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A Human-Centered Product Design Study for Compact Modular Indian Kitchens

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Abstract: This paper addresses the challenges of storage in compact Indian kitchens, focusing specifically on modular kitchen designs that often leave corner cabinets underutilized. It introduces NIVIRT, a corner kitchen organizer created through a human-centered design process involving literature reviews, user surveys, kitchen observations, workflow analyses, and prototype validation. The final design features a pull-out slide combined with rotating circular trays, allowing for easy access to frequently used ingredients without excessive bending or searching. Feedback from prototyping revealed that this design enhances accessibility, organization, and utilization of often neglected cabinet space. This project exemplifies how workflow-oriented product design can significantly improve the usability of compact modular kitchens.

Index Terms - Compact kitchen, corner cabinet, ergonomic storage, human-centered design, modular kitchen, product design, pull-out rotating mechanism, user research.

I. INTRODUCTION

Compact urban kitchens are prevalent in Indian apartments, necessitating efficient use of limited space for storage, preparation, cooking, and cleaning. While modular kitchens offer organized cabinets, frequently used items like spices and utensils often remain on countertops for easy access during cooking.

The study focuses on NIVIRT, a compact access system for modular kitchen corner cabinets, which employs a pull-out and rotating storage mechanism. This design aims to enhance the usability of underutilized corner spaces, support daily cooking workflows, reduce countertop clutter, and optimize the relationship between storage volume and functionality.

II. NEED FOR STUDY

The study addresses the discrepancy between available and usable storage in compact kitchens, highlighting that deeper corner cabinets are often neglected due to accessibility challenges during cooking. Users tend to favor countertop storage solutions for daily-use ingredients because retrieving items from these hard-to-reach areas requires bending and searching.

Therefore, a user-centered product study was conducted to explore these preferences further and to identify essential design requirements for a new storage product. The desired features include simplicity, affordability, visual compatibility with modular kitchen designs, and suitability for repeated use while cooking.

III. SCOPE OF STUDY

The study focuses on compact modular Indian kitchens, emphasizing corner cabinet storage for daily-use items like spice jars, oil bottles, condiments, and small cooking containers. It involves user research, secondary research, market research, design development, CAD development, prototype study, and user validation.

Notably, the scope excludes aspects such as mass production, advanced automation, electronic control systems, or prolonged commercial testing. Nevertheless, the design considers manufacturability, material selection, assembly, and potential future refinements.

IV. LITERATURE REVIEW

The literature review indicates a shift in kitchen design from expansive, segmented areas to compact modular systems, which requires meticulous planning for both storage and workflow. Ergonomics plays a crucial role, focusing on ensuring comfortable reach, visibility, and reducing physical strain, especially in smaller spaces. Research emphasizes that storage solutions should be evaluated not just on capacity but also on accessibility, frequency of use, user posture, and the effort needed to retrieve items. A storage unit that is large may still be impractical if it requires awkward movements, negatively affecting the cooking process. Current corner solutions, such as carousels, magic corners, and pull-out baskets, partially resolve these issues, though they often come with high costs or are better suited for premium kitchens.

V. METHODOLOGY AND RESEARCH

The methodology employed a human-centered design process, beginning with a literature review and secondary research to delve into compact kitchens, modular storage systems, kitchen ergonomics, and existing corner storage solutions. This was followed by primary research, which included user observation, informal interviews, surveys, and interaction analysis. The insights gained were organized into design opportunities using methods like affinity grouping, design brief development, Product Design Specification, QFD thinking, user flow mapping, and concept evaluation. The final design concept was further refined through CAD modeling, prototype development, and user validation.

