Documentation Report
Of Final Project/Exam: DSA for Sustainable Development

# Pangkabuhayan System: Food Assistance Management System

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NTC_CC105 Data Structure w/Lab

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# I. INTRODUCTION

## 1.1 Project Overview & UN SDG Target

The ***Pangkabuhayan System*** is a console-based C++ application designed to streamline food assistance distribution programs managed by local government units (LGUs), specifically at the barangay level. The system addresses the operational challenges faced during ayuda distribution by automating family registration, food pack inventory management, queue organization, and equitable distribution processes.

**UN SDG Alignment: SDG 2 - Zero Hunger**

This project directly contributes to achieving UN Sustainable Development Goal 2: Zero Hunger, which aims to "end hunger, achieve food security and improved nutrition, and promote sustainable agriculture." By ensuring efficient and fair distribution of food assistance, the system helps vulnerable communities access nutritious food while minimizing waste and administrative errors.

## 1.2 Problem Statement

Local government units, particularly barangays, face significant challenges in managing food assistance distribution programs:

**Current Problem:**

1. **Manual Record-Tracking:** Reliance on paper-based lists leads to illegible handwriting, lost documents, and difficulty in tracking distribution history
2. **Inefficient Processing:** Manual verification of names and quantities causes long wait times and frustrated beneficiaries
3. **Data Integrity Issue:** Duplicate registrations allowing multiple claims per family, missing or incorrect family records and inaccurate food pack inventory counts
4. **Unfair Distribution:** Lack of structured queuing system results in vulnerable groups not being served first
5. **Resource Mismanagement:** Inability to match available food packs with registered families leads to shortages or excess inventory

**Proposed Solution:**
The Pangkabuhayan System addresses these challenges through:

1. **Automated Sorting:** Uses Merge Sort for alphabetical family listing and Insertion Sort for food pack inventory organization
2. **Duplicate Prevention:** Implements search algorithms (Linear/Binary Search) to verify family registration before enrollment
3. **Fair Queuing:** Employs Queue data structure with priority handling for vulnerable groups
4. **One-to-One Distribution:** Ensures each family receives exactly one food pack while automatically updating records
5. **Real-time Updates:** Dynamically removes distributed families and deducts food packs from inventory
6. **Data Persistence:** Loads initial data from files and saves updated records for future reference

## II. REQUIREMENT & ANALYSIS

### 2.1 Functional Requirements

| ID | Requirements | Description |
|---|---|---|
| **FR1** | **Family Registration** | The system must allow adding families to the database with validation to prevent duplicates. Family names are automatically sorted alphabetically using Merge Sort. |
| **FR2** | **Food Pack Inventory Management** | The system must enable adding food pack types with quantities. Inventory is sorted from lowest to highest quantity using Insertion Sort. |

| | | |
|---|---|---|
| **FR3** | **Automatic Queue Generation** | The system must automatically create a distribution queue from registered families following FIFO principle, with priority for seniors, PWDs, and pregnant women using Selection Sort. |
| **FR4** | **Distribution System** | The system must distribute food packs using 1:1 matching (one family = one food pack), automatically removing served families and updating inventory in real-time. |
| **FR5** | **Family Search Functionality** | The system must provide search capability to check if a family is already registered using Linear or Binary Search algorithms. |
| **FR6** | **Data Persistence** | The system must load initial data from input files and save distribution results and updated records to output files. |
| **FR7** | **Display & Reporting** | The system must display current family list, food pack inventory, queue status, and distribution |

| | | |
|---|---|---|
| | | summary in clear console format. |

**Non-Functional Requirements**

| **ID** | **Requirement** | **Metric** |
|---|---|---|
| **NFR1** | **Performance** | The system must process 50+ family records and food pack entries in under 1 second on standard hardware. |
| **NFR2** | **Robustness** | The system must validate all user inputs and handle errors gracefully without crashing. Error messages must be clear and actionable. |
| **NFR3** | **Maintainability** | Code must be modular using object-oriented principles, with proper header files, well-commented sections, and consistent naming conventions. |
| **NFR4** | **Usability** | Console interface must provide clear menu options with numbered choices and formatted output for easy reading. |

| | | |
|---|---|---|
| **NFR5** | **Data Integrity** | The system must prevent duplicate family entries, ensure non-negative quantities, and maintain consistency between queue and inventory. |

