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SECD2523 DATABASE

SECTION 06

PHASE 3: DATABASE LOGICAL DESIGN

CARBON EMISSION MONITORING SYSTEM

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1. Introduction

In this phase, we are going to learn that understanding and actively controlling the flow of carbon throughout ecosystems has become critical in the constantly changing landscape of environmental consciousness and sustainable practices. An essential component of the ecosystem, carbon affects climate patterns and preserves ecological equilibrium in natural systems. The complex exchange of carbon between the land, oceans, atmosphere and living things is referred to as the "Carbon Cycle". Acknowledging the importance of carbon in the environment is critical for maintaining ecological balance as well as for reducing the effects of climate change.

The Carbon Emission Monitoring System, a ground-breaking tool for tracking, measuring and controlling carbon dioxide (CO2) levels in ecosystems is presented in this project. This system which was created especially for Majlis Perbandaran Iskandar Puteri (MBIP) is to support local government initiatives in the Iskandar Puteri region that promote sustainability and lessen global warming. One of the system's many impressive features is that it collects precise data from each user about how much water and power they use, making it possible to calculate each person's carbon footprint using a predetermined mathematical formula. In addition, the system offers users helpful advice on how to reduce carbon emissions locally which encourages a group effort to greatly improve the atmospheric conditions.

Crucially, the efficiency of the Carbon Emission Monitoring System lies in its minimal imposition on clients' time increasing the likelihood of widespread participation. By encouraging active involvement in carbon emission reduction, the system becomes a powerful tool for collective improvement in the local environment.

This phase also explores the technical features of the Carbon Emission Monitoring database conceptual design, the creation of exact business rules and following them are essential to building a reliable and effective data management system. This study examines the complexities of an advanced Carbon Emission Monitoring System, emphasising the system's changing conceptual architecture, updated business rules and logical relational.

The principles that provide the basis for the relationships and limitations in the database are the updated business rules. Every user in the system is closely linked to certain records such as statistics on water and power usage, total recycled garbage and low-carbon practices. These relationships are defined by the rules which guarantee that every record is only associated with a single participant. These business rules establish an organised foundation for the system's use and organisation of data.

Last but not least, a thorough reference handbook with thorough descriptions and explanations of all the data items in the database is provided by the data dictionary. Effective communication among stakeholders is ensured and data management is kept clear and consistent as a result. The logical arrangement of data is demonstrated by a Functional Dependency diagram, which highlights normalisation, a crucial phase in database architecture. The simplified structure is reflected in the normalised logical ERD that is produced, improving data integrity and reducing redundancy.

2. Overview Of Project

The Carbon Emission Monitoring System is a comprehensive initiative designed to monitor, measure, and regulate carbon dioxide (CO2) levels in ecosystems, specifically tailored for Majlis Perbandaran Iskandar Puteri (MBIP). The system aims to empower local authorities in mitigating global warming and promoting sustainability within the Iskandar Puteri region. The project focuses on tracking electricity and water consumption, recycled waste, and low-carbon practices among participants to effectively manage and reduce carbon emissions.

To control data interactions inside the system, the project creates explicit business rules. Records of water and power use, recycled garbage, and low-carbon behaviours are specifically linked to each participant. By guaranteeing exclusive connections, the rules offer a well-organised framework for organising data.

The conceptual design is visualised through an Entity Relationship Diagram (ERD), illustrating the relationships and entities within the system. The logical design refines this into participant-centric relational schemas, including Participant, Water_Consumption, Electric_Consumption, Recycled_Waste, and Low_Carbon_Practice. Foreign keys establish connections between these entities.

As a reference guide, a thorough data dictionary provides in-depth descriptions and explanations of every data object in the database. This guarantees good communication, uniformity, and clarity amongst project stakeholders.The purpose of normalisation, an essential database design phase, is to reduce redundancy and improve data integrity. The logical arrangement of the data is shown by the functional dependency diagram, which leads to a normalised logical ERD that represents an efficient data structure.

SQL statements that contain instructions in Data Definition Language (DDL) and Data Manipulation Language (DML) make practical implementation easier. These declarations make it possible to create, edit, and query the database, connecting the theoretical ideas with the practical implementation of the Carbon Emission Monitoring System.

