuery does not support enforced primary and foreign key constraints to maintain pricing efficiency since forced key constraints can increase computational costs (*BigQuery Overview*, n.d.). However, using the NOT ENFORCED constraint on primary keys helps to optimize joins and provides relationship documentation (Alamoudi & Zhang, 2023). Consequently, the original transactions table was renamed “staging” to load data from the storage bucket to newly created BigQuery tables (Figure 6).

Figure 6

*Renaming “transactions” Table to “staging”*



The screenshot shows a database management interface. On the left, there's a query editor window titled 'Untitled query' containing the SQL command: 'ALTER TABLE ecommerce.transactions RENAME TO staging;'. Above the editor are buttons for 'Run', 'Save', and 'Download'. To the right of the editor is a sidebar titled 'ecommerce' which lists several tables: 'customer', 'shopping\_cart', 'staging', and 'transaction'. Each table entry has a star icon and a three-dot menu icon.

Keeping raw and cleaned data in storage buckets in the cloud is essential to centralizing the data. Cloud functions provide a fully serviced ETL environment and can be automated with trigger events. For example, a trigger event could be someone uploading a raw file into a specific storage bucket. Leveraging the free trial of Google Cloud helped demonstrate the ETL procedure using a cloud function that precludes the database from being populated.

Creating a simple ETL cloud function to clean the ‘vendor’ field and write a JSONL file helps to maintain data accuracy and consistency that is automatic and efficient (*Cloud Run Functions Overview*, n.d.). The ETL cloud function code for cleaning the ‘vendor’ field and creating the JSONL file is demonstrated in Figure 7. At this point, a cloud function was created to listen for an event: uploading a raw JSON file into the ‘d607pa2-raw’ storage bucket. This event triggers the cloud function in Figure 7 to run.

Figure 7

*Clean Vendor Field, Create JSONL file, and Upload to ‘d607pa2-export’ Bucket*

```

import functions_framework
from google.cloud import storage
import json

# Helper function to rename keys in the JSON object
def rename_vendor_keys(obj):
    """ Recursively rename keys in the JSON object.
    Arguments:
    obj -- The JSON object to be processed.
    """
    if isinstance(obj, dict):
        return {
            key.replace("vendor:", "vendor"): rename_vendor_keys(value)
            for key, value in obj.items()
        }
    elif isinstance(obj, list):
        return [rename_vendor_keys(item) for item in obj]
    return obj

@functions_framework.cloud_event
def rename_vendor_and_upload(cloud_event):
    """Triggered by a change in a storage bucket.
    Args:
    |   cloud_event (CloudEvent): The CloudEvent object.
    """
    event = cloud_event.data

    bucket_name = event["bucket"]
    file_name = event["name"]

    # change from json to .jsonl
    output_file_name = f"processed_{file_name.replace('.json', '.jsonl')}"

    storage_client = storage.Client()

    print(f"Input file name: {file_name}")
    print(f"Output file name: {output_file_name}")

    input_bucket = storage_client.bucket(bucket_name)
    input_blob = input_bucket.blob(file_name)

    output_bucket_name = "d607pa2-export"
    output_bucket = storage_client.bucket(output_bucket_name)
    output_blob = output_bucket.blob(output_file_name)

    try:
        json_data = json.loads(input_blob.download_as_text())

        cleaned_data = [rename_vendor_keys(item) for item in json_data]
        ndjson_output = "\n".join(json.dumps(item) for item in cleaned_data)

        output_blob.upload_from_string(ndjson_output, content_type="application/jsonl")
        print(f"Uploaded cleaned file to: gs://{output_bucket_name}/{output_file_name}")

    except Exception as e:
        print(f"Error processing {file_name}: {e}")
        raise e

```

The functions framework is a Python library that helps write cloud functions by accessing cloud events, such as changes in cloud storage (*Functions Framework*, n.d.). The google-cloud-bigquery is a Python library with several classes, methods, and attributes that give users tools to communicate and interact with BigQuery (*Python Client Library | Google Cloud*, n.d.). The ‘rename\_vendor\_key’ is a helper function that cleans up the ‘vendor’ field across the JSON payload, which removes white space. This function is called inside the ‘rename\_vendor\_and\_upload’ function. The ‘rename\_vendor\_and\_upload’ accesses the event and listens for a change in the specific bucket (d607pa-raw), ingests the raw JSON file, cleans up the ‘vendor’ field, and then transforms it to a newline delimited JSON file. This JSONL file is then uploaded to the ‘d607pa2-export’ bucket. This change in ‘d607pa2-export’ triggers the cloud function to listen for an event in that bucket to load the processed data to BigQuery.

