

Fridges Never Lie: An Application of Integrated Data and Modern Lifestyles

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Abstract

An estimated 43 percent of food waste is due to in-home practices - as opposed to waste that happens in restaurants, grocery stores, and on the farm - making individuals the biggest contributors [1]. Ambiguous date labels on packages, unorganized food, drinks, and leftover, make Americans throw out a lot more food than they expect they will.[2] In pandemic, we spend more time stays at home, we need to use the refrigerator to store more necessities and food than ever before. Our contribution is to design a smart fridge app with a database to facilitate data integration and storage, providing the obsession over the contents of a person's refrigerator. Our goal is to avoid unnecessary food waste and help the user better control over his/her body and health. We intend to develop an efficient database and user-friendly interface to better support all functionalities of our application and fulfil different requirements from users. Our slogan is “Make good use of the fridge keeps the doctor away”.

Introduction

Individuals as the biggest contributors to food waste, they are also the most complicated group in which to drive change.[1] Understanding how people are using their refrigerators may stop some half-eaten food going to the dump. Besides, according to the United States Department of Agriculture, “Americans spend anywhere from \$130 to just under \$300 a week stocking up on

food for a family of four.” [10] However, sometimes, no one can tell what they bought every week and how much they wasted unintentionally.

It motivates us to develop an app which can keep track and analyzes inventories in people’s refrigerators. Specifically, if an item is taken out or into the fridge, its barcode will be scanned, and its information like the nutrient table and its expiration date will be recorded into the database. There will be plenty of functions stored in the fridge to display and deliver the information to users. Thus, such documentation will diminish food waste and raise one’s awareness of maintaining a well-organized fridge.

Due to the fact that American now get approximately 60 percent of their energy from processed food [3] and ‘fresh’ has been articulated to be a highly-sought attribute for refrigerated products as well as common food in general. [11] Our app also provides recommendations of the healthy diet for user. It could also be authorized to connect to one’s EMR for more professional and personal recommendations about diet and health.

This application will contribute to problem-solving beyond unconscious food waste. As products like iFridge are put into practical use at a larger scale, we expect more connections and collaborations between digital records like Health app, inventory lists from nearby grocery stores, EMR, health insurance, etc. The growing database could tell us about food qualities, habits, lifestyles, family relationships, geographical distribution of features in urban areas, market share, differences at an international scale and aspects that contribute to academic research and help decision-makers with potential changes before trends evolve to bigger problems.

Audiences:

- busy with work and often troubled by family chores
- has children, wants to provide most nutritious meals
- distressed by the expires food
- the fridge is empty and has no idea of what to eat
- the fridge is always full, lots of food are expired while cleaning the fridge
- don’t know how to maintain and repair home appliances
- bad smell when you open the fridge

Database Design

There are nine tables in our database design. The conceptual model of the database (figure 1) was developed based on the research about users' habits and requirements towards the functionalities of the fridges

