

**CASE STUDY 42: FINANCIAL TRANSACTION RECORD
SYSTEM**

By

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Users		
Attribute name	Attribute type	Data Type
user_id	PRIMARY KEY	INT
username	NOT NULL UNIQUE	VARCHAR(50)
role	NOT NULL	VARCHAR(30)

Accounts		
Attribute name	Attribute type	Data Type
acct_id	PRIMARY KEY	INT
account number	UNIQUE NOT NULL	VARCHAR(30)
entity_name		VARCHAR(100)
status		VARCHAR(20)
country		VARCHAR(30)

Devices		
Attribute name	Attribute type	Data Type
device_id	PRIMARY KEY	INT
ip_address		VARCHAR(50)

RiskFlags		
Attribute name	Attribute type	Data Type
flag_id	PRIMARY KEY	INT
flag_name	NOT NULL	VARCHAR(100)

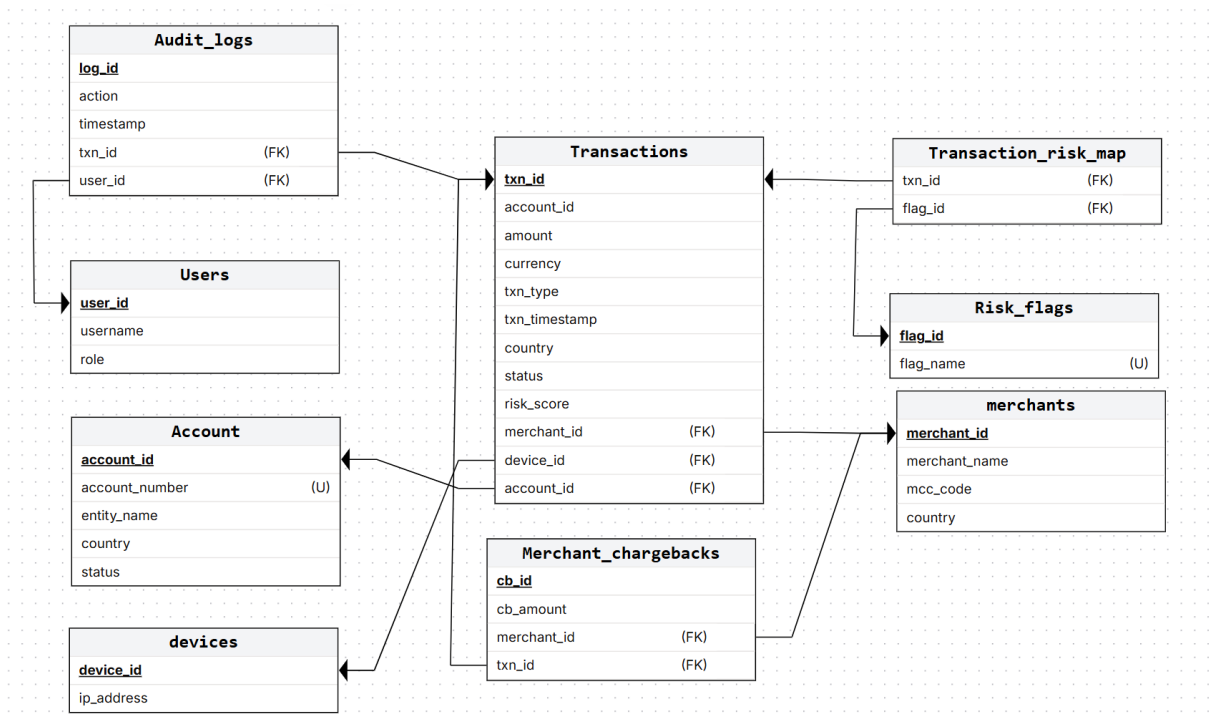
Merchants		
Attribute name	Attribute type	Data Type
merchant_id	PRIMARY KEY	INT
merchant_name		VARCHAR(100)
mcc_code		VARCHAR(10)
country		VARCHAR(30)

Transactions		
Attribute name	Attribute type	Data Type
txn_id	PRIMARY KEY	INT
account_id		INT
merchant_id		INT
device_id		INT
amount		DECIMAL(12,2)
currency		VARCHAR(10)
status		VARCHAR(20)
country		VARCHAR(30)
txn_type		VARCHAR(20)
txn_time		TIMESTAMP
risk_score		INT

Transaction_Risk_Map		
Attribute name	Attribute type	Data Type
txn_id		INT
flag_id		INT

