CX Tracker: Visualizing Customer Experience Metrics in Restaurant Service Via a Mobile Application

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‘ABSTRACT

In the increasingly competitive hospitality sector, the ability to rapidly synthesize customer experience data is critical for operational success; however, many service-oriented restaurants continue to rely on fragmented feedback mechanisms such as legacy paper forms and unaggregated online reviews. This research introduces CX Tracker, an Android-based mobile application designed to bridge this gap by visualizing real-time Customer Experience (CX) metrics. Utilizing the Modified Waterfall methodology, the system was engineered with a Flutter and Dart frontend and a Firebase backend to facilitate the instantaneous synchronization of data from customer-facing QR surveys to executive-level dashboards. The application focuses on the visualization of three core Key Performance Indicators (KPIs): Customer Satisfaction Score (CSAT), Customer Effort Score (CES), and Net Promoter Score (NPS). User Acceptance Testing (UAT) was conducted with a cohort of 35 participants ($n_{customer}=28$; $n_{owner}=7$). Quantitative analysis revealed high usability and adoption rates, with customers reporting a mean score of 4.32 for QR-based entry and 4.25 for overall satisfaction. Critically, 85.7% of restaurant owners identified specific actionable business improvements via the dashboard's visual analytics. The findings demonstrate that a mobile-first, real-time visualization framework significantly enhances service recovery capabilities and facilitates data-driven managerial decisions in the restaurant service environment.

Keyword: Customer Experience, Data Visualization, Restaurant Service, Customer Effort Score, Net Promoter Score, Customer Satisfaction Score.

INTRODUCTION

Customer satisfaction is a critical factor in restaurant competitiveness because dining decisions are influenced not only by food quality but also by service speed, staff behavior, ordering convenience, ambience, and the ease of giving feedback [1]. In a market where customers can rapidly express positive or negative opinions through digital channels, restaurants need practical methods to collect, interpret, and act on customer feedback [2, 3]. However, many establishments still rely on paper surveys, disconnected online reviews, or manual observation. These methods often produce delayed and fragmented insight, leaving managers uncertain about the real causes of customer dissatisfaction [4].

Customer experience metrics such as CSAT, CES, and NPS provide measurable ways to understand restaurant performance. CSAT captures immediate satisfaction, CES measures the effort required for customers to complete service interaction, and NPS estimates loyalty through customers' willingness to recommend the restaurant [5, 6, 7]. When these metrics are presented visually, they can help managers detect patterns quickly, compare service dimensions, and prioritize improvements [8, 9]. Without a clear visualization tool, however, managers may struggle to interpret raw scores or recognize urgent service issues in time.

This project addresses the gap by developing CX Tracker, a mobile application that enables customers to submit feedback through a streamlined digital survey and enables restaurant owners to monitor the results through real-time visual dashboards. The project objectives are to identify suitable visualization techniques for customer experience metrics, develop a mobile application for restaurant service satisfaction, and test the

usability of the application. The scope focuses on Android users, restaurant owners or managers, and customers who interact with participating restaurants through QR scanning and location-based discovery.

LITERATURE REVIEW

Customer Experience in Restaurant Service

Restaurant service quality is multidimensional. Studies in hospitality and service marketing emphasize that satisfaction is influenced by personal service behavior, functional service delivery, perceived value, restaurant image, and the customer's broader digital or physical experience. Recent restaurant research also highlights the increasing role of online reviews, electronic word of mouth, mobile interaction, and digital service expectations. These trends suggest that customer feedback should be collected continuously and interpreted in ways that restaurant managers can use immediately.

Customer Experience Metrics

CSAT, CES, and NPS were selected because they represent complementary perspectives on service performance. CSAT measures immediate satisfaction after experience, making it useful for identifying whether food, staff service, cleanliness, or environment met customer expectations [10]. CES focuses on friction by asking how much effort customers needed to complete an action such as ordering, payment, or submitting feedback [11]. NPS measures loyalty by classifying users as detractors, passive, or promoters according to their likelihood of recommending the restaurant [12]. Used together, these indicators provide a more complete picture than a single star rating.

