A Secure Economic Cashflow Management Web Application

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As the number of financial providers, products, and accounts increase for an individual, it can become difficult to define a clear picture of an individual's financial state. The regulatory shift from open banking initiatives has influenced financial markets, demanding legacy institutions to provide greater flexibility for customers to access their financial data. Sparking an influx of third-party applications and financial technologies to flourish and drive greater competition in the sector. This industry change has opened the opportunity to develop an application which can capture a comprehensive picture of an individual's financial state, allowing for optimization via the economic order quantity (EOQ) model from operations research. With slight modification to the classical EOQ model, a robust prediction of the thresholds in which one may invest, require more funds or maintain is uncovered. This discovery is substantial in that it converges across disciplines, to leverage the advancements in technology and regulation to define a novel approach in managing an individual's financial state through a mathematically robust optimization theorem.

CCS Concepts: • **Applied computing** → **Forecasting**; • **Computer systems organization** → **Cloud computing**; • **Human-centered computing** → *Collaborative and social computing systems and tools*; • **Social and professional topics** → *Intellectual property*.

Additional Key Words and Phrases: Economic Order Quantity (EOQ), Open Banking, Applied Computing, Social Media, Personal Finance

ACM Reference Format:
Anthony B. Trevino. 2025. A Secure Economic Cashflow Management Web Application. *ACM Trans. Model. Comput. Simul.* 77, 7, Article 7 (July 2025), 8 pages. https://doi.org/XXXXXXX.XXXXXXX

1 Introduction

With rise of internet-based technologies and tools which access them in the last quarter century, one of the core access patterns is the web application interface. In the financial products sector, customers demanded that institutions join the internet-based application space and therefore the dominant financial products today are accessible through mobile and web applications [Gozman et al. 2018]. In addition, the level of ease and accessibility of these applications is a critical factor of customer satisfaction for the financial product and institutions. Although the modernization of financial institutions is well underway, the development and impact of "open banking" is new, with the academic literature showing a sharp uptick since 2019 [Gorka Kaminsky and Plaza 2022]. This additional consumer demand for open banking and regulatory pressure has forced financial institutions to move away from a closed data ecosystem to an open one. Where a customer can leverage third-party applications to extract information, as well as perform specific actions to the account held within the integrated financial institution. Because of the early state of the open banking, financial data sharing space, there is still a lack of understanding a modern technology framework and web application architecture to support securely capturing the holistic view of an individual's financial state.

In capturing the comprehensive view of the individuals financial state across many financial institutions, additional computation can be applied to forecast a future financial state. Leveraging methodology of the classical economic order quantity (EOQ) theorem first defined by Harris in 1913 [Harris 1913] and further expanded upon by Snyder in 1973 [Snyder 1973] a significant body of literature exists in the context of inventory management. This research differs in applying the EOQ to the individual's financial context. To obtain the outcome of optimizing an individuals cashflows via a robust mathematical theorem, a user interface as well as data integration framework is required. This is accomplished using modern web application technologies, methodologies and third-party integration systems such as Plaid.

More specifically using React for the front-end, Node server-less functions deployed to Google Cloud Functions, Google Firestore and Firebase as the core databases, Google Cloud Storage and a content delivery network for hosting and delivery, Google Cloud KMS for data encryption at rest, and finally the Plaid API for financial institution connectivity. This framework provides the services and connectivity required to securely define an individuals financial state. Once the application has gathered enough historical data and the individual has entered a complete view of their assets and liabilities, the economic order quantity is applied to define the investment and re-order points, as well as the investment and re-order amounts. In the context of an individual that is optimizing assets on-hand to meet the average periodic demand or costs. Providing insight to when the individual may want to invest abundant cash on hand and how much they should invest, or the contrary when a individual may require additional cash from savings and how much to withdraw or order. The aforementioned discoveries provide novel advancements to the fields of applied computing, operations research and finance to benefit society in uplifting financial literacy. A unique technological framework based upon modern web application patterns, leveraging the open-banking financial industry shift, to implement a modified lot size optimization theorem enabling individuals with confident direction to act upon in managing cashflow across financial accounts.

To re-iterate the objective, this work seeks to resolve the following research questions thorough definition of the economic cashflow management theorem, integrated within a modern web application to maintain the security, privacy and flexibility for individuals while obtaining the required data for optimization.