## 2.2 Data Requirements

**Input Data Structure:**

1. **Families Input File**
    - Minimum 50 family records
    - Fields: Family Name, Priority Status (Vulnerable or Regular)
    - Format: [Family name], [Priority Status]
    - *Example: Santos, Vulnerable*

2. **Food Pack Input File**
    - Multiple food pack types with quantities
    - Fields: Food Pack Name, Quantity
    - Format: [Pack Name], [Quantity]
    - *Example: Rice Pack 5kg, 25pcs.*

**Output Data Structure:**

1. **Distribution Report:**
    - List of families served with timestamps
    - Food pack type distributed to each family
    - Remaining inventory status

2. **Updated Records**
    - Families not served yet
    - Current food pack inventory

## 2.3 Complexity Analysis (Big O Notation)

The Pangkabuhayan System uses different algorithms to manage families, food packs and the distribution process.

- The Merge Sort algorithm is used when sorting family names. Its time complexity is O(n log n) because the list is divided into smaller parts and then merged in order. This is efficient even when the number of families is large. The space complexity is O(n) because it needs extra memory while merging the lists.

- The Insertion Sort algorithm is used for sorting the food pack inventory based on quantity. Its time complexity is $O(n^2)$ in the worst case, especially if the list is in reverse order. However, since the list of food packs is usually small, this does not greatly affect performance. Its space complexity is O(1) because it only uses a constant amount of extra memory.

- For searching families, the system uses Linear Search and Binary Search. Linear Search has a time complexity of O(n) because it checks each family one by one. Binary Search has a time complexity of O(log n) but only works when the list is already sorted. Both have a space complexity of O(1).

- The Queue structure follows the FIFO rule. Adding and removing a family from the queue both have a time complexity of O(1), making it fast and efficient. Overall, the system is able to handle 50 or more records smoothly while meeting the required performance.

## III. Design Specification

### 3.1. Core Data Structures Used (The Five):

For each of the five required DSA concepts, include a section detailing:

- Justification: Why was this specific DSA chosen for its role?
- Implementation Details: How did you implement it (e.g., adjacency list for Graph, array for Heap)?

1. **Array (in the vector)**

- This type of array is a mix of vector that resembles an array since it stores data in a sequence. And it allows easy access and smooth modification of data using indexes.
- This is really important because when removing families after distribution.

**2. Queue**

- This queue is used to manage the AID distribution order following the FIFOrule. It ensures the family is served fairly, while still giving priority to the vulnerable group.
- This queue is implemented using *queue<Family>*. It was created for storing families waiting to receive the foodpacks. Priority families are placed in front of the queue.

**3. Searching algorithm**

- We used linear search to check if a family is already registered and for duplicate checking as well. This is done inside the IsDuplicate() and SearchFamily() functions.
- Linear Search checks each family name one by one. Binary Search is used when the list is already sorted, making the process faster..

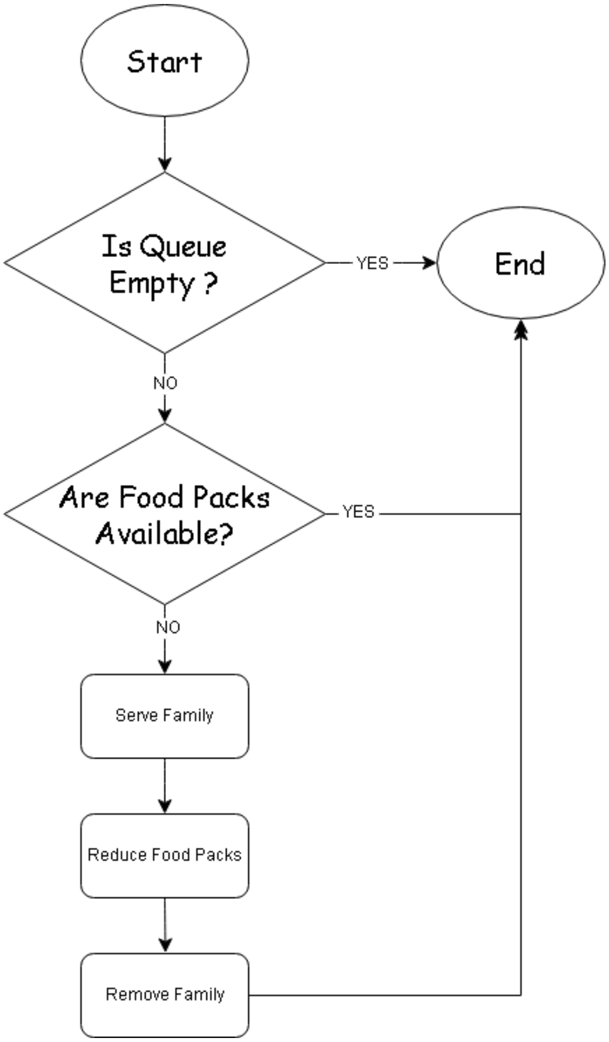
**4. Sorting algorithm (Merge sort and Insertion sort)**