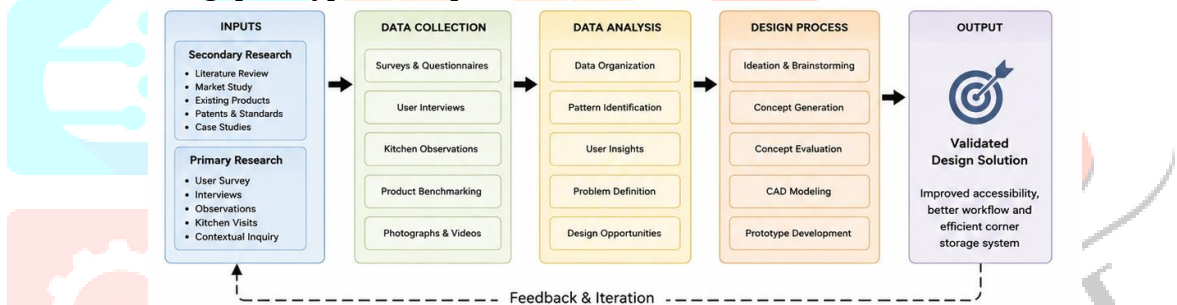


Fig. 1. Research and design methodology adopted for the project

VI. PROBLEM STATEMENT

Compact modular kitchens frequently feature deep corner cabinets that are underutilized for storing commonly accessed cooking items. Users typically place spices, oils, and condiments on countertops due to the difficulties involved in accessing corner cabinet storage, which often entails bending, reaching, and searching. This behavior leads to clutter, decreases preparation space, and disrupts cooking workflows. The project seeks to address the challenge of designing a compact corner cabinet storage system aimed at enhancing access, visibility, and organization of essential cooking items in Indian modular kitchens.

VII. DATA COLLECTION AND ANALYSIS

Data collection involved observing kitchen storage behavior, examining modular kitchen layouts, and gathering survey responses and user feedback on cabinet access. Users reported on cooking frequency, the storage location of daily-use items, challenges with corner cabinets, and preferences for storage solutions.

The analysis revealed that convenience is paramount during active cooking. Users often keep frequently used items outside cabinets, not due to a preference for clutter, but because existing storage systems hinder quick retrieval. This insight significantly influenced the design direction.

Table 1. Data collection summary

Method	Purpose
User observation	Understand real cooking and retrieval behavior.
Survey	Identify frequency of cooking and cabinet access problems.
Product study	Compare existing storage systems and mechanisms.
Prototype feedback	Evaluate usability, comfort and improvement areas.

VIII. MARKET RESEARCH

Market research assessed various kitchen storage solutions, including fixed shelves, carousel units, pull-out baskets, magic-corner systems, and open countertop organizers. Fixed shelves are cost-effective but offer limited access in deep corners, while premium magic-corner systems enhance access but tend to be expensive and may require extensive hardware. Open racks offer convenience yet contribute to visual clutter.

The findings highlight a market opportunity for a compact, mechanically simple, and visually cohesive organizer that efficiently retrieves items from corner cabinets while maintaining a clean kitchen appearance when not in use.



Fig. 2. Existing commercial corner storage products

Table 2. Market research comparison

Existing solution	Observed limitation
Fixed corner shelf	Low cost but poor rear access.
Carousel unit	Improves rotation but still requires reach.
Magic corner	Good access but costly and mechanism heavy.
Pull-out basket	Good reach but limited organization for small containers.
Countertop rack	Easy access but increases visible clutter.

IX. STRENGTHS, WEAKNESSES, OPPORTUNITIES AND THREATS

A SWOT analysis of NIVIRT identified several key factors influencing its product direction. Strengths include enhanced access, organized storage, improved visibility, and compatibility with compact kitchens. Weaknesses involve a reliance on cabinet dimensions, mechanism alignment issues, and the necessity for durability testing.

Opportunities for NIVIRT comprise adaptation to various modular kitchen sizes, creation of both premium and affordable variants, better hardware options, and possibilities for commercialization. Threats to consider include competition from established branded systems, cost sensitivity among consumers, and potential reluctance toward adopting new mechanisms.

Table 3. SWOT analysis of NIVIRT

Strengths	Weaknesses
Improves corner access and visibility.	Requires accurate cabinet measurement.
Reduces countertop clutter.	Needs long-term mechanism testing.
Simple pull-out and rotating interaction.	Hardware quality affects performance.

Table 4. Opportunities and threats

Opportunities	Threats
Can be adapted to different cabinet sizes.	Competition from established hardware brands.
Scope for soft-close and modular accessories.	Cost sensitivity in compact homes.
Suitable for modern modular kitchen market.	Poor installation could affect user experience.

