6. Class-based Modeling

The objects that the system will manipulate, the operations (also known as methods or services) applied to manipulate these objects, relationships (some hierarchical) between the objects, and interactions among the defined classes—all are represented by class-based modeling. Classes, objects, attributes, operations, Class-Responsibility-Collaborator (CRC) models, collaboration diagrams, and packages constitute components of a class-based model.

6.1 List of verbs

SI	Verbs	SI	Verbs	SI	Verbs
1	Will	13	is	25	Gains
2	are	14	Promote	26	Has
3	Create	15	Input	27	Edit
4	Update	16	Secure	28	Involve
5	Begin	17	Complete	30	Replace
6	Verify	18	Commence	31	Requisite
7	Generate	19	Check	32	Reflect
8	Sent	20	Ensure	33	Manage
9	Validate	21	Tailor	34	Solve
10	Grant	22	Seek	35	Face
11	Setup	23	Prompts	36	Take
12	Store	24	Dispatch	37	Calculate
38	can	62	Makes	88	
39	Empower	63	Continue	89	assign

40	Apply	64	Reconsider	90	implement
41	Receive	67	Play	91	enhance
42	Approval	68	Integrate	92	add
43	Submit	69	Incompass	93	orchestrates
44	Allow	70	Compute	94	facilitate
45	Enable	71	Conduct	95	gain
46	Disseminate	72	Contain	96	track
47	Reach	73	Provide	97	focus
48	Streamlines	74	Manage	98	optimize
49	Facilitate	75	Enhance	99	establish
50	Initiate	76	Share	100	serves
51	Purchase	77	Enter	101	engage
52	Review	78	Opt	102	showcase
53	Convert	79	Need	103	streamlines
54	Notify	80	Record	104	sold
55	Forward	81	Loges	105	capture
56	Utilize	82	offer	106	remain
57	Confirm	83	modify	107	triggering
58	Communicate	84	make		
59	Proceed	85	receive		
60	Process	86	dispatch		
61	Elapsed	87	includes		

6.2 General Classification

1. External entities (e.g., other systems, devices, people) that produce or consume information to be used
by a computer-based system.
2. Things (e.g., reports, displays, letters, signals) that are part of the information domain for the problem.
3. Occurrences or events (e.g., a property transfer or the completion of a series of robot movements) that
occur within the context of system operation.
4. Roles (e.g., manager, engineer, salesperson) played by people who interact with the system.
5. Organizational units (e.g., division, group, team) that are relevant to an application.
6. Places (e.g., manufacturing floor or loading dock) that establish the context of the problem and the overall function of the system.
7. Structures (e.g., sensors, four-wheeled vehicles, or computers) that define a class of objects or related classes of objects.

Noun	G.C
Account	2,3,5
Login	3,4
Employee	4,5,7
Employee ID	2
Phone number	3
Information	3
OTP	3
Admin	4,5,7
Password	2
Account Management	4,5,7
Bank	2

Bkash	2
Authentication	3
Supervisor	4,5,7
Purchase Manager	4,5,7
Role	4
Verification	2
Modification	2
Address	2
User photo	2
Designation	4
Shift	2
Resource	2,3
Attendance	2
Application	3,4,6
Notices	2
Work day	2
Card Machine	1,3,4
Hours	2
Delivery Date	2
Salary	2
Calculation	2
Request	3
Payment	
Leave	3,4

Overtime	3,4
Insurance	3,4
Help & Support	3,4
Reason	3
Notification	1,4,7
Approval	3
Documentation	3
System Admin	2,4,5,7
Updates	3
Harassment	2
Dashboard	4,5,7
Messages	2
Administration	4,5,7
Communication	3
Purchase	2
buyers	1,4,7
Goods	2
Receipt	2
Warehouse	4,5,7
Invoice	2
Performance	3
Analytics	3
Decision Making	4
Evaluation	2

Inventory	4,5,7
Items	2
Quantity	2
Order	2
fulfillment	3
Event	3
Salary	2,3,4
Department	7
Records	2
Time period	2
transaction	3
Supplier	1,4,7
Delivery	3
Product	2
Quality	2
decision	4
Tracking	2
Reporting	2
Online	2
Database	1,4,6
Onsite	2
Expense	2,3,7
Bonus	2
Summary	

Final	2
Account Manager	4,5,7
Balance	2
Banking	1
Rocket	1
Nagad	1
Numbers	2
Income	2,3,4
Transfer	2
amount	3
Withdrawal	3
Security	3
Analysis	3
Logistic Manager	4,5,7
Expenditures	2,3,4
Financial Help	4
Planning	4
Materials	2
Type	2
PO number	2
Origin	6
SMS	1,4,7
Arrival	6
Departure	6

Destination	6
Amount	3
Reports	2
Queries	2
Transportation	6
Vehicles	2
Logistic Distribution	5
Email	1,4,7
Demand	2
Delivery Schedule	6
Transparency	2
Satisfaction	2
Transport request	2
Income	2
GPS	1,3,7
User ID	2
Experience	3
Coordination	3
Production Manager	1,4,7
Negotiation	4
Showcasing	4
Specification	2
Collaborative	4
Consideration	4

6.3 Potential to be Class

1. Account
2. Employee
3. Salary
4. Database
5. Administrator
6. Account Manager
7. Supervisor
8. Purchase Manager
9. Buyer
10. GPS
11. System Admin
12. Email
13. SMS
14. Application
15. Card Machine
16. Notification
17. Dashboard
18. Administration
19. Warehouse
20. Inventory
21. Supplier
22. Logistic Manager
23. Production Manager
24. Expenditures
25. Income

6.4 Selection Criteria

1. Retained information: The potential class will be useful during analysis only if information about it must be remembered so that the system can function.
2. Needed services: The potential class must have a set of identifiable operations that can change the value of its attributes in some way.

3. Multiple attributes: During requirement analysis, the focus should be on "major" information; a class with a single attribute may, in fact, be useful during design, but is probably better represented as an attribute of another class during the analysis activity.