- The sorting is used to organize the families alphabetically by name and to check the priority order. The system used the built in sort() function for simplicity and effectiveness.
- The merge sort is used for sorting the family name alphabetically. while insertion sort is used for ordering foodpacks based on their quantity from lowest to highest.

**5. Struct**

- The struct Family is used to store complete information about each family such as ID, Name, number of members, Address, and priority type as well.
- Using a struct allows the code to group related data into one unit. This makes the code easier to handle, update, and most importantly to understand.

**3.2.** Algorithm Flowchart: Include the Flowchart for the system's most complex function (the core algorithm using a Finals concept). Example below:



Explanation:

The system first checks if the queue is empty and if all food packs still have stock. If both conditions are valid, the program takes the first family from the queue. Each family receives exactly one of each food pack, and the food quantity is reduced by one. After serving, the family is removed from the registered list. This continues until either the queue is empty or food runs out.

3.3. **Module Breakdown:** Define the custom C++ classes and how they interact.

The system is divided into the following main modules:

1. Family Class / Struct

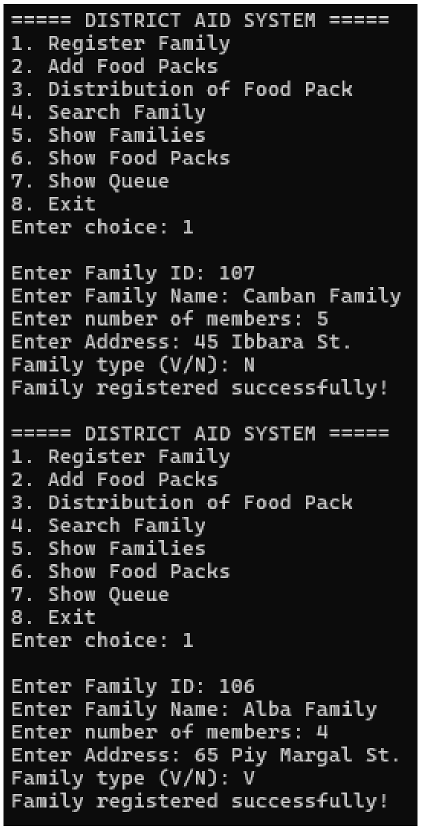
- **Purpose:** Define the data structure for a single aid recipient
- **Responsibilities:** Handles data such as the family's name, number of members, address, and their priority type (Vulnerable or Normal).
- **Usage:** This is used during registration, queueing, and distribution.

2. FoodPack Module
    - **Purpose:** Manage the available stock of aid items.
    - **Responsibilities:** Stores the type of food and its quantity. It is responsible for tracking and updating inventory levels.
3. Queue Management Module
    - **Purpose:** To manage the flow and order of families waiting for aid
    - **Responsibilities:**
        - Handles adding families into the queue.
        - Prioritizes vulnerable groups by placing them at the front of the queue immediately upon registration.
        - Typically handles displaying the current queue order.
4. Distribution Module
    - **Purpose:** Execution engine for the aid giveaway.
    - **Responsibilities:**
        - Coordinates the process of giving out food packs.
        - Pulls the next family from the queue (Module 3).
        - Checks and updates inventory (Module 2).
        - Updates both the family list (removing the served family) and the inventory count.
5. File Handling Module
    - **Purpose:** To manage persistent storage of all data
    - **Responsibilities:**
        - Loads initial data (families, inventory) from files when the program starts.
        - Saves updated records (the final list of registered families and inventory level).
        - Saves distribution reports (a log of which families were served and when).