X. ETHNOGRAPHY

Ethnographic observation was conducted to analyze user behavior in kitchen environments, focusing on interactions such as reaching for ingredients, transitioning between preparation and cooking zones, and managing cabinet storage. The findings highlighted a disparity between intended storage solutions and actual user practices.

A significant insight is that users prioritize visible and easily accessible locations for items, especially when under time constraints. Consequently, effective cabinet organizers should facilitate quick retrieval and uncomplicated return of kitchen items; otherwise, users are likely to resort to using countertops as temporary storage.



Fig. 3. Compact kitchen context observed during the study

XI. QUALITY FUNCTION DEPLOYMENT

Quality Function Deployment (QFD) effectively translated user needs into design requirements for a product. Key user needs identified included easy access, visibility, reduced clutter, simple operation, durability, and a premium aesthetic. These were transformed into technical specifications such as pull-out travel, rotating trays, tray depth, choice of materials, hardware strength, and finish quality. The QFD methodology ensured that design decisions were anchored in user needs and associated with anticipated product performance metrics, thereby preventing the design from being merely aesthetic.

Table 5. QFD translation of user needs

User need	Technical response
Easy access	Pull-out slide brings the unit forward.
Visibility	Rotating trays expose stored items.
Reduced clutter	Dedicated storage for daily-use ingredients.
Simple operation	Manual pull and rotate sequence.
Durability	Engineered wood and metal support hardware.
Kitchen aesthetics	Wood finish and concealed hardware.

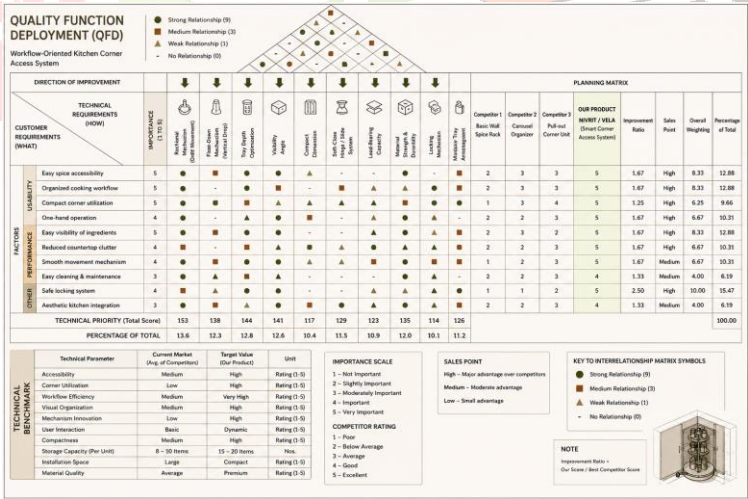


Fig. 4. QFD

XII. SURVEY INSIGHTS

Survey findings indicate that users frequently engage in cooking, utilizing spices, oils, and condiments multiple times during meal preparation. A significant number of respondents expressed challenges with deep or corner cabinets, leading many to prefer keeping frequently used items accessible outside of cabinets for convenience. The results emphasize that accessibility and visibility outweigh the importance of storage volume. Additionally, users showed a greater willingness to adopt straightforward mechanical solutions rather than complex or costly mechanisms.

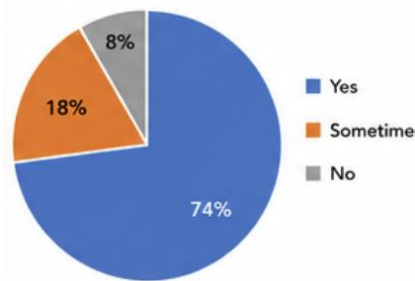


Fig. 5. Survey response on difficulty in accessing corner cabinets

XIII. PRODUCT DESIGN SPECIFICATION

The Product Design Specification was prepared from the literature review, user research, market study and design brief. It defines the functional, ergonomic, manufacturing, aesthetic and maintenance requirements for NIVIRT.

Table 6. Product design specification

Requirement category	Specification
Function	Improve access to spices, oils, condiments and small containers.
Ergonomics	Reduce bending, reaching and searching inside deep cabinet space.
Mechanism	Combine forward movement with rotational access.
Manufacturing	Use wood, steel hardware and modular components.
Aesthetics	Match premium modular kitchen interiors.
Maintenance	Allow cleaning and replacement of trays or slides.

