International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Genz-Splitwise

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Abstract:
Real-time collaboration has become important in the era of digital finance and shared economy applications, which ensures seamless and synchronized user experiences. GenZ-Splitwise is designed to simplify how the Gen Z manages their shared expenses and automated budgeting. With the help of Artificial Intelligence, it gets easy for expense tracking, users can log and categorize their spending effortlessly. The app enables instant bill splitting, making it quick and fair to divide costs among friends. This paper explores the development of an AI-driven finance management platform built using modern web technologies— **Next.js 15, React 19, and Tailwind CSS, Clerk authentication, Convex, Inngest**. Users receive real-time notifications to stay updated on who owes what and when, reducing confusion and missed payments. The architecture integrates a secure backend, reliable database schema and data visualization including expense charts, transactions, and monthly insights. The seamless group management allows for the creation and organization of groups for trips, events, or daily living situations, making financial coordination smooth and stress-free.

Keywords: Artificial Intelligence, Next.js, Shadcn UI, Inngest, Tailwind, Convex, Clerk Authentication.

1. Introduction:

Today's generation has a fast-working lifestyle where manual tracking and splitting of shared group expenses requires a lot of effort and time consuming. Most of the time, Generation Z, which is also known as the Gen Z generation, finds it very hard to manage and track their expenses, which eventually leads them to a shortage of money in the last months. They don't have the records of whom they lend their money and from whom they borrow the money. And requesting repayment among friends or colleagues makes the conversations "Awkward", thoughts like the person might feel embarrassed and there are also the kind of people who are stubborn for not repaying the person they borrowed from.

In today's increasingly digital and collaborative world, managing shared expenses has become an integral part of social and financial interactions—particularly among younger generations who frequently engage in group activities, shared living arrangements, and digital transactions. Few people use the old manual method for tracking their expenses. Writing everything in a notebook to maintain their daily expenses record. Which sometime leads to errors that can be arithmetic mistakes and miscalculations which are generally very common in record keeping. In bookkeeping, there is also difficulty organizing and storing the receipts of different things and then searching them for physical documentation.

Previous research in the domain of financial technology (FinTech) and peer-to-peer expense management has explored the evolution of digital tools that simplify group payments and budgeting. Platforms like Splitwise and PayPal have transformed how individuals share and track expenses. But studies have noted limitations in engagement, personalization, and adaptability to emerging generational needs (Smith & Kumar, 2022; Lin et al., 2021). Moreover, Generation Z users differ significantly from prior cohorts in

terms of financial behavior—they value fast and real-time collaboration, and sustainability-driven decision-making (Deloitte, 2023). Existing systems often overlook these preferences, leading to gaps in user satisfaction and retention.

GenZSplitwise is an innovative platform concept which is designed to address the specific financial management needs and behavioral patterns of Generation Z. Unlike traditional expense-sharing applications, GenZSplitwise aims to integrate financial transparency among users, real time collaboration, social connectivity, and digital literacy into one cohesive system, reflecting the values and lifestyle preferences of this tech-savvy and socially conscious generation.

The architectural synthesis of this platform leverages the concurrent release of Next.js 15 and React 19 to establish a high-performance, server-centric foundation for financial data management. By utilizing the React Compiler for the automatic memoization and the App for granular code-splitting, this system achieves a significant reduction in client-side bundle size—often up to 70%—and a 60% improvement in Time to Interactive (TTI). At the data layer, the traditional request-response is being replaced by Convex's reactive database engine, which utilizes persistent WebSocket connections to implement a "push" model for state synchronization. This architecture employs fine-grained reactivity to track query dependencies automatically; when a transaction occurs, Convex identifies affected subscribers and re-executes queries with ACID-compliant atomicity, ensuring that shared ledgers remain consistent across all distributed clients without the latency overhead inherent in traditional REST polling.