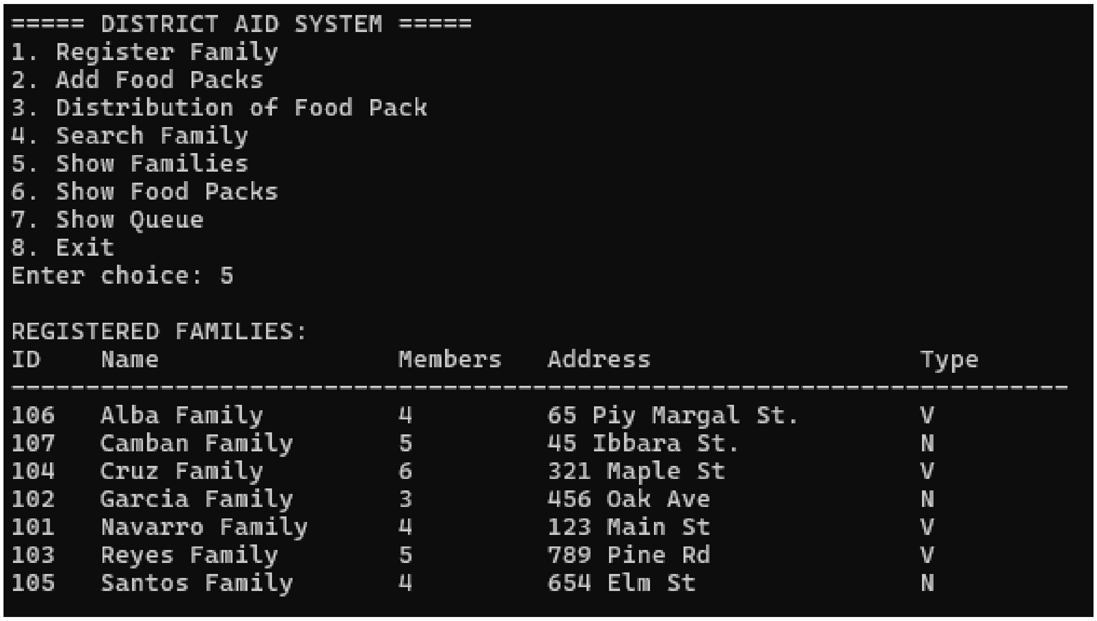
## IV. Testing and Results (Optional)