- RQ1: *What web application tools and methods can be utilized to securely capture a holistic, reliable view of an individuals financial state?*

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ACM 1558-1195/2025/7-ART7
https://doi.org/XXXXXXX.XXXXXXX

- RQ2: *What is the optimal investment point, re-order point, investment amount and re-order amount given a holistic view of the individuals financial state?*
- RQ3: *How can the latest regulatory and technological advancements in open banking integrate with a traditional operations research lot size optimization method to improve the financial literacy and subsequent financial well-being of individuals?*

2 Methodology

As the research questions are divided into three sections, the procedures and methodology required to provide clarity to each research question are broken apart similarly. The mathematical proof of the application of the economic order quantity to the individuals financial context will be discussed first, leveraging unknown or random variables, less process and technology intensive. Next, a modern web application framework for open banking is defined with the specific functionalities and security controls in place. Lastly, the end-to-end integration of these discoveries, distribution to users, security monitoring, financial impact, data usage, data retention and feedback are discussed.

2.1 Economic Cashflow Management Theorem

This section will define the Economic Cashflow Management Theorem, an application of the Economic Order Quantity Model (EOQ) to personal finance. Optimizing an individuals cashflow to increase assets available for higher returns while meeting the average periodic demand. The following classical EOQ variables and definition were shared during the undergraduate production control coursework at Arizona State University by Professor Askin [Askin 2019]. Subsequently these variables are applied to the individuals financial context.

2.1.1 Classical EOQ Variables.

Holding Costs: $= \ h = \ \ i\, C\, \bar{I}$ an (Annual) percentage (i) of average inventory investment

Rate of Holding Costs: i = Cost of Space, Lost Investment Opportunity Cost, Obsolescence, etc.

Setup/Changeover/Ordering Cost: $= \frac{AD}{Q}$, costs per order Ax orders per year D/Q.

Annual Demand $= D$

Order Quantity $= Q$

Cost per Unit: C = 1\$ = 1 $Unit$

Average Inventory $\bar{I} \implies \bar{I}_i = \frac{1}{i}\sum_{i=0}^{i} I_i$

Cost per Order: $= A$

Economic Order Quantity: $= Q_i$

$[\text{if } I_i < r_i] \implies Q_i = \sqrt{\frac{2A_i\overline{D_i}}{h_i}}$

$[\text{if } I_i > r_i] \implies Q_i = 0$

Re-Order Point: $= r_i = \tau_A \overline{D_i}$

Lead Time : $= \tau_A$ = Lead time between order of inventory and arrival.

2.1.2 Individual Financial Context. In order to apply this theorem to the individual financial context, additional considerations are required. In this context the "Inventory" would be the individuals short term assets or cash available for immediate use. Whereas savings, retirement, property or other assets would be considered longer term assets. This distinction is important because short-term assets are the amount for which investment optimization will occur. Additionally the demand per period will require flexibility dependent on the short-term assets change during that period. Relaxing one of Professor Askins noted constraints on constant demand [Askin 2019]. Instead if an individual spends 150 dollars but got paid 1000 dollars in a period then the demand is zero as the short term assets had a net increase not decrease. This leads to the concept of net change, for which demand is dependent. Given the period of measurement if the individuals short term assets decreased then demand is equal to that negative net change. However if the net change is positive within the period of measurement the demand is zero, further defined below. An intuitive investment threshold is defined as a sum of the re-order value, order quantity and desired investment amount. The diagram in in figure 1 below shows the high level orchestration of the economic order quantity application to personal finance.

Holding Costs: $= h_i = \ \ i\, C\, \bar{I}$

[Lost Investment Opportunity Cost]

Investment Return: i;

[Estimate return on long term assets]

Cost per Unit: C = 1\$ = 1 $Unit$

Average Short Term Assets: $\bar{I} \implies \bar{I}_i = \frac{1}{i}\sum_{i=0}^{i} I_i$

Setup Cost: $= \frac{AD}{Q}$

Income: $= A_i$;

[Approximate cash generated per period]

Net Change: $= NC_i =$ Sum of all Cash flows in period $= CF_i^{+} - CF_i^{-}$

$[\text{if } NC_i < 0] \implies D_i = |NC_i|$

$[\text{if } NC_i > 0] \implies D_i = 0$

Demand: $= \overline{D}_i = \frac{1}{i+1}\sum_{i=0}^{i-1}|NC_i| \implies \frac{1}{i+1}\sum_{i=0}^{i-1} D_i$

