A Mobile App for Food Purchase Decision and Waste Minimizing Using IoT, Social Tools, ML and Chatbots

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Abstract: Chatbots and conversational systems are increasingly emerging as technologies to support decision- making systems and to improve human-machine interaction. Our paper aims to demonstrate how social media and chatbots can improve the decisions of a consumer of food products and reduce food waste, whereas simplified conversational systems are taken into account to facilitate the interaction between users and application. In particular the paper presents a mobile app for Food Purchase Decision and Waste Minimizing where social tools and chatbots play an important role to support the implementation of an electronic pantry to optimize food purchase and consumption. This smart pantry has a memory of all the foods present in the home pantry. This allows the app to recommend the use of products that are about to expire, to provide with the help of a chatbot advice for the purchase of products useful for making recipes that take into account the products present in the pantry, to highlight gastronomic events to participate in for the type of tastings that are offered.

1 INTRODUCTION

Chatbots and conversational systems are increasingly recognized for enhancing decision-support systems (DSSs) (N. Bhaskar, 2023; D. Albuquerque, 2021) and improving human-machine interaction (A.F. Fujii, 2023). Recent research emphasizes developing efficient conversational systems (P.D. Sree, 2023) and showcasing the role of social media and chatbots in specific applications (C.H.S. Pokhariya, 2024).

This paper explores how IoT, social media and chatbots enhance food purchase decisions and reduce waste. It introduces a mobile app for Food Purchase Decision and Waste Minimization, integrating an electronic pantry to optimize food management. The pantry tracks home food inventory, recommends using expiring products, suggests recipes, and highlights nearby gastronomic events.

The chatbot plays a crucial role in providing actionable recommendations and fostering sustainable consumption. It suggests recipes that minimize food waste by utilizing pantry items. By integrating with the app, the chatbot helps enhance decision-making related to food purchases and consumptions.

Other key features include seamless product entry via barcodes/RFID tags and voice-to-text systems, with product data stored in relational databases like MySQL or Postgres. Time-series data is managed using InfluxDB, enabling trend analysis and consumption classifications and forecasting through statistical and Machine Learning (ML) techniques.

The proposed app is a game-changer in the home food management space. By combining IoT-enabled automation, conversational DSSs, and proactive waste reduction strategies, it addresses pain points that other apps (e.g., Too Good to Go, Mealime, Paprika, Yummly, and Big Oven) only partially solve. This positions the app as an original and competitive solution with high potential to attract users and make a significant environmental impact.

For enterprises operating in food production and distribution, the app is a valuable tool because it aims at significantly reduceing food waste and its associated carbon footprint, contributing to sustainability goals. In particular, he app fosters stronger relationships across the supply chain by showcasing stakeholders' commitment to environmental responsibility and social impact. By enabling real-time data sharing, facilitating surplus donations, and aligning sustainability goals, it

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enhances collaboration, trust, and mutual benefits among producers, distributors, and retailers.

Section 2 outlines the app's basic framework as an e-commerce system integrated with an electronic pantry. Section 3 details product data loading with Bar Code/QR code and RFID tags and voice-text systems. Section 4 explains how the electronic pantry supports decisions through consumption statistics and recommendations. Section 5 focuses on the chatbot's role in providing recipe suggestions and identifying relevant events. The conclusion highlights the app's benefits and potential future developments.

2 A SMART PANTRY FOR SMARTER FOOD CONSUMPTION

The app's initial version integrates a cross-platform solution (Android/iOS) with web dashboards. Producers manage offerings, while consumers get pantry-based recommendations to reduce waste and suit preferences, with organized inventory views and category filters.

Producers can manage product details (e.g., quantity, price, expiry) and publish food and wine events. The consumer dashboard allows users to explore products, events, and manage purchases with e-commerce features like keyword search, category navigation, and shopping carts.