XIV. USER FLOW

The user flow for NIVIRT involves a straightforward process: opening the cabinet, pulling the organizer forward, rotating the tray, selecting the desired item, returning it, and pushing the organizer back in. This sequence is intended to be intuitive and easy to repeat for daily cooking.

When not in use, the product remains concealed, maintaining the sleek look of a modular kitchen, while during use, it enhances visibility and accessibility of stored items, thereby aiding in organization and workflow.

Table 7. User flow sequence

Step	User action
1	Open the corner cabinet.
2	Pull the organizer outward.
3	Rotate the tray to view stored items.
4	Select or return the required item.
5	Push the organizer back inside and close the cabinet.

XV. CONCEPT 1

Concept 1 explored a rotating central organizer. This concept improved visibility through circular movement but did not sufficiently solve the problem of reaching into the rear corner of the cabinet. It was useful for understanding tray organization but required further development for access.

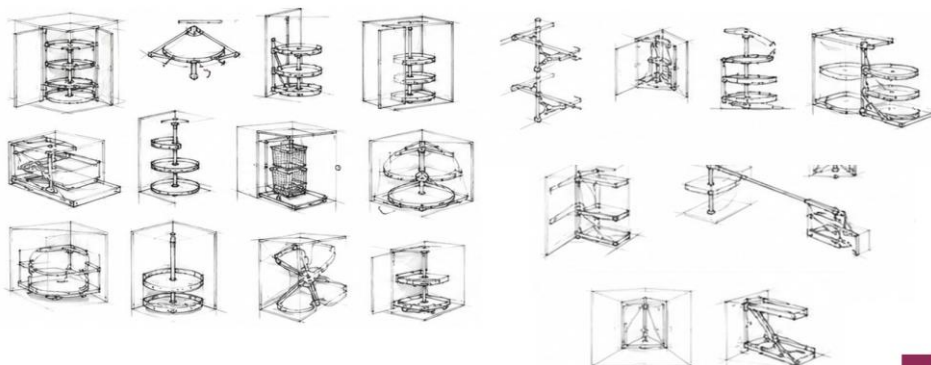


Fig. 6. Initial ideation sketches explored for corner cabinet access

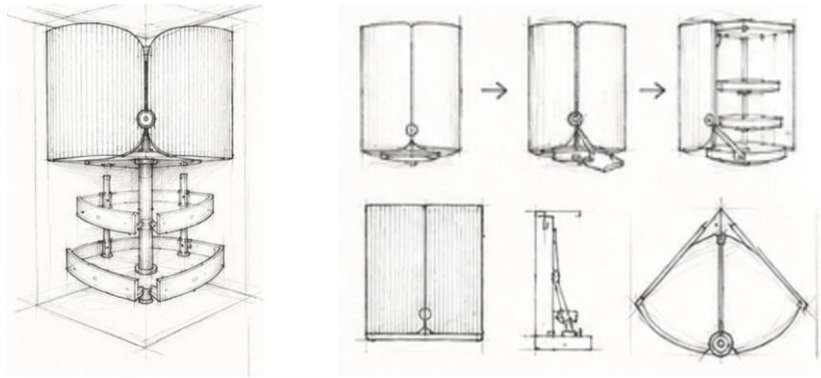


Fig. 7. Concept 1 - rotating central organizer

XVI. CONCEPT 2

Concept 2 explored a pull-out rotating organizer. This concept combined forward sliding movement with tray rotation, allowing stored items to move out of the cabinet and become visible. It performed strongly in access, visibility, usability and manufacturability, and was selected for further development.

