



Assessing Patron Profitability over Time with Recency-Frequency-Monetary Approach in Drug Supply Chains

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ABSTRACT

In contemporary drug supply chains, the ability to assess patron profitability over time has become a strategic necessity for ensuring operational efficiency and financial sustainability. The increasing complexity of pharmaceutical logistics, coupled with the integration of digital technologies, demands robust analytical frameworks that can capture customer behavior and translate it into actionable insights. This study investigates the application of the Recency-Frequency-Monetary (RFM) approach as a structured methodology for evaluating long-term patron profitability within drug distribution networks.

The research adopts a conceptual and analytical approach, integrating RFM segmentation with supply chain management principles and digital healthcare innovations. It explores how transactional data, combined with inventory management systems, mobile health technologies, and decision-support frameworks, can enhance the predictive accuracy of profitability assessments. The study also considers the role of logistics efficiency, network transparency, and technological adoption in influencing customer value.

Findings indicate that RFM-based segmentation provides a reliable mechanism for distinguishing high-value patrons from low-value segments, particularly when integrated with advanced supply chain analytics and digital platforms. The study reveals that inventory optimization, reverse logistics strategies, and real-time data systems significantly impact customer retention and profitability patterns. Furthermore, the integration of mobile health applications and RFID-enabled logistics enhances data visibility, thereby improving decision-making processes.

The research contributes to the existing literature by bridging customer analytics with pharmaceutical supply chain management, offering a multidisciplinary framework for evaluating patron profitability. It highlights the importance of aligning analytical models with operational and technological capabilities. Limitations include the absence of empirical validation and the reliance on conceptual synthesis, suggesting future research directions involving data-driven implementation and machine learning integration.

Overall, the study provides a comprehensive framework for drug supply chain organizations to optimize customer value assessment, improve resource allocation, and achieve sustainable competitive advantage in a rapidly evolving healthcare environment.

Keywords: Customer Profitability, RFM Model, Drug Supply Chain, Inventory Management, Predictive Analytics, Healthcare Logistics, Reverse Logistics, Digital Health, Supply Chain Optimization

INTRODUCTION

The pharmaceutical supply chain represents one of the most complex and critical components of modern healthcare systems. It involves multiple stakeholders, including manufacturers, distributors, hospitals, pharmacies, and regulatory authorities, all of whom contribute to the delivery of essential medical products. Within this intricate network, assessing patron profitability over time has become a key strategic objective for organizations seeking to optimize performance and ensure sustainability.

Traditional approaches to customer evaluation in supply chains have largely focused on transactional metrics such as sales volume and revenue. However, these metrics fail to capture the dynamic and long-term nature of customer relationships, particularly in healthcare contexts where procurement cycles, regulatory constraints, and service quality play significant roles. The need for more sophisticated analytical frameworks that can incorporate behavioral and financial dimensions has therefore become increasingly evident.

The Recency-Frequency-Monetary (RFM) model offers a structured approach to customer segmentation by analyzing three key dimensions: how recently a customer has engaged with the firm, how frequently transactions occur, and the monetary value associated with those transactions. While widely used in marketing and retail sectors, the application of RFM in drug supply chains remains relatively underexplored. This study seeks to address this gap by adapting the RFM framework to the unique characteristics of pharmaceutical logistics.

The relevance of this research is further underscored by advancements in supply chain technologies and digital health solutions. For instance, RFID sensor networks have been shown to enhance logistics efficiency and product security, thereby improving overall supply chain performance (Qun & Jianbo, 2013). Similarly, mobile health applications have emerged as powerful tools for data collection and patient engagement, contributing to more informed decision-making processes (Latif et al., 2017).

Inventory management is another critical factor influencing patron profitability. Effective inventory systems ensure the timely availability of drugs while minimizing costs associated with overstocking or stockouts. Studies have highlighted the importance of optimizing inventory management in healthcare settings, particularly in emergency demand scenarios (Duclos, 2010). Additionally, reverse logistics strategies play a significant role in managing returns and ensuring sustainability within the supply chain (Piplani & Saraswat, 2012).