Data Visualization and Mobile Feedback

Data visualization helps transform large or unstructured feedback into patterns that can be understood quickly [13]. Charts such as bar charts, pie charts, histograms, gauges, and trend displays reduce the cognitive effort required to compare service dimensions. For restaurant managers, this is important because operational decisions often need to be made during active service periods [14]. A mobile application further increases practicality by allowing managers to monitor service performance without depending on desktop dashboards [9]. While established customer experience platforms—such as Customer Alliance, Staffino, and HappyFox—offer robust feedback functionalities, current literature underscores a critical gap for a mobile-centric system tailored specifically to the unique operational demands of the restaurant industry [15]. Consequently, this study proposes a solution developed for a mobile-centric platform that integrates seamless customer submission, real-time analytics, and QR-mediated access with intuitive visual metric interpretation.

METHODOLOGY

The development and evaluation of the mobile application were guided by the Modified Waterfall Model, a framework chosen for its ability to combine structured sequential progress with iterative feedback loops. This model was particularly advantageous for this study, as it allowed for the refinement of data visualization components and database schemas based on technical constraints encountered during the implementation phase. Unlike the rigid traditional waterfall approach, the modified version facilitated a "backtracking" mechanism between the implementation and design stages, ensuring that the final visual analytics were both technically feasible and user centric.

The process initiated with the Requirements and Planning phase, where the functional needs of the system were defined. The primary objective was to capture and visualize three key metrics: Customer Satisfaction Score (CSAT), Customer Effort Score (CES), and Net Promoter Score (NPS). During this stage, the necessity of integrating QR code scanning and location-based services was identified as a critical requirement to ensure that feedback was tethered to the correct restaurant profile and to prevent fraudulent entries. Following this, the System Design phase focused on the architecture of the platform, utilizing the Flutter SDK for the front-end and Firebase for the back-end infrastructure. The design prioritized a minimalist UI for the owner’s dashboard, ensuring that the complex data fetched from the Firebase Real-time Database could be translated into intuitive charts for users without specialized analytical training.

In the Implementation phase, the application was developed using the Dart programming language. A significant portion of this phase involved the synchronization of customer submissions with the owner's dashboard through Firebase Authentication and storage services. The "modified" nature of the model was utilized here; as specific visualization packages were integrated, the data structures within Firebase were iteratively adjusted to optimize the rendering speed of the CSAT and NPS charts. This overlapping of design and coding ensured that the synchronization between the two user roles—customer and owner—remained seamless.

The Integration and Testing phase involved a pilot study with 35 participants to evaluate the system's efficacy. According to Faulkner [16] and Nielsen [17], a sample size of this magnitude is highly sufficient for usability and pilot testing, as a group of 20 or more participants typically uncovers over 95% to 98% of usability deficiencies, offering a rigorous quantitative and qualitative baseline. This cohort consisted of 28 general customers and 7 restaurant owners, providing a dual-perspective evaluation of the application's utility. Crucially, the subgroup of 7 restaurant owners aligns with the industry benchmark established by Nielsen and Landauer [18], which asserts that a minimum of 5 participants per user profile is sufficient to identify the vast majority of core usability issues for that specific group. The customers tested the convenience of the QR code access and the submission interface, while the restaurant owners focused on the interpretability of the visual analytics provided in the dashboard. The feedback gathered during this phase allowed for final refinements in the Operation and Maintenance stage, ensuring that the application met the rigorous demands of a real-time restaurant service environment.

Survey Instrument and Data Collection

To evaluate the efficacy and usability of the developed system, a structured survey instrument was derived and exported from the CX Tracker App questionnaire. The instrument was strategically bifurcated into two distinct modules to ensure that evaluation criteria remained contextually relevant to each specific user group. This dual-module approach allowed for a comprehensive assessment of the system's end-to-end functionality, from data entry to analytical output.