4. Common attributes: A set of attributes can be defined for the potential class and these attributes apply to all instances of the class.

5. Common operations: A set of operations can be defined for the potential class and these operations apply to all instances of the class.

6. Essential requirements: External entities that appear in the problem space and produce or consume information essential to the operation of any solution for the system will almost always be defined as classes in the requirements model.

SI	Noun	S.C
1.	Account	1,2,3,4,5
2.	Employee	1,2,3,4,5
3.	Database	1,6
4.	Administrator	1,2,3,4,5
5.	Account Manager	1,2,3,4,5
6.	Supervisor	1,2,3,4,5
7.	Purchase Manager	1,2,3,4,5
8.	Income	1,3,4
9.	Supplier	1,2,3,4,5
10.	GPS	6
11.	Email	6
12.	SMS	6
13.	Dashboard	1,2,3,4,5
14.	Salary	1,3,4
15.	Expenditure	1,3,4

16.	Application	3,4
17.	Administration	1,2
18.	Logistic Manager	1,2,3,4,5
19.	Card Machine	6
20.	Warehouse	1,2,3,4,5
21.	Inventory	1,2,3,4,5
22.	Logistic Manager	1,2,3,4,5
23.	System Admin	2,3,4,5
24.	Buyer	1,2,3,4,5
25.	Notification	2,3,4,5

6.5 Selected Classes

1. Account
2. Employee
3. Database
4. Administrator
5. Account Manager
6. Supervisor
7. Purchase Manager
8. Buyer
9. GPS
10. System Admin
11. Email
12. SMS
13. Card Machine
14. Notification
15. Dashboard
16. Warehouse
17. Income
18. Inventory

19. Supplier
20. Logistic Manager
21. Production Manager
22. Salary
23. Expenditure

Analysis

- Here, 'Accounts' encompasses activities like registration, login, and profile updates. Hence, we may define the class as 'Registration' rather than 'Account.'

- The attributes of the Account Manager, Purchase Manager, Logistic Manager, and Production Manager are the same, involving the common task of managing their respective departments. However, the working functionalities vary according to the departments. Therefore, we can create a superclass called 'Manager' and include these four types of managers within it. Subsequently, we define a class named 'Manager,' with subclasses such as Account Manager, Purchase Manager, Logistic Manager, and Production Manager.

- In the Expenditure class, the total expenses are calculated, while the Income class records the total earnings. Subsequently, all transactions are aggregated in the Accounts class. Employees receive their salary from the company accounts. Considering that transactions constitute the primary function, we can consolidate these classes into an 'Account Management' class.

After analysis

1. Registration
2. Employee
3. Database
4. Administrator
5. Supervisor
6. Manager
7. Buyer
8. Account Management
9. GPS

10. System Admin
11. Email
12. SMS
13. Card Machine
14. Notification
15. Dashboard
16. Warehouse
17. Inventory
18. Supplier

Further Analysis

- 'Inventory' functions as a sub-module of 'Warehouse ', therefore, we can remove the 'Inventory' class.
- Considering that 'SMS' and 'Email' both are external systems, we can amalgamate them into a single class named 'SMS & Email System'.
- Notifications are displayed on the Dashboard, so there's no necessity to create a separate 'Notification' class. The 'Dashboard' class already showcases these notifications.
- The Card Machine has a singular responsibility of recording attendance. Hence, I've transferred this responsibility to the Employee class. Consequently, there's no requirement for a separate Card Machine class.

6.6 Finally Selected Classes

1. Registration
2. Administrator
3. Manager
4. Supervisor
5. Employee
6. Supplier
7. Buyer
8. Warehouse
9. Account Management
10. GPS

11. Dashboard
12. Database
13. System Admin
14. Email & SMS System

6.7 Class Cards

1. **Registration**

Registration	
Attribute	**Method**
userType userID email password Name address designation department contactNumber confirmationStatus	+generate_ID(userType) +selectUserType() +sendConfirmationEmail() +sendOTP() +updateContactNumber() +getUserDetails() +authenticateUser() +updateLoginAttempts() +grantAdminPrivileges() +passwordRecovery() +logout()
Responsibilities	**Collaborator class**
1.User registration	Admin,Manager,Supervisor,Employee,Buyer, Supplier
2.User authentication & login	Admin,Manager,Supervisor,Employee,Buyer, Supplier
3.Password Recovery	Admin,Manager,Supervisor,Employee,Buyer, Supplier

2. **Administrator:**

Administrator	
Attribute	**Method**
-Administrator_ID -Email -Password -Phone Number -Address -Photo	+change_employee_info() + set_maximum_overtime_hour() + set_insurance_amount() + view_information() + insert_information() +delete_account() +provide_employee_id() +send_salary() +launch_dashboard() +get_employee_id()
Responsibilities	**Collaborator class**
1.View information	System Admin,Database
2.Send salary	Account Management
3.Set Overtime hour	Employee,Database
4.Set insurance amount	Database

3. **Manager**

Manager	
Attribute	**Method**
Employee ID Email Password Phone Number Salary Address Photo Designation Department	+launch_dashboard() +Responsibility() +verify_provided_info() +approve_request() +review_invoice() +communicate() +review_analysis_report() +initiate_salary_calc()

	+log_expense() +transport_request() +showcase_product_details() +negotiation() +generate_sale_record()
Responsibilities	**Collaborator**
1.Approve Supervisor's applications	Supervisor
2.Send notices	Dashboard
3.Oversees the work of supervisor	Database
4.Negotiation with buyers,suppliers	Buyers,Supplier
5.Generate sale report	Dashboard,Database

Sub-Classes:

Account Manager	
Attribute	**Method**
Employee ID Designation Department	+Responsibility()
Responsibilities	**Collaborator**
1. Manages Account system	Account Management

Production Manager	
Attribute	**Method**
Employee ID Designation Department	+Responsibility()
Responsibilities	**Collaborator**
1.Manages Production system	Warehouse