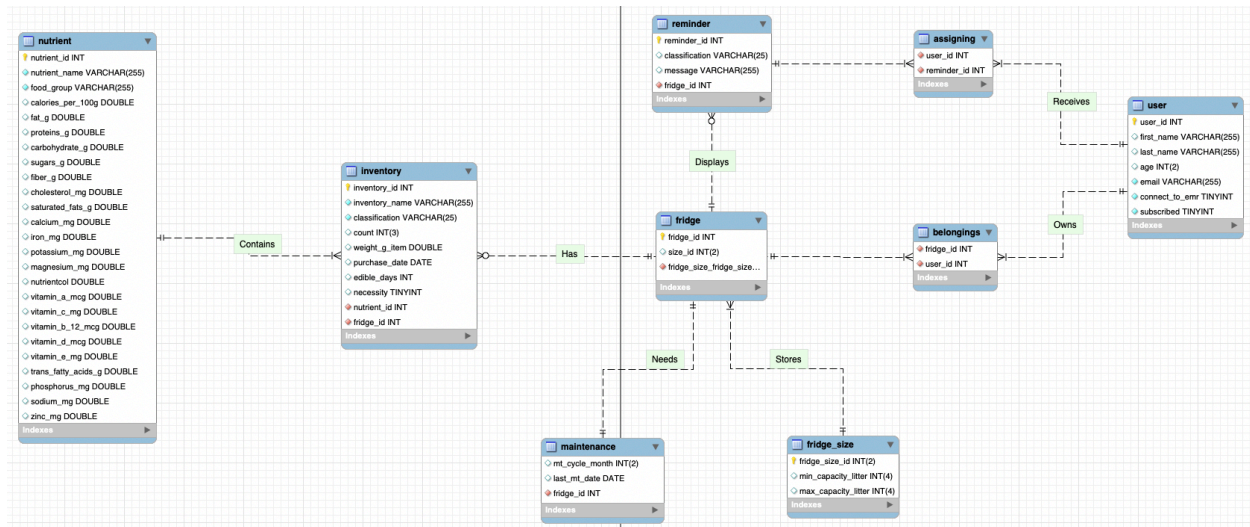


Figure 1 ER Table

fridge:

In our design, the fridge corresponds to four different sizes with a certain capacity range. All these data are stored in the Fridge_size table which has a one-to-many relationship to the Fridge.

belongs:

Belongs table is a user fridge join table. According to the research, more than 40% of Americans have two or more refrigerators in their house, so it is reasonable that a user has two or more fridges and a fridge can be assigned to multiple users. We designed a many-to-many relationships between User and Fridge, belongs as a Join table indicates which user (specific user_id) owns the fridges (distinct fridge_id).

maintenance:

We designed a separate table to record the latest maintenance information of the fridge. Because the maintenance record will keep update, so the relationship between maintenance and fridge is one-to-one relationship.

user:

In order to better serve users, we include user's name, age, email address, and there are two optional functions to protect users' privacy. One is that each user could choose to open the subscribed to the public or not, the other one is user can decide whether connect their health insurance report to the app or not. User table connected with both fridge table and reminder table, guarantying the newest notification of updating the fridge can be received by target users.

reminder:

For reminder, the reminder_id distinguishes the same classification and message so that we know which reminder is sent to the corresponding user, through **assigning table** -- a join table of user and reminder—supports the functionality of creating a reminder accordingly with any update of the certain fridge (due to its fridge_id) and assign the reminder to target users.

In addition, there are six classifications of different messages: *'Fridge Care'*, *'Necessity Supply'*, *'Expiration Alert'*, *'Weekly Tips'*, *'Holiday Special'*, and *'Costumer'*.

nutrient:

The nutrient table as the largest table in our database design contains more than 11614 rows which includes 23 attributes and all kinds of foods. For each food, we give it a specific nutrient id and record all the nutrient value. This nutrient value includes six essential nutrients that the body needs to function properly. And we subdivided vitamins into 5 common vitamins include the water-soluble B group vitamins and vitamin C and the fat-soluble vitamins A, D and E. Minerals are also subdivided into separate attributes such as sodium, calcium, iron, magnesium, zinc, etc. In light of that many foods are now processed products, we also include records about food trans fatty acids, sugar and fiber content.

inventory:

The inventory table shows what inside of a fridge. Whenever there is a new thing adding into the fridge, the auto scanning process will automatically assign inventory_id to the food. In addition, it will record the purchase date and estimate how long it can be kept. User could enter the count and weight of food manually, which will be useful for calculating the usage of capacity. Besides, in the view of the pandemic, some necessities storage becomes a big problem. Hence, the attribute *'Necessity'* is used to determine which good is necessary, keeping track of the usage of all necessities and giving users reminder before these things are used up. The inventory table has

a one-to-many relationship with the nutrient table and fridge table. It is reasonable that every fridge may contain 0 or more inventories. And inventory is like a subset of a nutrient table.

Data Sources and Methods

Resources:

We did a lot of researches about the usage of the fridge and find out some social issues caused by improper use of fridge. Individuals has become the biggest contributors to food waste. As we continue to search through all web platforms such as Instagram, Twitter, Facebook with keywords ‘fridge’. We find out that most of the users’ fridges are not as organized as we saw in TV shows. The article ‘Refrigerator Lifestyle Charts’[4] shows ‘we are what we eat’(figure 2).