Economic Order Quantity: $= Q_i$

$[\text{if } I_i < r_i] \implies Q_i = \sqrt{\frac{2A_i\overline{D_i}}{h_i}}$

$[\text{if } I_i > r_i] \implies Q_i = 0$

Re-Order Point: $= r_i = \tau_A \overline{D_i}$

Lead Time : $= \tau_A$

[Lead time between paychecks or aggregate income flow and transfer time]

Desired Investment Amount: $= z$

[Target amount of money individual desires to invest during interval]

Investment threshold: $Y_i = r_i + Q_i + z$

Invest if condition A and B are Met:

[Condition A] $I_i > Y_i$

[Condition B] $I_i - Y_i - D_i > 0$

Investment Amount: $\Delta_i = I_i - Y_i - D_i$

2.1.3 Mathematical Proof - Example. The following is a sample of questions and data points to initiate the model.

Google Sheets Example Problem https://docs.google.com/spreadsheets/d/19UFwlwobvhcvf8LA1VnPy0XWBtuGiWFGkX-fbACpsl4/edit?usp=sharing

- **Long Term Asset Return:** 5% $\implies i = 5\%$

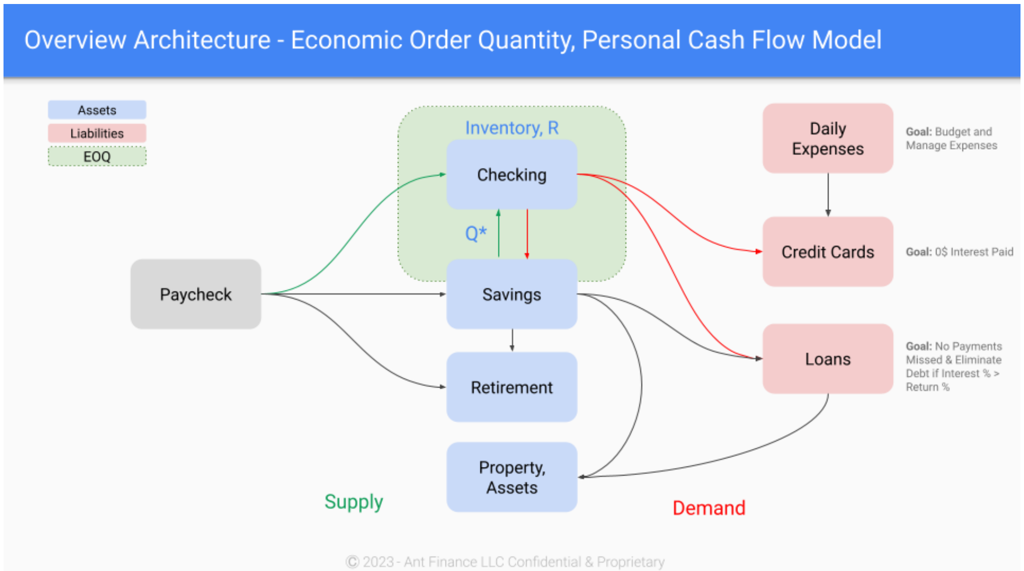

Fig. 1. EOQ Application to Personal Finance - Logical Flow

- **Personal Statement on Cash/Balance:** "Maintain 4000$ in checking and 200 cash"
- **Personal Statement on Spend/Demand:** "Spend roughly 500 dollars a week in daily expenses and have 1200 in monthly costs"
- **Personal Statement on Income:** "I make 1000 dollars weekly after tax" $\implies$ Weekly $A_i = 1000$
- **Personal Statement on Savings:** "I have 98,000 dollars saved and plan to save 30% of all paychecks" $\implies$ $S_0 = 98000$ $[\implies z = 1000 * .3 = 300]$
- **Personal Statement on Expected Demand:** "I have 2000 dollar loan that I will pay off in 2 weeks" $\implies$ $D_2 = D_2 + 2000$

2.1.4 Initiate.

$$\begin{aligned} I_0 &= 1000 - 1200 - 500 + 4200 = 3500 \\ NC_0 &= 1000 - 1200 - 500 = -700 \\ weeklyh_0 &= (.05/52weeks)(\$1)(\$3500) = h_0 = 3.4 \\ &\implies \overline{I_0} = 3500 \\ &\implies D_0 = |NC_0| = 700 \\ &\implies \overline{D_0} = 700 \end{aligned} \tag{1}$$

$$\begin{aligned} Q_0 &= \sqrt{\frac{2(1000)(700)}{3.4}} = 645 \\ I_0 > r_0 &= 3500 > 700 \implies Q_0 = 0 \\ r_0 &= \tau\overline{D_i} = \overline{D_i} = 700 \\ &\implies \tau = 1 \text{ week of work time to generate paycheck} \\ Y_0 &= Q_0 + r_0 + z = 645 + 300 + 700 = 1645 \\ &\implies 3500 - 1645 - 700 > 0 = True \\ \Delta_0 &= -1155 \end{aligned} \tag{2}$$