The second cloud function in Figure 8 shows the code for loading the JSONL file to the BigQuery staging table.

Figure 8

*Load File from ‘d607pa2-export’ Bucket to BigQuery Staging Table*

```

on entry point: load_to_bigquery    Edit source

1 import functions_framework
2 from google.cloud import bigquery
3
4 # Adds ndjson data to BigQuery
5 @functions_framework.cloud_event
6 def load_to_bigquery(cloud_event):
7     """Triggered by a change in a storage bucket.
8     Args:
9         cloud_event (CloudEvent): The CloudEvent object.
10    """
11    #Initialize BigQuery client
12    project_id = "d607pa2-456203" # Replace with your actual project ID
13    bqclient = bigquery.Client(project=project_id)
14
15    # Initialize cloud event
16    event = cloud_event.data
17
18    bucket_name = event['bucket']
19    file_name = event['name']
20    source_uri = f"gs://{bucket_name}/{file_name}"
21
22    dataset_name = "ecommerce"
23    table_name = "staging"
24    table_id = f"{project_id}.{dataset_name}.{table_name}"
25
26    job_config = bigquery.LoadJobConfig(
27        autodetect=True,
28        source_format=bqclient.SourceFormat.NEWLINE_DELIMITED_JSON,
29    )
30
31    try:
32        load_job = bqclient.load_table_from_uri(
33            source_uri, table_id, location="us-central1", job_config=job_config
34        )
35
36        load_job.result() # Wait to complete
37
38        table = bqclient.get_table(table_id)
39        print(f"Loaded {table_id} from {file_name} into {table}")
40
41    except Exception as e:
42        print(f"Error loading {file_name} to BigQuery: {e}")
43        raise e
44

```

Keeping the ETL procedures within the Google Cloud Functions environment lets us monitor for errors and debug problems in one location. Figure 9 shows the Google Cloud Storage buckets with the raw JSON file (`transactions_20`) manually uploaded and the generated JSONL file (`processed_transactions_20`) loaded into BigQuery by the second cloud function.

Figure 9

### *Storage Buckets*

The screenshot shows the AWS S3 console interface. At the top, there are two tabs: 'Buckets > d607pa2-raw' and 'Buckets > d607pa2-export'. The 'd607pa2-raw' tab is active, displaying a list of objects:

Name	Size	Type	Created
<a href="#">transactions_20.json</a>	28.7 KB	application/json	Apr 10, 2025, 4:32:18 PM

Below this, the 'd607pa2-export' tab is shown, also listing objects:

Name	Size	Type	Created
<a href="#">processed_transactions_20.json</a>	18.9 KB	application/json	Apr 10, 2025, 4:32:20 PM

## B. Populating the Database

Figure 10 shows the staging table with the loaded data from the ‘d607pa2-export’ bucket.