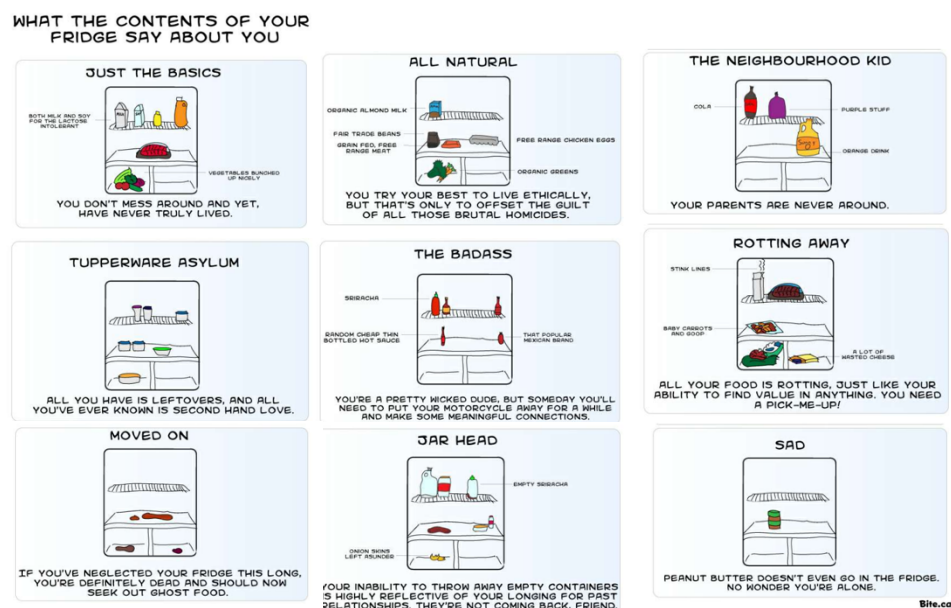


Figure 2 Refrigerator Lifestyle Charts

A lot of us will find one or more expired food in our fridge accidentally. There is a small group of people has a rather biased fridge that only contains a single type of foods. These posts and results of researches review that people lack awareness of clean and maintain their fridge. Based on the researches, we designed and made up most of our tables except the nutrient table which needs authorized data of nutrient values of each food.

For the fridge size table, we use the following data as a reference.

Family size	Suggested capacity
Bachelors, 1 person	50 Liters - 80 Liters
Family size of 2 to 3 members	150 Liters - 250 Liters
Family size of 4 to 5 members	250 Liters - 330 Liters
Family size of 6 or more members	350 Liters - 490 Liters
By www.zelect.in	

Figure 4 Fridge size based on family size [7]

Refrigerator size	Suggested models
50 Liters - 80 Liters	Single door refrigerator
150 Liters - 250 Liters	Single door, double door and triple door refrigerator
250 Liters - 330 Liters	Double door, triple door refrigerator
350 Liters - 490 Liters	Double door and side by side refrigerator
By www.zelect.in	

Figure 5 Matching refrigerator models based on refrigerator size [7]

modifications:

We download the **nutrient table** from the MYFOODDATA website [8], and it contains more nutrients than we need to operate in our query, so we only keep 25 nutrients that our body needs most. They are Carbohydrates (CHO), Lipids (fats), Protein, 5 common vitamins include the water-soluble B group vitamins and vitamin C, and the fat-soluble vitamins A, D, and E, 5 minerals which are sodium, calcium, iron, magnesium, zinc, etc. Because many foods are processed products nowadays, we also include calories per 100g, saturated fats, trans-fatty acids, sugar, and fiber content.

we used **makaroon** to randomly select nutrients into the **inventory table** and assign them with random fridge ids, and other required attributes. After the basic table was generated, we join the current inventory table with nutrient table to get access of food_group and then we assigning corresponding classifications to the inventory. There are 5 classifications to specify where the adding inventory can be stored: 'ready-to-eat', 'dairy', 'veg&fruits', 'freeze', 'meds&skincare' (with reference to figure 3).



Figure 3 How to store food in fridge[5]

maintenance table: The maintenance cycle varies from fridge to fridge because of different fridge size and brands, which will add complexity to query. So, we manipulated all cycle to the same time -- half year (i.e. 6 months). Then, the query directly finds the next maintenance date and sends reminders to user with the reference of maintenance cycle. The first maintenance date is the first day of using the refrigerator.

User Cases Queries with the table:









We developed 12 queries and 8 stored procedures to achieve the basic functionality of our application.

Reminder:

The 'Fridge Care' is about reminding users to maintain their fridge in time, by accessing the data in Maintenance, we know the maintenance cycle and the latest date of maintenance of the given fridge. So, we create a stored procedure to generate specific reminders towards the different maintenance situations. Users could also customize the reminder according to their needs, so we have 'Customer' in our classification domain. The 'Holiday Special' is about recommended certain menus for coming festivals such as Thanksgiving, Christmas, etc. This needs back up with recipe data and we designed our app to connect with the internet and search for a recipe online. But in further development, we plan to create a recipe table instead and connect it with the inventory table. In that case, we could combine these two tables and give recommending holiday special recipes according to what's inside of the user's fridge.