Fig.1 highlights the app's food categories, gatronomic events and smart pantry, designed to help users manage purchases by tracking expiration dates and usage. Features include: a) adding products via QR/barcode scanning, b) viewing all pantry items, opened or closed, c) tracking expiration and post-open eding deadlines, d) receiving alerts for near-expiry items, and e) creating shopping lists with recommendations.

Fig. 2a shows the smart pantry interface, accessed via voice commands or product tag scanning, displaying pantry items linked to detailed product sheets (e.g., name, description, images, and attributes). Fig. 2b aids purchase decisions by indicating product status (opened/closed, quantity, expiration) with color-coded indicators.

The app structure is therefore a step ahead of traditional e-commerce apps as it effectively integrates the process of purchasing with the storing/consuming food products in order to support sustainable food consumptions.

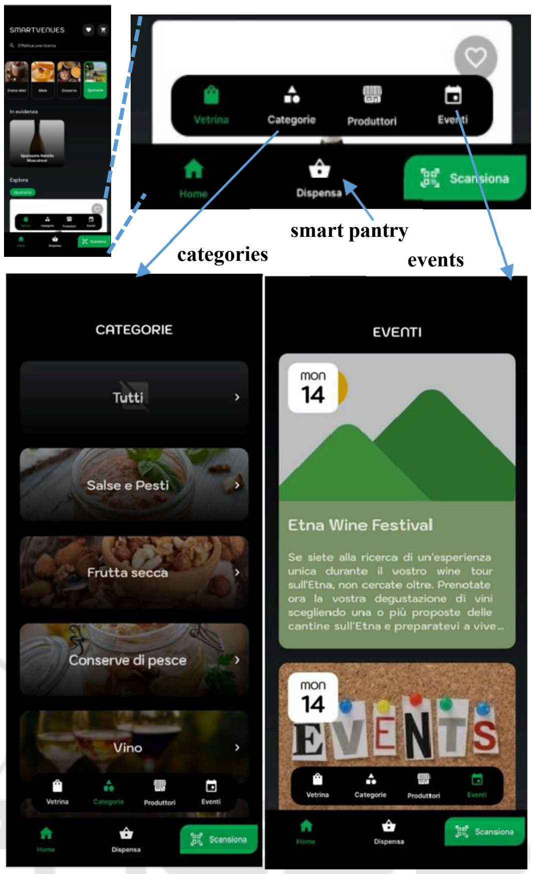

Figure 1: Smart pantry interface accessed via voice commands or tag scanning, showing items linked to detailed product sheets (e.g., name, description, images).

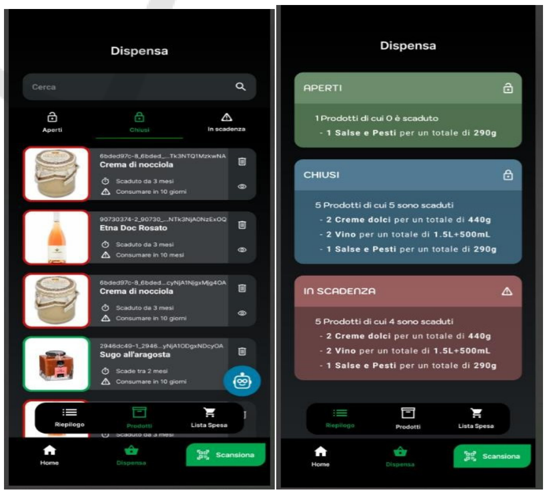

Figure 2: List of products in the pantry and their status.

However, there are some limitations that reduced the effectiveness of the initial version of the app only to the purchase and consumption of local products sold through the app.

In fact only for these products it is reasonable to assume that the producers may accept to use our QRcode/RFID tag in which they specify for each batch the expiration date and the period within which to consume the products once opened.

Moreover, upon subsequent analysis, it turned out that the consumer generally does not want to take into account only the typical products in the pantry but all the products to have a complete picture of the food consumption.

Therefore, it seemed useful that the pantry, like similar apps available on the market (M. M. Khan 2020, Studio56 2022) will be able to manage products purchased from other commercial sites or directly at the supermarket.