Purchase Manager	
Attribute	**Method**
Employee ID Designation Department	+Responsibility()
Responsibilities	**Collaborator**
1.Manages Purchase system	Buyer,Supplier

Logistic Manager	
Attribute	**Method**
Employee ID Designation Department	+Responsibility()
Responsibilities	**Collaborator**
1.Manages Logistic system	Warehouse

4. <u>Supervisor</u>

Supervisor	
Attribute	**Method**
Employee ID Email Password Phone Number Department Designation Address Salary Photo	+launch_dashboard() +verify_provided_info() +insurance_approval() +send_notice() +confirm_accuracy() +provide_onsite_salary() +update()_inventory()
Responsibilities	**Collaborator**
1.Approve Employee's applications	Employee
2.Send Notices	Dashboard
3.Confirm accuracy	Database
4.Provide onsite salary and update status	Account Management,Database
5.Update material information	Warehouse,Database

5. <u>Employee</u>

Employee	
Attribute	**Method**
Employee ID Email Password Phone number	+launch_dashboard() +submit_application_request() +eave_overtime_application()

Designation Working days Working hours Shift Salary Address Photo	+claim_insurance() +seek_assistace() +conduct_online_transaction() +initiate_on_site_payment() +card_for_attendance()
Responsibilities	**Collaborator**
1. Applying for leave,insurance,help & support	Supervisor
2.Receive Salary	Account Management
3.Receive product from supplier and update status	Database

6. <u>Supplier</u>

Supplier	
Attribute	**Method**
Supplier ID Email Password PhoneNumber Address	+launch_dashboard() +submit_invoice() +receive_bill()
Responsibilities	**Collaborator**
1.Receive bills for supplies	Account Management
2.Submit invoice	System Admin

7. <u>Buyer</u>

Buyer

Attribute	Method
Buyer ID Email Password PhoneNumber Address	+launch_dashboard() +get_notified() +pay_bill() +order_product()
Responsibilities	**Collaborator**
1.Order Product	System Admin
2.Pay bill	Account Management,Database

8. **Database**

Database	
Attribute	**Method**
User ID User information Records	+verify_provided_info() +store_information() +record_attendance() +update_delivery_status() +store_work_hour_report()
Responsibilities	**Collaborator**
1. Creating employee, Buyer, Supplier, information table, inventory table etc.	Admin,Supervisor,System Admin
2. Updating changed employee information, payment status, warehouse information etc	Admin,Supervisor,System Admin
3. Providing records of employee information,	System Admin

inventory etc.	

9.<u>Account Management</u>

Account Management	
Attribute	**Method**
Employee_ID Designation Buyer_ID Revenue ID Supplier_ID Expense ID Account Number phone number Salary payment method	+pay_salary() +receive_revenue() +pay_supplier_expense()
Responsibilities	**Collaborator**
1.Paying salary to Employees	Employee,Database
2.Receive payment from Buyers	Buyers,Database,Supplier
3.Give payment to supplier	Supplier,Database
4.Others withdrawal or expenses	Admin,Warehouse

10.<u>Warehouse</u>

Warehouse	
Attribute	**Method**

PO_Number Department Arrival_Product moved_product Date_of_departure	+materials_arriaval() +check_quality() +assign_vehicle() +select_department() +provide_location() +product_shortage() +select_product_type() +add_information_of_incoming_product() +add_information_of_moved_product()
Responsibilities	**Collaborator**
1.Setting PO number of product	Supervisor
2.Adding information of incoming products to database	Supervisor,Database
3. Adding information of moving products to database	Supervisor,Database

11.<u>Dashboard</u>

Dashboard	
Attribute	**Method**
User_Photo User_ID User_name Phone_Number	+receive_notification() +notify_purchase_request() +notify_salary_preview() +company_notices()
Responsibilities	**Collaborator**
1.Showing all notices	Admin,Manager,Supervisor,Database
2.Informing about products running low	Warehouse,Database,System Admin

3.Showing total salary	Database
4.Notifying leave decision,overtime decision,insurance decision	System Admin

12. <u>GPS</u>

Attribute	Method
Vehicle_ID Transaction_ID	+track_location() +notification()
Responsibilities	**Collaborator**
1.Track Product Location	Dashboard,Buyer

13.<u>System Admin</u>

System Admin	
Attribute	**Method**
Employee_id Supplier_id Buyer_id overtime insurance_amount OTP final_salary working_hour	+calculates_work_hour() +generate_purchase_order() +generate_performance_report() +send_transaction_noti() +generate_financial_report() +verify_employee_info() +notify_in_dashboard() +update_online_payment_history()

report	+update_offline_payment_history() +provide_overtime_information() +update_overtime_information() +provide_leave_info() +update_leave_info() +provide_insurance_info() +update_insurance_info() +calculate_salary() +transaction_doc() +salary_accessible() +calculate_remaining_product() +link_employee() +dataAnalysis()
Responsibilities	**Collaborator**
1.Verifying employee id and phone number for creating account	Database
2. generating OTP	Email/SMS system
3. Sending notifications in Dashboard	Dashboard
4. Verifying employee id and password for login	Database
5. Calculating working hours of an employee	Database
6. Providing additional info related to overtime, leave etc. Application, Database	Database
7. Updating application status	Database
8. Calculating remaining amount product stored in inventory	Database,Warehouse
9. Calculating final salary	Database,Account Management
10. Generating inventory report at the end of the month/week	Database,Warehouse

| 11.Analyzing the supplier data | Database |

14. <u>Email & SMS System:</u>

Email & SMS System	
Attribute	**Method**
Email SMS sender's email address receiver's email address sender's phone number receiver's phone number	+sendEmail() +receiveEmail() +sendSMS() +receiveSMS() +send_OTP
Responsibilities	**Collaborator**
1.Send & receive Email	Employee,Supervisor,Manager,Admin,Buyer,Supplier,dashboard
2.Send & receive SMS	Employee,Supervisor,Manager,Admin,Buyer,Supplier,dashboard