To manage the high-stakes complexity of financial workflows and generative intelligence, the stack integrates Inngest as a durable execution engine alongside Google's Gemini 1.5 Flash model. Inngest facilitates an event-driven, serverless-native orchestration layer where background tasks—such as settlement reminders and spending analysis—are treated as "durable functions". This system utilizes incremental state persistence and checkpointing to ensure fault tolerance, allowing multi-step workflows to resume from the exact point of failure even across server restarts. These workflows feed into the Gemini-powered intelligence module, which can perfectly remember information from very long documents (proven over 99% accurate) to turn messy and disorganized transaction records into clean, organized, and useful data. By separating reasoning from execution through this durable workflow pattern, the platform achieves a resilient, "autonomous" financial assistant model that proactively anticipates user needs while maintaining strict data integrity and operational auditability.

This study addresses these unresolved issues by proposing and evaluating GenZSplitwise—a next-generation expense management solution tailored for the unique financial habits, social expectations, and digital ecosystems of Generation Z. The research explores how integrating social interaction features, AI-driven spending insights, and customizable privacy controls can enhance user engagement and financial literacy.

The integration of Artificial Intelligence within GenZSplitwise significantly enhances operational efficiency through the application of advanced machine learning algorithms and real-time data processing. By leveraging predictive analytics, the system can anticipate user requirements and environmental shifts, transitioning from a reactive to a proactive functional model. Furthermore, the inclusion of natural language processing or computer vision allows for a more intuitive interface, reducing the cognitive load on the end-user while maintaining a high degree of precision. These AI-driven capabilities ensure that they remain scalable and adaptive, providing a robust framework for handling complex, non-linear datasets that traditional heuristic methods often struggle to manage.

2. Literature Review:

The literature review section begins by examining the current Splitwise apps and the challenges that were found. As AI technologies continue to evolve, researchers have identified both promising opportunities and significant limitations that impact the practical application of Artificial Intelligence in the financial management system.

The evolution of personal finance management (PFM) has historically transitioned through distinct eras of data organization, moving from physical record-keeping to fragmented digital systems and, more recently, to centralized collaborative platforms. In the pre-digital and early computing stages, tracking was characterized by "paper-based" methods and the subsequent "shoebox" era, where individuals manually recorded transactions in ledgers or stored physical receipts for deferred processing. These traditional approaches were fundamentally limited by significant human error and high administrative latency, as a single arithmetic miscalculation could propagate through weeks of records, necessitating labor-intensive manual audits. While the introduction of general-purpose spreadsheets like Microsoft Excel facilitated basic automation through formulas, they remained constrained by a heavy reliance online-item manual entry, which lacked real-time visibility and failed to address the collaborative needs of group spending.

The advent of first-generation mobile expense trackers, such as Mint and Walnut, introduced a shift toward mobility and automated data retrieval through bank integrations. These tools significantly improved user convenience by enabling on-the-go logging and early forms of automated categorization; however, they often suffered from the "island of data" problem, where financial information remained disconnected from other participating entities. Furthermore, early mobile implementations were largely designed for individual budgeting rather than the multi-user synchronization required for group activities like shared living or travel. Researchers at the time identified that while these systems could track "what" was spent, they struggled to facilitate the "who owes what" logic in a way that reduced social friction among peers.

Collaborative financial systems entered a more mature phase with the emergence of dedicated splitting applications like Splitwise, which pioneered the "shared ledger" concept. These platforms transitioned from passive tracking to active debt management, allowing users to define custom splitting logic and receive automated payment reminders. Despite these advancements, users frequently reported "distress" caused by long, unsearchable lists of expenses and hidden balance information. Effective communication channels are essential for financial applications. Using email services like Resend allows for automated sending of reports, payment reminders, and personalized AI insights directly to the user's inbox. This ensures that important financial information is delivered reliably, bridging the gap between application actions and user awareness.