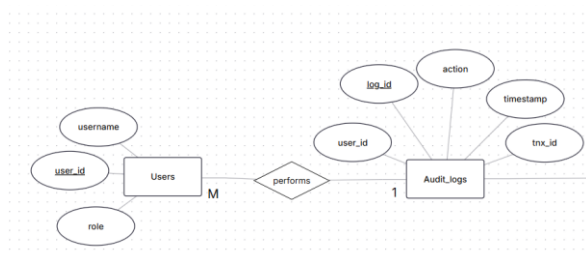
Chargebacks		
Attribute name	Attribute type	Data Type
cb_id	PRIMARY KEY	INT
txn_id		INT
merchant_id		INT
cb_amount		DECIMAL(12,2)

Audit_Logs		
Attribute name	Attribute type	Data Type
log_id	PRIMARY KEY	INT
user_id		INT
txn_id		INT
action		VARCHAR(200)
timestamp	DEFAULT	CURRENT_TIMESTAMP



Relationship mapping

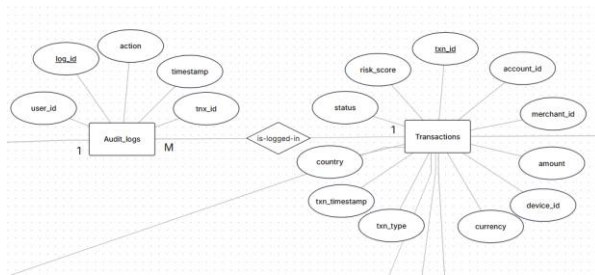
1.Audit_Logs → Users



Explanation:

Audit_Logs is connected to Users using the user_id. It follows a Many-to-One relationship.

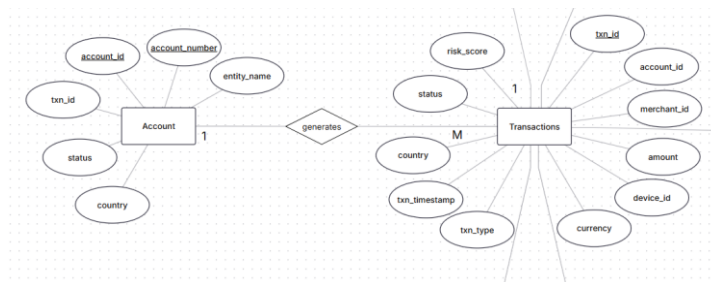
2.Audit_Logs → Transactions



Explanation:

Audit_Logs is connected to Transactions using the txn_id. It follows a Many-to-One relationship.

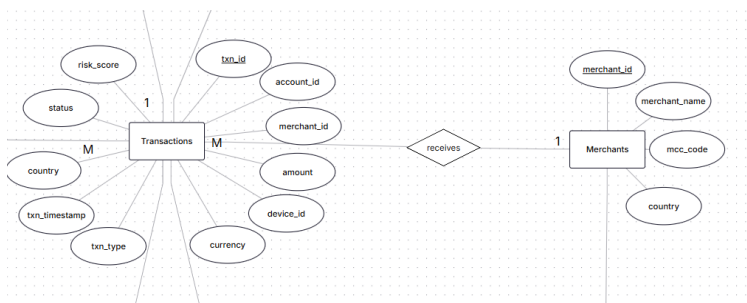
3.Transactions → Accounts



Explanation:

Transactions are connected to Accounts using the account_id. They follow a Many-to-One relationship.

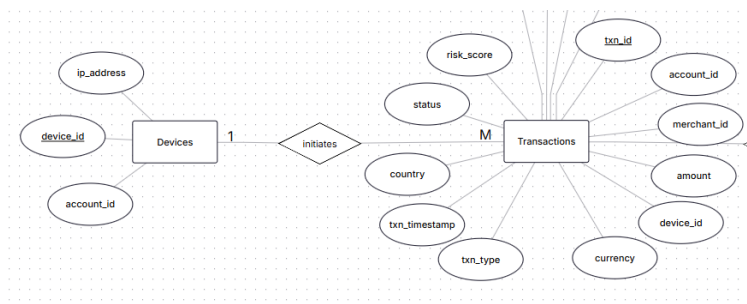
4.Transactions → Merchants



Explanation:

Transactions are connected to Merchants using the merchant_id. They follow a Many-to-One relationship.