6.8 CRC Diagram

Diagram:01
Name:Registration
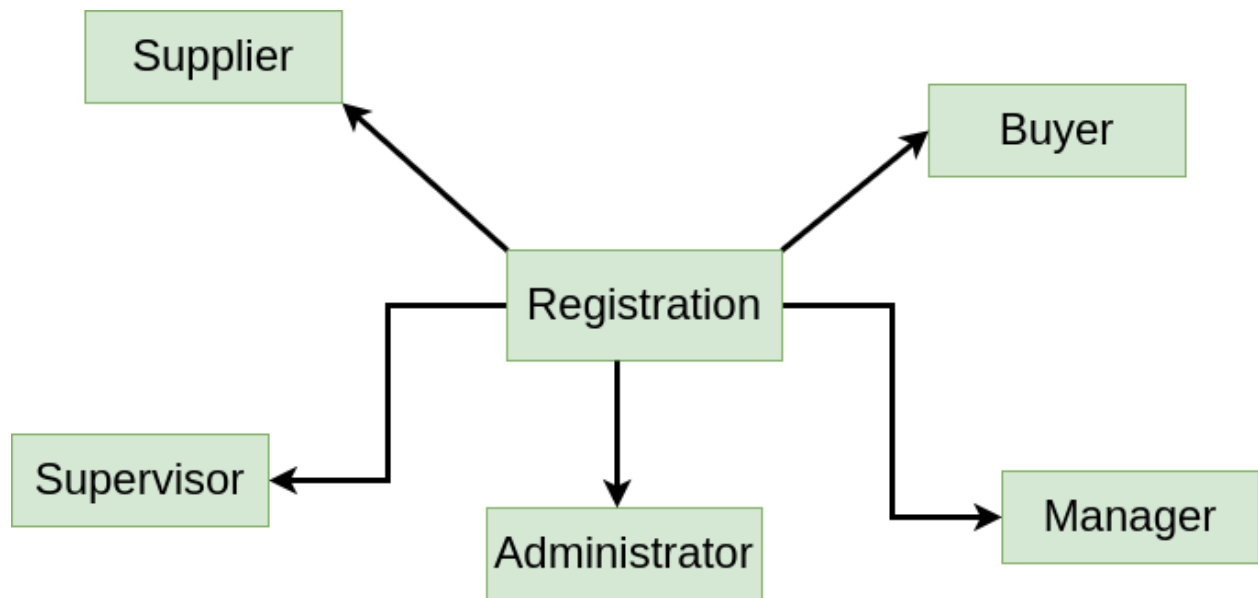
Figure : CRC diagram for Registration class

Diagram:02
Name:Administrator
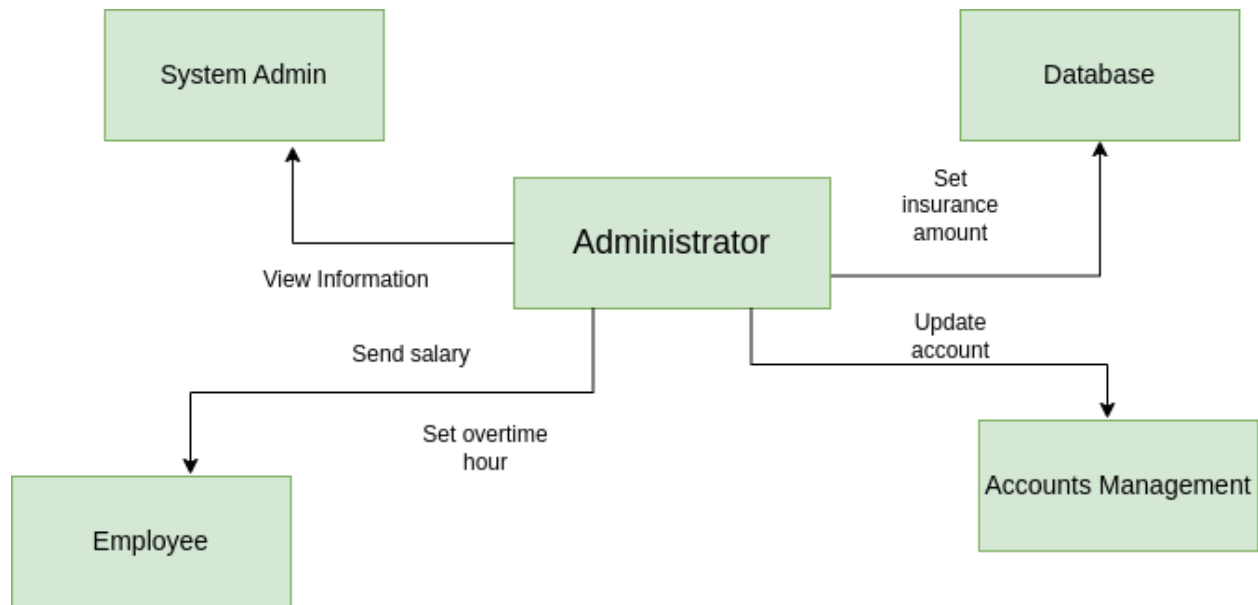
Figure : CRC diagram for Administration class