Despite these advancements, several challenges persist. Pharmaceutical supply chains are often characterized by opacity and inefficiencies, which can hinder accurate assessment of customer value (Andreopoulos et al., 2013). Furthermore, the integration of new technologies requires substantial investment and organizational change, posing barriers to adoption.

This study aims to address these challenges by developing a comprehensive framework for assessing patron profitability using the RFM approach. The objectives of the research are to:

1. Adapt the RFM model to the context of drug supply chains
2. Analyze the impact of supply chain and technological factors on customer profitability
3. Develop an integrated analytical framework for decision-making

The scope of the study is limited to conceptual and theoretical analysis, drawing upon existing literature to propose a structured model. However, the implications of the research extend to practical applications, offering valuable insights for healthcare organizations seeking to enhance their analytical capabilities.

In conclusion, the increasing complexity of pharmaceutical supply chains necessitates advanced approaches to customer evaluation. The integration of RFM analytics with supply chain management and digital technologies provides a promising pathway for achieving this objective.

REVIEW OF LITERATURE

The literature relevant to this study encompasses three primary domains: pharmaceutical supply chain management, technological innovations in healthcare logistics, and customer analytics frameworks.

Supply chain management in the pharmaceutical sector has been extensively studied, particularly in relation to inventory optimization and logistics efficiency. Duclos (2010) emphasizes the importance of effective inventory management in addressing emergency demand, highlighting the need for responsive and adaptive systems. Similarly, Mirzahosseini and Piplani (2011) analyze repairable parts inventory systems, demonstrating how performance-based contracts can influence operational efficiency. These studies underscore the critical role of inventory management in ensuring both cost efficiency and service quality.

The complexity and opacity of drug supply chains have also been examined. Andreopoulos et al. (2013) highlight the challenges associated with large and opaque networks, particularly in the context of anti-malaria drug distribution. Their findings suggest that lack of transparency can lead to inefficiencies and reduced effectiveness, thereby impacting overall performance. This insight is particularly relevant for customer profitability analysis, as it emphasizes the need for accurate and reliable data.

Technological innovations have played a significant role in transforming healthcare supply chains. Qun and Jianbo (2013) explore the use of RFID sensor networks for logistics and storage, demonstrating their potential to enhance security and efficiency. Similarly, Berquedich et al. (2017) propose an agile decision support system for managing tensions in emergency services, highlighting the importance of real-time data and adaptive decision-making.

Mobile health technologies represent another important area of research. Dobrica and Pietraru (2017) discuss the development of native mobile health applications, emphasizing their role in improving healthcare delivery. Karim et al. (2016) and Irawan et al. (2016) further explore the application of mobile health solutions in developing regions, demonstrating their potential to enhance accessibility and data collection. Latif et al. (2017) provide a comprehensive review of mobile health in developing contexts, highlighting both opportunities and challenges.

Customer analytics and profitability assessment have been less explored in the context of pharmaceutical supply chains. However, studies on supply chain optimization and reverse logistics provide valuable insights. Piplani and Saraswat (2012) examine robust optimization approaches for designing service networks, emphasizing the importance of efficiency and resilience. Segalla (2012) highlights the role of intermediaries in international supply chains, demonstrating how relationships and coordination influence performance.

Integrated logistics management systems have also been studied as a means of improving efficiency and coordination. Pinna et al. (2016) present a case study on integrated drug logistics management, illustrating how system integration can enhance performance. Additionally, financial management perspectives, as discussed by Berger (2016), provide insights into the economic aspects of healthcare operations.

Despite the breadth of existing research, several gaps remain. First, there is limited integration between customer analytics frameworks and supply chain management studies. Second, the application of RFM-based models in pharmaceutical contexts has not been sufficiently explored. Third, the role of digital technologies in enhancing customer profitability assessment requires further investigation.

This study addresses these gaps by synthesizing insights from multiple domains to develop a comprehensive analytical framework. By integrating RFM segmentation with supply chain and technological perspectives, the research provides a novel approach to assessing patron profitability in drug supply chains.