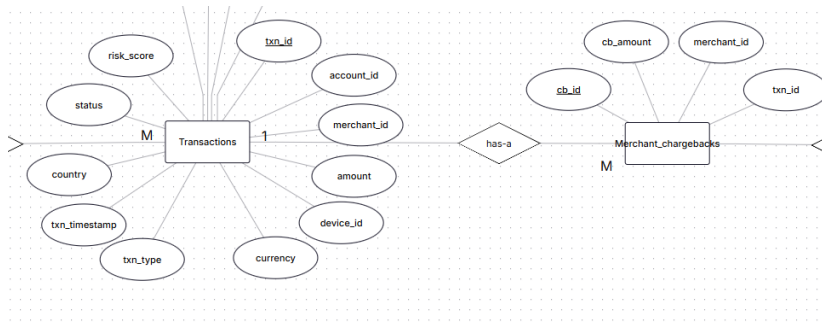
5.Transactions → Devices



Explanation:

Transactions are connected to Devices using the device_id. They follow a Many-to-One relationship.

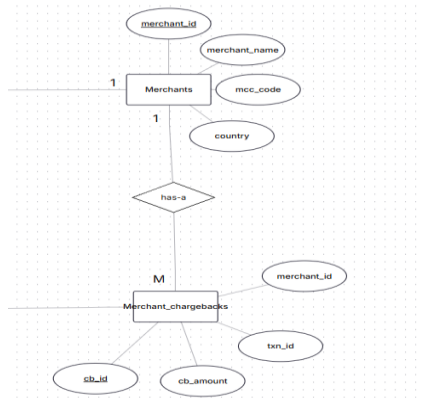
6.Merchant_chargebacks → Transactions



Explanation:

Chargebacks are connected to Transactions using the txn_id. They follow a Many-to-One relationship.

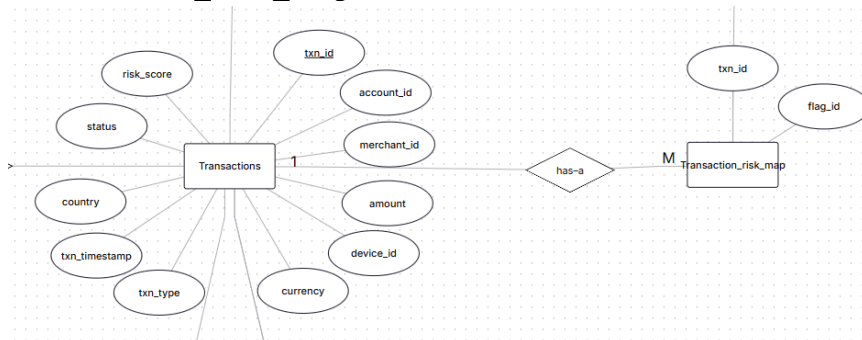
7.Merchant_chargebacks→ Merchants



Explanation:

Chargebacks are connected to Merchants using the merchant_id. They follow a Many-to-One relationship.

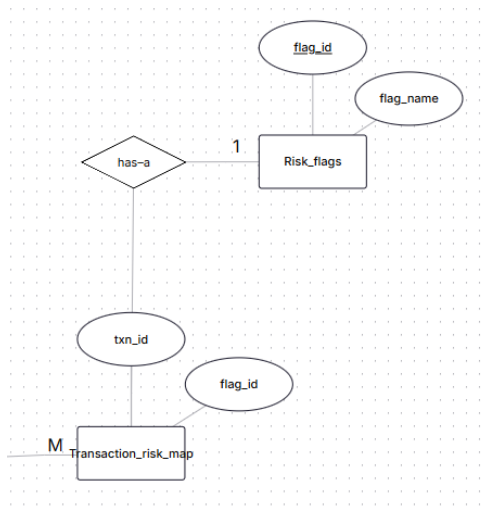
8.Transaction_Risk_Map → Transaction



Explanation:

Transaction_Risk_Map is connected to Transactions using the txn_id. It follows a Many-to-One relationship.

9.Transaction_Risk_Map → RiskFlags



Explanation:

Transaction_Risk_Map is connected to RiskFlags using the flag_id.
It follows a Many-to-One relationship.

NORMALIZATION

1NF

Definition: A table is in 1NF when all values are atomic (no repeating groups, no multi-valued cells).

Examples:

Users: Each column stores a single atomic value

Accounts: No multi-valued fields; each attribute is atomic

2NF

Definition: A table is in 2NF if it is in 1NF and has no partial dependency on a composite key.