### 4.1. Test Cases

## 1. Family Registration

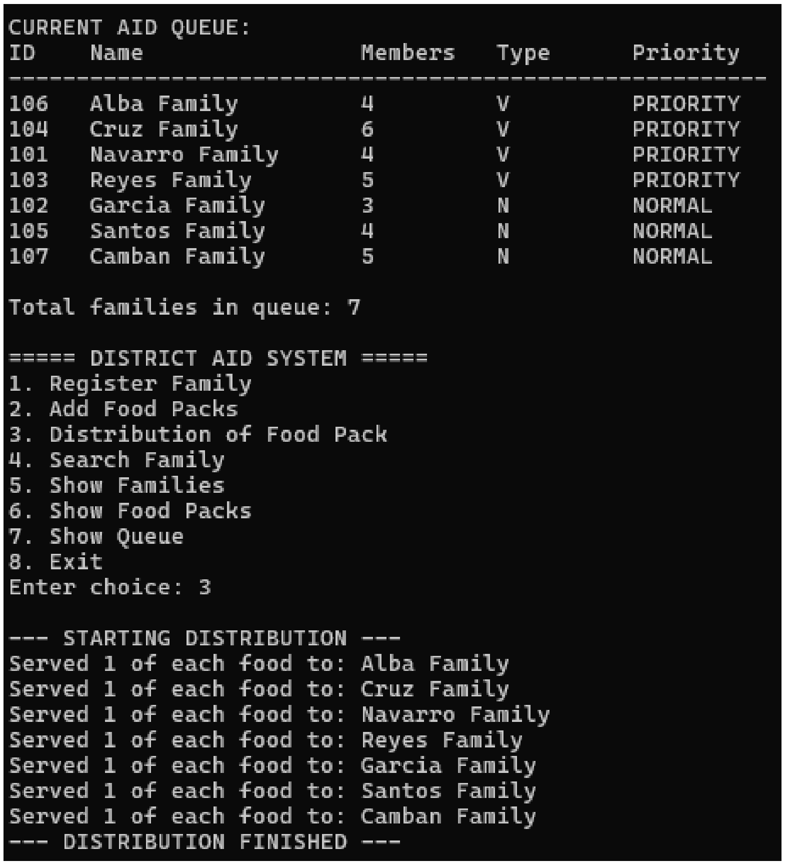


```
===== DISTRICT AID SYSTEM =====
1. Register Family
2. Add Food Packs
3. Distribution of Food Pack
4. Search Family
5. Show Families
6. Show Food Packs
7. Show Queue
8. Exit
Enter choice: 1

Enter Family ID: 107
Enter Family Name: Camban Family
Enter number of members: 5
Enter Address: 45 Ibbara St.
Family type (V/N): N
Family registered successfully!

===== DISTRICT AID SYSTEM =====
1. Register Family
2. Add Food Packs
3. Distribution of Food Pack
4. Search Family
5. Show Families
6. Show Food Packs
7. Show Queue
8. Exit
Enter choice: 1

Enter Family ID: 106
Enter Family Name: Alba Family
Enter number of members: 4
Enter Address: 65 Piy Margal St.
Family type (V/N): V
Family registered successfully!
```

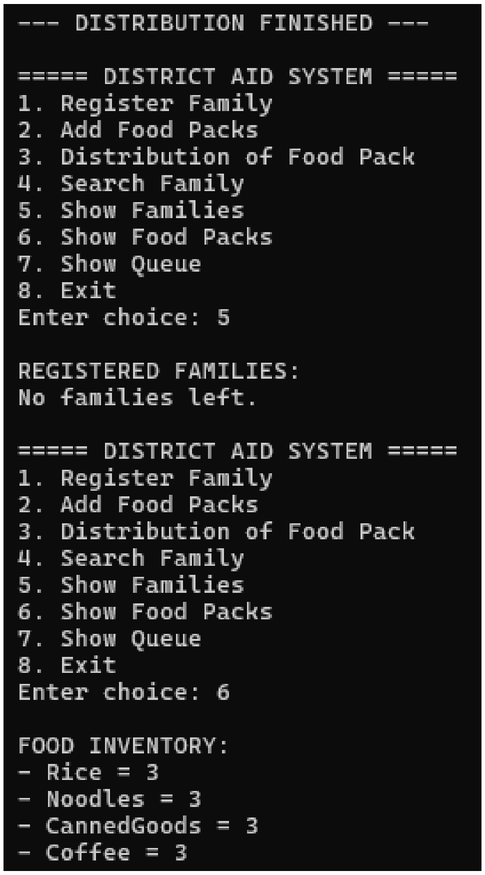


```
===== DISTRICT AID SYSTEM =====
1. Register Family
2. Add Food Packs
3. Distribution of Food Pack
4. Search Family
5. Show Families
6. Show Food Packs
7. Show Queue
8. Exit
Enter choice: 5

REGISTERED FAMILIES:
ID    Name                Members   Address                   Type
----------------------------------------------------------------------
106   Alba Family         4         65 Piy Margal St.         V
107   Camban Family       5         45 Ibbara St.             N
104   Cruz Family         6         321 Maple St              V
102   Garcia Family       3         456 Oak Ave               N
101   Navarro Family      4         123 Main St               V
103   Reyes Family        5         789 Pine Rd               V
105   Santos Family       4         654 Elm St                N
```