Furthermore, given the importance that consumers increasingly give to the quantity and quality of food consumption, it is useful that the consumers are notified not only when a product is about to expire but also that they may know the consumption statistics, possibly including nutrients, and the pleasant and compatible ways of consuming the available products, especially those about to expire, with diets and economic criteria.

For this reason, the following sections show the generalization of the electronic pantry currently offered by the app using social tools and the enhancement of the interface with conversational systems and chatbots for an optimized use of food consumption and for a minimization of waste in a non-imposing but useful and pleasant way.

3 IoT AND SOCIAL TOOLS FOR SMART PANTRY DATA ENTRY

Despite the growing number of IoT devices and technological integrations in households, pantry management often remains a largely manual process, discouraging monitoring of the products on the pantry. To address this, the paper proposes a rethinking of product labelling, so that labels contain not only the name and price but also a range of parameters that allow interaction with the product itself.

For this reason, it is useful to design systems that facilitate the insertion of data for new products into the pantry DB, in our case Postgres DB, avoiding or limiting the intervention of the consumer to enter such data via the keyboard. Furthermore, these data could not be limited to the bar code or QRcode, but should provide the name and the quantity of the purchased product, the nutritional contents and the expiry date for an optimal consumption.

As above said, a first method to avoid this criticality is to provide each product with our tag able to store all the information mentioned above, which would be partly stored in the tag and partly obtainable from a database containing all the food products managed by the app. But replacing the bar code of their products with this QRcode/RFID that facilitates is reasonable only for local producers as shown in Fig.3 (left).

A possible solution to overcome this problem may be that the producers themselves or the points of sale to replicate the bar code inside our tag where they will insert at least the product expiration date. The product would thus have both the bar code as long as it is essential for checkout operations and the QRcode/RFID tag.

However, also this is difficult to achieve in practice. Therefore, in the following we assume that the products at e-commerce sites and local stores are provided only by bar code, as shown in Fig.3 (right).

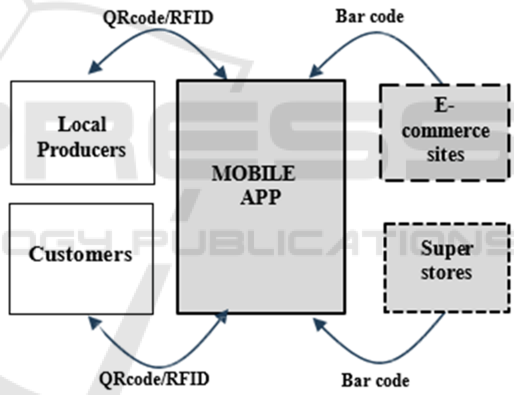

Figure 3: Products inserted/retrieved using QRcode (left) or Bar code /right).

For this reason, the consumer, when inserting the product into the real pantry, should opened a pantry loading procedure offered by the app and click on the bar code of the purchased products. If the app does not find this product in the app's DB, then it would do a get to a database containing all the products asking for the data of the product whose identification code is given by the bar code.

The retrieved data would then be loaded into the app's DB and in the next screen the consumer would only have to enter the number of packages purchased of the same product and the expiry date.

3.1 Uploading Products Data Using Bar Codes and Open Food Facts

The previous method allows adding new products to the app database, assuming a comprehensive food product database is available. To leverage existing resources, we identified the Open Food Facts database (https://world.open foodfacts.org/), a collaborative project that includes extensive food product and nutritional data, available for download and remote querying. Below, we outline the steps to implement this method, showcasing its effectiveness through social systems.

The first step requires the customer to open the *Open Food Facts* app and select the products of interest by entering the product name or product type, thus obtaining a list from which to identify the one of specific interest.

Fig. 4 (left) illustrates how a consumer can resolve doubts about a product name by entering the product type or producer. For instance, if unsure about a specific pesto by Campo d'Oro, the consumer can first select the producer and then choose the desired product from a list provided by the Open Food Facts app.