Diagram:03
Name:Manager
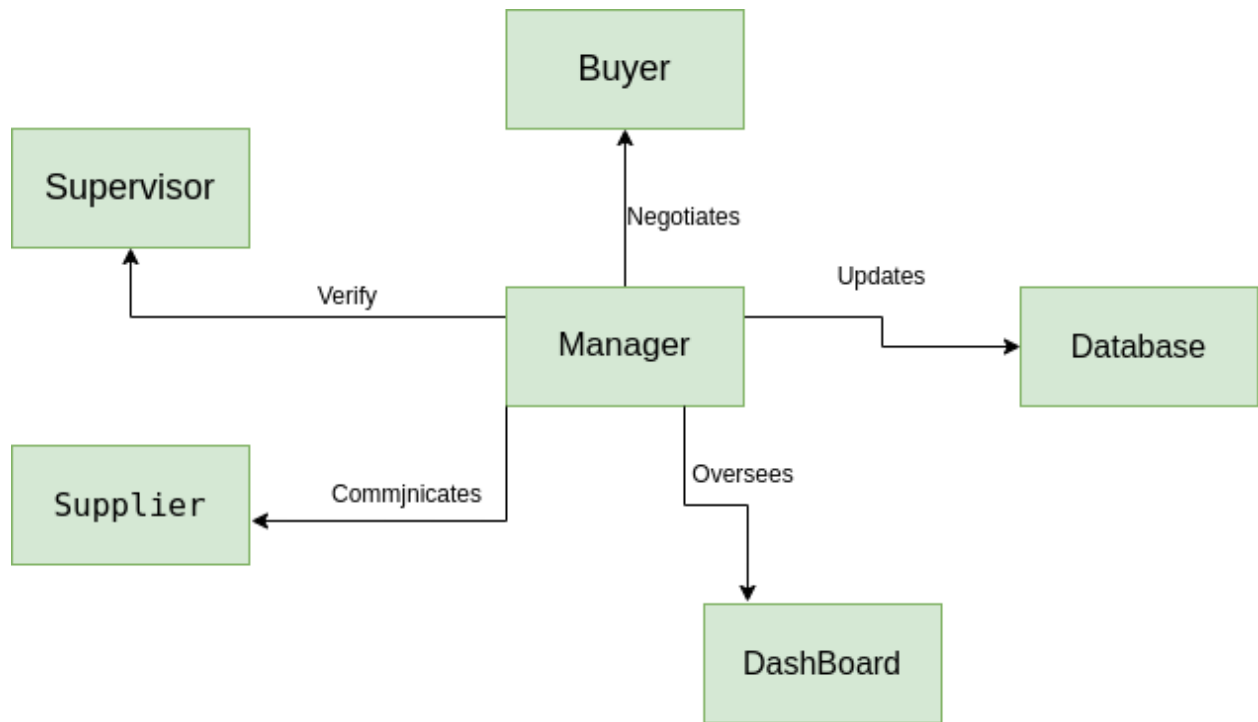
Figure : CRC diagram for Manager class

Diagram:04
Name:Supervisor
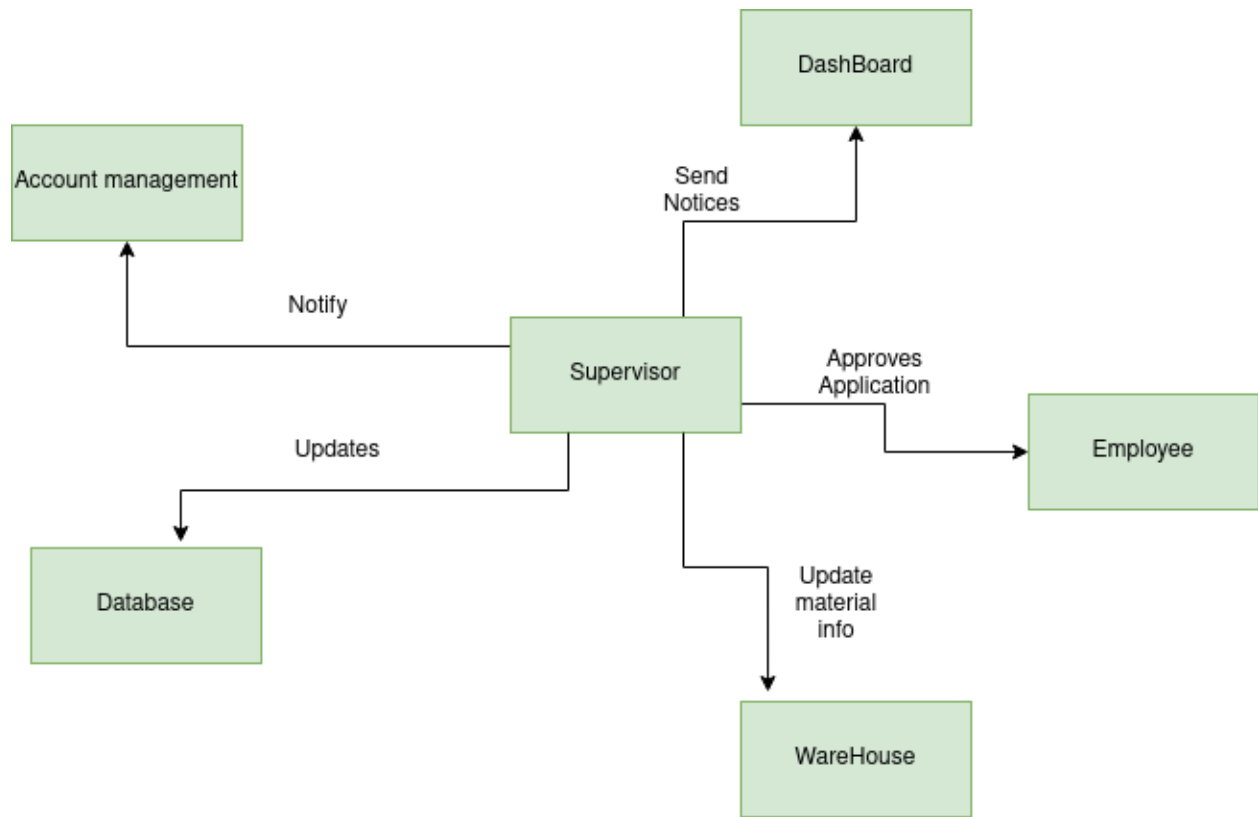
Figure : CRC diagram for Supervisor class