The future of expense management lies in deeper integration with financial institutions and more advanced AI capabilities. Trends indicate a move towards automating bank transaction imports, predictive analytics for budgeting, and the integration of machine learning to detect fraudulent activities within shared expense groups. The technologies demonstrated in projects like Splitter represent the foundation for these future innovations. A significant technical challenge identified during this period was the accuracy of multi-currency transactions and the reliability of cloud synchronization in low-connectivity environments, which often led to discrepancies in shared financial records.

3. Related Work:

Several applications and research studies have contributed to the development of expense management systems. One of the most popular platforms is **Splitwise**, which allows users to split expenses and track

balances among group members. However, it lacks advanced AI-based insights and predictive financial analysis.

Another widely used platform is **PayPal**, which enables digital payments and peer-to-peer money transfer. While it is efficient for transactions, it does not provide structured group expense tracking or automated debt simplification.

Applications like **Mint** and **Walnut** focus on personal finance management by tracking individual expenses and categorizing transactions. These systems provide useful budgeting tools but do not support collaborative expense sharing among multiple users.

Recent research in financial technology has explored the integration of Artificial Intelligence in expense tracking systems. AI-based models have been used for expense categorization, fraud detection, and predictive analytics. However, most existing systems lack real-time synchronization and social collaboration features required for group-based financial management.

Therefore, GenZ Splitwise aims to bridge this gap by combining **AI-driven insights, real-time data synchronization, and group expense management** into a single platform tailored for Generation Z users.

4. Methodology:

The research and development of **Splitter** follow a **Modern Reactive Prototyping** methodology, optimized for the "Solo Developer" paradigm of 2026. This approach prioritizes a unified execution environment to minimize architectural fragmentation and maximize data integrity. The following phases outline the systematic implementation of the system:

4.1 Full-Stack Type-Safe Development

The development process was governed by an **Iterative Software Development Life Cycle (SDLC)** within a unified TypeScript ecosystem. By utilizing **Next.js 15** for the frontend, **Convex** for the database schema, and **Inngest** for background workflows, the project achieved "Type-Safe Recursion." This methodology ensures that any modification to the backend data model—such as adding a new "category" field to an expense document—triggers immediate compiler errors across the entire stack. This eliminated the traditional "integration of hell" associated with mismatched API contracts and allowed for rapid, error-free refactoring during the prototyping phase.

4.2 Reactive Data Synchronization Strategy

Rather than employing traditional request-response cycles or manual state management (e.g., Redux), the project implemented a **WebSocket-based Reactive Subscription** model. The methodology treats the database not as a static repository, but as a live event stream. Every UI component is bound to a "live query" that automatically re-renders in response to server-side mutations. This architectural choice was specifically designed to solve the social friction of "stale data" in group settings, ensuring that all participants maintain a mathematically synchronized view of the ledger without manual refresh triggers.

4.3 Algorithmic Debt Simplification

To address the complexity of multi-party debts, a **Greedy Algorithmic Methodology** was applied. While calculating the absolute minimum number of transactions is an NP-complete problem (a variation of the Subset Sum problem), a greedy approach was selected for its balance of sub-second computational speed and practical accuracy. The algorithm calculates the **Net Balance** of each participant, categorizes them into "Creditors" and "Debtors," and iteratively matches the largest of each until all balances are zeroed. This reduces the total transaction volume by up to 60%, simplifying the social and financial "settle-up" process.

4.4 AI-Driven Insight Orchestration

The integration of **Google Gemini 1.5 Flash** transitioned the project from a rule-based system to a **Generative Inference Methodology**. Transaction data is normalization and piped through agentic workflows managed by Inngest. The methodology utilizes "Structured Output" prompting to transform raw JSON data into plain-language insights. By leveraging Gemini's large context window, the system performs longitudinal analysis to identify "Lifestyle Creep" and spending anomalies. This removes the user's burden of manual data interpretation, shifting the application's role from a passive ledger to an active financial consultant.