2.1.5 First Iteration and Action.

$$\begin{aligned} I_1 &= 3500 - 700 = 2800 \\ NC_1 &= 1000 - 1155 - 500 = -655 \\ weeklyh_1 &= (.05/52weeks)(\$1)(\$3150) = h_1 = 3.0 \\ &\implies \overline{I_1} = 3150 \\ &\implies D_1 = |NC_1| = 655 \\ &\implies \overline{D_1} = (700 + 655)/2) = 677.5 \end{aligned} \tag{3}$$

$$\begin{aligned} Q_1 &= \sqrt{\frac{2(1000)(677.5)}{3.0}} = 668.9 \\ I_1 > r_1 &= 2800 > 677.5 \implies Q_1 = 0 \\ r_1 &= \tau\overline{D_1} = \overline{D_1} = 677.5 \\ &\implies \tau = 1 \text{ week of work time to generate paycheck} \\ Y_0 &= Q_0 + r_0 + z = 668.9 + 300 + 677.5 = 1646.4 \\ &\implies 2800 - 1646.4 - 655 > 0 = True \\ \Delta_0 &= -498.6 \end{aligned} \tag{4}$$

$$\begin{aligned} S_1 &= S_0(1 + (i/52)) - Q_0 - \Delta_0 \\ S_1 &= 98000(1 + (.05/52)) - 0 - (-1155) = 99249.25 \end{aligned} \tag{5}$$

This example illustrates the cashflow management theorems impact on long term and short-term assets balance. Tables 1, 2, and 3 have further detail of each iteration and variables values. Initially the expected demand and current assets indicated a need to invest which was done in period zero and one with 1155 and 498 dollar investments to long term assets. However an unusually high demand is required in period two, causing the balance to sink below the re-order point triggering two economic order quantity orders from the long term assets in periods three and four. When modeled for the remainder of the year with static demand and income no more orders are incurred. Indicating a positive trend in short-term

Table 1. $i = 0$ Initiate Model

i	NC_i	D_i	$\overline{D_i}$	I_i	$\overline{I_i}$	$I_i - Y_i - D_i > 0$	Δ_i	S_i	$I_i < r_i$	(Q_i, r_i)
0	-700	700	700	3500	3500	1155 > 0	-1155	98000	No	(0, 700)

Table 2. $i = 1$ First Iteration

i	NC_i	D_i	$\overline{D_i}$	I_i	$\overline{I_i}$	$I_i - Y_i - D_i > 0$	Δ_i	S_i	$I_i < r_i$	(Q_i, r_i)
0	-700	700	700	3500	3500	1155 > 0	-1155	98000	No	(0, 700)
1	-655	655	677.5	2800	3150	498.6 > 0	-498.6	99249.25	No	(0, 677.5)

Table 3. $i = 2, 3$ Second and Third Iterations

i	NC_i	D_i	$\overline{D_i}$	I_i	$\overline{I_i}$	$I_i - Y_i - D_i > 0$	Δ_i	S_i	$I_i < r_i$	(Q_i, r_i)
0	-700	700	700	3500	3500	1155 > 0	-1155	98000	No	(0, 700)
1	-655	655	677.5	2800	3150	498.6 > 0	-498.6	99249.25	No	(0, 677.5)
2	-1998.6	1998.6	1117.9	2144.98	2815	$-2180.32 > 0$	0	99843.29	No	(0, 1117.5)
3	500	0	838.4	146.37	2147.8	$-1893.5 > 0$	0	99939.30	Yes	(901.1, 838.4)