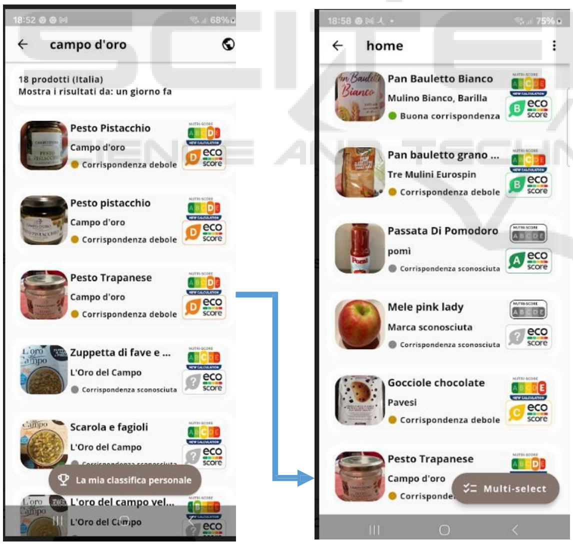

Figure 4: List of products of "Campo d'oro" stored on *Open Food Facts* (left) and list of products inserted into the list home from customer (right)

This list, called *home* in fig.4 right, can be updated continuously, and each time it is updated it must be exported to Google Drive where. as shown in fig.5, it consists of an https link containing a list of barcodes relating to the selected products.

Figure 5: Bar codes of the products present on the *home* list.

The mobile app can read this list and query *Open Food Facts* with subsequent queries that will provide the product data that will be uploaded to the pantry DB with a quantity of zero. This will allow the customer to just click on the product barcode at checkout to enter it and its quantity into the pantry. If the product was not selected at the initial stage using the above procedure, at the time of purchase the app will select it from Open Food Facts and insert its descriptive data into the pantry DB. In case it is not present on Open Food Facts the app will opened a screen to insert the product basic data both into the app DB and into the Open Food Facts DB.

This latter insertion phase is supported and encouraged by Open Food Facts itself but, for now, is not available to customers. It will be managed by the app's team upon the consumer's request. Additionally, instead of or alongside Open Food Facts , we plan to utilize product databases from food distributors adopting the app.

3.2 Inserting Product Quantity and Expiry Date

After entering product descriptive data into the app's database, the next challenge is adding quantity and expiry date information. To address this, customers utilize a voice-to-text tool that converts spoken commands into text, which is stored on Google Drive. The commands, listing items (see Fig. 6.a), are processed using the Sound-Type-AI converter (see Fig. 6.b). The app then links each item's data to its corresponding product barcode.

Alternatively, customers can record the list after scanning all pantry products without interruptions, a mobile app matches the scanned product names with its database, ensuring accuracy. It then records the quantity and expiration date. If a product is missing from the pantry database, it is retrieved from Open Food Facts as described earlier.

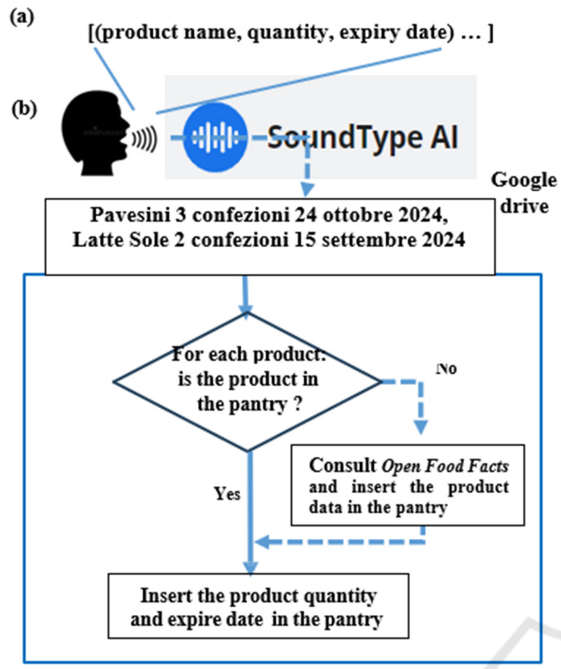

Figure 6: List of products and relevant data to be stored in the pantry. A voice-to-text can facilitate this insertion.

