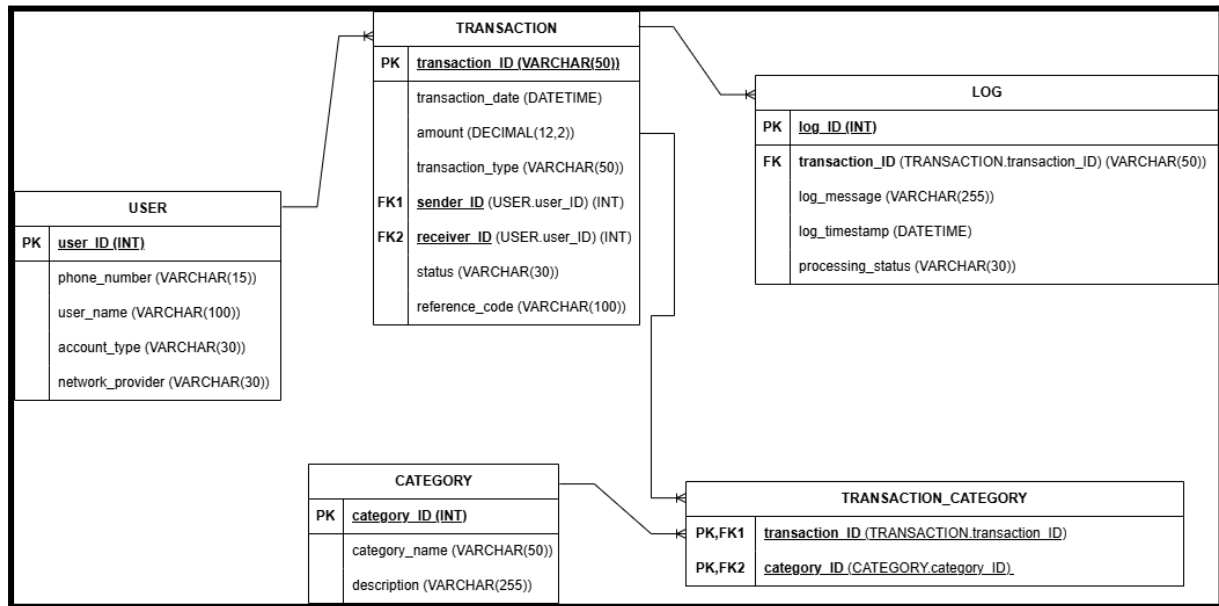


## Entity Relationship Diagram (ERD)



*Figure 1.1 MoMo SMS Analytics DB Relationship*

## ERD Justification

This database is designed to support and represent the structure of MoMo SMS XML data. It makes use of normalisation (3rd Normal Form) and ensures scalability.

The **USER** entity represents all mobile money users and each user could either be a sender or a receiver depending on the transaction. The different attributes - phone\_number, user\_name, account\_type, and network\_provider - all hold necessary information about each user. The **TRANSACTION** entity is the centre of the whole system as it stores details like the amount of money sent, timestamps, and reference codes gotten from SMS messages. There are two foreign key links to the user ID in the USER table to identify which user is the sender and/or receiver. The XML data shows that one transaction could fall under multiple categories, like “Airtime” and “Payment.” this is classified as a many-to-many relationship, however, we solved this problem using the junctions table **TRANSACTION\_CATEGORY**. This follows the rules of the 3rd Normal Form. The **CATEGORY** entity enables analysis and reporting for transactions without repeating text values and the **LOGS** entity stores the parsing status, processing details, and errors, which is important for troubleshooting the MoMo SMS analysis. This ERD reduces redundancy, and makes use of referential integrity through primary and foreign keys.

## Data Dictionary

Table	Column	Meaning
USER	user_ID	Unique MoMo user identifier
USER	phone_number	Register mobile number
USER	account_type	Personal or merchant account
USER	network_provider	Telecom network (MTN, Vodafone or AirtelTigo)
TRANSACTION	transaction_ID	Uniquely identifies transactions
TRANSACTION	amount	Value sent each transaction
TRANSACTION	sender_ID	User initiating the transaction
TRANSACTION	receiver_ID	User receiving the transaction
CATEGORY	category_ID	Uniquely identifies categories
CATEGORY	category_name	Name of transaction category
TRANSACTION_CATEGORY	transaction_ID	Linked to transaction table
TRANSACTION_CATEGORY	category_ID	Linked to category table
LOG	log_ID	To uniquely identify log entries
LOG	log_message	Processing message
LOG	log_timestamp	Time of log creation