The project overview encapsulates a holistic approach, from conceptualization to implementation, in developing an efficient and robust Carbon Emission Monitoring System. By adhering to clear business rules, employing effective design strategies, and utilising SQL for practical implementation, the system aims to contribute significantly to carbon emission reduction and sustainability in the Iskandar Puteri region.

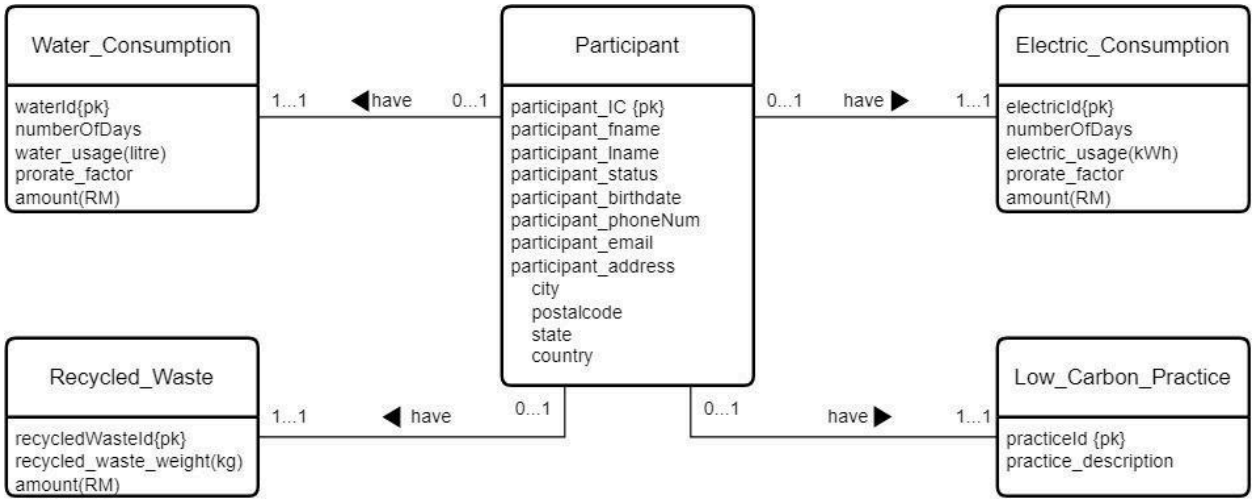
3. Database Conceptual Design

3.1. Updated Business Rule

A business rule articulates constraints on the elements and relationships within a given relation, providing a clear framework for how an organisation perceives and utilises its data. The updated business rules are outlined as follows:

1. Every participant is associated with a singular electricity consumption record and each electricity consumption record is linked exclusively to one participant.
2. Each participant is connected to a unique water consumption dataset and each water consumption dataset is specifically tied to one participant.
3. Every participant is linked to a distinct total recycled waste data set and each total recycled waste data entry is exclusively associated with one participant.
4. Each participant is associated with an individual low-carbon practice data and each low-carbon practice data point is uniquely related to one participant.