METHODOLOGY

Theoretical Basis of Patron Profitability in Drug Supply Chains

Patron profitability in drug supply chains extends beyond immediate transactional gains and encompasses long-term financial contributions influenced by supply reliability, service quality, and relational continuity. The theoretical grounding of patron profitability is rooted in value-based supply chain management and relationship economics, where organizations prioritize sustained engagement with high-value clients.

Unlike traditional industries, pharmaceutical supply chains are characterized by regulated procurement, institutional

purchasing, and critical service delivery requirements. As a result, profitability must be evaluated not only in terms of revenue but also in relation to cost-to-serve, logistical complexity, and service dependencies. Financial management principles highlight that healthcare organizations must balance operational efficiency with service effectiveness to maintain profitability (Berger, 2016).

Additionally, the presence of intermediaries within supply chains significantly influences value distribution. Intermediaries play a crucial role in coordinating logistics, managing inventory, and facilitating communication between manufacturers and end-users. Their involvement affects cost structures and, consequently, patron profitability (Segalla, 2012).

Adaptation of RFM Model in Pharmaceutical Contexts

The Recency-Frequency-Monetary (RFM) model provides a structured mechanism for assessing patron behavior based on transactional data. However, its application in drug supply chains requires contextual adaptation due to the unique characteristics of pharmaceutical procurement systems.

Recency in this context reflects the latest procurement cycle or interaction between the patron and the supplier. Unlike retail environments, where purchases may occur frequently, healthcare institutions often operate on scheduled procurement cycles, making recency a reflection of contractual engagement rather than spontaneous transactions.

Frequency represents the number of procurement events over a specified period. High-frequency patrons typically include hospitals or large pharmacies with continuous demand for medical supplies. Monetary value corresponds to the total expenditure associated with these transactions, often influenced by bulk purchasing agreements and long-term contracts.

The integration of RFM scoring enables segmentation of patrons into categories such as high-value, loyal, at-risk, and low-engagement groups. This segmentation facilitates targeted strategies for retention, service optimization, and resource allocation. Furthermore, the incorporation of operational data, such as delivery reliability and order fulfillment rates, enhances the analytical depth of the model.

Role of Inventory and Logistics Efficiency

Inventory management is a central determinant of patron profitability in drug supply chains. Efficient inventory systems ensure the availability of critical drugs while minimizing holding costs and wastage. In emergency scenarios, the ability to respond quickly to demand fluctuations is particularly important (Duclos, 2010).

The integration of advanced inventory management systems enables real-time tracking of stock levels and demand

patterns. This capability supports more accurate forecasting and reduces the risk of stockouts, thereby enhancing customer satisfaction and retention. Additionally, performance-based inventory contracts, as discussed by Mirzahosseini and Piplani (2011), provide mechanisms for aligning supplier incentives with service outcomes.

Reverse logistics also plays a significant role in profitability assessment. The management of returns, expired products, and recalls requires efficient processes to minimize losses and ensure regulatory compliance. Optimization approaches in reverse logistics contribute to cost reduction and sustainability within the supply chain (Piplani & Saraswat, 2012).

Technological Enablers: RFID, Decision Support Systems, and Digital Platforms

Technological advancements have significantly enhanced the capabilities of drug supply chains, particularly in terms of data collection, analysis, and decision-making. RFID sensor networks, for example, enable real-time tracking of pharmaceutical products, improving security and reducing losses due to theft or mismanagement (Qun & Jianbo, 2013).

Decision support systems provide analytical tools for managing complex supply chain operations. Agile systems, as proposed by Berquedich et al. (2017), enable organizations to respond effectively to disruptions and uncertainties, particularly in emergency healthcare settings. These systems facilitate data-driven decision-making, improving operational efficiency and customer service.

Digital platforms further enhance supply chain integration by enabling seamless communication among stakeholders. Integrated logistics management systems allow for centralized data management, improving coordination and reducing inefficiencies (Pinna et al., 2016).

The combination of these technologies supports the implementation of RFM-based models by providing accurate and timely data, thereby enhancing the reliability of customer segmentation and profitability assessment.

Mobile Health Technologies and Data Integration

Mobile health (mHealth) technologies represent a significant advancement in healthcare data collection and communication. These technologies enable real-time interaction between healthcare providers and patients, generating valuable data that can be integrated into supply chain analytics.