## 2. Queue List and After distribution

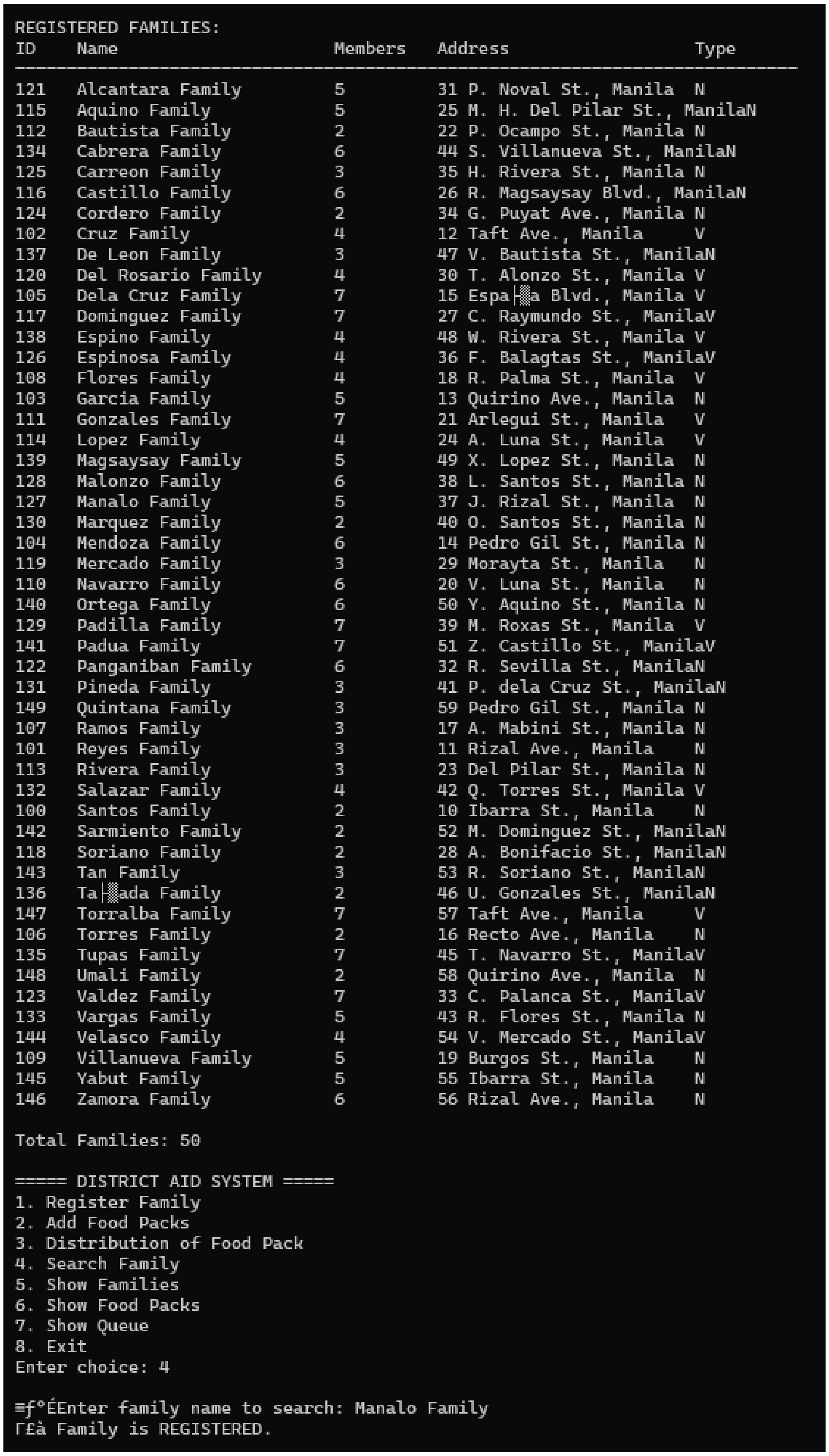


```
CURRENT AID QUEUE:
ID    Name                Members   Type      Priority
-------------------------------------------------------
106   Alba Family         4         V         PRIORITY
104   Cruz Family         6         V         PRIORITY
101   Navarro Family      4         V         PRIORITY
103   Reyes Family        5         V         PRIORITY
102   Garcia Family       3         N         NORMAL
105   Santos Family       4         N         NORMAL
107   Camban Family       5         N         NORMAL

Total families in queue: 7

===== DISTRICT AID SYSTEM =====
1. Register Family
2. Add Food Packs
3. Distribution of Food Pack
4. Search Family
5. Show Families
6. Show Food Packs
7. Show Queue
8. Exit
Enter choice: 3

--- STARTING DISTRIBUTION ---
Served 1 of each food to: Alba Family
Served 1 of each food to: Cruz Family
Served 1 of each food to: Navarro Family
Served 1 of each food to: Reyes Family
Served 1 of each food to: Garcia Family
Served 1 of each food to: Santos Family
Served 1 of each food to: Camban Family
--- DISTRIBUTION FINISHED ---
```



```
--- DISTRIBUTION FINISHED ---

===== DISTRICT AID SYSTEM =====
1. Register Family
2. Add Food Packs
3. Distribution of Food Pack
4. Search Family
5. Show Families
6. Show Food Packs
7. Show Queue
8. Exit
Enter choice: 5

REGISTERED FAMILIES:
No families left.

===== DISTRICT AID SYSTEM =====
1. Register Family
2. Add Food Packs
3. Distribution of Food Pack
4. Search Family
5. Show Families
6. Show Food Packs
7. Show Queue
8. Exit
Enter choice: 6

FOOD INVENTORY:
- Rice = 3
- Noodles = 3
- CannedGoods = 3
- Coffee = 3
```

