BIG DATA ANALYTICS FOR SUPPLY CHAIN MANAGEMENT

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ABSTRACT

Supply chain management (SCM) is a dynamic and intricate process that requires the integration of multiple operations across multiple entities in the modern day. There are benefits as well as constraints associated with the growing amount, diversity, and velocity of data generated throughout supply chains. Businesses may now optimize their supply chains by using Big Data Analytics (BDA), a potent tool for turning vast amounts of data into actionable insights. The integration of big data analytics with supply chain management will be investigated in this study, with an emphasis on how data-driven insights can improve forecasts, lower risks, better decision-making, and streamline procedures. By using machine learning methods, predictive analytics, and real-time data analysis, BDA enables businesses to comprehend their supply chains, increase the accuracy of demand forecasting, lower operating costs, and boost overall efficiency. Additionally, the research explores ways Big Data might be used to address important issues including demand-supply mismatches, inventory management, and supply chain interruptions. Businesses can increase supply chain agility, improve customer satisfaction, and allocate money effectively by utilizing BDA. The future of big data in supply chain management and its effects on the global supply chain are examined in the paper's conclusion.

KEYWORDS

Network Protocols, Artificial Intelligence, Supply chain, Software development, Data

1. INTRODUCTION

Over Big data analytics is crucial in marketing and customer retention, especially in the banking industry. There are two main divisions in banking: personal banking, which serves individuals, and corporate banking, which serves businesses. While banks collect vast amounts of customer data, big data analytics has mainly focused on personal banking for marketing purposes. Corporate banking, although a significant revenue source for banks, has primarily used data analytics for risk management. Supply chains, which involve integrating key business processes from suppliers to end users, can benefit from unlocking working capital through supply chain finance offered by banks. Two main purposes of a marketing campaign are to retain existing customers and to acquire new customers. Many businesses are recognizing the significant role that big data analytics could play in growing customer loyalty and marketing, especially in the banking industry (Hassani, Huang, & Silva, 2018). The major two divisions in the banking industry are personal and corporate banking. The former provides services to individuals, and the latter focuses on corporate customers. Many banks systematically track and store large amounts of customer data (Ghafari & amp; Ansari, 2018). However, regarding the idea of applying big data analytics in marketing, this effort has been mainly focused on personal banking (Hassani et al., 2018; He, Wang, & Akula, 2017). Since corporate banking is the major revenue source for most banks, their applications of data analytics have been limited to risk management only

(Choi, Chan, & Yue, 2017). The term “supply chain” has been defined as “the integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers and other stakeholders” (Lambert, Cooper, & Pagh, 1998). That means that each corporation is a node in the supply chain network. As a result of internationalization, supply chains might stretch across the globe with multinational buyers and suppliers. Corporations are under pressure to unlock the working capital trapped in their supply chains. Banks' supply chain finance, also known as “supplier finance” or “reverse.

2. LITERATURE REVIEW

Customer Lifetime Value Prediction

Customer Lifetime Value (CLV) prediction involves estimating the total revenue a customer will generate throughout their relationship with a business. This enables informed decisions regarding customer acquisition, retention, marketing, and investment strategies. Expedia Group uses machine learning to predict CLV, retraining models monthly to update predictions for millions of customers daily.

Visual Example of CLV Implementation Architecture

Expedia Group uses a Unified Machine Learning Platform for CLV prediction models, visually representing the implementation architecture. The architecture streamlines the deployment of machine learning models across test and production environments, facilitating training, deployment, management, and monitoring.

Customer Clustering

Customer clustering is a customer relationship management model that classifies customers based on similarities in their attributes. This technique groups customers with similar traits to improve marketing strategies and customer loyalty. K-means clustering is often used, and visualizing the data beforehand helps identify clusters and patterns.

A. Supply Chain Finance (SCF) Services

Supply Chain Finance (SCF) optimizes cash flow and enhances financial stability across the supply chain. SCF combines financial services and technology to offer short-term credit, improving working capital for businesses. It involves buyers, suppliers, and a financing institution, facilitating transactions through pre shipment, in-transit, and post shipment financing.