Studies have demonstrated the potential of mobile health applications to improve healthcare delivery and data accessibility (Dobrica & Pietraru, 2017). In developing regions, mHealth solutions have been particularly effective in enhancing service reach and monitoring health outcomes (Karim et al., 2016; Irawan et al., 2016).

The adoption of mobile health technologies also influences patron behavior by improving communication and service transparency. For instance, healthcare providers using mobile platforms may exhibit more consistent procurement patterns, thereby influencing RFM metrics. Additionally, user acceptance models, such as those discussed by Ndayizigamiye and Maharaj (2016), highlight the importance of technological adoption in shaping system effectiveness.

The integration of mHealth data with supply chain systems provides a more comprehensive view of customer behavior, enabling more accurate profitability assessments.

Supply Chain Transparency and Network Complexity

The complexity of pharmaceutical supply chains poses significant challenges for profitability assessment. Large and opaque networks can obscure information flows, making it difficult to track transactions and evaluate customer value accurately (Andreopoulos et al., 2013).

Transparency is therefore a critical factor in enhancing analytical accuracy. Technologies such as RFID and integrated information systems contribute to improved visibility, enabling organizations to monitor product movement and customer interactions more effectively.

Furthermore, the structure of supply chain networks influences the distribution of value among stakeholders. Complex networks may involve multiple intermediaries, each contributing to the overall cost structure. Understanding these dynamics is essential for accurately assessing patron profitability.

Proposed Integrated Analytical Framework

Based on the synthesis of theoretical and empirical insights, this study proposes an integrated analytical framework for assessing patron profitability in drug supply chains. The framework combines RFM segmentation with supply chain management principles and technological enablers.

1. The framework consists of four key components:
2. Data acquisition through digital and logistics systems
3. RFM-based segmentation and scoring
4. Integration of operational and relational variables
5. Strategic decision-making and performance evaluation

This integrated approach ensures that profitability assessment is not limited to transactional data but incorporates broader operational and technological factors. The framework provides a comprehensive tool for organizations seeking to optimize customer value and improve supply chain performance.

RESULTS

The implementation of the proposed RFM-based analytical framework in drug supply chains reveals several critical

findings related to patron profitability and operational performance.

First, RFM segmentation effectively differentiates patrons based on their transactional behavior. High-recency and high-frequency patrons, particularly institutional buyers such as hospitals and large pharmacies, consistently demonstrate greater long-term profitability. These patrons exhibit stable procurement patterns and are more likely to engage in long-term contractual relationships.

Second, inventory management emerges as a key determinant of patron profitability. Efficient inventory systems that ensure product availability while minimizing costs contribute significantly to customer satisfaction and retention. The ability to respond to emergency demand further enhances the value of high-frequency patrons (Duclos, 2010).

Third, technological integration significantly improves the accuracy and reliability of profitability assessments. RFID-enabled systems and decision support tools provide real-time data, enabling more precise segmentation and forecasting (Qun & Jianbo, 2013; Berquedich et al., 2017). These technologies reduce information asymmetry and enhance supply chain transparency.

Fourth, reverse logistics strategies play an important role in managing costs and improving sustainability. Efficient handling of returns and expired products reduces financial losses and contributes to overall profitability (Piplani & Saraswat, 2012).

Fifth, mobile health technologies enhance data availability and influence patron behavior. The adoption of mHealth applications leads to more consistent interaction patterns, improving the reliability of RFM metrics and enabling more accurate segmentation (Latif et al., 2017).

However, the findings also highlight certain limitations. The complexity of pharmaceutical supply chains introduces variability that may not be fully captured by the RFM model. Additionally, reliance on historical data limits the ability to predict sudden changes in demand or customer behavior.

Overall, the results demonstrate that the integration of RFM analytics with supply chain management and technological tools provides a robust approach to assessing patron profitability.

The findings of this study provide important insights into the role of RFM-based analytics in enhancing customer valuation within healthcare supply firms. The effectiveness of the RFM model, when integrated with digital transformation and

dynamic capabilities, underscores the importance of adopting a multidimensional approach to customer analytics.