QUERIES (12)

Question & Reference table / other functions

1	Number of users per fridge	fridge JOIN belongings USING (fridge_id)	
2	Maximum fridge capacity for each family	fridge f JOIN belongings USING (fridge_id) JOIN fridge_size fs ON (f.size_id = fs.fridge_size_id) JOIN user USING (user_id)	
3	Scanning and adding an inventory into your fridge	inventory CALL store()	
4	Percentage of food types in the elder's fridges	Inventory JOIN nutrient USING (nutrient_id) JOIN belongings USING (fridge_id)	
5	Find list of families with elder people to deliver fresh vegetable and fruits	JOIN user USING (user_id) CALL coronaCare();	
6	Percentage of users connecting their iFridge accounts to their EMR	user JOIN belongings USING (user_id)	
7	Eat healthier after medical examination	 CALL nutrientSupplements(user_id, nutrient_name,food_group)	
8	Fridge Care: reminder of maintenance	CALL fridgeCare(user_id,fridge_id)	
9	Necessity Supply: notification to the user about their necessity shortage(0%, < 50%, = 50% , >50%)	CALL necessityPercentage(user_id, fridge_id, min_amount)	
10	Necessity Supply/shortage Trigger: generate reminder (if any necessity's count<=1.) Delete reminder (if enough necessities are added back)	 Trigger:necessity_after_purchase()	

11	Expiration Alert if any food is expired in given fridge	CALL expirationAlert(fridge_id)	
12	Customize a reminder	CALL customizeMsg()	

STORED PROCEDURES (8)

- **store()**
- **coronaCare()**
- **nutrientSupplements()**
- **fridgeCare()**
- **necessityPercentage()**
- **Necessity_after_purchase**
- **orderByExpirationDate()**
- **customizeMsg()**

Conclusions

This application successfully helps each family/individual control the food waste by recording the expiration date of each inventory and automatically sending a reminder to the user when the food is about expired. It also creates a database to store all inventories in detail to give users big pictures about what things inside their fridges, allowing users to better plan the usage of capacity and making reasonable shopping. The data can also fulfill the requirements of any healthy diet in two ways. One is to analyze a user's eating habits according to fridge inventory and then giving users reminders or alerts as weekly tips. Another way is user-initiative that users could enter their request and the app will report the food list that best for users' health. The privacy issue is always a concern while designing our project. In order to protect users' privacy, we ask users permission to connect their medical reports with our application. The subscriptions are available only if the user agreed to open it to the public. What's more, while using this app, users will also pay attention to fridge care which they may ignore before.

In general, a variety of tables and detailed classifications make the application more flexible for distinct functions and problems. User experience is also more personalized. Despite focusing on improving healthy life and solving the last long social problem. The application additionally develops with temporary news and social change. Due to the serious pandemic, there exists a group of elder people didn't prepare well for a long-time home segregation. Therefore, we update our application with the function to solve current hidden problems in society that it finds users who need fresh vegetables and fruits in the pandemic and help them to get their necessities.

Limitations:

There are several constraints we didn't conclude in our project design which we will work on in further app development. Geographical limitations and political issues can be one research direction when there are enough user data in our database. "Certain brands are popular in certain geographical areas," Stonehill said.[9] According to the politics in the food world, we can find an interesting fact that what social causes people support based on what brands they do and don't have in their fridge.

Besides, our current fridge type and size are rather basic which does not include mini-fridge and other fridges in a temporary fashion like wine-fridge and beauty-fridge to keep a single kind of goods. Moreover, most mini-refrigerators are currently used for simple storage of food in dormitories, users may not choose to buy smart refrigerators, so the user of mini-fridge is not our primary intended user but we will design some functions to expand our user circle.

Author Contributions

Felicia developed and revised the conceptual model, designed and modified the fridge and user tables to group users, and assign the fridge to each family. She worked on the queries about fridge maintenance, necessary supplies, and general question towards the EMR connection. She contributed to most of part of the final report except the 'Use Cases'.

All team members participated in project research, designing the logical and conceptual models, finding all relevant useful databases, and drafting the query questions.

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