3.2. Conceptual ERD



4. DB Logical Design

4.1. Logical ERD

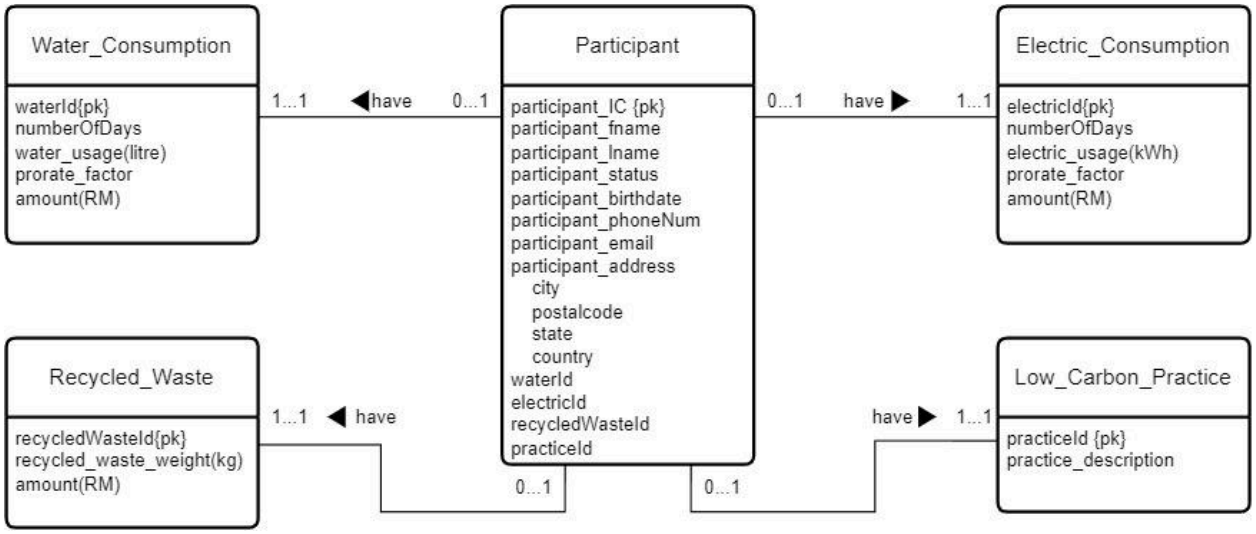


Figure x: Logical ERD

Relational Schemas:

1. Participant(<u>participant_IC</u>, participant_fname, participant_lname, participant_status, participant_birthdate, participant_phoneNum, participant_email, city, postalcode, state, country, waterId, electricId, recycledWasteId, practiceId)

   Primary key participant_IC

   Foreign key waterId reference Water_Consumption(waterId)

   Foreign key electricId reference Electric_Consumption(electricId)

   Foreign key recycledWasteId reference Recycled_Waste(recycledWasteId)

   Foreign key practiceId reference Low_Carbon_Practice(practiceId)

2. Water_Consumption (<u>waterId</u>, numberOfDays, water_usage(litre), prorate_factor, amount(RM))

   Primary key waterId

3. Electric_Consumption (electricId, numberOfDays, electric_usage(kWh), prorate_factor, amount(RM))

   Primary key electricId

4. Recycled_Waste (recycledWasteId, recycled_waste_Weight, amount(RM))

   Primary key recycledWasteId

5. Low_Carbon_Practice (practiceId, practice_description)

   Primary key practiceId

4.2. Updated Data Dictionary

A Data Dictionary is a collection of entities, definitions and attributes used or captured in a relation or database. Therefore, the Low Carbon Emission Calculation System Data Dictionary is defined as follows:

Entity name	Attributes	Description	Data Type & Length	Nulls	Multi-Valued
Participant	participant_IC	Participant's IC number	12 variable characters	No	No
	participant_fname	Participant's first name	20 variable characters	No	No
	participant_lname	Participant's last name	20 variable characters	No	No
	participant_status	Participant's status	10 variable characters	No	No
	participant_birthdate	Participant's birthdate	Date	Yes	No
	participant_phoneNum	Participant's phone number	11 variable characters	No	No
	participant_email	Participant's email	40 variable characters	No	No
	participant_address	Participant's current home address			
	city		20 variable characters	No	No
	postalCode		5 variable characters	No	No
	state		20 variable characters	No	No
	country		20 variable characters	No	No
Water_ Consumption	waterId	Uniquely identifies the water consumption tuple	10 variable characters	No	No
	numberOfDays	Number of water consumption days	2 digits number	No	No
	water_usage	The amount of water usage in liters	5 digits number	No	No
	prorate_factor	The rate for the water charged in liters	5 digits number	No	No
	amount	Total amount of water usage in Ringgit Malaysia	8 digits number	No	No
Electric_ Consumption	electricId	Uniquely identifies the electric consumption tuple	10 variable characters	No	No
	numberOfDays	Number of electric consumption days	2 digits number	No	No
	electric_usage	The amount of electric usage in kWh	5 digits number	No	No
	prorate_factor	The rate for the electricity charged in kWh	5 digits number	No	No
	amount	Total amount of electric usage in Ringgit Malaysia	8 digits number	No	No