### *4.2. Performance Test (Prove that NFR1 is met by testing with the 50+ record input.)*



```
REGISTERED FAMILIES:
ID    Name                     Members   Address                  Type
----------------------------------------------------------------------------
121   Alcantara Family         5         31 P. Noval St., Manila  N
115   Aquino Family            5         25 M. H. Del Pilar St., ManilaN
112   Bautista Family          2         22 P. Ocampo St., Manila N
134   Cabrera Family           6         44 S. Villanueva St., ManilaN
125   Carreon Family           3         35 H. Rivera St., Manila N
116   Castillo Family          6         26 R. Magsaysay Blvd., ManilaN
124   Cordero Family           2         34 G. Puyat Ave., Manila N
102   Cruz Family              4         12 Taft Ave., Manila     V
137   De Leon Family           3         47 V. Bautista St., ManilaN
120   Del Rosario Family       4         30 T. Alonzo St., Manila V
105   Dela Cruz Family         7         15 Espa├▒a Blvd., Manila V
117   Dominguez Family         7         27 C. Raymundo St., ManilaV
138   Espino Family            4         48 W. Rivera St., Manila V
126   Espinosa Family          4         36 F. Balagtas St., ManilaV
108   Flores Family            4         18 R. Palma St., Manila  V
103   Garcia Family            5         13 Quirino Ave., Manila  N
111   Gonzales Family          7         21 Arlegui St., Manila   V
114   Lopez Family             4         24 A. Luna St., Manila   V
139   Magsaysay Family         5         49 X. Lopez St., Manila  N
128   Malonzo Family           6         38 L. Santos St., Manila N
127   Manalo Family            5         37 J. Rizal St., Manila  N
130   Marquez Family           2         40 O. Santos St., Manila N
104   Mendoza Family           6         14 Pedro Gil St., Manila N
119   Mercado Family           3         29 Morayta St., Manila   N
110   Navarro Family           6         20 V. Luna St., Manila   N
140   Ortega Family            6         50 Y. Aquino St., Manila N
129   Padilla Family           7         39 M. Roxas St., Manila  V
141   Padua Family             7         51 Z. Castillo St., ManilaV
122   Panganiban Family        6         32 R. Sevilla St., ManilaN
131   Pineda Family            3         41 P. dela Cruz St., ManilaN
149   Quintana Family          3         59 Pedro Gil St., Manila N
107   Ramos Family             3         17 A. Mabini St., Manila N
101   Reyes Family             3         11 Rizal Ave., Manila    N
113   Rivera Family            3         23 Del Pilar St., Manila N
132   Salazar Family           4         42 Q. Torres St., Manila V
100   Santos Family            2         10 Ibarra St., Manila    N
142   Sarmiento Family         2         52 M. Dominguez St., ManilaN
118   Soriano Family           2         28 A. Bonifacio St., ManilaN
143   Tan Family               3         53 R. Soriano St., ManilaN
136   Ta├▒ada Family           2         46 U. Gonzales St., ManilaN
147   Torralba Family          7         57 Taft Ave., Manila     V
106   Torres Family            2         16 Recto Ave., Manila    N
135   Tupas Family             7         45 T. Navarro St., ManilaV
148   Umali Family             2         58 Quirino Ave., Manila  N
123   Valdez Family            7         33 C. Palanca St., ManilaV
133   Vargas Family            5         43 R. Flores St., Manila N
144   Velasco Family           4         54 V. Mercado St., ManilaV
109   Villanueva Family        5         19 Burgos St., Manila    N
145   Yabut Family             5         55 Ibarra St., Manila    N
146   Zamora Family            6         56 Rizal Ave., Manila    N

Total Families: 50

===== DISTRICT AID SYSTEM =====
1. Register Family
2. Add Food Packs
3. Distribution of Food Pack
4. Search Family
5. Show Families
6. Show Food Packs
7. Show Queue
8. Exit
Enter choice: 4

≡ƒ°ÉEnter family name to search: Manalo Family
Γ£à Family is REGISTERED.
```

