A/B Test Experimental Thesis Report
Impact of Navigation Layout Redesign on Monetization Performance
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Abstract

This research evaluates the causal impact of a navigation layout redesign within an e-commerce platform using a randomized controlled A/B experimentation framework. The experiment investigates whether transitioning from a horizontal navigation menu to a vertical layout improves user engagement and monetization outcomes. Validation procedures confirm balanced experimental allocation and unbiased sampling across treatment groups.

Statistical analysis reveals that although conversion rates remain unchanged, the treatment variant significantly reduces revenue per user. These results indicate that structural interface changes can introduce monetization friction even when engagement metrics remain stable. Based on statistical inference and projected business impact, deployment of the vertical layout is not recommended.

Chapter I — Introduction

1.1 Background

Continuous experimentation is essential in digital product development to ensure that interface changes improve both user experience and business performance. Navigation menus strongly influence user browsing behavior, product discoverability, and purchase decisions. Although vertical navigation designs are often perceived as modern and space-efficient, their behavioral impact must be empirically validated before large-scale deployment.

1.2 Research Objective

This study aims to estimate the causal effect of replacing the horizontal navigation layout with a vertical design on key performance indicators (KPIs), particularly conversion rate and revenue per user.

1.3 Research Questions

1. Does the vertical navigation layout improve conversion performance?
2. Does the redesign affect monetization efficiency measured through revenue per user?
3. Should the new layout be deployed based on statistical and business evaluation?

Chapter II — Methodology

2.1 Experimental Design

The study employs a Randomized Controlled Trial (RCT) framework, specifically a two-arm A/B test.

- Unit of Randomization: User Session.

- Population: Platform users during the active experiment window.

- Assignment Mechanism: Users were assigned to variants using a deterministic hashing algorithm to ensure consistent experience across a single session and a balanced 50/50 split.

- Variants:

    - Control: Existing Horizontal Navigation Menu.

    - Treatment: New Vertical Navigation Sidebar.

2.2 Data Acquisition & Preprocessing

The dataset (test1_menu.csv) comprises 7,000 unique sessions. Preprocessing steps included:

- Feature Engineering: Derived a binary is_purchase flag from the revenue column (1 if revenue > 0, else 0).

- Attribute Mapping: Standardizing categorical variables such as device_type, browser, and region for covariate analysis.

- Outlier Handling: Revenue data was inspected for extreme outliers that could disproportionately affect the mean; however, the use of non-parametric tests (Mann-Whitney U) reduced the necessity for aggressive trimming by focusing on rank-based distributions.

2.3 Experiment Validation & Guardrail Metrics

To ensure the internal validity of the experiment, three primary validation checks were performed:

1. Sample Ratio Mismatch (SRM): A Chi-squared goodness-of-fit test was applied to verify if the observed counts (3,500 vs 3,500) deviated from the expected 50/50 distribution. SRM detection is critical for identifying technical bugs in the randomization engine.

2. Covariate Balance (A/A Testing Logic): Independence tests (Chi-squared for categorical data) were performed on pre-treatment attributes (Device, Browser, Region) to confirm that no variant was accidentally biased toward a specific user segment.

3. Temporal Stability: Analysis of metric trends over time to ensure that the treatment effect was consistent and not driven by a single-day anomaly.

2.4 Statistical Framework & Hypothesis Testing

The statistical analysis was tailored to the mathematical properties of the KPIs:

- Conversion Rate (Binary Metric): Analyzed using a Two-Sample Z-Test for Proportions. This test assumes that under the null hypothesis, the difference in proportions follows a normal distribution, which is valid given the large sample size ($N=7,000$).

- Average Revenue Per User (ARPU) / Revenue Yield:
  - Preliminary checks using the Shapiro-Wilk test indicated that revenue data was highly non-normal and right-skewed.
  - Consequently, the Mann-Whitney U Test (a non-parametric alternative to the T-test) was selected. This test compares the distributions' medians and is robust to outliers and non-normality.

- Error Control: To mitigate the risk of Type I Errors (False Positives) arising from testing multiple metrics simultaneously, the Holm-Bonferroni correction was applied to the resulting p-values.

- Confidence Level: All tests were conducted at a 95% confidence level ($\alpha = 0.05$).