Figure 10

### Populated Staging Table

staging		Query	Open in	Share	Copy	Snapshot	Delete	Export
Schema	Details	Preview	Table Explorer	Preview	Insights	Lineage	Data Profile	Data Quality
Row	transaction_id	customer.customer_id	customer.name	customer.email	customer.phone	customer.address		
1	8810c3f3-059b-4450-add1-c54...	0566d2f9-9700-4c77-a595-6da...	Eric Hinton	jillstevens@example.org	(946)654-8170	PSC 2971, Box 7891 APO AA 05336		
2	69749120-eb03-4344-87d3-68...	f068720b-ff9c-4f55-9e03-7952...	Vincent Koch	mitchellsheila@example.com	(850)675-6467	1856 Brittany Mountains Suite ... Blackfort, ND 86836		
3	412b8adf-56fe-453e-b1b4-d1b...	5024044c-e689-4d62-b003-12...	Nicholas Hansen	rosshannah@example.net	(582)300-3282	79422 Bryant Cliff Bradleyfurt, OK 77867		
4	e0ae43a-9b32-4fdc-b5be-50b...	cb4ef4b2-9114-461c-97cf-2d8...	Alexandra Young	philiphale@example.net	576.791.5701	504 Blake Junction Suite 379 Johnsonburgh, ND 94508		
5	170f8c30-ac07-4aa2-aab9-ddc...	39d3644a-10b9-4014-ac23-e9c...	Amanda Campbell	steven45@example.net	+1-489-209-6587x7250	766 Sandra Pass Suite 688 Terriberg, NM 61918		
6	d88effe6-631f-43d4-9ba1-3c60...	826fb1c6-6d63-4a30-8d9c-c1a...	Jessica Palmer	aguilarjames@example.com	(941)749-2437	2779 Stephens Stravenue North Ronaldstad, MP 67480		

## 1. Inserting Transaction Records

Figures 11 to 13 show the queries used to insert the data into the normalized tables. These queries can be scheduled to add incremental data to the tables as users upload additional JSON files to the storage bucket. The code must be refactored to include a NOT IN clause to avoid duplication since the JSONL loads BigQuery append data to the staging table. Figure 14 shows an example of the NOT IN clauses added to the INSERT INTO queries.

Figure 11

*Insert Into ‘customer’ Table*



The screenshot shows a BigQuery query editor interface. The title bar says "Insert Into Customer". Below it are buttons for "Run", "Save query", "Download", and "Share". The main area contains the following SQL code:

```
1 INSERT INTO d607pa2-456203.ecommerce.customer (customer_id, name, email, phone, address)
2 SELECT DISTINCT
3     customer.customer_id,
4     customer.name,
5     customer.email,
6     customer.phone,
7     customer.address
8 FROM
9     d607pa2-456203.ecommerce.staging;
```

customer		Query	Open in ▾	Share	Copy	Snapshot	Delete	Export
Schema	Details	Preview	Table Explorer	Preview	Insights	Lineage	Data Profile	Data Quality
Row	customer_id	name	email	phone	address			
1	7230020c-774e-4802-aaea-fc8...	Kevin Martinez	rogersgeorge@example.com	(346)222-4394x58303	77106 Thomas Vista Apt. 860	Johnsonsider, AR 73471		
2	39102e3c-41a0-4eaa-bbd3-21c...	James Maldonado	ghughes@example.net	(614)581-5106x22992	191 Kelly Orchard	Calvinland, ND 80478		
3	d8e2ace9-88c6-479d-91fd-aad...	Diane Molina	anthony65@example.net	7934045288	63611 Hernandez Mall	New David, VT 54030		
4	87e2a2bf-bd67-47a6-8079-c60...	Dorothy Nichols	hollycooley@example.net	+1-511-605-1154x49483	44625 Wells Field Suite 057	Molinaburgh, WI 11046		
5	aa8e5339-4dfb-4fa6-a1da-c64...	Ashley Adams	debrajohnson@example.org	(378)989-9871	81234 Lisa Springs	Gordonstad, WV 77651		
6	79111a7d-42e8-4756-a200-8b...	Jason York	swansonjoe@example.net	311.291.3885x8886	093 Goodman Crossroad	Jamestown, ID 51701		
7	a7eee55f-76f9-4d82-a102-82d...	Brenda Baker	yevans@example.com	747.209.0447	PSC 8360, Box 2948	APO AA 99909		
8	d396d293-1c77-46ad-94c4-45...	Kathryn Ortega	richard80@example.org	933-815-6588x03123	87869 Craig Station	Allemouth, LA 77400		
9	39d3644a-10b9-4014-ac23-e9c...	Amanda Campbell	steven45@example.net	+1-489-209-6587x7250	766 Sandra Pass Suite 688			