Table 1: Data Dictionary for Low Carbon Emission Calculation System

4.3. Normalisation

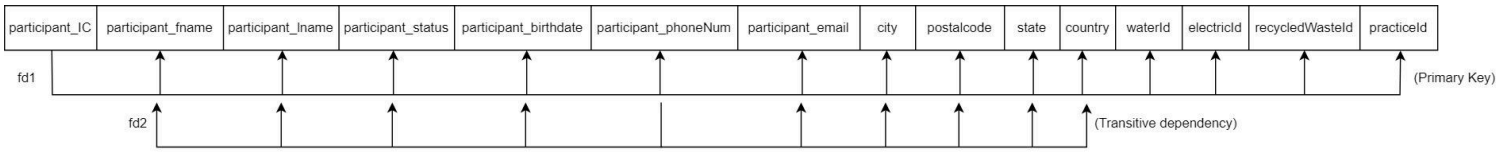


Figure 4.3: Functional Dependency diagram

5. Relational DB Schemas (after normalisation)

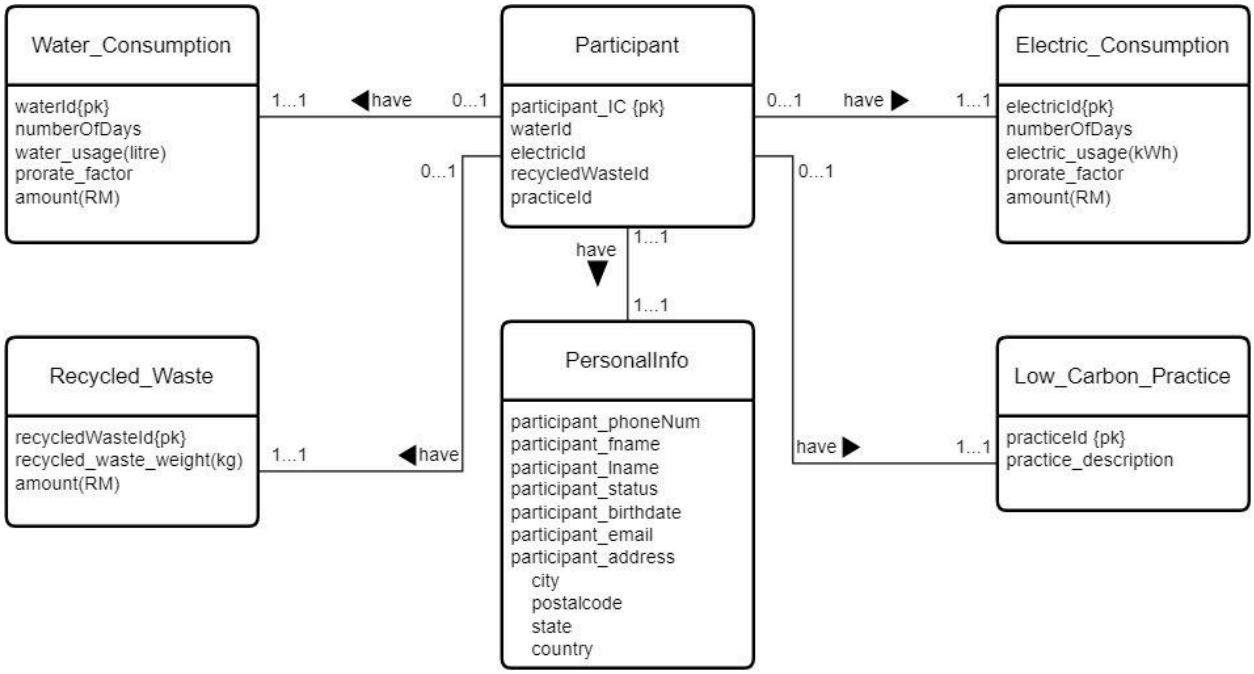


Figure 5.0: Normalised Logical ERD

1. Participant(<u>participant_IC</u>, participant_phoneNum, waterId, electricId, recycledWasteId, practiceId)

   Primary key participant_IC

   Foreign key participant_phoneNum reference PersonalInfo(participant_phoneNum)

   Foreign key waterId reference Water_Consumption(waterId)