The customer-facing module focused on the front-end user experience, utilizing constructs designed to measure the efficiency of the QR-based survey access and the clarity of instructions. Beyond basic navigation and rating-scale usability, this module assessed the respondents' conceptual understanding of the CSAT, CES, and NPS metrics to ensure the feedback process was meaningful. Technical robustness was evaluated through successful submission rates, while behavioral intentions were gauged via repeat-use intention and perceived feedback value.

Conversely, the restaurant-owner module was designed to evaluate the Visual Analytics and Dashboard components. Key performance indicators for this group included the independent interpretation of visualized metrics, the perceived utility of the 30-Day Improvement Plan, and the professional quality of the generated PDF reports. Furthermore, this module investigated the actionability of the insights provided, specifically identifying which metrics—NPS, CSAT, or CES—offered the most significant business value for operational improvement.

Participant Demographics and Evaluation Focus

The evaluation involved a total of $N=35$ participants, stratified into two primary respondent groups as detailed in Table 1. The majority of the sample ($n=28$; 80%) represented the customer segment, focusing on the seamlessness of the survey flow and metric clarity. The professional segment consisted of restaurant owners ($n=7$; 20%), who provided expert evaluation on the dashboard's usability and the strategic value of the automated recommendations.

Table 1: Participants demographic

Respondent Group	Frequency	Percentage	Main Evaluation Focus
Customer	28	80.0%	QR survey flow, metric clarity, rating-scale usability, technical submission, and satisfaction
Restaurant Owner	7	20.0%	Dashboard usability, analytics interpretation, PDF report, QR generator, and actionable insights
Total	**35**	**100.0%**	**Overall system acceptance**

The demographic profile of the participants (see Table Y) indicates a predominantly male sample (68.6%), with a significant concentration in the 18–30 age bracket (94.3%). This demographic skew toward younger users is consistent with the early-adopter profile for mobile-based feedback systems and QR-code-driven technology in the restaurant industry.

System Architecture

The technical framework of the application is structured into a multi-tier architecture, as illustrated in Figure 1. This design ensures a clear separation of concerns across three primary layers: the User/Presentation Layer, the Visualization and Business Logic Layer, and the Data Persistence Layer. This modular approach was critical during the development phase of the Modified Waterfall Model, allowing for independent testing and optimization of each component.