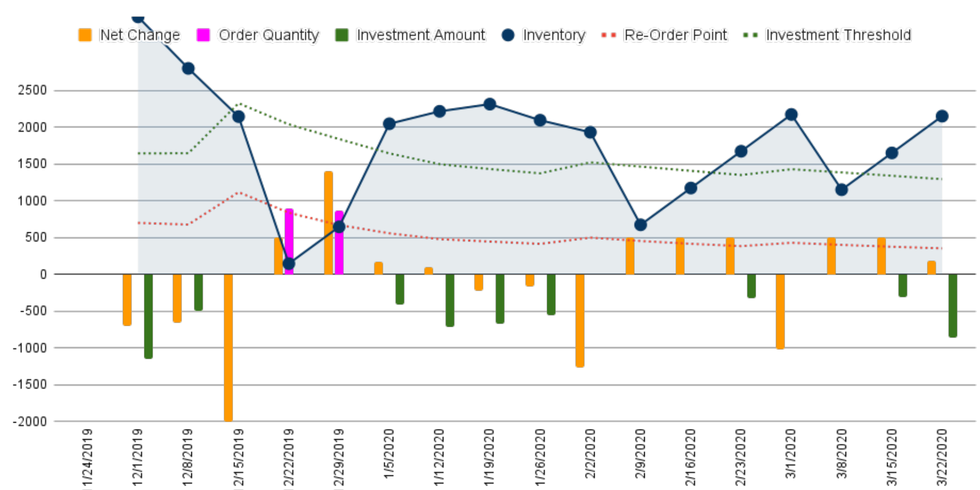

Fig. 2. Example Problem Graph

assets balance of demand and income, providing the ability to save in each period.

2.2 Developing a Secure Open Banking Web Application Framework

The following is a brief overview of the tools and technologies used to develop and enable the open banking web application framework. It is important to note this stems from a personal project exploring the latest large-language models over a 12 month span, in this case LLM Claude sonnet 3.5 and 3.7. With support of these models a prototype consisting of many services, tools and technologies was rapidly developed, which may have required multiple individual experts and a large financial backing to build in the past. As such the following is an excerpt of the response to the question "Please detail the tools, technologies, architecture enabling antfinance.app", where Claude sonnet 3.7 is leveraged in extended thinking mode and eight context files. These context files were a collaborative progression in development of the prototype www.antfinance.app for Ant Finance LLC, an individual corporation for which the author created and further sample context file details displayed in table 4.

2.2.1 ***Architecture Overview.*** Ant Finance is a comprehensive financial insights platform built on a modern cloud-native architecture. The application follows a serverless microservices approach with a secure and scalable infrastructure on Google Cloud Platform.

Table 4. Claude Sonnet 3.7 - Extended: Project File Information

File Name	Line Count	File Type
deploy-react.ps1	381	.ps1
kmsService.js	168	js
deploy-kms.ps1	91	.ps1
Deploy-AntFinanceFunctions.ps1	360	.ps1
kmsService.js	168	js
App.js	1,169	js
PlaidLink.js	627	js
index.js	8,951	js

2.2.2 *Frontend Technologies*.

Core Framework and UI

- React: Single-page application framework providing an interactive user experience
- Ant Design Library: Component library for consistent UI elements and responsive design
- React Router: Client-side routing for seamless navigation between features
- SVG Graphics: Custom visualizations including the ant logo and financial charts

State Management and Data Flow

- React Hooks: Functional approach to component state management
- Custom API Client: Abstraction layer for communicating with backend services
- Browser Storage: Local and session storage for caching and authentication tokens
- Custom Throttling/Caching: Performance optimizations for API calls

2.2.3 *Backend Infrastructure*.

Google Cloud Platform

- Cloud Functions: Serverless API endpoints for all business logic, minimizing infrastructure management
- Firestore: NoSQL document database for user profiles, financial data, and forum content
- Firebase Authentication: User identity management integrated with custom JWT implementation
- Cloud Storage: Secure storage for user profile images and other assets
- Cloud CDN: Content delivery network for optimized global performance
- Cloud KMS: Encryption service for sensitive financial data

Serverless API Architecture

The backend consists of modular Cloud Functions organized by domain:

- Account Management (login, logout, session management)
- Financial Data Services (asset tracking, liabilities, history)
- Plaid Integration (bank connections, transaction fetching)
- Community Features (forums, colony statistics)
- Admin Functions (user management, statistics)

2.2.4 *Data Security and Privacy*.

Encryption and Key Management

- Google Cloud KMS: Hardware-backed key management service
- Envelope Encryption: Two-tier encryption model for financial data
- Data Isolation: Separate encrypted storage for sensitive information
- Tokenization: For bank account details and financial records

Authentication and Authorization

- JWT-Based Sessions: Custom implementation with token refresh mechanism
- Role-Based Access Control: Different permission levels

$$(user, admin, super-admin)$$

- Secure Password Management: bcrypt hashing for credential storage

2.2.5 *Third-Party Integrations*.