Figure 12

*Insert Into ‘shopping\_cart’ Table*

Insert Into Shopping Cart    Run    Save query ▾    Download    Share ▾    Schedule    Open in ▾    More

```
1 INSERT INTO d607pa2-456203.ecommerce.shopping_cart (transaction_id, product_id, vendor, product_category, product_name, quantity, price)
2 SELECT
3     staging.transaction_id,
4     sc.product_id,
5     sc.vendor,
6     sc.product_category,
7     sc.product_name,
8     CAST(sc.quantity AS INT64),
9     CAST(sc.price AS FLOAT64)
0 FROM
1     d607pa2-456203.ecommerce.staging AS staging,
2     UNNEST(staging.shopping_cart) AS sc;
```

shopping_cart		Query	Open in ▾	Share	Copy	Snapshot	Delete	Export
Schema	Details	Preview	Table Explorer	Preview	Insights	Lineage	Data Profile	Data Quality
Row	transaction_id	product_id	vendor	product_category	product_name	quantity	price	
1	7de4e2d-4e34-433a-8116-1d1...	2456ac12-ae56-4ed8-a0db-51c...	Discount Gaming	Gaming	Gaming Mouse	3	56.99	
2	a53d067c-ac08-4b31-ac72-159...	1dbb4128-349c-409e-9442-496...	Boogie Photography	Photography	DSLR Camera	3	1259.99	
3	170f8c30-ac07-4aa2-aab9-ddc...	89af6fc9-86c2-4dab-b8ae-c67...	Discount Home Appliances	Home Appliances	Dryer	2	854.99	
4	412b8adf-56fe-453e-b1b4-d1b...	ab6050c-100c-40a0-9906-0b3...	Discount Kitchen Appliances	Kitchen Appliances	Coffee Maker	1	123.49	
5	a53d067c-ac08-4b31-ac72-159...	46b46cd1-a93b-4b47-98f0-166...	Boogie Office Equipment	Office Equipment	Desk Chair	2	157.49	
6	9ff38dda-d152-4043-a77f-0a7a...	1ef993fd-cdbd-420d-86d6-0c1...	Store Electronics	Electronics	4K TV	2	1199.99	
7	7de4e2d-4e34-433a-8116-1d1...	0aba1b7b-474e-4167-b98c-c07...	Discount Entertainment	Entertainment	Blu-ray Player	1	142.49	
8	69749120-eb03-4344-87d3-68...	ac875b7f-1188-47ea-936e-1f2...	Boogie Kitchen Appliances	Kitchen Appliances	Blender	1	94.49	
9	e0aae43a-9b32-4fdc-b5be-50b...	f13fee3e-80cc-4be8-bd4f-cccf...	Boogie Smart Home	Smart Home	Smart Door Lock	2	262.49	
10	f5934d2d-4494-4230-9655-015...	94589340-a360-4156-bc42-f03...	Store Fitness	Fitness	Fitness Tracker	2	129.99	
11	e7b125e4-fcfc-488b-9bdb-b91...	b16a1b51-8355-4115-abbb-33f...	Store Entertainment	Entertainment	Home Theater System	3	999.99	
12	4f32fcfa3-bee8-468a-ad91-9ad...	bfbff53b-d621-41e1-a7ee-e745...	Boogie Electronics	Electronics	Wireless Earbuds	3	209.99	
13	2a86617d-0b71-440e-b318-f81...	e3f96ecc-1e5a-41be-a0ad-be8...	Store Fitness	Fitness	Fitness Tracker	1	129.99	
14	9ff38dda-d152-4043-a77f-0a7a...	de1c8dfa-0548-4236-a4b6-d20...	Store Personal Care	Personal Care	Electric Toothbrush	1	99.99	
15	170f8c30-ac07-4aa2-aab9-ddc...	b19e9be6-77d7-433d-b362-56...	Discount Electronics	Electronics	Laptop	3	1139.99	

Figure 13

*Insert Into ‘transaction’ Table*

The screenshot shows a database interface with two main sections: a query editor at the top and a table preview below it.