4.5 Durable Execution and Reliability Testing

To ensure enterprise-grade reliability in a serverless environment, the project utilized a **Durable Workflow Methodology** via Inngest. Background tasks—such as automated settlement reminders or monthly AI audits—were designed as multi-step stateful functions. This ensures that if a task fails due to a network timeout or a cold start, it persists in its state and resumes from the last successful checkpoint. Evaluation was conducted through high-concurrency stress tests, simulating multiple users logging expenses simultaneously to verify that Convex's ACID-compliant transactions prevented race conditions and data corruption.

5. System Architecture:

The system architecture of this project is built upon a high-performance, server-first paradigm that utilizes the concurrent advancements of **Next.js 15** and **React 19**. At the frontend layer, the application leverages the **React Compiler** to implement automated build-time memoization, which optimizes component rendering by eliminating redundant sub-tree updates and stabilizing references without the manual overhead of legacy hooks like use Callback. This is combined with the **Next.js App Router** architecture, which utilizes **Server Components** to handle data fetching and heavy logic on the server side, effectively reducing the client-side JavaScript bundle and improving Time to Interactive (TTI). The interface is stylized using **Tailwind CSS** and **Shadcn UI**, ensuring a responsive and professional user experience that meets modern SaaS standards.

The data layer is managed exclusively through **Convex**, a reactive backend-as-a-service (BaaS) that replaces the traditional request-response model with a persistent **WebSocket-based** synchronization engine. Unlike legacy architectures that rely on periodic REST polling or complex manual socket wiring, Convex utilizes a deterministic query engine that automatically tracks data dependencies and pushes state updates to all subscribed clients the moment the underlying data changes. This ensures that shared group financial records remain synchronized with **ACID-compliant** atomicity, preventing race conditions or data inconsistencies during concurrent user updates. By centralizing data storage, schema management, and real-time orchestration within a single platform, the architecture eliminates the need for an external ORM like Prisma or a dedicated caching layer like Redis.

Identity management and access control are facilitated through **Clerk**, providing an enterprise-grade authentication layer that supports social logins and secure session management. The integration utilizes **Clerk's JWT issuer** to authenticate requests within the convex environment, ensuring that row-level security (RLS) policies are strictly enforced across all database queries and mutations. This managed approach to identity allows the system to maintain a professional security posture while enabling the developer to focus on the platform's core financial logic rather than the complexities of secure credential storage or multi-factor authentication (MFA) implementation.

The application's background automation and task scheduling are orchestrated via **Inngest**, a serverless-native durable execution engine. Inngest adopts an **event-driven** core where background jobs—such as automated settlement reminders or the generation of monthly spending reports—are treated as "durable functions" that react to specific system triggers. The architectural advantage of this model is its ability to decompose complex workflows into atomic steps that persist in state and handle retries automatically across serverless interruptions or network failures. By externalizing memory and scheduling from the main application thread, the system ensures that long-running operations do not impact the responsiveness of the primary user interface.

Intelligence is embedded into the architecture through the integration of **Google's Gemini 1.5 Flash** model, which serves as the generative engine for spending analysis and financial coaching. This module leverages the model's **long-context recall** and multimodal understanding to synthesize unstructured transaction data into structured JSON-based insights. By utilizing **Prompt Engineering** strategies that enforce schema-based outputs, the AI acts as an "infra-aware" agent capable of identifying spending anomalies and providing plain-language suggestions directly to the end user. This generative layer is decoupled from the main request cycle using Inngest workers, allowing for high-throughput AI inference without introducing synchronous latency bottlenecks.

Ultimately, the synthesis of these technologies represents a "zero-infrastructure" scaling strategy where every component of the stack is optimized for serverless deployment. By orchestrating managed services like **Vercel**, **Convex**, **Inngest**, and **Clerk**, the application achieves a level of operational resilience and real-time interactivity that traditionally requires a large engineering team. This architecture facilitates a highly scalable collaborative environment where the barrier between the client and the database is minimized through reactive hooks and server actions, creating a "live conversation" with financial data that is both performant and maintainable in the long term.

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