To support consumption and food waste detailed analysis, the app logs each product into a time-series database, InfluxDB (X. Zhu, 2023), to track consumption history for each item (see Fig. 6), enabling calculations for consumption and waste.

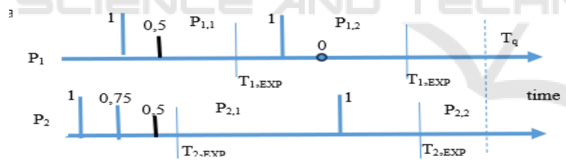

Figure 7: History of four products: P1,1 and P1,2 (type P1), P2,1 and P2,2 (type P2). Vertical lines show remaining pantry quantities, $T_{1,EXP}$ and $T_{2,EXP}$ are the expiration times and T_q indicates when customers inquire about consumption and waste. The consumption percentages are 75% for P1 and 25% for P2.

4 CONVERSATIONAL DSS FOR SMART FOOD CONSUMPTION

For the optimal use of the purchased products, it may be useful for the customer to know at least the following data:

a) which products are expiring and related warnings/alerts
b) what is the last weekly or last monthly consumption of each product
c) what is the waste for each product on a weekly or monthly basis
d) what is the foreseen weekly or monthly consumption or discard of each product.

Such four main queries give raise to a recommender system supporting customer decision, i.e., the responses to such queries are at the core of a DSS for an effective food management at home.

By the information obtained by the first query, i.e., query a), the consumer is encouraged by the app to immediately consume the expiring products.

By knowing the data obtained by the second query i.e., query b), the consumer will be able to check whether the quantities consumed are in line with what was planned, for example on the basis of a diet or economic criteria, while the data related to the third query i.e., query c), may be useful for the consumer to carefully evaluate the purchased products that are discarded in significant quantities.

By the fourth query, i.e., query d), the customer may know what is the forecast of consumptions and discards on the basis of the food consumed in the last period. This may induce the customer to modify timely her/his food consumption.

4.1 Product Status: Inquiries, Alerts, Warnings, and Recommendations

The product status and related warnings or alerts required for inquiries of the first type (a) are calculated through an app procedure that queries the database to identify products nearing expiration. The app includes an intelligent notification mechanism that informs users when a product is close to or very near its expiration date, issuing a warning or an alert, respectively, as follows:

- Closed Products: Alerts notify users when a product nears or reaches expiration, prompting disposal and removal from the pantry.
- Opened Products: Notifications indicate the recommended consumption period after opening and suggest disposal once this period ends.

Therefore, in order to have effective information about the pantry status, the consumer must enter not only the product quantity into the app DB and InfluxDB, but also the remaining quantity once the product has been openeded after having used it. The remaining quantity of the products can be entered into the app using the voice-to-text converter or more simply by clicking on one of the options offered by the app.

In particular, in the first case, the consumer will say that the remaining quantity is *a lot, medium , a* *little, or nothing,* while in the second case, the customer may select one of these options by clicking on a button offered by the app for communicating the product remaining quantity.

The app computes every day an expiry table T_{ex} in which it reports the products that are close to expire. Let say t_i and t_{ei} respectively the time at which the product i is entered into the pantry and has to be consumed, the remaining quantity r_i of the product will be put in table T_{ex} if the last r_i stored on InfluxDB is different from nothing and the remaining time meets the following formula:

$$t_{ri} = t_{ei} - t \leq 3 \text{ days},$$

where t is the time at which the computation is done.