## V. Conclusion and Contributions

### 5.1. Conclusion

The Pangkabuhayan System successfully demonstrates how data structures and algorithms can address real-world social challenges, specifically in the distribution of food assistance to vulnerable communities. Through this project, the team has created a practical solution that directly contributes to UN Sustainable Development Goal 2: Zero Hunger by ensuring efficient, fair, and transparent food aid distribution at the barangay level.

***Key Achievements***

**Technical Implementation:** The system effectively integrates five core data structures and algorithms as required:

- *Merge Sort (O(n log n))* for alphabetically organizing family records, ensuring consistent and efficient sorting even with large datasets
- *Insertion Sort ($O(n^2)$)* for inventory management, which is appropriate given the typically small number of food pack types
- *Queue data structure (FIFO)* with priority handling that ensures fair distribution while giving precedence to vulnerable groups (seniors, PWDs, pregnant women)
- *Search algorithms (Linear and Binary)* that prevent duplicate registrations and enable quick family verification
- *Struct/Array* structures that organize complex family data into manageable, cohesive units

**Functional Success** The system successfully addresses the critical problems identified in manual food distribution:

- Eliminates paper-based inefficiencies and illegible records through digital record-keeping
- Prevents duplicate registrations and multiple claims through algorithmic validation
- Reduces wait times and frustration through automated queue management
- Ensures equitable distribution with priority for vulnerable populations
- Maintains real-time inventory tracking to prevent shortages or excess
- Provides data persistence for accountability and future planning

**Performance Validation** The system meets all specified non-functional requirements:

- Processes 50+ family records efficiently within the 1-second performance threshold
- Demonstrates robust error handling and input validation
- Maintains data integrity throughout the distribution process
- Provides a clear, user-friendly console interface

**Overall**

The Pangkabuhayan System shows that computer science is not all about theoretical knowledge; it equips us students with tools for creating meaningful solutions for societal challenges. By anchoring this academic project into UN SDG 2, Our team has shown how data structures and algorithms, usually thought of as abstract concepts, directly improve lives and contribute to sustainable development.

This project validates the principle that, when thoughtfully designed and well implemented, technology can indeed improve governance, enhance service delivery, and engender social equity. This team, NepoCoders, as future IT professionals, are aware of a responsibility to apply technical competencies not simply for commercial gain, but for community betterment and to further sustainable development goals.

The Pangkabuhayan System stands as a testament to the power of algorithmic thinking applied to humanitarian purposes, proof that even a console-based application built with fundamental data structures can make a tangible difference in ensuring food for no hungry family in times of need.

### 5.2. Individual Contributions (Detailed breakdown of each member's assigned module/class.)

## 5.2 Individual Contributions

### Alba, Jimmy Paul

- Coding the Distribution System

- Assisted in algorithm logic and documentation

### Camban, Christian James

- Coding the Family Registration and Sorting
- Helped to make a ppt presentation

### Doton, Athan Josch

- Coding the Search and Display Functions
- Contributing in making and organized documentation
- Assisting me on making the Github

### Navarro, Aaron Christian (You)

- Coding the Queue and Priority Management and other Functions like Menu
- Doing some test run of the code
- Created flowchart

### Santos, Justine

- Coding the Food Pack Management
- Helped in preparing the final documentation format

### Full Flowchart