Example:

All tables use single-column primary keys, so no partial dependency is possible

3NF

Definition: A table is in 3NF if it is in 2NF and has no transitive dependencies (non-key attributes must not depend on other non-key attributes).

Example:

Users: username and role depend only on user_id, no transitive dependency

Accounts: entity_name, status, country depend only on acct_id

BCNF

Definition: A table is in BCNF when for every functional dependency $X \rightarrow Y$, X is a superkey.

Example:

Users: user_id is the only determinant and is the key

Accounts: acct_id and account_number uniquely identify rows, all determinants are keys

SQL Schema & Data Population

```
CREATE DATABASE finlog;
USE finlog;
```

```
CREATE TABLE Users (
    user_id INT PRIMARY KEY,
    username VARCHAR(50) NOT NULL UNIQUE,
```

```

    role          VARCHAR(30) NOT NULL
);

CREATE TABLE Accounts (
    acct_id       INT PRIMARY KEY,
    account_number VARCHAR(30) UNIQUE NOT NULL,
    entity_name   VARCHAR(100),
    status        VARCHAR(20),
    country       VARCHAR(30)
);

CREATE TABLE Devices (
    device_id     INT PRIMARY KEY,
    ip_address    VARCHAR(50)
);

CREATE TABLE Merchants (
    merchant_id   INT PRIMARY KEY,
    merchant_name VARCHAR(100),
    mcc_code      VARCHAR(10),
    country       VARCHAR(30)
);

CREATE TABLE Transactions (
    txn_id        INT PRIMARY KEY,
    account_id    INT,
    merchant_id   INT,
    device_id     INT,
    amount        DECIMAL(12,2),
    currency      VARCHAR(10),
    status        VARCHAR(20),
    country       VARCHAR(30),
    txn_type      VARCHAR(20),
    txn_time      TIMESTAMP,
    risk_score    INT,
    FOREIGN KEY (account_id) REFERENCES Accounts(acct_id),
    FOREIGN KEY (merchant_id) REFERENCES Merchants(merchant_id),
    FOREIGN KEY (device_id) REFERENCES Devices(device_id)
);

CREATE TABLE Chargebacks (
    cb_id         INT PRIMARY KEY,
    txn_id        INT,
    merchant_id   INT,
    cb_amount     DECIMAL(12,2),
    FOREIGN KEY (txn_id) REFERENCES Transactions(txn_id),
    FOREIGN KEY (merchant_id) REFERENCES Merchants(merchant_id)
);

CREATE TABLE RiskFlags (
    flag_id       INT PRIMARY KEY,
    flag_name     VARCHAR(100) NOT NULL
);


CREATE TABLE Transaction_Risk_Map (
    txn_id        INT,
    flag_id       INT,
    PRIMARY KEY (txn_id, flag_id),
    FOREIGN KEY (txn_id) REFERENCES Transactions(txn_id),
    FOREIGN KEY (flag_id) REFERENCES RiskFlags(flag_id)
);

```

```
);
CREATE TABLE Audit_Logs (
    log_id    INT PRIMARY KEY,
    user_id   INT,
    txn_id    INT,
    action    VARCHAR(200),
    timestamp TIMESTAMP DEFAULT CURRENT_TIMESTAMP,
    FOREIGN KEY (user_id) REFERENCES Users(user_id),
    FOREIGN KEY (txn_id) REFERENCES Transactions(txn_id)
);
```

Sample Data


Users

Result Grid  Filter Rows: <input type="text"/>			
	user_id	username	role
▶	1	admin_user	ADMIN
	2	risk_analyst_1	RISK_ANALYST
	3	risk_analyst_2	RISK_ANALYST
	4	ops_user	OPERATIONS
	5	auditor_1	AUDITOR
	6	fraud_lead	RISK_MANAGER
	7	cs_agent_1	CUSTOMER_SUPPORT
	8	cs_agent_2	CUSTOMER_SUPPORT
	9	comp_officer_1	COMPLIANCE_OFFICER
	10	comp_officer_2	COMPLIANCE_OFFICER
•	NULL	NULL	NULL

Accounts

	acct_id	account_number	entity_name	status	country
▶	1	ACCT0001	John Doe	ACTIVE	USA
	2	ACCT0002	Jane Smith	ACTIVE	USA
	3	ACCT0003	Acme Corp	ACTIVE	UK
	4	ACCT0004	Globex Ltd	SUSPENDED	UK
	5	ACCT0005	Ravi Kumar	ACTIVE	India
	6	ACCT0006	Priya Sharma	CLOSED	India
	7	ACCT0007	TechWorld Inc	ACTIVE	Canada
	8	ACCT0008	Olivia Brown	ACTIVE	Australia
	9	ACCT0009	Carlos Fernandez	ACTIVE	Mexico
	10	ACCT0010	EuroShop GmbH	ACTIVE	Germany
•	NULL	NULL	NULL	NULL	NULL