**Query Editor:**

```

1 INSERT INTO d607pa2-456203.ecommerce.transaction (transaction_id, customer_id, transaction_date, shipping_method, total_amount)
2 SELECT
3     transaction_id,
4     customer.customer_id,
5     CAST(transaction_date AS TIMESTAMP),
6     shipping_method,
7     CAST(total_amount AS FLOAT64)
8 FROM
9     d607pa2-456203.ecommerce.staging;

```

**Table Preview:**

Row	transaction_id	customer_id	transaction_date	shipping_method	total_amount
1	69749120-eb03-4344-87d3-68...	f068720b-ff9c-4f55-9e03-7952...	2024-01-04 18:25:00 UTC	Expedited	923.92
2	69749120-eb03-4344-87d3-68...	f068720b-ff9c-4f55-9e03-7952...	2024-01-04 18:25:00 UTC	Expedited	923.92
3	412b8adf-56fe-453e-b1b4-d1b...	5024044c-e689-4d62-b003-12...	2024-01-07 18:25:00 UTC	Expedited	3286.92
4	412b8adf-56fe-453e-b1b4-d1b...	5024044c-e689-4d62-b003-12...	2024-01-07 18:25:00 UTC	Expedited	3286.92
5	8810c3f3-059b-4450-add1-c54...	0566d2f9-9700-4c77-a595-6da...	2024-01-04 16:15:00 UTC	Expedited	4699.93
6	8810c3f3-059b-4450-add1-c54...	0566d2f9-9700-4c77-a595-6da...	2024-01-04 16:15:00 UTC	Expedited	4699.93
7	7c1c5031-91b5-4fe5-9a24-896...	e2a54987-b8a4-4e71-b903-7d...	2024-01-04 16:20:00 UTC	Overnight	854.97
8	7c1c5031-91b5-4fe5-9a24-896...	e2a54987-b8a4-4e71-b903-7d...	2024-01-04 16:20:00 UTC	Overnight	854.97
9	d88effe6-631f-43d4-9ba1-3c60...	826fb1c6-6d63-4a30-8d9c-c1a...	2024-01-03 15:15:00 UTC	Overnight	1139.97
10	d88effe6-631f-43d4-9ba1-3c60	826fb1c6-6d63-4a30-8d9c-c1a	2024-01-03 15:15:00 UTC	Overnight	1139.97

**2. Explanation of Insertion Code and Functions**

The `INSERT INTO` queries programmatically adds selected data from the staging table into the respective tables. All customer data is inserted into the customer table. Since a customer is considered a record within the staging table, the dot notation (e.g., `customer.name`) specifies that each value within each customer record needs to be exported into the table.

The query to load data into the `shopping_cart` table involves the `UNNEST` operator. Since the `shopping_cart` field in the JSON file is an array of products, we must create a temporary view of the unpacked rows per `shopping_cart` field. These temporary rows are inserted as rows into the

shopping\_cart table. In each array object, several attributes, such as product\_id, vendor, product\_category, and product\_name, are selected and inserted into the table as columns. The transaction\_id is also inserted as a column for reference in table joining. Price and quantity are cast as FLOAT64 and INT64, respectively, as a data type double-check.

The query for the transaction table acts as the fact table from the proposed ERD. It consists of customer\_id and transaction\_id and other information that relates directly to each transaction, such as transaction\_date, shipping\_method, and total\_amount. The transaction\_date is cast as a timestamp type because it is most likely stored as a string in the JSON files. Casting the data type of timestamp allows users to perform time-related operations.

The code in Figure 14 shows a different version of all table inserts for all subsequent inserts. This code is designed explicitly for recurring inserts. It leverages BigQuery's scheduled query feature to update the database as new data is added continuously. The query schedule should align with the raw data upload frequency to ensure a consistent update cadence.