   Foreign key electricId reference Electric_Consumption(electricId)

   Foreign key recycledWasteId reference Recycled_Waste(recycledWasteId)

   Foreign key practiceId reference Low_Carbon_Practice(practiceId)

2. PersonalInfo(<u>participant_phoneNum</u>, participant_fname, participant_lname, participant_status, participant_birthdate, participant_email, city, postalcode, state, country

Primary key participant_phoneNum

3. Water_Consumption (waterId, numberOfDays, water_usage(litre), prorate_factor, amount(RM))

   Primary key waterId

4. Electric_Consumption (electricId, numberOfDays, electric_usage(kWh), prorate_factor, amount(RM))

   Primary key electricId

5. Recycled_Waste (recycledWasteId, recycled_waste_Weight, amount(RM))

   Primary key recycledWasteId

6. Low_Carbon_Practice (practiceId, practice_description)

   Primary key practiceId

6. SQL Statements (DDL & DML)

DDL

```
CREATE TABLE Water_Consumption(
    waterID VARCHAR(10),
    numberOfDays NUMBER(2) NOT NULL,
    water_usage NUMBER(5) NOT NULL,
    prorate_factor NUMBER(5, 2) NOT NULL,
    amount NUMBER(8, 2) NOT NULL,
    CONSTRAINT waterID_pk PRIMARY KEY (waterID),
    CONSTRAINT water_numberOfDays_chk CHECK (numberOfDays > 0),
    CONSTRAINT water_usage_chk CHECK (water_usage > 0),
    CONSTRAINT water_prorate_factor_chk CHECK (prorate_factor > 0),
    CONSTRAINT water_amount_chk CHECK (amount > 0)
);


CREATE TABLE Electric_Consumption(
    electricID VARCHAR(10),
    numberOfDays NUMBER(2) NOT NULL,
    electric_usage NUMBER(5) NOT NULL,
    prorate_factor NUMBER(5, 2) NOT NULL,
    amount NUMBER(8, 2) NOT NULL,
    CONSTRAINT electricID_pk PRIMARY KEY (electricID),
    CONSTRAINT electric_numberOfDays_chk CHECK (numberOfDays > 0),
```

```
    CONSTRAINT electric_usage_chk CHECK (electric_usage > 0),
    CONSTRAINT electric_prorate_factor_chk CHECK (prorate_factor > 0),
    CONSTRAINT electric_amount_chk CHECK (amount > 0)
);

CREATE TABLE Recycled_Waste(
    recycledWasteID VARCHAR(10),
    recycled_waste_weight NUMBER(5) NOT NULL,
    amount NUMBER(8, 2) NOT NULL,
    CONSTRAINT recycledWasteID_pk PRIMARY KEY (recycledWasteID),
    CONSTRAINT recycled_waste_weight_chk CHECK (recycled_waste_weight > 0),
    CONSTRAINT recycled_amount_chk CHECK (amount > 0)
);

CREATE TABLE Low_Carbon_Practice(
    practiceID VARCHAR(10),
    practice_description VARCHAR(50),
    CONSTRAINT practiceID_pk PRIMARY KEY (practiceID)
);

CREATE TABLE PersonalInfo(
    participant_phoneNum VARCHAR(11),
    participant_fname VARCHAR(20) NOT NULL,
```

```
    participant_lname VARCHAR(20) NOT NULL,
    participant_status VARCHAR(10) NOT NULL,
    participant_birthdate DATE,
    participant_email VARCHAR(40) NOT NULL,
    city VARCHAR(20) NOT NULL,
    postalcode VARCHAR(5) NOT NULL,
    state VARCHAR(20) NOT NULL,
    country VARCHAR(20) NOT NULL,
    CONSTRAINT participant_phoneNum_pk PRIMARY KEY (participant_phoneNum)
);

CREATE TABLE Participant(
    participant_IC VARCHAR(12),
    participant_phoneNum VARCHAR(11),
    waterID VARCHAR(10),
    electricID VARCHAR(10),
    recycledWasteID VARCHAR(10),
    practiceID VARCHAR(10),
    CONSTRAINT participant_IC_pk PRIMARY KEY (participant_IC),
    CONSTRAINT participant_phoneNum_fk FOREIGN KEY (participant_phoneNum)
REFERENCES PersonalInfo (participant_phoneNum),
    CONSTRAINT waterID_fk FOREIGN KEY (waterID) REFERENCES Water_Consumption
(waterID),
```