Financial Services

Plaid API: Secure bank account connections and transaction retrieval

- Link token generation
- Public token exchange
- Transaction synchronization
- Webhook handling for real-time updates

Payment Processing

Stripe: Subscription management and payment processing

- Multiple membership tiers (Worker Ant, Early Adopter, Colony Guardian)
- Webhook integration for subscription lifecycle events
- Secure payment gateway integration

Communication

SMTP Relay: Email notifications for:

- Account creation and verification
- Password reset flows
- Subscription updates
- Security notifications

2.2.6 *Key Application Features*.

Financial Management

- Asset Tracking: Bank accounts, investments, custom assets
- Liability Management: Credit cards, loans, custom liabilities
- Net Worth Calculation: Real-time financial position tracking
- Financial History: Historical net worth and asset allocation trends
- Transaction Analysis: Categorization and insights

Community Engagement

- Colony Statistics: Anonymous aggregated financial metrics
- User Rankings: Privacy-preserving financial benchmarking
- Achievement System: Gamified financial progress badges
- Discussion Forums: Community engagement with moderation tools

User Experience

- Responsive Dashboard: Main overview of financial status
- Interactive Charts: Visual representation of financial data

- Notification System: Updates for financial changes and community engagement
- Profile Management: User settings and customization options

2.2.7 *Development and Deployment*.

CI/CD Pipeline

- PowerShell Deployment Scripts: Automated function deployment
- Environment Configuration: Separate dev/staging/production environments
- Secret Management: Secure handling of API keys and credentials

Infrastructure as Code

- GCP Resource Provisioning: Scripted creation of cloud resources
- Security Policy Automation: IAM permissions and security configurations
- KMS Key Rotation: Automated cryptographic key management

Monitoring and Operations

- Error Logging: Detailed error tracking in Firestore collections
- Performance Metrics: API response time and function execution monitoring
- User Activity Tracking: Anonymized usage patterns for feature optimization
- Admin Dashboard: Real-time system monitoring and management

Security Best Practices

- Defense in Depth: Multiple security layers throughout the stack
- Principle of Least Privilege: Granular permission model for all services
- Regular Security Audits: Vulnerability scanning and security updates
- Data Minimization: Only collecting necessary information
- Secure API Design: Input validation, rate limiting, and authentication
- Content Security Policies: Protection against XSS and injection attacks

These tools, technologies and features were enabled through the prompt engineers understanding of the information technology space in tandem with the expansive responses that an LLM such as Claude Sonnet 3.7 Extended can produce. Although each line, function and logical operation may not be directly understood, with a general knowledge of technology, tools and frameworks, granular issues and bugs were resolved. Using additional LLM support or re-prompting where required. This increased the development speed of the prototype but may not prove viable under the greater strain of concurrent global users or malicious attackers.

2.3 Experimentation and Measurement of Impact

With the foundational advancements of personal finance optimization and a modern open banking web application framework outlined, the final phase of integration, deployment and usage of the web application was measured via experiment. It was important to consider the recruitment methods and disclosures required in obtaining sensitive user information. Additionally the usage and retention of the data during as well as after the study is discussed. Gathering and incorporating feedback of the subjects to mitigate experimental risks while improving the web application ecosystem.

2.3.1 Recruitment. To identify and obtain subjects for the study first a brief of the experiment timeline, objectives alongside potential risks was defined. Additionally a consent form for the capture, usage and handling of sensitive user information was created. Using the internal student volunteer subjects research distribution list available at Georgia tech and Linked In advertised posts as channels of recruitment. A Microsoft form was used to display the experiment brief and register the volunteers interest in the study. Volunteers were screened and contacted with a Docusign link containing the consent form for subjects agreement.

2.3.2 Usage Procedure. Each subject was directed to define a holistic view of their financial state using either the Plaid integration or maintaining custom entries. Each subject was tasked to refresh their respective custom assets at least once a week. Through click streams and site analytics the physical usage of each feature within the web application was observed. Additionally in enforcing standard updates from the subjects a more reliable impact of the web application may be indicated.

2.3.3 Data Security and Retention. To assuage concerns around the usage and privacy of sensitive information the following data retention procedures are followed. Granular subjects data will only be maintained throughout the course of the experiment, after the analysis and aggregated insights are made the subjects data will be deleted. Subjects data will only be used for the purpose of this experiment. Subjects data will be encrypted and only accessible by the subject themselves or through an administrative support account wit h "super-admin" access for technical issues resolution, both requiring a specific decryption key to view the sensitive data. Although these procedures are in place there will always be an inherent risk of sharing sensitive data to the internet, these measures have been taken reduce the possibility of sensitive data exposure however the possibility will always remain.