Although the expiring products in the next three days are communicated by a warning reporting the table T_{ex}, the customer may issue a voice requests in natural language to have a prompt response about a product status. For example, the customer could ask

- **Is** *milk* **expiring**
- **Is** *pesto* **expiring**

where the part of the inquiry in bold is mandatory and the one in italic may contain the name of any product in the pantry.

Let us note that a warning system implicitly recommends the product that should be consumed in the next three days, but it does not indicate at which rate the consumption should be done, e.g., by specifying that the consumption should be little increased or highly increased. For this reason the app is able to carry out a fuzzy computation for giving the following more detailed recommendations:

IF the remaining quantity r_i is little/medium/a_lot ***THEN*** the percentage consumption c_i in the next day should be:

$$c_i = 100 \text{ x } s_i \ / \ Ni$$

where s_i is 0.25, 0.5, 0.75 depending on if remaining quantity is little/medium/a_lot, and Ni is the product expiry time expressed in days.

4.2 Inquiries on Consumption, Waste, and Forecasting

The second piece of information required by inquiry of type (b) deals with product consumption. It may be obtained by querying the app with vocal commands as follows:

- **How much** *milk* **have I consumed in the last** *week*
- **How much** *meat* **have I consumed in the last** *month*

where the part of the inquiry in bold is mandatory and the one in italic may contain the name of a product in the pantry and a time period, i.e., week or month, indicated by the customers.

The response will be the consumption of product i in the last week or month, i.e., C_{iw} and C_{im}, given by summing the term (1 - s_i) for all the purchased packages of products in the last week or month. This may be easily obtained thanks to data registered in InfluxDB (as illustrated in fig.6).

A warning is issued by the app reporting the consumption that exceeds a prefixed threshold, if:

$$C_{iw} > Th_{ciw} \text{ or } C_{im} > Th_{cim}$$

where Th_{ciw} and Th_{cim} are the consumption thresholds of product i for the same period. Analogously, the third piece of information required by inquiry of type (c) may be obtained by querying the app with vocal commands as follows:

- **Were there any discards for** *apples* **in the last** *week*
- **Were there any discards for** *meat* **in the last** *month*

where the part of the inquiry in bold is mandatory and the one in italic may contain the name of a product in the pantry and the period chosen by the customer. The response is given by summing s_i for all the purchased packages of products i in the last week or month for packaged products.Let us note that, to address questions related to loose products, a possible simplified approach is to indicate the purchased quantity qi, expressed in kilograms, for the most popular items such as bread, meat, and fish when these products are added to the pantry. In this way, a warning will be issued reporting the products that exceeds a prefixed discard threshold, i.e.:

$$D_{iw} > Th_{diw} \text{ or } D_{im} > Th_{dim}$$

where D_{iw} and D_{im} is the discard of product i in the last week or month given by summing the remaining quantity s_i for each product package, or q_i x s_i for each loose product, purchased in the last week or month, and Th_{diw} and Th_{dim} are the related thresholds for the same period. Type (d) questions focus on forecasting consumption and waste trends, enabling timely alerts by analyzing historical patterns and future purchase projections. The app employs three method such as Linear Regression, ARIMA, and LSTM, to predict consumption and waste for upcoming periods using past data (C. Chakraborty, 2017).

For food consumption influenced by seasonality, external factors, and patterns, LSTM often provides the most accurate predictions, especially with large, multivariate datasets that incorporate factors like weather, price, and seasonality. ARIMA is better suited for simpler, univariate patterns, while regression is appropriate for data with linear trends.

Fig.8 presents forecasts for next week's meat consumption and their accuracy, using ARIMA (Fig. 8a) and LSTM (Fig. 8b). As the literature suggests, we may observe in such figures that LSTM outperforms ARIMA, particularly for complex and non-linear patterns. Understanding these trends aids lifestyle adjustments to meet dietary or economic goals, with the recommender system suggesting strategies like gradual food consumption reductions to achieve targets, offering tailored advice based on individual needs.

