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INNOVATION IN ACTION: TURNING IDEAS INTO REALITY

Chapter 26
FRESHOLIFT: Smart Vertical Shelf System for People with Disabilities

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ABSTRACT
FRESHOLIFT is an inclusive smart vertical shelf system designed to revolutionize fresh food storage in supermarkets. It addresses three significant challenges: accessibility for people with disabilities, food freshness, and environmental sustainability. With a vertical lift mechanism and AI-driven inventory management, FRESHOLIFT uses temperature, humidity, and gas sensors to monitor and maintain optimal freshness while reducing food waste through FIFO (First-In-First-Out) usage. Its user-friendly interface includes voice commands, screen readers, and Braille support, making it accessible to the elderly and people with mobility or visual impairments. The design also incorporates modular, energy-efficient components and supports clean energy options like solar power. Through its smart, inclusive, and sustainable features, FRESHOLIFT promotes healthier food practices, empowers independent shopping experiences, and contributes to responsible retail innovations.

Key Words: smart shelf, accessibility, food freshness, AI inventory, disabilities

1. INTRODUCTION

Ensuring the freshness of vegetables is vital for maintaining their nutritional value and minimizing household food waste. Post-harvest, vegetables rapidly lose moisture, texture, and essential nutrients. Proper storage conditions, specifically regulated temperature, humidity, and airflow, can significantly delay spoilage, preserving flavor and nutritional content and reducing food waste and associated costs (Albrecht, 2016). Beyond freshness, accessibility in food storage systems is crucial, especially in public retail environments like supermarkets. Traditional storage designs often overlook the needs of individuals with disabilities, presenting barriers such as high shelves, narrow aisles, and a lack of assistive technologies. Recent studies highlight that 88% of consumers believe that accessible retail

environments are the hallmark of inclusivity, yet many retailers fall short in implementing necessary accommodations (SLD, 2023).

Innovative technologies like AI-driven inventory systems and automated mechanisms can improve food storage and enhance the shopping experience. AI applications are being developed to transform customer service for individuals with disabilities, ensuring broader accessibility and inclusivity in retail settings (Forbes, 2024). Implementing such innovative, inclusive systems in supermarkets caters to a wider customer base and aligns with corporate social responsibility goals.

2. PROBLEM STATEMENT

One of the most pressing issues in modern supermarkets is the lack of physical accessibility in food storage systems, particularly for individuals with disabilities. Many chiller cabinets and shelving units are designed without consideration for wheelchair users or those with limited mobility, creating physical barriers to access. This issue has been raised by advocacy groups and shoppers alike, with several supermarket chains facing criticism for introducing inaccessible fridge and freezer systems (Disability News Service, 2024). Without accessible designs like lower shelves and easy-to-open doors, supermarkets may exclude a key segment of their customers and neglect universal design principles.

Inefficient management of perishable inventory contributes to food waste and reduced availability. Traditional shelves lack monitoring tools for tracking freshness and demand, leading to overstocking and expired items due to poor rotation. Recent developments in AI-driven retail solutions have shown promise in addressing these issues by enabling real-time inventory tracking, demand prediction, and automated FIFO (first-in, first-out) management strategies (Culinary Coverage, 2025). However, such systems have yet to be widely adopted in most supermarkets, particularly low-resource or high-traffic settings.

Retail staff often lack training and resources to effectively support customers with diverse abilities, leading to feelings of exclusion. Enhancing service through accessibility-oriented staff training and integrating assistive technologies, such as voice-guided systems and braille labeling, can significantly improve the customer experience (Joy Delivery UK, 2025). Supermarkets must acknowledge that inclusivity is a social obligation and a business opportunity to serve all customers with equity and dignity. With increasing demands for sustainable, accessible, and innovative storage, there is a clear need for FRESHOLIFT.

3. OBJECTIVES

3.1 To Enhance Accessibility and Independent Use for Disabled Individuals in Supermarkets

To create an inclusive food storage system enabling independent, dignified shopping for people with disabilities through accessible design and assistive features.

3.2 To Improve Freshness Monitoring and Minimize Perishable Food Waste

Optimize storage and reduce waste using AI-driven climate control and FIFO inventory in modular trays.

3.3 To Promote Energy-Efficient and Environmentally Sustainable Storage Practices

To support sustainability through energy-saving components, recyclable materials, and alignment with SDGs 7 and 12.

4. MATERIALS/METHODS

4.1 Product Description

FRESHOLIFT is an innovative vertical shelf system that elevates fresh food storage in supermarkets with a lift-and-slide mechanism, improving accessibility and maximizing floor space. It reduces messes, enhances food rotation, and delivers fresh produce at an easily reachable height.