Diagram:05
Name:Employee
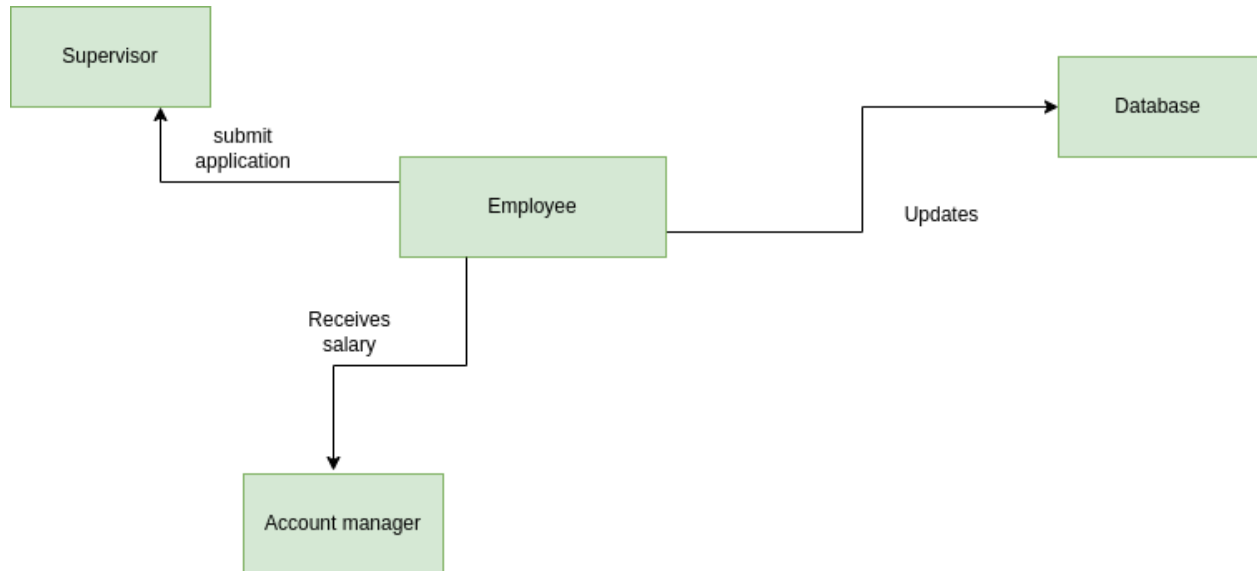
Figure : CRC diagram for Employee class

Diagram:06
Name:Supplier

Figure : CRC diagram for Supplier class

Diagram:07
Name:Buyer
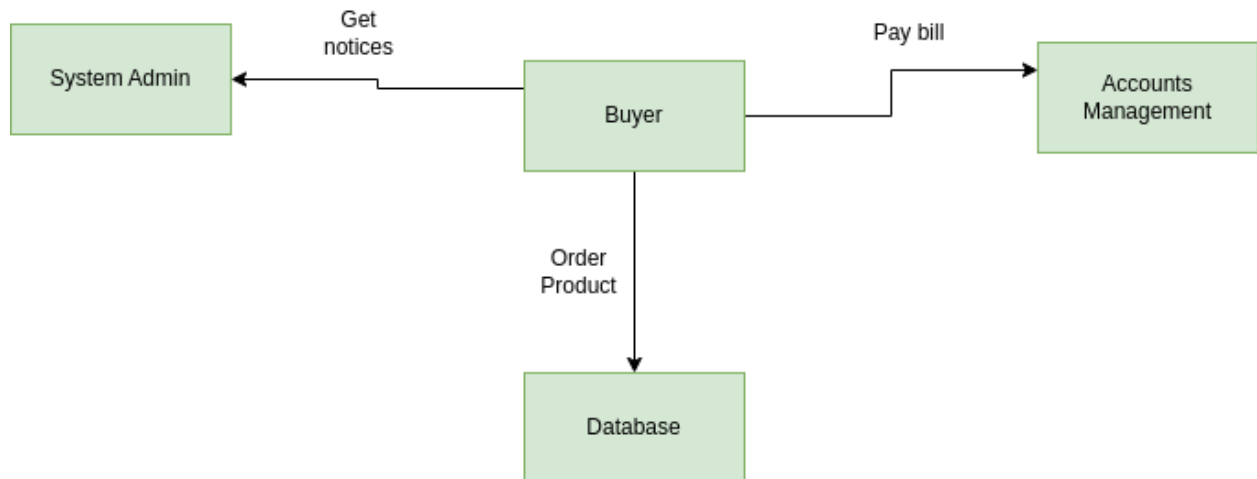
Figure : CRC diagram for Buyer class

Diagram:08
Name:Database
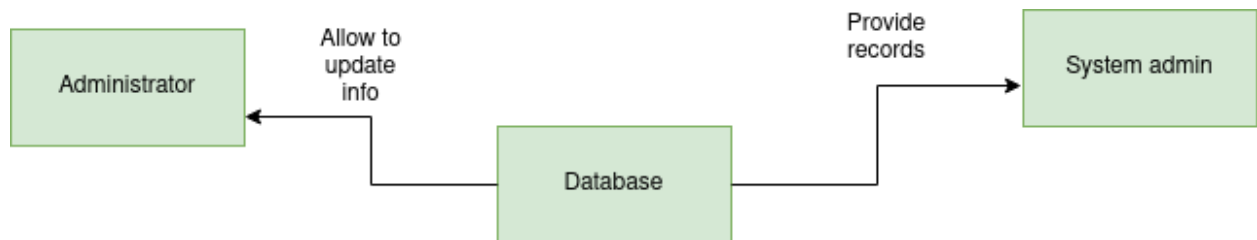
Figure : CRC diagram for Database class