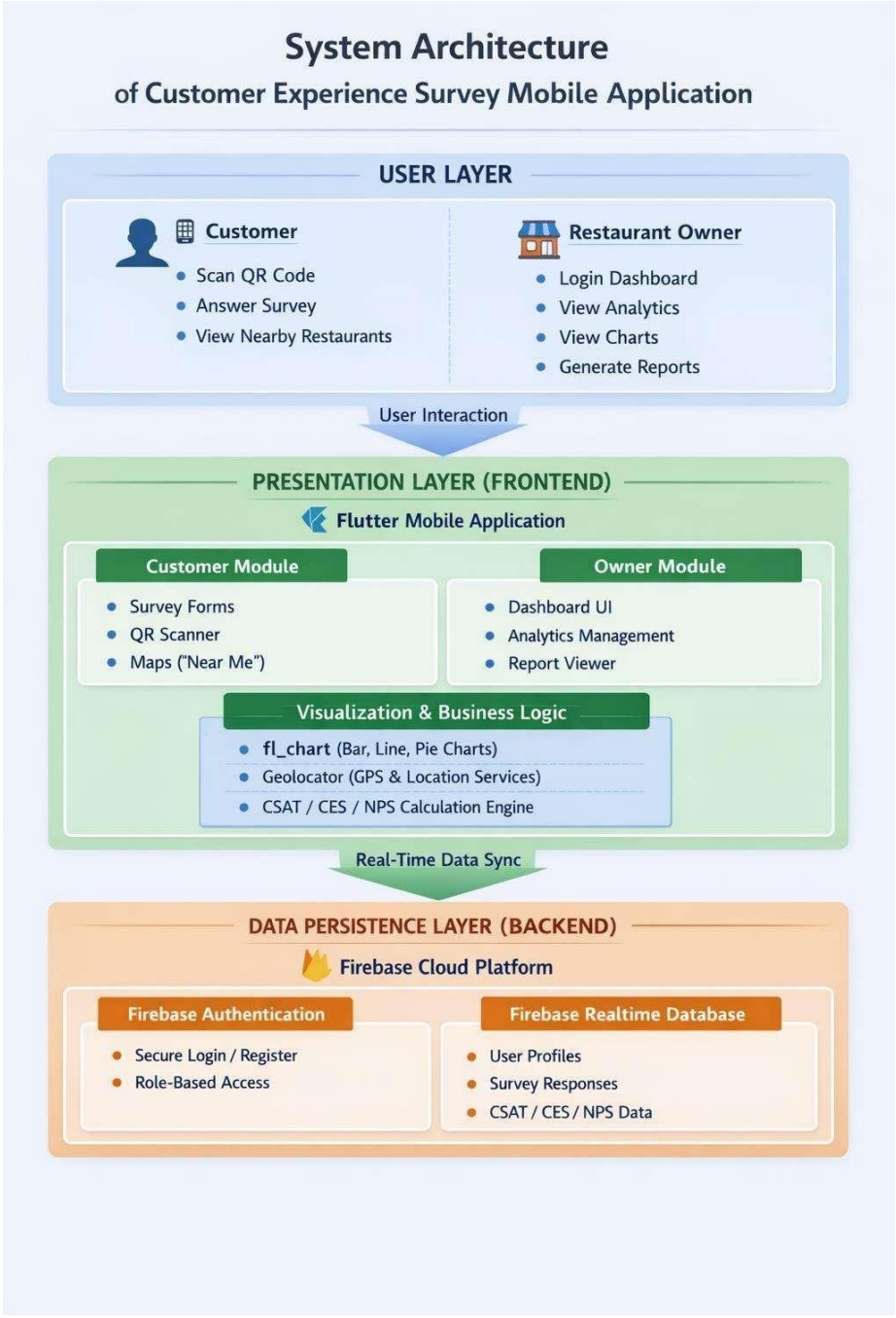

Figure 1: System architecture of the CX Tracker mobile application.

Presentation Layer (Frontend)

The frontend was developed using the Flutter SDK, providing a responsive and unified interface for two distinct user roles: Customers and Restaurant Owners. For the customer module, the interface facilitates seamless

interaction through QR code scanning, GPS-enabled restaurant discovery via the **Geolocator** package, and an intuitive survey submission flow. For restaurant owners, the interface serves as an analytical command center, enabling profile management, QR code generation, and high-fidelity data visualization.

Visualization and Business Logic Layer

The middle tier acts as the system's computational engine, bridging the gap between raw data and actionable insights. This layer manages authentication protocols and role-based access control to ensure data security. Central to this layer is the Metric Calculation Engine, which processes raw survey inputs into standardized Customer Experience (CX) metrics, including CSAT, CES, and NPS. These values are subsequently rendered into visual components—such as comparison bar charts, pie charts, and trend-based summaries—using the fl_chart library. A distinctive feature of this layer is the Insight Engine, which applies logical heuristics to metric patterns to generate automated operational recommendations and a structured 30-Day Improvement Plan for the owners.

Data Persistence Layer (Backend)

The backend infrastructure is powered by the Firebase Cloud Platform, specifically utilizing Firebase Authentication for secure user management and the Firebase Realtime Database for storage. Data is organized hierarchically to allow for efficient querying and real-time synchronization. One of the technical highlights of this architecture is the use of asynchronous data streams (WebSockets), which ensures that the owner's dashboard reflects customer submissions with minimal latency. During the evaluation phase, it was observed that dashboard values updated within approximately one to two seconds of a submission. This near-instantaneous synchronization eliminates the need for manual data processing, directly supporting the research objective of providing restaurant owners with rapid, actionable feedback loops.