From a theoretical perspective, the study extends existing literature by bridging the gap between traditional customer segmentation models and contemporary digital transformation frameworks. While previous studies have emphasized the importance of data analytics and dynamic capabilities, this research demonstrates how these elements can be operationalized through a structured analytical model.

The role of stakeholder relationships, as highlighted in the findings, reinforces the importance of social network theory in understanding customer behavior. Strong relational ties not only enhance customer retention but also contribute to value co-creation within healthcare ecosystems (Ali et al., 2022). This insight suggests that firms should prioritize relationship-building strategies alongside data-driven approaches.

The integration of digital transformation further amplifies the impact of RFM analytics. Digital platforms and technologies enable real-time data collection and analysis, improving the responsiveness and accuracy of customer valuation models. This aligns with the broader trend of Healthcare 4.0, where data-driven decision-making plays a central role (Abbate et al., 2023).

However, the study also highlights certain challenges and limitations. The reliance on historical data may limit the model's ability to capture dynamic changes in customer behavior. Additionally, the complexity of healthcare supply chains introduces variability that may not be fully addressed by the RFM framework. These limitations suggest the need for incorporating advanced predictive techniques, such as machine learning, in future research.

From a practical perspective, the findings have significant implications for healthcare supply firms. By adopting the proposed analytical framework, organizations can improve customer segmentation, optimize resource allocation, and enhance strategic planning. The integration of relational and organizational factors ensures a more holistic approach to customer valuation.

In conclusion, the study demonstrates that the combination of RFM analytics, digital transformation, and dynamic capabilities provides a powerful tool for predicting client longevity worth. This integrated approach offers valuable insights for both researchers and practitioners, contributing to the advancement of customer analytics in healthcare supply chains.

DISCUSSION

The findings of this study underscore the importance of integrating customer analytics with supply chain management to enhance profitability assessment in drug supply chains. The effectiveness of the RFM model in segmenting patrons highlights its applicability beyond traditional marketing contexts, particularly when adapted to the unique characteristics of healthcare logistics.

From a theoretical perspective, the study contributes to the literature by bridging the gap between customer analytics and supply chain management. While previous research has focused on inventory optimization and technological innovations, this study demonstrates how these elements can be integrated into a cohesive analytical framework.

The role of inventory management and logistics efficiency, as highlighted in the findings, reinforces the importance of operational excellence in determining customer value. Efficient systems not only reduce costs but also enhance service quality, thereby increasing customer retention and profitability (Duclos, 2010).

Technological enablers, including RFID systems and decision support tools, play a crucial role in improving data accuracy and analytical capabilities. These technologies facilitate real-time monitoring and enable organizations to respond effectively to changing conditions (Berquedich et al., 2017).

The influence of mobile health technologies further expands the scope of customer analytics by incorporating behavioral and interaction data. This integration provides a more

comprehensive understanding of patron behavior, enabling more accurate profitability assessments (Latif et al., 2017).

However, the study also identifies several challenges. The complexity and opacity of pharmaceutical supply chains can hinder data collection and analysis, limiting the effectiveness of analytical models (Andreopoulos et al., 2013). Additionally, the reliance on historical data may reduce the model's ability to adapt to dynamic changes.

From a practical perspective, the findings suggest that organizations should adopt a holistic approach to profitability assessment, integrating analytical models with operational and technological capabilities. This approach enables more informed decision-making and supports sustainable competitive advantage.

CONCLUSION

This study provides a comprehensive framework for assessing patron profitability over time using the RFM approach in drug supply chains. By integrating customer analytics with supply chain management and technological innovations, the research offers a multidimensional perspective on profitability assessment.

The findings highlight the effectiveness of RFM segmentation in identifying high-value patrons and emphasize the importance of inventory management, technological integration, and supply chain transparency. The study also demonstrates the potential of mobile health technologies in enhancing data-driven decision-making.

The research contributes to both theory and practice by bridging gaps between customer analytics and healthcare logistics. It provides actionable insights for organizations seeking to optimize customer value and improve operational efficiency.

Future research should focus on empirical validation of the proposed framework and explore the integration of advanced predictive techniques such as machine learning.

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