B. Visual Example of Supply Chain Finance in Action

A diagram from Bank of America (2024) illustrates supply chain finance in action, connecting buyers and suppliers via BofACashPro® Trade. This diagram demonstrates the flow of financial resources between the buyer, supplier, and the financing institution within the supply chain.

C. Benford Analysis in Forensic Analytics for Supply Chain Fraud Detection

Benford's Law is applied to detect fraud in supply chain management through forensic accounting and auditing. It aids in detecting suspicious activities by analyzing the distribution of first digits in numerical data. Deviations from Benford's Law can indicate potential fraud, prompting further investigation.

D. Visual Example of Benford's Law Application

Benford's Law predicts that in many naturally occurring datasets, the number 1 appears as the leading digit about 30.1% of the time, the number 2 about 17.6% of the time, and so on, with the number 9 appearing as the leading digit only 4.6% of the time. This distribution can be visualized using a combo chart to compare actual percentages against the expected percentages.

E.Visual Example of Customer Clustering Using Pairplots

Pairplots can reveal clusters based on gender, income, spending score, and age. K-means works by assigning points to the nearest cluster center and recalculating the centers until convergence.

3. CASE STUDY

3.1. Case Background

The target bank (ABC Bank, hereafter) is under a financial holding company and is ranked as one of the top 250 ban worldwide. Its headquarters is in Asia, and it has 190 branches, 34 overseas branches/ representative offices, and o 7000 domestic employees. Overall, ABC Bank's strength is in corporate banking, especially in SME loans. Until the end of 2018, the bank's active corporate customers numbered about fourteen thousand companies. Here, "active" means that the corporate customer had completed at least one active transaction in the past six months. Among the fourteen thousand companies, about 35,000 companies (25%) applied the e-wiring service, which allows corporates to schedule online payments to corporate accounts. Table 1 shows the statistics of e-wiring transactions in 2016. 3.2. Analysis The purpose of the analysis aims to establish and expand the supply chain network relationships of the ABC's corporate customers. The supply chain relationships come from the following sources: (1) affiliated or upstream/downstream companies on a corporation's credit report; or (2) e-wiring transactions to upstream or downstream companies tracked by ABC Bank. A corporation has the obligation to reveal important affiliated companies, major downstream/upstream companies, and the list of the members of its board of directors, when it files a loan application. Fig. 2 lists the da collection and the data analysis flows. First, an e-wiring network is developed, using all online wiring transactions among companies. The senders these wiring transactions are ABC Bank's corporate customers. The analytic flow examines whether the receivers a ABC Bank's corporate customers, as well. If the answer is No, then the list will become a partial list of A. If the answer is Yes, then the analytic flow checks whether sender's or receiver's credit report is available. If the sender/receiver is A Bank's corporate customer, and the credit report is available, then affiliated and down-stream/upstream companies be retrieved from the report. These affiliated and downstream/upstream companies will be appended to the wiring network. At the same time, if affiliated and upstream/ downstream companies are also ABC Bank's corporate customer the analytic flow will loop back to search for corresponding credit reports. If not, these companies will be merged into Li A. The loop will continue until all potential customers have been identified via the credit reports (Lists B and C List A includes companies identified via various relationships, but they are not ABC Bank's corporate customers. E-wiring transactions or credit reports are required to include a company's Tax ID, which allows a search of the government's open data for company's contact in- formation. The contact information contains the name pf the company's president, a list of the members of its board of directors, the company's phone number, the company's address, and its registered capital amount. The next step checks whether the members of the board of directors are ABC Bank's personal banking customers or if they own other companies. If the answer is Yes, then it continues to search