Figure 14

*Recurring Inserts Code*

The screenshot shows a database interface with a toolbar at the top containing 'Run', 'Save query', 'Download', 'Share', 'Schedule', 'Open in', and 'More' buttons. The main area displays a multi-line SQL script for recurrent inserts:

```

1 INSERT INTO
2   d607pa2-456203.ecommerce.customer (customer_id, name, email, phone, address)
3 SELECT DISTINCT
4   customer.customer_id,
5   customer.name,
6   customer.email,
7   customer.phone,
8   customer.address
9 FROM
10  d607pa2-456203.ecommerce.staging
11 WHERE customer.customer_id IS NOT NULL
12 AND customer.customer_id NOT IN (SELECT customer_id FROM d607pa2-456203.ecommerce.customer);
13
14 INSERT INTO
15   d607pa2-456203.ecommerce.shopping_cart (transaction_id, product_id, vendor, product_category, product_name, quantity, price)
16 SELECT
17   staging.transaction_id,
18   sc.product_id,
19   sc.vendor,
20   sc.product_category,
21   sc.product_name,
22   CAST(sc.quantity AS INT64),
23   CAST(sc.price AS FLOAT64)
24 FROM
25  d607pa2-456203.ecommerce.staging AS staging,
26  UNNEST(staging.shopping_cart) AS sc
27 WHERE NOT EXISTS (
28   SELECT 1
29   FROM d607pa2-456203.ecommerce.shopping_cart AS existing_cart
30   WHERE existing_cart.transaction_id = staging.transaction_id
31   AND existing_cart.product_id = sc.product_id);
32
33
34 INSERT INTO
35   d607pa2-456203.ecommerce.transaction (transaction_id, customer_id, transaction_date, shipping_method, total_amount)
36 SELECT
37   transaction_id,
38   customer.customer_id,
39   CAST(transaction_date AS TIMESTAMP),
40   shipping_method,
41   CAST(total_amount AS FLOAT64)
42 FROM
43  d607pa2-456203.ecommerce.staging
44 WHERE
45   staging.transaction_id NOT IN (SELECT transaction_id FROM d607pa2-456203.ecommerce.transaction);

```

## C. Queries

The screenshots below demonstrate the queries required in the performance assessment rubric.

### 1. List All Unique Customers

The code below (Figure 15) shows a selection of all unique customer names and customer IDs inside the customer table. This table is helpful when querying a need specifically for customer analysis. Any customer data updates can also occur inside the customer table

without updating additional rows. Alliah should also anticipate that there will be customers who do not necessarily have any products in their shopping carts, and new customers may not have made transactions yet. Therefore, not all customers may exist in the transaction or shopping\_cart table.

Figure 15

*List All Unique Customers Query*

```

1  SELECT
2    DISTINCT(customer_id),
3    name
4  FROM
5    `d607pa2-456203.ecommerce.customer`
6  ORDER BY name;

```

Query results

Job information	Results	Chart	JSON	Exe
Row	customer_id	name		
1	cb4ef4b2-9114-461c-97cf-2d8...	Alexandra Young		
2	39d3644a-10b9-4014-ac23-e9c...	Amanda Campbell		
3	aa8e5339-4dfb-4fa6-a1da-c64...	Ashley Adams		
4	a7eee55f-76f9-4d82-a102-82d...	Brenda Baker		
5	3a9cd354-a35d-4c58-8602-6a9...	David Williams		
6	d8e2ace9-88c6-479d-91fd-aad...	Diane Molina		
7	87e2a2bf-bd67-47a6-8079-c60...	Dorothy Nichols		
8	0566d2f9-9700-4c77-a595-6da...	Eric Hinton		
9	39102e3c-41a0-4eaa-bbd3-21c...	James Maldonado		
10	79111a7d-42e8-4756-a200-8b...	Jason York		
11	826fb1c6-6d63-4a30-8d9c-c1a...	Jessica Palmer		
12	d396d293-1c77-46ad-94c4-45...	Kathryn Ortega		
13	7230020c-774e-4802-aaea-fc8...	Kevin Martinez		
14	e3569694-b348-4200-9f37-dab...	Matthew Ramirez		
15	5024044c-e689-4d62-b003-12...	Nicholas Hansen		
16	e4ce7fdb-7a84-4e9a-b469-a48...	Russell Anderson		
17	e2a54987-b8a4-4e71-b903-7d6...	Shannon Hoffman		
18	1d45ddca-993c-47ec-91cc-0cc...	Tammy Carpenter		
19	23a5c3af-f0d4-486b-a756-a17...	Victoria Jacobs		
20	f068720b-ff9c-4f55-9e03-7952...	Vincent Koch		

## 2. List All Items of One Customer's Shopping Cart

The query in Figure 16 demonstrates how normalized tables must be joined to get the specified list of a customer's shopping cart items. The tables are joined by their respective primary and foreign keys. BigQuery can optimize its joins based on the primary and foreign key references. The JOIN operator combines the shopping\_cart table with the transaction table on transaction\_id. Then, the combined table undergoes another join with the customer table, joining on the customer id. The column name is derived from the customer table, while the product name comes from the shopping\_cart table.