CONSTRAINT electricID_fk FOREIGN KEY (electricID) REFERENCES Electric_Consumption (electricID),

CONSTRAINT recycledWasteID_fk FOREIGN KEY (recycledWasteID) REFERENCES Recycled_Waste (recycledWasteID),

CONSTRAINT practiceID_fk FOREIGN KEY (practiceID) REFERENCES Low_Carbon_Practice (practiceID)

);

DML

--Personal Info DML

INSERT INTO PersonalInfo(

participant_phoneNum,

participant_fname,

participant_lname,

participant_status,

participant_birthdate,

participant_email,

city,

postalcode,

state,

country

```
)
VALUES(
    '01355897234',
    'Lio',
    'Hock',
    'Single',
    TO_DATE('11-12-2003', 'DD-MM-YY'),
    'liohock90@gmail.com',
    'Iskandar Puteri',
    '79250',
    'Johor',
    'Malaysia'
);



INSERT INTO PersonalInfo(
    participant_phoneNum,
    participant_fname,
    participant_lname,
    participant_status,
    participant_birthdate,
    participant_email,
    city,
```

```
    postalcode,
    state,
    country
)
VALUES(
    '01899016578',
    'Ahmad',
    'Saifudin',
    'Married',
    TO_DATE('30-06-2000', 'DD-MM-YY'),
    'ahmadsaifudin00@gmail.com',
    'Iskandar Puteri',
    '79250',
    'Johor',
    'Malaysia'
);



--Water_Consumption DML
INSERT INTO Water_Consumption(
    waterID,
    numberOfDays,
    water_usage,
```

```
    prorate_factor,
    amount
)
VALUES(
    'WC13900011',
    30,
    368,
    0.10,
    238.10
);



INSERT INTO Water_Consumption(
    waterID,
    numberOfDays,
    water_usage,
    prorate_factor,
    amount
)
VALUES(
    'WC16500025',
    31,
```

```
    241,
    0.15,
    125.23
);


--Electric_Consumption DML
INSERT INTO Electric_Consumption(
    electricID,
    numberOfDays,
    electric_usage,
    prorate_factor,
    amount
)
VALUES(
    'EC14910011',
    30,
    390,
    0.21,
    320.15
);
```

```
INSERT INTO Electric_Consumption(
    electricID,
    numberOfDays,
    electric_usage,
    prorate_factor,
    amount
)
VALUES(
    'EC12900023',
    31,
    421,
    0.18,
    490.25
);



--Recycled_Waste DML
INSERT INTO Recycled_Waste(
    recycledWasteID,
    recycled_waste_weight,
    amount
)
VALUES(
```

```
    'RW23900056',
    12,
    50.10
);


INSERT INTO Recycled_Waste(
    recycledWasteID,
    recycled_waste_weight,
    amount
)
VALUES(
    'RW16950027',
    15,
    68.90
);


--Low_Carbon_Practice DML
INSERT INTO Low_Carbon_Practice(
    practiceID,
    practice_description
)
```

```
VALUES(
    'LP15508701',
    'Turn off lights when it is not in use'
);


INSERT INTO Low_Carbon_Practice(
    practiceID,
    practice_description
)

VALUES(
    'LP13600102',
    'Using public transportation'
);

--Participant DML
INSERT INTO Participant(
    participant_IC,
    participant_phoneNum,
    waterID,
    electricID,
    recycledWasteID,
```

```
    practiceID
)
VALUES(
    '031211095789',
    '01355897234',
    'WC13900011',
    'EC14910011',
    'RW23900056',
    'LP15508701'
);


INSERT INTO Participant(
    participant_IC,
    participant_phoneNum,
    waterID,
    electricID,
    recycledWasteID,
    practiceID
)
VALUES(
    '000630016719',
    '01899016578',
```

```
    'WC16500025',
    'EC12900023',
    'RW16950027',
    'LP13600102'
);


--Display all of the relations
SELECT * FROM Participant;
SELECT * FROM PersonalInfo;
SELECT * FROM Water_Consumption;
SELECT * FROM Electric_Consumption;
SELECT * FROM Recycled_Waste;
SELECT * FROM Low_Carbon_Practice;


--Display Participant's Personal Info
SELECT p.participant_IC "Participant's IC", i.participant_fname || ' ' || i.participant_lname AS "Participant's Name",