2.3.4 Subject Feedback Monitoring. Throughout the experiment it was important to ensure the concerns or feedback from subjects is addressed and incorporated in a timely manner. With the use of a standalone feedback/response page in the web application subjects feedback were collected. At any point in time a subject was free to release themselves from the study. Most of the feedback from subjects was focused on the user experience and technical issues within the web application rather than any concern about the experiment itself.

3 Analysis and Planning

In this section the results of each experiment are described with linkage to the research questions. Also the "plan of attack" to accomplish this research over a 200 hour one semester masters level course are described.

3.1 Data Analysis

To further solidify the economic cashflow management theorem additional examples with normally distributed sampling were preformed. Resulting in 1000 experiments, each containing a normally distributed progressive data for each of the 365 days in a year. The sample data will be modeled after the latest U.S. census reports "Wealth of Household: 2022" [Sullivan and Ghosh 2024] and "Income of Households: 2022" [Kollar and Melissa 2023] median income and wealth across various age, ethnicity, education or other demographic groups. These reference populations statistics will provide a large breadth of real-world scenarios. Adding variability to the inputs and generating sample experiments provides additional confidence to real world application of the theorem and RQ2. The hypothesis of RQ2 is that there exists an application of the economic order quantity to personal finance which provides relevant guidance in financial planning for individuals thorough definition of an order amount, re-order and investment points. Although this simulation does not directly measure impact to real-life subjects, the mathematical validation of the normally distributed experiments further proves the validity of the application and highlights insights which have broader impacts to financial literacy across a wide range of individual circumstances.

The experimental application was deployed to a 100 user research group with required data maintenance procedures over a 2 month duration of study. Through the raw financial data collected per subject alongside interactive and user activity based metrics the results of the secure open banking cloud web application were observed. During the course of the experiment 15 users withdrew, 10 did not complete the required procedures, resulting in complete data for a set of 75 users. On average users maintained 3 custom accounts and 5 linked accounts for a total of 7 financial accounts. Across the users the median net worth at the start of the study was $37,102, where at the end of study was $39,977. The average user cashflow per month was $247, supported by a $2988 of median monthly income. 55 bugs or application errors were reported by subjects and 1 known cyber attack was sustained to the application during the time of the experiment. These data points indicate an accurate capture of the individuals wealth and a possible increase of financial literacy through median net worth increase. With a decent amount of application failures and application improvement feedback from users, the interest as well as experimental data captured indicate the the broader impacts of RQ2 implementation and usability of the cloud application framework defined for RQ1. From the above two experiments addressing the hypotheses of RQ1 and RQ2 insights to RQ3 are gleaned. To further cement the over-arching hypothesis of RQ3 beyond controlled experimental study the web application will be deployed to the general public for wider adoption and analysis in a less scientific and calculated setting. Wide-spread adoption of the application and analysis of the improvement in users financial state only further validates the hypothesis of RQ1, R2 and RQ3.

3.2 Planning

To support the data collected and potential negative impacts a subject may face it is important to clearly outline these aspects of the study for peer review prior to execution. Specifically as it relates to the data usage, subject recruitment, understanding of potential negative impacts and consent must be discussed further prior to completion of the study. To summarize the intended research procedures and data usage of the study are as follows:

(1) Generate Sample Data Referring U.S. Census Bureau Distributions of Wealth and Income
(2) Validate Economic Cashflow Management Theorem Application to Generated Sample Data
(3) Develop Secure Open Banking Web Application Interface
(4) Implement the Economic Cash flow management theorem with the Web Application Interface
(5) Advertise and Obtain Research Experiment Participants
(6) Conduct 100 User Group 2 month Study
(7) Analyze Results
(8) Delete Personal Data, Retain De-personalized Aggregate Results Only
(9) Delete Experimental Environment and Establish Public Environment
(10) Public Release
(11) Industry Observation

Through steps one and two there is less ethical consideration to be made as the Census statistics are public and the simulation and analysis of data not performed on any individuals or their respective sensitive data. During development steps two and three it is critical to ensure the security of any sensitive data provided by the user including, email, name, zip and capture of personal financial data as well as mathematical validity of theorem implementation to real-life. In advertisement and recruitment of experiment participants the objective of research alongside potential risks associated were shared with the participants prior to providing documentation of consent. User data obtained during the study will be purged after aggregation analysis to ensure the protection of the subjects identities and sensitive financial information. Upon purge of the experimental data the experimental environment will also be deleted. This opens the pathway for public release in establishing parallel development, and production environments, limiting any chance for experimental data leakage. Although steps eleven and twelve pose greater risk due to public facing interactions, the application is no longer considered an experiment but rather a publicly accessible web application with financial services, moving away from the academic sector. It is important to note this is the reality today.