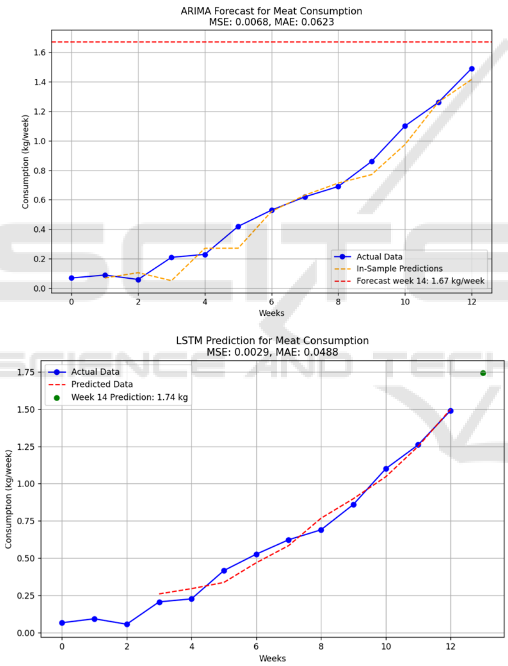

Figure 8: Forecast of the next week meat consumption by ; ARIMA, and LSTM methods

5 OPTIMIZING SMART PANTRY WITH A CHATBOT

With growing complexity in food choices and awareness of sustainability, consumers need advanced tools for pantry management.chatbot, based on the Google Gemini 1.5 Flash model with a custom prompt, provides personalized and proactive support.

The chatbot oversees pantry inventory, monitors expiration dates and quantities, and suggests items to use or buy. It recommends recipes using near-expiration ingredients to minimize waste and tailors suggestions to user preferences. Fig. 9 (left) shows the "recipes" feature generating suggestions from pantry items, while the chatbot option handles text or voice requests (Fig. 9, right). Upon receiving a request, the chatbot processes it (Fig. 10, left) and delivers responses via text or voice (Fig. 10, right).

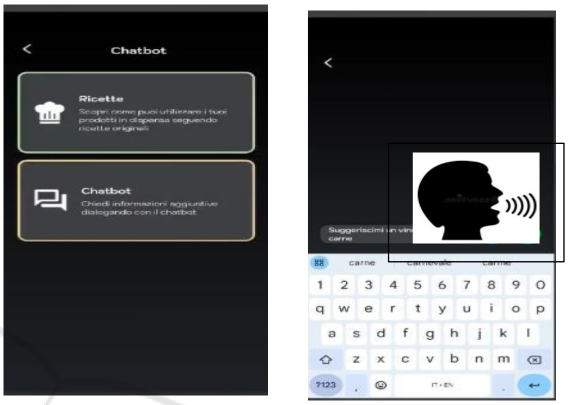

Figure 9: Two ways to obtain recipe suggestions from the Chatbot choosing respectively the option recipe or the one denoted by chatbot.

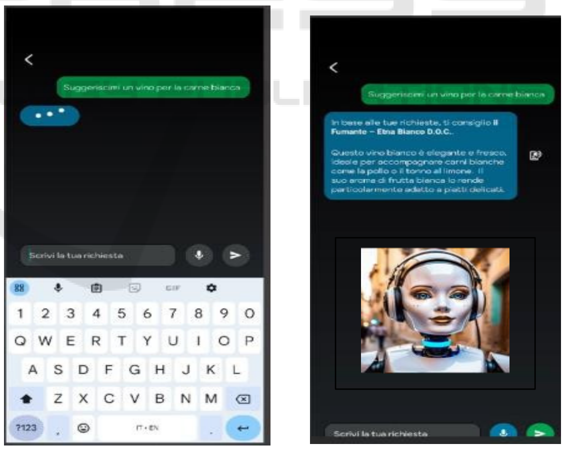

Figure 10: Interacting by voice with the Chatbot with requests expressed in natural language. The Chabot will respond by both voice and text.