Chapter III — Results

3.1 Experimental Goals

Business Objective: The primary goal was to evaluate the impact of transitioning the Menu Layout from a traditional Horizontal orientation to a modern Vertical layout to enhance user engagement and potentially increase monetization.

Key Findings:

- Conversion Rate: Remained statistically stable across both variants.

- ARPU: Experienced a significant decrease in the Treatment group (~9.1% drop).

Final Recommendation: Retain the Horizontal layout. The Vertical design negatively impacts monetization without providing a lift in conversion efficiency.

3.2 Business Problem & Experiment Context

A/B testing is critical because "intuitive" design changes often lead to counter-intuitive behavioral shifts. The E-Commerce team hypothesized that a Vertical menu would better utilize screen real estate and improve product discoverability.

Hypotheses:

- Null Hypothesis (H_0): The Menu Layout change has no effect on user engagement or revenue metrics.
- Alternative Hypothesis (H_1): The Menu Layout change results in a significant shift in primary or secondary KPIs.

3.3 Data Overview

Variant	Sample Size (N)
Control (Horizontal)	3,500
Treatment (Vertical)	3,500
Total	7,000

3.4 Experiment Validation Framework

- Sample Ratio Mismatch (SRM) Test: $p = 1.000$ (PASS). The 50/50 split is perfectly aligned.
- Covariate Balance Checks:
  - Device Type: $p = 0.519$ (Pass)
  - Browser: $p = 0.663$ (Pass)
  - Region: $p = 0.835$ (Pass)

Conclusion: The experiment is trustworthy and the observed deltas can be attributed to the layout change.

3.5 Statistical Results

Metric	Control (H)	Treatment (V)	p-value	Relative Lift	Significant?
Conversion Rate	100%*	100%*	1.000	0.0%	No
Median ARPU	2.86	2.60	2.38e-08	-9.1%	YES

Note: In this specific dataset iteration, conversion was saturated at 100%, allowing for focused analysis on revenue yield.

Interpretation: The Mann-Whitney U test confirms the decrease in ARPU is highly significant ($p < 0.001$). The Vertical layout reduces the amount spent per transaction despite users still completing purchases.

3.6 Experimental Outcomes (Cross-Test Summary)

Experiment	Primary Metric	Result	Impact
Test 1: Menu	ARPU	-9.1% Lift	Significant Decline
Test 2: Novelty	ARPU	+5.57% Lift	Significant Increase
Test 3: Product	ARPU	+20.97% Lift	Significant Increase
Test 4: Reviews	CR	+0.53% Lift	Not Significant
Test 5: Search	ARPU	0.00% Lift	Not Significant

Chapter IV — Discussion

The findings highlight that interface redesigns appearing neutral in engagement (conversion) can still negatively impact monetization. The vertical layout likely alters browsing flow or product visibility, creating friction in the purchase funnel. Such negative outcomes are vital as they prevent deployments that would harm business performance.

Chapter V — Business Impact Assessment

- Behavioral Insight: The Vertical layout creates a friction point in the monetization funnel. It preserves "purchase intent" but reduces "basket value."
- Practical Significance: A -9.1% drop is a massive regression. In production, this would typically trigger an automated rollback.
- Risks: While the "Novelty Effect" might play a role, the statistical evidence is strong enough that waiting for recovery is too risky.

Strategic Implications: The Vertical menu may clutter the interface or bury high-margin items. "Modernizing" without considering visual hierarchy can be detrimental.

Chapter VI — Conclusion

The vertical navigation layout leads to a statistically and practically significant decline in monetization while leaving conversion rates unchanged.

Decision Statement: Reject the transition to a Vertical Menu layout. Recommendations:

1. Cease Traffic: Return 100% of users to the Horizontal baseline.
2. Future Research: Test a Hybrid Menu or refined Horizontal categories. Investigate why the Vertical layout suppressed spending (e.g., hidden filters or clutter).

Appendix: Experimental Results Table

Metric	Control	Treatment	p-value	Relative Lift	Significant
Conversion Rate	100%	100%	1.000	0.0%	No
Median Revenue per User	2.86	2.60	2.38e-08	-9.1%	Yes