4 Conclusion

To summarize this work has defined the economic cashflow management theorem, an open banking web application framework and an experimental study exploring the effectiveness of the theorem integrated within a web application. Although there is much existing literature on the economic order quantity model applied to inventory management, there has been less discussion in the space of personal finance and asset management. In definition of the secure economic cashflow management theorem the aim is to provide individuals with a reference point for saving and investing based on mathematic theory rather than subjectivity. With the introduction of Large Language Models (LLMs) web application development has become more accessible, the security and scalability of such applications is still unknown. This work has provided one example of such development effort utilizing an LLM to create an open banking web application. Finally the proposed experiment provided supporting evidence to the application of the theorem in practice. Driving an estimated growth of seven percent across the subjects of the experiment. Although controlling all external variables contributing to the experiment or individuals financial actions was difficult.

Areas of future research should focus on the use of LLM during development of sensitive data handling applications, what are the methods and tools across the industry someone can use to validate the application security. During the development of this web application the data integration was focused on directly linking to various financial institutions, however in the sector of credit bureau the integration/aggregation is already established. In this way the complexity and setup of financial institutions integration may be reduced in leveraging credit institution customer data. Potential drawbacks may be the latency of data to the credit bureau and single point of user sensitive data. Lastly the open banking web application features social interactions with financial data which may be distressing or greater influencing to users and this psychological influence should be further understood.

In further sharing the insights of this work the following conferences have been identified for potential publication submission with a fail fast and recycle approach for further submission of declined work in 2026 if still viable. First the 2025 IEEE 4th World Conference on Applied Intelligence and Computing (AIC) with a call for paper deadline of May 15th 2025. Next the 2025 IEEE International Conference on Industrial Engineering and Engineering Management (IEEM) June 1st 2025. Finally for this year the the 2025 IEEE International Conference on Technology Management, Operations and Decisions (ICTMOD) with a call for paper deadline of June 30th 2025. For additional diversity the Annual Modeling and Simulation Conference (ANNSIM) 2026 with a tentative paper submission deadline of February 2nd, 2026, leveraging the feedback and inputs of the initial few submissions to increase the chance of success in 2026. Additionally if any rejected IEEE 2025 submissions can be re-targeted in 2026 based upon feedback provided.

Acknowledgments

Thank you to my family and friends for always supporting me.

References

Ronald Askin. 2019. Chapter 6, Inventory Management and the EOQ. Arizona State University - Lecture 5 IEE 461 (2019).

Briones de Araluze Gorka Kaminsky and Nuria Cassinello Plaza. 2022. Open banking: A bibliometric analysis-driven definition. *PLOS ONE* 17, 10 (Oct. 2022), e0275496. doi:10.1371/journal.pone.0275496

Daniel Gozman, Jonathan Liebenau, and Tomaso Aste. 2018. Open Banking: Emergent Roles, Risks and Opportunities. In *Proceedings of the European Conference on Information Systems (ECIS)*. Association for Information Systems. AIS Electronic Library (AISeL). research.cbs.dk/en/publications/open-banking-emergent-roles-risks-amp-opportunities

Ford Harris. 1913. The Magazine of Management. *Operations Research* 10, 2 (1913), 135–136. userhome.brooklyn.cuny.edu/irudowsky/CIS10.31/articles/EOQModel-OriginalPaper.pdf

Gloria Guzman Kollar and Melissa. 2023. Income in the United States: 2022. https://www.census.gov/library/publications/2023/demo/p60-279.html

Ralph D. Snyder. 1973. The Classical Economic Order Quantity Formula. *Operational Research Quarterly (1970-1977)* 24, 1 (March 1973), 125. doi:10.2307/3008042 Accessed 23 February 2025.

Briana Sullivan and Shomik Ghosh. 2024. Wealth of households: 2022 - census.gov. https://www2.census.gov/library/publications/2024/demo/p70br-202.pdf

Received 1 March 2025; revised 1 May 2025; accepted 5 July 2025