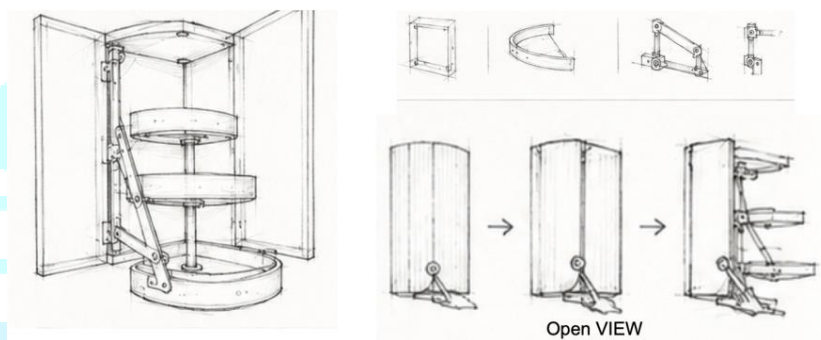


Fig. 8. Concept 2 - pull-out rotating organizer

XVII. CONCEPT 3

Concept 3 explored a vertical storage organizer. The concept offered compact storage but limited access to rear items and created difficulty in arranging different container sizes. It was not selected because it did not provide the required level of workflow support.

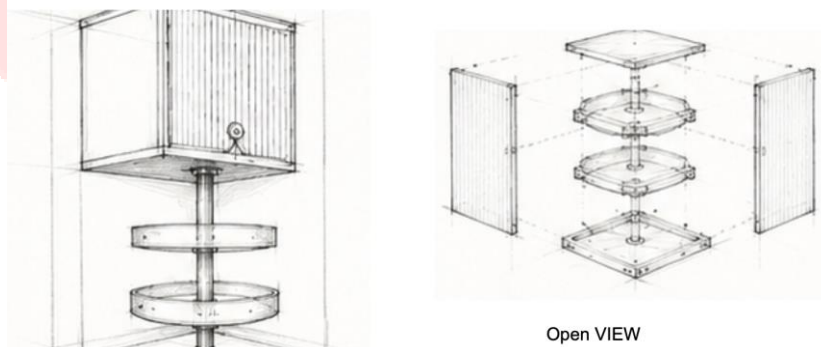


Fig. 9. Concept 3 - vertical storage organizer

XVIII. CONCEPT 4

Concept 4 explored a modular kitchen organizer with multiple storage sections. It offered flexibility but increased assembly complexity and maintenance. The design was considered less suitable for compact kitchens because it could become mechanism-heavy.

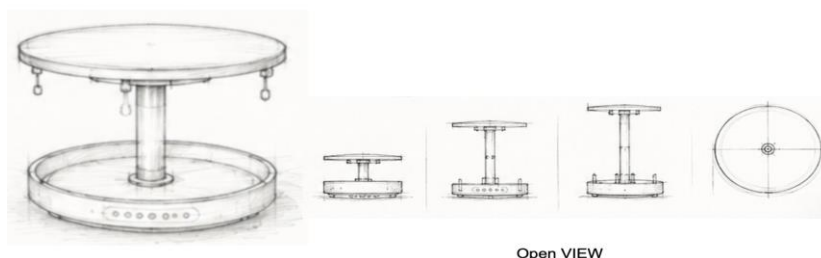


Fig. 10. Concept 4 - modular kitchen organizer

Table 8. Concept comparison

Concept	Key observation
Concept 1	Good rotation but limited pull-out access.
Concept 2	Best balance of access, visibility and manufacturability.
Concept 3	Compact but weak rear access.
Concept 4	Flexible but complex to assemble and maintain.

XIX. FINAL CONCEPT

Concept 2 was chosen as the ultimate design, evolving into NIVIRT. Its design features a cabinet-mounted sliding base with a central vertical support and circular trays positioned at various levels. These trays are designed to hold commonly used cooking essentials and can rotate around a central shaft when the unit is pulled outward. This concept effectively meets key design objectives by enhancing access, increasing visibility, minimizing countertop clutter, and optimizing the use of underutilized corner cabinet space.