RESULT AND DISCUSSION

User Acceptance Testing and Participant Profile

User Acceptance Testing (UAT) was conducted to evaluate the application's efficacy from the dual perspectives of customers and restaurant owners. A total of $N=35$ valid responses were recorded, comprising 28 customers (80%) and 7 restaurant owners (20%). The demographic analysis revealed a predominantly young adult cohort, with 94.3% ($n=33$) of respondents aged between 18 and 30, and a gender distribution of 24 males (68.6%) and 11 females (31.4%). This profile is highly representative of "digital natives," characterized by a high degree of proficiency in QR code interaction, mobile navigation, and digital feedback ecosystems, thereby ensuring that the evaluation was conducted by a technologically competent user base. The gender distribution presented in Figure 2.

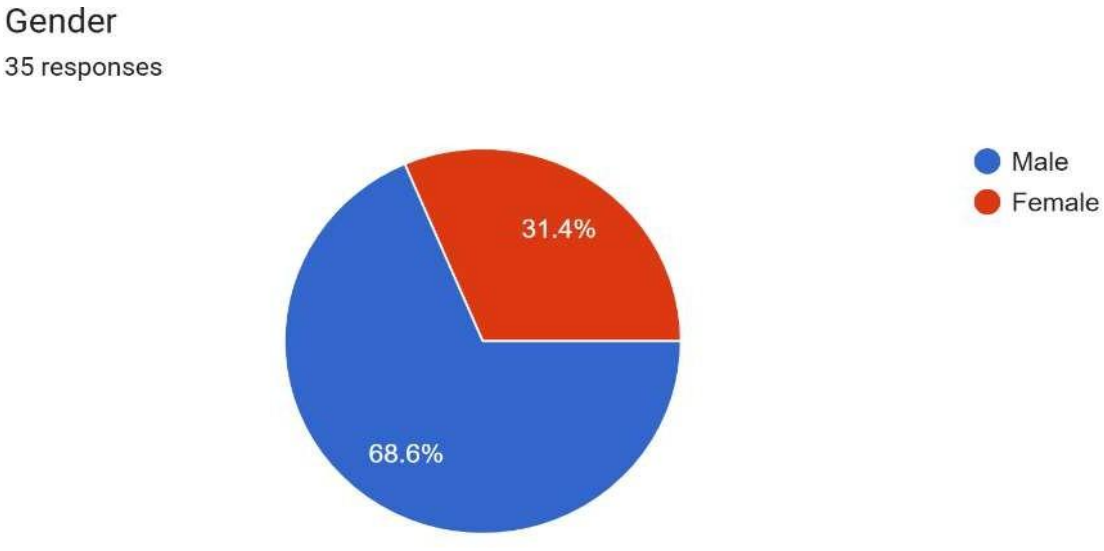

Figure 2: Gender distribution of survey respondents.

Customer Usability Evaluation

The customer-facing interface demonstrated robust usability metrics across several key performance indicators. As illustrated in Table 2, the "Ease of starting survey after QR scan" achieved a mean score of 4.32, with 89.3% of respondents providing a positive rating (4 or 5 on a Likert scale). This indicates that the QR-based entry point effectively minimizes friction in the feedback process.

Table 2: Usability evaluation result

Customer Survey Item	Mean Score	Positive Rating
Ease of starting survey after QR scan	4.32	25/28 (89.3%)
Clarity of CSAT, CES, and NPS instructions	4.00	20/28 (71.4%)
Navigation between survey questions	4.25	23/28 (82.1%)
Intuitiveness of 0-10 rating slider	4.11	22/28 (78.6%)
Likelihood of completing another survey	4.07	21/28 (75.0%)
Feedback would be valued by restaurant	4.36	25/28 (89.3%)
Overall survey experience satisfaction	4.25	25/28 (89.3%)

While general satisfaction remained high ($\mu = 4.25$), a qualitative breakdown of metric comprehension revealed a critical area for improvement. Approximately 39.3% ($n=11$) of customers expressed confusion regarding the specific definitions of CSAT, CES, and NPS before engaging with the system. This suggests that while the UI is intuitive, the theoretical framework of the metrics requires further on-screen elucidation, such as tooltips or contextual definitions, to improve data validity.