Additional information about a customer's line-item totals demonstrates how data in the table can be manipulated to provide additional information. This customer purchased three microwave ovens, spending over \$600. This detail can better inform the marketing team with their data-driven strategy for marketing plans.

Figure 16

*List of Products in Customer's Shopping Cart (by customer ID)*

The screenshot shows a database query editor interface. At the top, there are buttons for 'Run', 'Save', 'Download', 'Share', 'Schedule', and 'Open in'. Below the toolbar, the query text is displayed:

```

1 SELECT
2   c.name,
3   sc.product_name,
4   SUM(sc.quantity) as quantity,
5   AVG(sc.price) as per_unit_price,
6   SUM(sc.price * sc.quantity) as line_item_total
7 FROM
8   `d607pa2-456203.ecommerce.shopping_cart` as sc
9 INNER JOIN
10  `d607pa2-456203.ecommerce.transaction` as t
11 ON
12  t.transaction_id = sc.transaction_id
13 INNER JOIN
14  `d607pa2-456203.ecommerce.customer` as c
15 ON
16  t.customer_id = c.customer_id
17 WHERE
18  c.customer_id = "f068720b-ff9c-4f55-9e03-795205a5531a"
19 GROUP BY
20  c.name,
21  sc.product_name;

```

Below the query text, the heading 'Query results' is followed by a table with the following data:

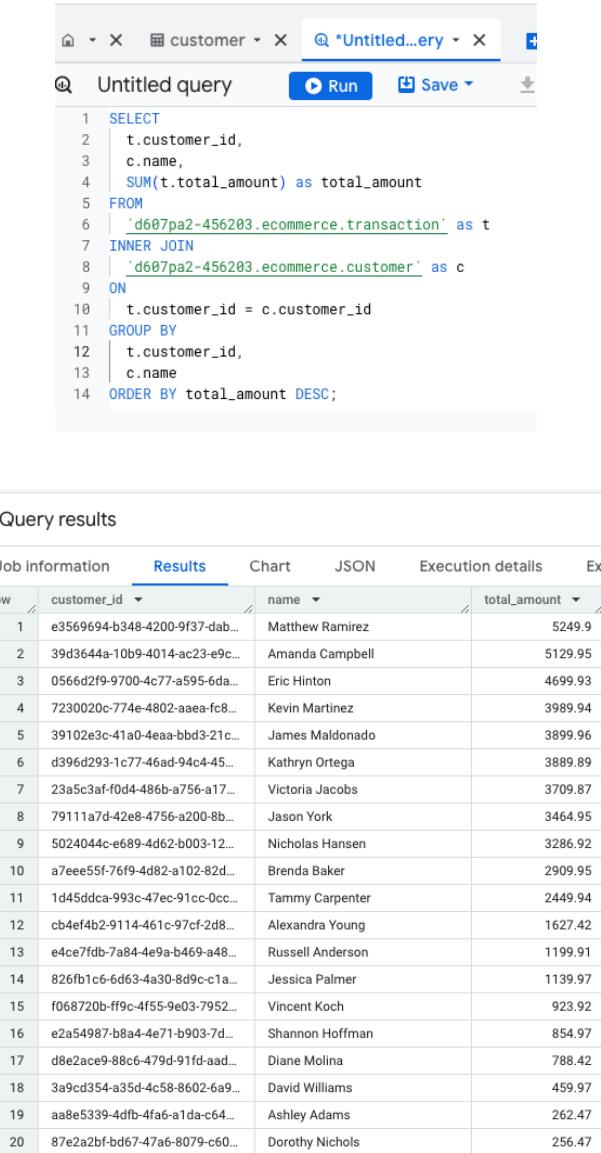
Row	name	product_name	quantity	per_unit_price	line_item_total
1	Vincent Koch	Blender	1	94.49	94.49
2	Vincent Koch	Microwave Oven	3	209.99	629.97
3	Vincent Koch	Smart Light Bulb	3	31.49	94.47
4	Vincent Koch	Gaming Keyboard	1	104.99	104.99

### 3. List the Total Purchase Amounts for all Customers in Descending Order

The query in Figure 17 selects the customer\_id from the transaction table and the name from the customer table to identify the customer. Then, it calculates the sum of the total amount from the transaction table per customer. It joins the transaction table and the customer table based on customer\_id to select only the customers with transactions. The results are grouped by customer ID and name. The total amount is shown in descending order. Matthew Ramirez has spent the most, with a total of \$5,249.90.