## Sample Queries Demonstrating Database Functionality

**Query 1: View all transactions with sender and receiver details**

```

● PS C:\Users\david\Desktop\momo-sms-analytics> & "C:\Program Files\MySQL\MySQL Server 8.0\bin\mysql.exe" -u root -p momo_sms_analytics -e "SELECT t.transaction_ID, t.transaction_date, t.amount, t.transaction_type, t.status, sender.user_name AS sender_name, sender.phone_number AS sender_phone, receiver.user_name AS receiver_name, receiver.phone_number AS receiver_phone FROM transaction t LEFT JOIN user sender ON t.sender_ID = sender.user_id LEFT JOIN user receiver ON t.receiver_ID = receiver.user_id ORDER BY t.transaction_date DESC;"
Enter password: *****
+-----+-----+-----+-----+-----+
| transaction_ID | transaction_date | amount | transaction_type | status |
| sender_name   | sender_phone   | receiver_name | receiver_phone |
+-----+-----+-----+-----+-----+
| TXN20260119007 | 2026-01-19 08:20:00 | 25.00 | airtime | completed |
| Efua Darko    | 0244455667      | NULL   | NULL    |
| TXN20260118006 | 2026-01-18 13:30:00 | 100.00 | transfer | completed |
| Kofi Adjei    | 0201122334      | Akua Boateng | 0267788990 |
| TXN20260117005 | 2026-01-17 11:00:00 | 500.00 | withdrawal | completed |
| Akua Boateng  | 0267788990      | Yaw Osei   | 0509988776 |
| TXN20260116004 | 2026-01-16 16:45:00 | 200.00 | payment | completed |
| Kofi Adjei    | 0201122334      | Ama Asante | 0554567890 |
| TXN20260116003 | 2026-01-16 09:15:00 | 150.00 | received | completed |
| Ama Asante   | 0554567890      | Kwame Mensah | 0241234567 |
| TXN20260115002 | 2026-01-15 14:20:00 | 150.00 | transfer | completed |
| Kwame Mensah | 0241234567      | Ama Asante | 0554567890 |
| TXN20260115001 | 2026-01-15 10:30:00 | 50.00 | airtime | completed |
| Kwame Mensah | 0241234567      | NULL      | NULL     |
+-----+-----+-----+-----+-----+
● PS C:\Users\david\Desktop\momo-sms-analytics>

```

**Query 2: Count transactions by CATEGORY (proof of many-to=many relationship)**

```

-----+-----
PS C:\Users\david\Desktop\momo-sms-analytics> & "C:\Program Files\MySQL\MySQL Server 8.0\bin\mysql.exe" -u root -p m
omo_sms_analytics -e "SELECT c.category_name, COUNT(tc.transaction_ID) AS transaction_count FROM category c LEFT JOI
N transaction_category tc ON c.category_id = tc.category_ID GROUP BY c.category_id, c.category_name ORDER BY transac
tion_count DESC;"
Enter password: *****
+-----+-----+
| category_name | transaction_count |
+-----+-----+
| airtime       | 2 |
| transfer      | 2 |
| payment       | 1 |
| received      | 1 |
| withdrawal    | 1 |
| other         | 0 |
+-----+-----+
PS C:\Users\david\Desktop\momo-sms-analytics>

```

### Query 3: Total transaction amounts per user

```

PS C:\Users\david\Desktop\momo-sms-analytics> & "C:\Program Files\MySQL\MySQL Server 8.0\bin\mysql.exe" -u root -p m
omo_sms_analytics -e "SELECT u.user_id, u.user_name, u.phone_number, COALESCE(SUM(CASE WHEN t.sender_ID = u.user_id
THEN t.amount ELSE 0 END), 0) AS total_sent, COALESCE(SUM(CASE WHEN t.receiver_ID = u.user_id THEN t.amount ELSE 0 E
ND), 0) AS total_received, COALESCE(SUM(CASE WHEN t.sender_ID = u.user_id THEN t.amount ELSE 0 END), 0) + COALESCE(S
UM(CASE WHEN t.receiver_ID = u.user_id THEN t.amount ELSE 0 END), 0) AS total_amount FROM user u LEFT JOIN transacti
on t ON u.user_id = t.sender_ID OR u.user_id = t.receiver_ID GROUP BY u.user_id, u.user_name, u.phone_number ORDER B
Y total_amount DESC;"
Enter password: *****
+-----+-----+-----+-----+-----+-----+
| user_id | user_name | phone_number | total_sent | total_received | total_amount |
+-----+-----+-----+-----+-----+-----+
| 4 | Akua Boateng | 0267788990 | 500.00 | 100.00 | 600.00 |
| 2 | Ama Asante | 0554567890 | 150.00 | 350.00 | 500.00 |
| 5 | Yaw Osei | 0509988776 | 0.00 | 500.00 | 500.00 |
| 1 | Kwame Mensah | 0241234567 | 200.00 | 150.00 | 350.00 |
| 3 | Kofi Adjiei | 0201122334 | 300.00 | 0.00 | 300.00 |
| 6 | Efua Darko | 0244455667 | 25.00 | 0.00 | 25.00 |
+-----+-----+-----+-----+-----+-----+
PS C:\Users\david\Desktop\momo-sms-analytics>