Owner Dashboard and Analytical Utility

The results from the restaurant-owner segment suggest that the visual analytics dashboard significantly enhances managerial decision-making. Both the "data discoverability" and "system navigation" achieved a mean score of 4.57, indicating a high level of interface efficiency. The highest recorded score ($\mu = 4.71$) was attributed to the usefulness of the automated recommendations, confirming that owners value the system's ability to translate raw data into actionable insights. The owner dashboard and analytical utility result presented in Table 3.

Table 3: Owner dashboard and analytical utility result

Owner Survey Item	Survey Result	Interpretation
Finding restaurant performance data	Mean 4.57; 7/7 (100.0%) positive	The dashboard made key statistics easy to access.
Dashboard, Insights, and QR Generator navigation	Mean 4.57; 7/7 (100.0%) positive	Owners could move between major functions with little friction.
Recommendation usefulness	Mean 4.71; 7/7 (100.0%) positive	Interpretive recommendations made the analytics more actionable.
PDF report professionalism	Mean 4.14; 6/7 (85.7%) positive	Most owners viewed the exported report as suitable for sharing.
Actionable improvement identified	Yes clearly: 4; Somewhat: 2; No: 1	6 out of 7 owners gained at least some actionable insight.
Recommendation to other owners	Definitely: 4; Probably: 3	All owner respondents expressed a positive recommendation intention.

Discussion of Managerial Implications

A significant contribution of this system is the multi-dimensional visualization of CX metrics. By presenting CSAT (immediate satisfaction), CES (process friction), and NPS (long-term loyalty) in a unified dashboard, owners can identify nuanced operational issues. For instance, a discrepancy between high CSAT and low CES scores may reveal that while the food quality is satisfactory, the service process is excessively laborious for the customer. Such insights are typically obscured in single-metric evaluation systems.

CONCLUSION

This research successfully developed CX Tracker, a mobile-based analytical solution designed to bridge the gap between raw customer feedback and strategic managerial decision-making in the restaurant industry. By integrating the Flutter SDK with a Firebase real-time backend, the system addresses the critical challenge of delayed and fragmented data common in traditional feedback mechanisms. The application facilitates a seamless, end-to-end digital workflow—from QR-mediated data collection to the real-time visualization of CSAT, CES, and NPS metrics—allowing restaurant owners to monitor service performance with unprecedented speed and clarity.

The adoption of the Modified Waterfall Model proved instrumental in the system's development, providing a structured yet flexible framework that allowed for the iterative refinement of visual components and data synchronization protocols. Evaluation results confirmed the system's high usability and perceived utility among both customer and owner demographics. The study demonstrates that the consolidation of disparate metrics (satisfaction, effort, and loyalty) into a single, intuitive visual dashboard enables owners to identify complex service-process contradictions that single-metric evaluations frequently overlook.

Despite its success, the study highlights several avenues for future enhancement. To address identified gaps in user comprehension, future iterations should incorporate embedded instructional tooltips and "just-in-time" education regarding CX terminology. Technical expansions, including iOS platform compatibility, theme customization (e.g., Dark Mode), and the integration of gamified incentive modules, could further drive higher response volumes and user engagement. Furthermore, integrating advanced methodologies such as AI-driven sentiment analysis and predictive analytics would significantly elevate the system's research contribution by transitioning it from a descriptive tool to a predictive framework. Additionally, the introduction of moderation features would empower owners with reputation management capabilities. CX Tracker represents a significant step forward in leveraging mobile-first architectures to transform qualitative customer sentiment into quantitative, actionable business intelligence, fostering a more responsive and data-driven hospitality sector.

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