    i.participant_status "Marital Status", i.participant_birthdate "Birthdate", i.participant_email "E-mail",
    p.participant_phoneNum "Phone Number", i.postalcode || ' ' || i.city || ', ' || i.state || ', ' || i.country AS "Address"
```

```
FROM Participant p JOIN PersonalInfo i ON (p.participant_phoneNum =
i.participant_phoneNum);



--Display Participant's Consumption IDs

SELECT p.participant_IC "Participant's IC", i.participant_fname || ' ' || i.participant_lname AS
"Participant's Name",

    p.waterID "Water Consumption ID", p.electricID "Electric Consumpmtion ID",
p.recycledWasteID "Recycled Waste ID",

    p.practiceID "Low Carbon Practice ID"

FROM Participant p JOIN PersonalInfo i ON (p.participant_phoneNum =
i.participant_phoneNum);



--Display Participant's water consumption data

SELECT p.participant_IC "Participant's IC", i.participant_fname || ' ' || i.participant_lname AS
"Participant's Name",

    p.waterID "Water Consumption ID", w.numberOfDays "Number of Days", w.water_usage
"Water Usage (Litre)",

    w.prorate_factor "Prorate Factor (RM/Litre)", w.amount "Amount (RM)"

FROM Participant p JOIN Water_Consumption w ON (p.waterID = w.waterID) JOIN
PersonalInfo i ON (p.participant_phoneNum = i.participant_phoneNum);
```

```
--Display Participant's electricity consumption data

SELECT p.participant_IC "Participant's IC", i.participant_fname || ' ' || i.participant_lname AS "Participant's Name",

    p.electricID "Electric Consumption ID", e.numberOfDays "Number of Days", e.electric_usage "Electric Usage (kWh)",

    e.prorate_factor "Prorate Factor (RM/kWh)", e.amount "Amount (RM)"

FROM Participant p JOIN Electric_Consumption e ON (p.electricID = e.electricID) JOIN PersonalInfo i ON (p.participant_phoneNum = i.participant_phoneNum);


--Display Participant's recycled waste data

SELECT p.participant_IC "Participant's IC", i.participant_fname || ' ' || i.participant_lname AS "Participant's Name",

    p.recycledWasteID "Recycled Waste ID", w.recycled_waste_weight "Recycled Waste Weight (kg)",

    w.amount "Amount (RM)"

FROM Participant p JOIN Recycled_Waste w ON (p.recycledWasteID = w.recycledWasteID) JOIN PersonalInfo i ON (p.participant_phoneNum = i.participant_phoneNum);


--Display Participant's low carbon practice data

SELECT p.participant_IC "Participant's IC", i.participant_fname || ' ' || i.participant_lname AS "Participant's Name",

    p.practiceID "Low Carbon Practice ID", c.practice_description "Participant's Practice Description"

FROM Participant p JOIN Low_Carbon_Practice c ON (p.practiceID = c.practiceID) JOIN PersonalInfo i ON (p.participant_phoneNum = i.participant_phoneNum);
```

7. Summary

In summary, this project explores the process of creating a Carbon Emission Monitoring System, highlighting the value of conceptual and logical architecture, business rule, normalisation, SQL statements in building a solid database system. The revised business rules provide precise limitations for documents pertaining to users, guaranteeing that they are only associated with low carbon operations, recycled garbage and the use of water and power. The relationships throughout the system are depicted in the conceptual Entity Relationship Diagram (ERD) which paves the way for the logical design of user centric relational schemas. The data dictionary facilitates real-world application including instructions written in Data Definition Language (DDL) and Data Manipulation Language (DML). This all encompassing strategy guarantees a functioning, effective and well organised carbon emission monitoring system.