Diagram:09
Name:Accounts Management
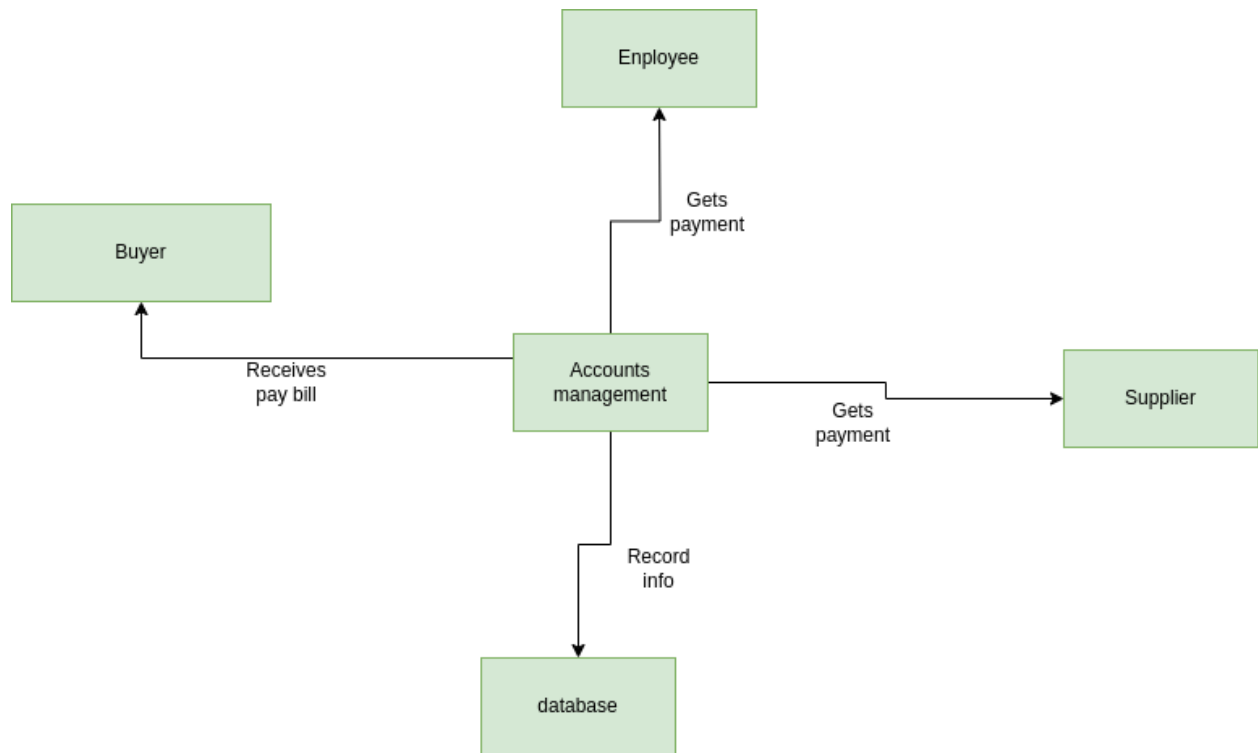
Figure : CRC diagram for Accounts Management class

Diagram:10
Name:WareHouse
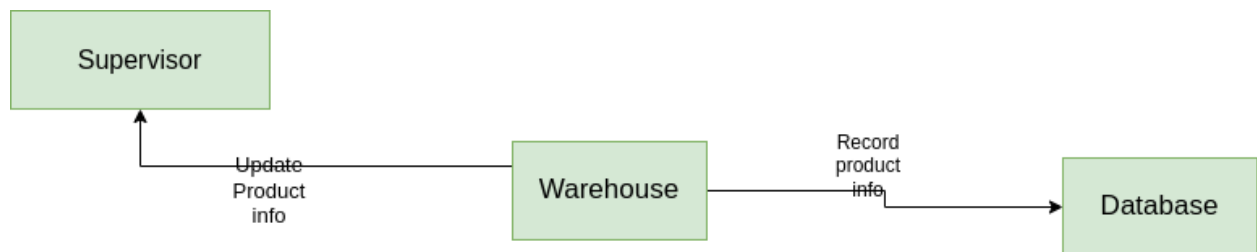
Figure : CRC diagram for Warehouse class

Diagram:11
Name:Dashboard
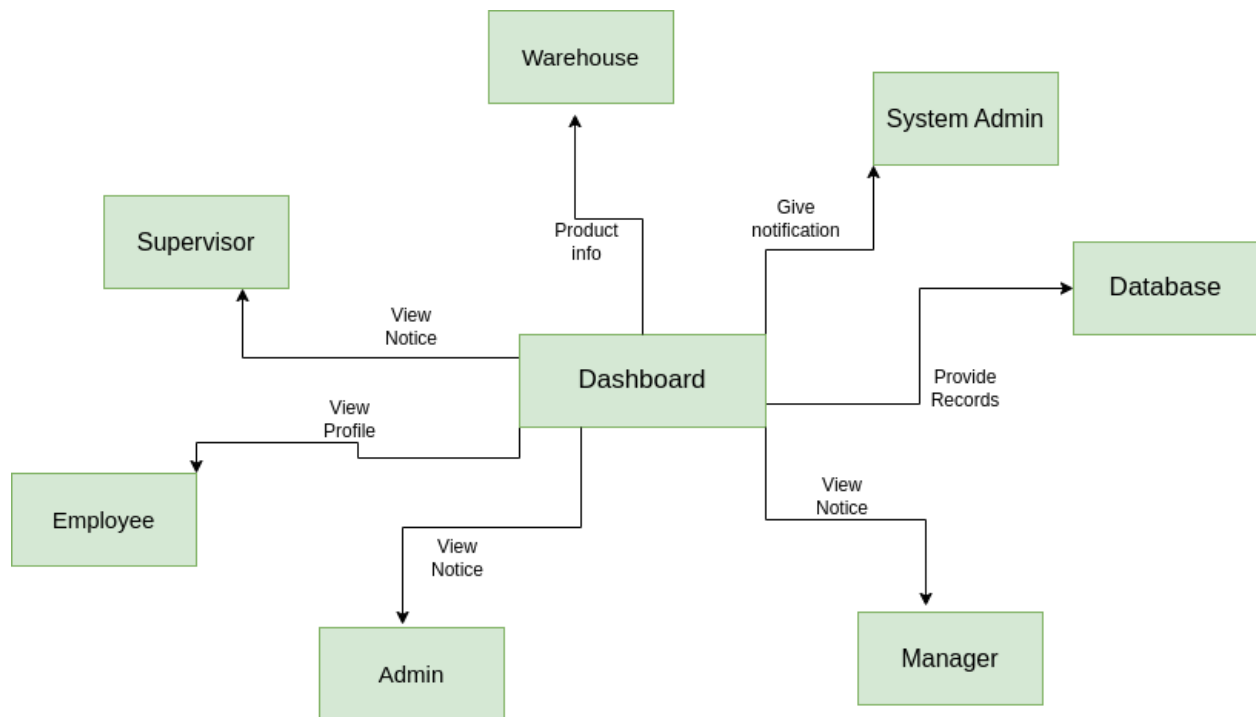
Figure : CRC diagram for Dashboard class
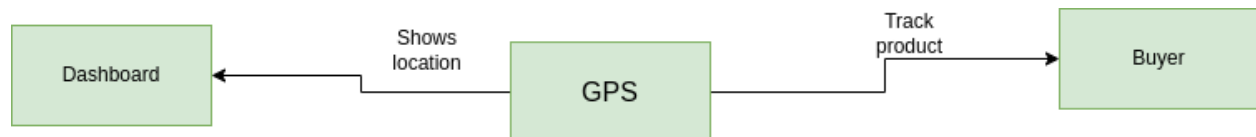
Diagram:12
Name:GPS