4.1.1 The System

FRESHOLIFT's innovative technology employs robotic tray retrieval elements similar to those used for car lifts in parking structures. The robotic system consists of vertical rails with stepper motors that use a horizontal slider to extract chosen shelves from their storage positions before moving them to a usable height.

4.1.2 Multi-Sensing Smart Module (VEG Guard)

The innovative sensor system controls vending machines' temperatures and moisture levels while monitoring freshness outcomes. The product has integrated three sensors into its small format. The humidity sensor detects ideal moisture conditions for leafy vegetables' proper growth. The low-power microcontroller analyzes all collected data for cloud system or machine controller updates.

4.1.3 The Controller

The interface features shatterproof capacitive glass on its touchscreen and rubberized physical buttons that maintain good tactility. Interface features support sensory needs, including voice guidance, visual contrast settings, and Braille labels.

4.2 The Operation Process

The FRESHOLIFT operation involves six key steps. Step 1: Easy Access – The user approaches the machine, which is designed to accommodate wheelchair users, with the interface positioned at a comfortable height. Step 2: Product Selection – Items are selected using a touchscreen or voice-guided controls, supporting those with visual or mobility

impairments. Step 3: Payment – The user completes the purchase through various payment options, initiating the retrieval process. Step 4: Shelf Retrieval – The system automatically rotates and retrieves the selected tray, reducing physical effort. Step 5: Item Delivery – The tray is delivered at an accessible height for easy collection. Step 6: Collection and Exit – The user collects the item and exits, completing a smooth, self-service shopping experience.

5. NOVELTY

FRESHOLIFT has a built-in cooling system with independently climate-controlled compartments and high-precision sensors to monitor freshness. It features a low-reach tray delivery system for accessibility, making it easy for the elderly and individuals with disabilities to use. Voice-guided interaction and extensive touchscreen controls enhance the customer experience.

6. FEEDBACK FROM COMMUNITY

Survey findings reveal that 70% of respondents face moderate to high difficulty accessing fresh food independently, mainly due to layout and shelf height. A significant 80% believe supermarkets lack inclusive design for people with disabilities. Notably, 76.7% strongly agree that FRESHOLIFT would support independent shopping for the disabled. An overwhelming 96.7% recognize the importance of inclusive technologies like FRESHOLIFT. Additionally, 70% feel it would enhance their shopping experience, highlighting its broad appeal and usefulness.

7. BENEFITS TO THE COMMUNITY

Installing a FRESHOLIFT raises awareness about accessibility for disabled individuals, promoting empathy and social responsibility. It enhances convenience and independence, allowing users to shop at their own pace. Including automatic vegetable vending machines also improves access to healthy produce, removing barriers in traditional grocery stores.

8. COMMERCIALIZATION POTENTIAL

FRESHOLIFT benefits supermarkets by enabling intelligent climate control and real-time freshness monitoring, minimizing loss and enhancing efficiency. In healthcare and assisted living, its accessible design helps people with disabilities store and prepare fresh foods independently, promoting dignity and better nutrition.

9. CONCLUSION

FRESHOLIFT is an eco-friendly shelving system that enhances fresh food storage in supermarkets. Designed with AI technology, it improves accessibility for the elderly and individuals with disabilities. This system reduces waste and promotes a healthier lifestyle.

REFERENCES

Albrecht, J. A. (2016, June 16). *Proper harvesting and post-harvest storage can significantly extend vegetable shelf life*. NebGuide. https://extensionpubs.unl.edu/publication/g1264/na/html/view

Culinary Coverage. (2025, February 14). *How supermarkets are using AI to optimize inventory management.* https://culinarycoverage.com/2025/02/how-supermarkets-are-using-ai-to-optimize-inventory-management/

Disability News Service. (2024, March 1). *Seven supermarket chains have introduced inaccessible fridges in their stores, say disabled shoppers*. https://www.disabilitynewsservice.com/seven-supermarket-chains-have-introduced-inaccessible-fridges-in-their-stores-say-disabled-shoppers/

Forbes. (2024, February 16). *AI's Inclusive Touch: Customer Service For People With Disabilities.* https://www.forbes.com/councils/forbestechcouncil/2024/02/16/ais-inclusive-touch-transforming-customer-service-for-individuals-with-disabilities/

Joy Delivery UK. (2025, January 10). *How supermarkets can improve accessibility for all shoppers.* https://www.joydelivery.uk/How-Supermarkets-Can-Improve-Accessibility-for-All-Shoppers

SLD. (2023). *Inclusivity In Retail*. https://www.sld.com/white-papers/inclusivity-in-retail/