If customers want recipes based on specific pantry items, they can access the electronic pantry, select the desired products, and click a button (Fig. 11a, left). The chatbot then suggests recipes (Fig. 11a, right) using those products, as shown in Fig. 11b, left. The customer selects a recipe and receives the details from the chatbot (Fig. 11b, right).

Figure 11: How obtaining recipes related to a specific product.

6 CONCLUSIONS

This paper introduces a mobile app for pantry management integrated with an e-commerce platform for food products, leveraging IoT as envisaged in (C.Mauri, 2021), conversational AI, and chatbots to enhance user experience. Benefits include streamlined pantry management, simplified shopping, reduced food waste, and fresher products. The recommendation system uses statistical and ML tools, while the chatbot suggests purchases based on pantry contents and preferences, integrating data from price lists and producer catalogs for a reliable database.The app targets a 20% reduction in household waste, which, according to UNEP Food Waste Index Report 2021, could result in: a) 15–20 kg of food saved per person annually in high-waste regions, b) $300–500 in annual savings per household, and c) reduced CO2 emissions, supporting sustainability goals.

Future plans include developing a smart system with Barcode/QRCode/NFC/RFID readers and scales for easier product management at home. The backend, currently hosted on Salesforce, Google Firebase, and local servers, will be centralized on a private server. Apps will be distributed via Google Play and Apple App Store. Additionally, a part of the backend will be implemented also on edge systems (e.g., Jetson Nano Orin) for local data storage and ML computations, along with a telemedicine service (G. Di Dio, 2024) to assist residents remotely. The overall system integrates pantry management, health monitoring, and energy consumption optimization, offering a holistic solution for modern households.

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REFERENCES

N. Bhaskar, et alii, "An Effective Prediction and Recommendation System for Smart Farming using Machine Learning Techniques," *2023 International Conference on Integration of Computational Intelligent System (ICICIS)*, Pune, India, 2023,

D. Albuquerque, G. Bhavani, B. Gaur and S. Kuttipravan, "A Smart Mobile Application to Boost Grocery Shoppers Experiential Marketing," *2021 Int-Conference on Computational Intelligence and Knowledge Economy (ICCIKE)*, Dubai.

A. Fujii and J. Kristiina, "Opened Source System Integration Towards Natural Interaction with Robots," *2022 17th ACM/IEEE International Conference on Human-Robot Interaction (HRI)*, Sapporo, Japan, 2022,

P. D. Sree, M. R. Kokkiligadda, J. Teja and Y. Sandeep, "Product Negotiation in E-Commerce Website using Chatbot," *2023 7th International Conference on Computing Methodologies and Communication (ICCMC)*, Erode, India, 2023

C. Bhuvaneswari, et alii, "Implementing AI-Powered Chatbots in Agriculture for Optimization and Efficiency," *2024 2nd International Conference on Intelligent Data Communication Technologies and Internet of Things (IDCIoT)*, Bengaluru, India, 2024

M. M. Khan, "Development of An e-commerce Sales Chatbot," *2020 IEEE 17th International Conference on Smart Communities: Improving Quality of Life Using ICT, IoT and AI (HONET)*, Charlotte,NC, USA, 2020

Studio56, e-Grocy, https://studio56.it/articolo/software-web-application-erp/2021-09-05/grocy-come-informatiz zare-la-propria-dispensa, 2022

Zhu, Xiaoxiang et al. "Time Series Database Optimization Based on InfluxDB." *2023 International Conference on Power, Electrical Engineering, Electronics and Control (PEEEC)* (2023)

Chakraborty, C., & Joseph, A. (2017). "Machine learning at the forefront of time series forecasting." *SN Applied Sciences*, Springer.

C. Mauri, P .Pasini, Smart grocery retail: the impact of new technologies, Egea editor, 2021

G. Di Dio, R. Faro, R. Di Dio, A. Fortuna, "Smart Telemedicine Services for Students on University Campus and in Jogging Areas," IEEE *Int. Conf. on Internet of Things and Intelligence Systems* (IoTaIS), Bali, Indonesia, 2024