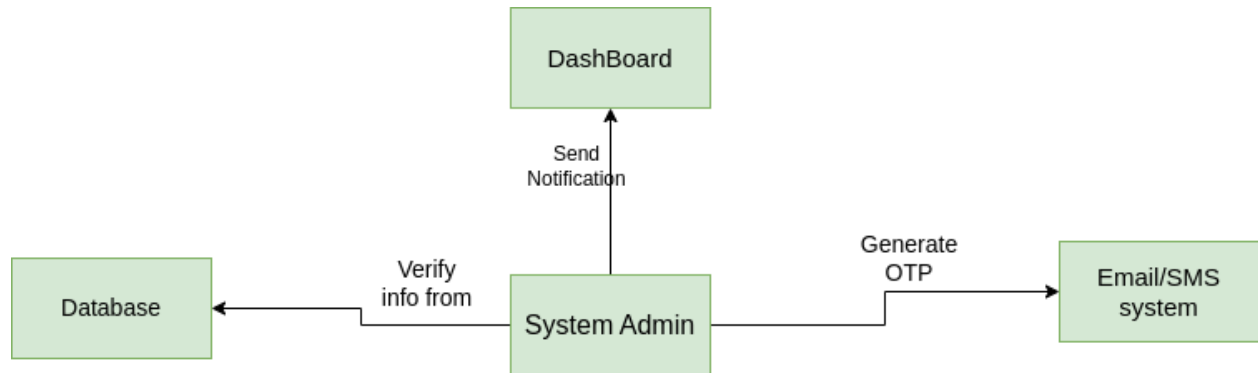**Figure : CRC diagram for GPS class**

Diagram:13
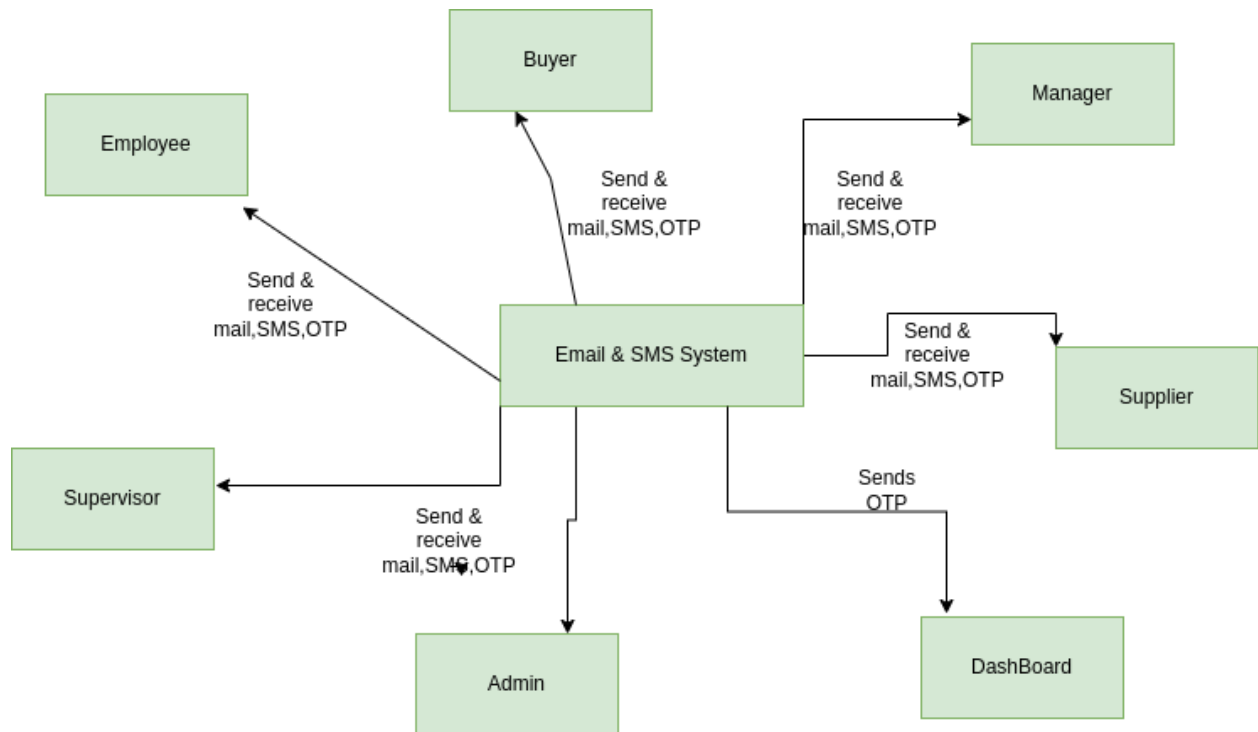**Name:System Admin**

Figure : CRC diagram for System Admin class

Diagram:14
Name: Email & SMS System

CRC diagram for Email & SMS System