Figure 17

*Total Amounts by Customer in Descending Order*



The screenshot shows the Google BigQuery web interface. At the top, there's a navigation bar with icons for file, search, and refresh, followed by the word "customer" and a dropdown for "Untitled query". Below the navigation is a toolbar with a magnifying glass icon, "Run" (highlighted in blue), "Save", and a download icon.

The main area is titled "Untitled query" and contains the following SQL code:

```

1 SELECT
2   t.customer_id,
3   c.name,
4   SUM(t.total_amount) as total_amount
5 FROM
6   `d607pa2-456203.ecommerce.transaction` as t
7 INNER JOIN
8   `d607pa2-456203.ecommerce.customer` as c
9 ON
10  t.customer_id = c.customer_id
11 GROUP BY
12  t.customer_id,
13  c.name
14 ORDER BY total_amount DESC;

```

Below the code, there's a section titled "Query results" with a table. The table has columns: Job information, Results (which is underlined), Chart, JSON, Execution details, and Example. The "Results" column displays the query results:

row	customer_id	name	total_amount
1	e3569694-b348-4200-9f37-dab...	Matthew Ramirez	5249.9
2	39d3644a-10b9-4014-ac23-e9c...	Amanda Campbell	5129.95
3	0566d2f9-9700-4c77-a595-6da...	Eric Hinton	4699.93
4	7230020c-774e-4802-aaea-fc8...	Kevin Martinez	3989.94
5	39102e3c-41a0-4eaa-bbd3-21c...	James Maldonado	3899.96
6	d396d293-1c77-46ad-94c4-45...	Kathryn Ortega	3889.89
7	23a5c3af-f0d4-486b-a756-a17...	Victoria Jacobs	3709.87
8	79111a7d-42e8-4756-a200-8b...	Jason York	3464.95
9	5024044c-e689-4d62-b003-12...	Nicholas Hansen	3286.92
10	a7eee55f-76f9-4d82-a102-82d...	Brenda Baker	2909.95
11	1d45ddca-993c-47ec-91cc-0cc...	Tammy Carpenter	2449.94
12	cb4ef4b2-9114-461c-97cf-2d8...	Alexandra Young	1627.42
13	e4ce7fdb-7a84-4e9a-b469-a48...	Russell Anderson	1199.91
14	826fb1c6-6d63-4a30-8d9c-c1a...	Jessica Palmer	1139.97
15	f068720b-ff9c-4f55-9e03-7952...	Vincent Koch	923.92
16	e2a54987-b8a4-4e71-b903-7d...	Shannon Hoffman	854.97
17	d8e2ace9-88c6-479d-91fd-aad...	Diane Molina	788.42
18	3a9cd354-a35d-4c58-8602-6a9...	David Williams	459.97
19	aa8e5339-4dfb-4fa6-a1da-c64...	Ashley Adams	262.47
20	87e2a2bf-bd67-47a6-8079-c60...	Dorothy Nichols	256.47

In conclusion, this paper achieves the practical application and creation of a data pipeline within the Google Cloud Platform for Alliah's transaction records. Let us revisit the research question, "Can Alliah create a data pipeline utilizing the tools provided within the Google Cloud Platform?" By leveraging Google Cloud Storage buckets along with cloud functions for raw data ETL procedures and BigQuery for analytical processing, Alliah can definitively create a data pipeline using the Google Cloud Platform for their business needs.

The iterative process of development, starting with manual cleaning in a local environment to direct BigQuery uploads, which evolved to an automated solution using cloud functions for ETL, highlighted the challenges and necessary changes in establishing a production-ready cloud solution. Ultimately, the normalized schema implemented in BigQuery and its querying capabilities provides Alliah with a scalable and efficient data warehouse for OLAP purposes, enabling valuable insights into their business transactions.

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