Devices

Result Grid  Filter Rows: <input type="text"/>		
	device_id	ip_address
▶	1	192.168.0.10
	2	192.168.0.11
	3	10.0.0.5
	4	10.0.0.6
	5	172.16.5.20
	6	172.16.5.21
	7	203.0.113.10
	8	198.51.100.25
	9	192.168.55.200
•	NULL	NULL

Merchants

	merchant_id	merchant_name	mcc_code	country
▶	1	Amazon Online	5311	USA
	2	Flipkart	5311	India
	3	Walmart Store	5411	USA
	4	Tesco Supermarket	5411	UK
	5	Uber Rides	4121	USA
	6	Air India	4511	India
	7	Local Electronics	5732	Canada
	8	Global Fashion	5651	Germany
	9	TravelWorld	4722	Netherlands
	10	Café Bonjour	5812	France
•	NULL	NULL	NULL	NULL

Transactions

Result Grid											
Filter Rows:											
	txn_id	account_id	merchant_id	device_id	amount	currency	status	country	txn_type	txn_time	risk_score
▶	1	1	1	1	25.50	USD	SUCCESS	USA	ECOM	2025-01-01 10:15:00	10
	2	1	3	2	120.00	USD	SUCCESS	USA	POS	2025-01-02 11:20:00	20
	3	2	1	1	1000.00	USD	SUCCESS	USA	ECOM	2025-01-05 09:05:00	70
	4	3	4	3	45.75	GBP	DECLINED	UK	POS	2025-01-06 14:30:00	40
	5	3	4	3	45.75	GBP	SUCCESS	UK	POS	2025-01-06 14:32:00	30
	6	4	4	7	500.00	GBP	SUCCESS	UK	ECOM	2025-01-07 16:10:00	80
	7	5	2	4	150.00	INR	SUCCESS	India	ECOM	2025-01-08 18:45:00	25
	8	5	2	4	800.00	INR	DECLINED	India	ECOM	2025-01-09 09:01:00	60
	9	5	6	5	25000.00	INR	SUCCESS	India	ECOM	2025-01-10 21:10:00	95
	10	6	2	5	200.00	INR	PENDING	India	ECOM	2025-01-11 10:00:00	35
*	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL	NULL

Audit_Logs

	log_id	user_id	txn_id	action	timestamp
▶	1	1	3	Created transaction manually for testing	2025-01-05 09:06:00
	2	2	3	Reviewed high amount transaction	2025-01-05 09:10:00
	3	2	4	Investigated declined POS transaction	2025-01-06 14:35:00
	4	3	6	Marked as high-risk cross-border	2025-01-07 16:15:00
	5	4	8	Checked multiple declines	2025-01-09 09:05:00
	6	2	9	Escalated to fraud lead	2025-01-10 21:20:00
	7	6	9	Approved transaction after review	2025-01-10 21:30:00
	8	5	12	Audit check on refunded transaction	2025-01-13 15:30:00
	9	3	15	Flagged for chargeback risk	2025-01-15 20:20:00
	10	6	16	Approved high-value Euro transaction	2025-01-16 11:20:00
*	NULL	NULL	NULL	NULL	NULL

Chargebacks

Result Grid				
Filter Rows:				
	cb_id	txn_id	merchant_id	cb_amount
▶	1	12	7	80.00
	2	15	5	500.00
	3	16	8	600.00
	4	19	6	50000.00
	5	25	9	750.00
	6	3	1	400.00
	7	30	11	9800.00
*	NULL	NULL	NULL	NULL

RiskFlags

Result Grid		Filter Rows:
	flag_id	flag_name
▶	1	High amount transaction
	2	Cross-border transaction
	3	Multiple declines
	4	Suspicious device
	5	Velocity risk
	6	Chargeback history
	7	Manual review required
	8	Potential Money Laundering
*	NULL	NULL

Transaction_Risk_Map

Result Grid		Filter Rows:
	txn_id	flag_id
▶	3	1
	6	1
	9	1
	16	1
	17	1
	19	1
	25	1
	26	1
	42	1
	47	1
*	NULL	NULL