```

### Query 4: Viewing system logs of all failed transactions

```

PS C:\Users\david\Desktop\momo-sms-analytics> & "C:\Program Files\MySQL\MySQL Server 8.0\bin\mysql.exe" -u root -p m
omo_sms_analytics -e "SELECT transaction_ID, sender_ID, receiver_ID FROM TRANSACTION WHERE sender_ID IS NULL OR rece
iver_ID IS NULL LIMIT 5;"
Enter password: *****
+-----+-----+-----+
| transaction_ID | sender_ID | receiver_ID |
+-----+-----+-----+
| TXN20260115001 | NULL | NULL |
| TXN20260115002 | NULL | 2 |
| TXN20260116003 | 2 | NULL |
| TXN20260119007 | 6 | NULL |
+-----+-----+-----+
PS C:\Users\david\Desktop\momo-sms-analytics>

```

### Query 5: Testing referential integrity

```
omo_sms_analytics -e "SELECT u.user_id, u.user_name, u.phone_number, COALESCE(SUM(CASE WHEN t.sender_ID = u.user_id THEN t.amount ELSE 0 END), 0) AS total_sent, COALESCE(SUM(CASE WHEN t.receiver_ID = u.user_id THEN t.amount ELSE 0 END), 0) AS total_received, COALESCE(SUM(CASE WHEN t.sender_ID = u.user_id THEN t.amount ELSE 0 END), 0) + COALESCE(SUM(CASE WHEN t.receiver_ID = u.user_id THEN t.amount ELSE 0 END), 0) AS total_amount FROM user u LEFT JOIN TRANSACTION t ON u.user_id = t.sender_ID OR u.user_id = t.receiver_ID;"
```

```
Y total_amount DESC;"
```

```
Enter password: *****
```

user_id	user_name	phone_number	total_sent	total_received	total_amount
4	Akua Boateng	0267788990	500.00	100.00	600.00
2	Ama Asante	0554567890	150.00	350.00	500.00
5	Yaw Osei	0509988776	0.00	500.00	500.00
3	Kofi Adjei	0201122334	300.00	0.00	300.00
6	Efua Darko	0244455667	25.00	0.00	25.00

```
PS C:\Users\david\Desktop\momo-sms-analytics> & "C:\Program Files\MySQL\MySQL Server 8.0\bin\mysql.exe" -u root -p momo_sms_analytics -e "SELECT 1.log_ID, 1.transaction_ID, t.transaction_type, t.amount, 1.log_message, 1.log_timestamp, 1.processing_status FROM log 1 LEFT JOIN TRANSACTION t ON 1.transaction_ID = t.transaction_ID WHERE t.status = 'failed' OR 1.processing_status = 'error' ORDER BY 1.log_timestamp DESC;"
```

```
Enter password: *****
```

```
PS C:\Users\david\Desktop\momo-sms-analytics> & "C:\Program Files\MySQL\MySQL Server 8.0\bin\mysql.exe" -u root -p momo_sms_analytics -e "SELECT transaction_ID, sender_ID, receiver_ID, transaction_type, amount FROM TRANSACTION WHERE sender_ID IS NULL OR receiver_ID IS NULL;"
```

```
Enter password: *****
```

transaction_ID	sender_ID	receiver_ID	transaction_type	amount
TXN20260115001	NULL	NULL	airtime	50.00
TXN20260115002	NULL	2	transfer	150.00
TXN20260116003	2	NULL	received	150.00
TXN20260119007	6	NULL	airtime	25.00