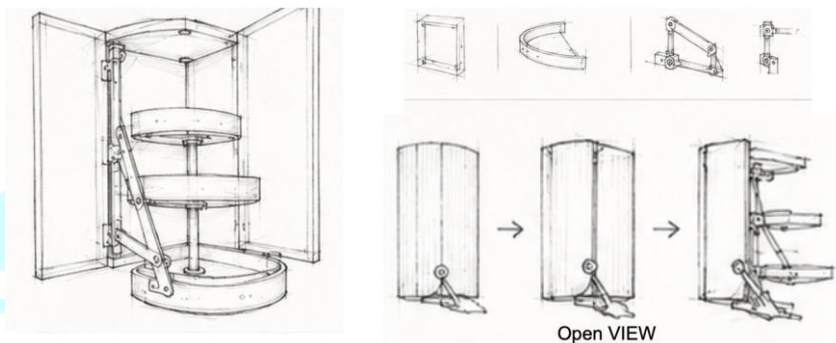


Fig. 11. Concept 2 rendered model selected as the final concept



Fig. 12. Final concept of NIVIRT pull-out rotating organizer

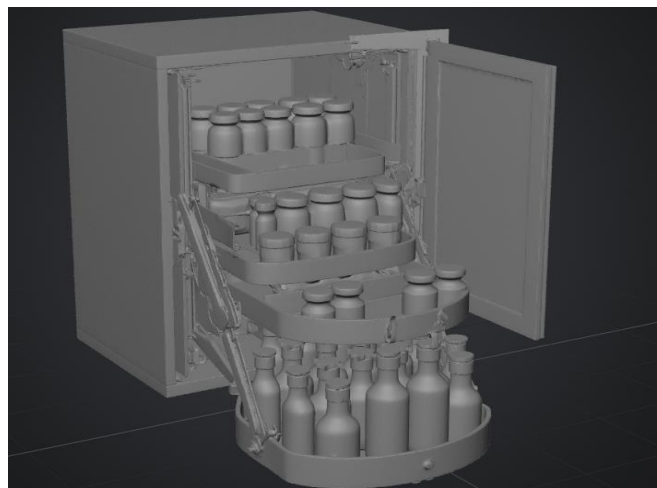


Fig. 13. Three-dimensional CAD model of NIVIRT

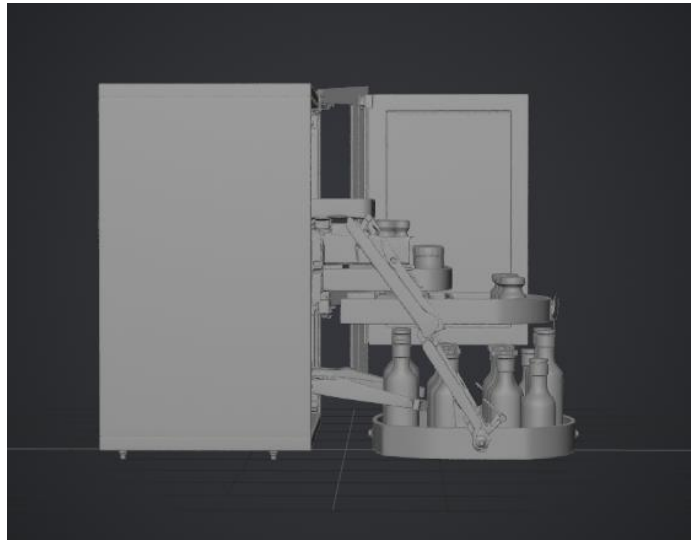


Fig. 14. Orthographic drawing set of NIVIRT

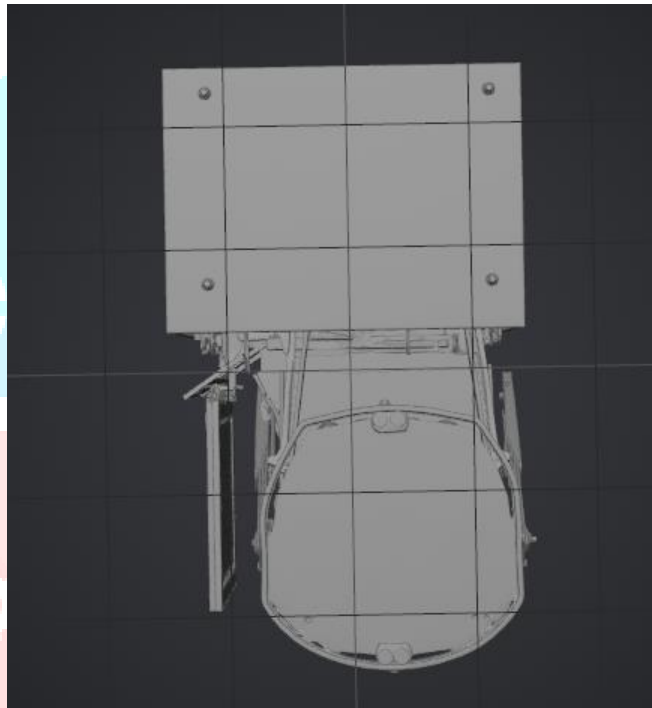


Fig. 15. Additional orthographic and dimensional views of NIVIRT

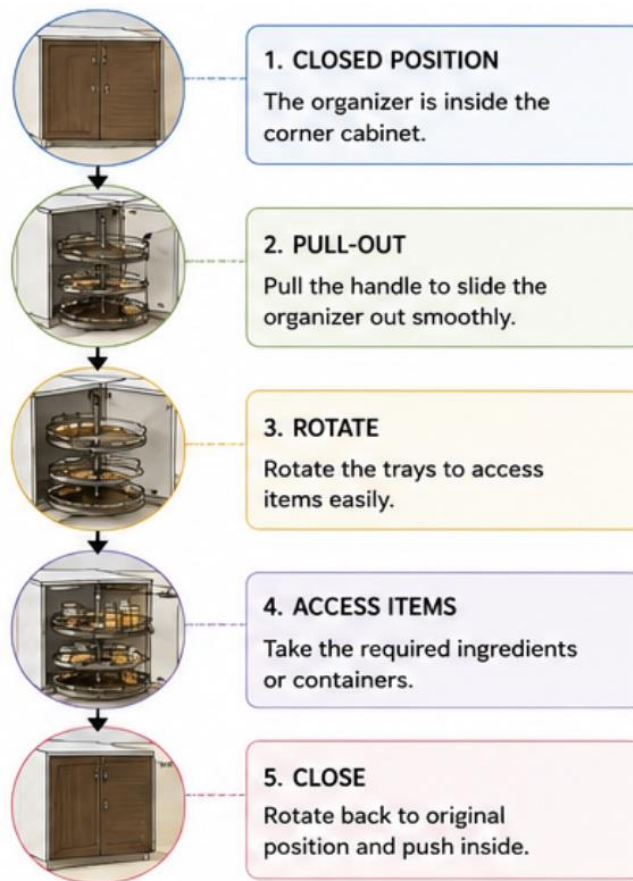


Fig. 16. Working principle of NIVIRT

XX. USER VALIDATION

User validation of the prototype aimed to assess its effectiveness in enhancing access and workflow. Users engaged with the design by pulling the organizer, rotating the tray, and retrieving items, providing feedback on aspects such as ease of use, visibility, comfort, and potential improvements. The validation results showed that users grasped the pull-and-rotate mechanism and appreciated the improved visibility of stored items. Recommendations for future iterations included ensuring smoother closing, allowing adjustable tray heights, and enhancing hardware alignment for better stability.



Fig. 17. Prototype development of NIVIRT



Fig. 18. User interaction with the NIVIRT prototype during functional evaluation



Fig.19 final product look

Table 9. User validation observations

Testing parameter	Observation
Movement	Pull-out and rotation sequence was understandable and usable.
Access	Stored items moved into a more reachable position.
Visibility	Circular layout improved selection of spices and condiments.
Stability	Tray support required careful balancing and joint reinforcement.
User feedback	Soft-close and adjustable heights were recommended.

XXI. CONCLUSION

The study introduced NIVIRT, a compact access system designed to enhance the usability of corner cabinets in Indian modular kitchens. It was discovered that users often leave frequently accessed cooking items on countertops due to the challenging nature of reaching deep cabinet areas while cooking.

Through a multifaceted approach that included user research, market analysis, design synthesis, and various development stages such as QFD, concept evaluation, CAD design, and prototype validation, the project transformed this common issue into an innovative product solution.

The final design features a combination of pull-out movements and rotating trays, aiming to improve accessibility, visibility, and organization, thereby maximizing the use of often neglected corner space. With further refinements in engineering, durability testing, and cost analysis, NIVIRT holds significant promise as a functional storage solution for compact urban kitchens.

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