whether the credit report is available, and the loop will continue until all potential customers have been identified. If the answer is No, then the analytic flow stops. Fig. 3 shows the results of the initial network (i.e. the list of potential customers), which contains. 225,733companies. Compared with the original 35,000 customers upon opening the e- wiring service, the analytic fl expands the network 5.4 times larger. Fig. 3 can be further used to generate potential customers by applying filtering conditions. For example, Fig. 4 show the network of corporations with at least eight annual wiring transactions and over 13,500 USD total wiring amounts. The network contains 1621 current corporate customers (green nodes). The other 2563 companies were non-ABC Bank customers (purple nodes). Both types of companies can be potential customers for marketing campaigns. Fig. 4 shows that more than half of the companies were not ABC bank customers. How to select potential customers with higher responses and higher credit approval rates are the major goals of the follow-up analysis. Because the corporate loan is the most profitable product in corporate finance, the first campaign aimed to id potential corporate loan customers. However, if the potential customer does not need a corporate loan, the account official will introduce other corporate financial services. The campaign list was generated with the following five conditions: Identify companies with at least 50 million in USD loan amounts as the core companies. Limit the search scope to the companies which had supply chain relationships with these core companies. (Most of these core companies are exchange-listed companies, and this condition promotes target potential companies' credits and enhances the credit approval rate.) Possible supply chain relationships include: (1) affiliated companies with or without wiring transactions; upstream/downstream companies with or without wiring transactions; (3) inbound or outbound wiring transactions with the core companies only. Exclude companies whose tax IDs or contact information cannot be located. The first round of implementation selected 4800 companies. Table 3 lists the distributions of these 4800 companies which were assigned to account officers at all domestic branches. Because corporate finance usually requires a l time to interact with customers, to prepare application materials, and to review and approve applications, the implementation period lasted nine months, during 2017. Table 2 lists the numbers of potential companies and their relationships with the core companies. Based on Table 2, it is clear that most of the potential companies had only one relationship with the core companies: (1) companies with an affiliate relationship only (34.4%), (2) companies with up stream / down stream relationship only (12.7 %) or (3) companies with an e-wiring transaction relationship only (50.3 %).

4. RESULTS

Table 3 shows the campaign results by checking the response and the approval rates. Traditionally, account officers w used to check into the yellow pages or the list of companies within their branch's region to identify potential customers. They were also required to input their contact histories with these potential customers into the salesforce system. The baseline response rate is the number of applied companies divided by the total number of contacted companies. The baseline approval rate is the number of approved applications divided by the number of submitted applications. Both are the indictors to evaluate the effectiveness of this campaign. Based on Table 3's results, it is clear that both t response and the approval rate were significantly higher than the baseline rates. ABC Bank approved almost all of t applications in the campaign. Fig. 5 shows the results of a decision tree analysis which analyzed what kind of companies responded to the campaign and applied for a corporate loan (since it was the major target product of this campaign). The results show the average rate of response to the corporate loan was 2.17% (104 companies). The response rates were higher if these potential customers already had a corporate account at ABC Bank. If their experience with ABC was longer than 4.5 years, then the response rate was 1.96%. However, if their experience with ABC was shorter than 4.5 years, the response rate increased. to 15.35%. The condition, plus at

least one wiring transaction, increased the response rate to 20.66%. It decreased to 9.35% for companies without any wiring transactions. For companies with a longer experience with ABC Bank (longer than 4.5 years), the average response rate was 1.96%. The response rate increased to 9.52% for companies with at least 3.5 of ABC Bank's corporate product holdings. The response rate decreased to 1.71% if the product holding was less than 3.5. For companies that were only listed on the core companies' credit reports (i.e., with zero corporate product holdings), the response rate was zero. Finally, for companies with wiring transactions, but which had not been ABC Bank's customers before the campaign began, the response rate was 1.25% (still higher than the baseline). 1. Discussion Traditional banks and Fintech companies might choose to collaborate or compete with each other (Hung & Luo, 2016). Traditional banks look for new technologies to maintain their competitive strength, when they are facing challenges from FinTech companies (Hung & Luo, 2016). FinTech companies might have creative ideas to design and develop innovative products and services. However, the challenge is how to attract customers to use their innovative services. However, for with these core companies, the loan approval rate was also significantly higher than the natural baseline. Unlike ban that have more complete customer profiles, historical wiring records, and account activities, most of the FinTech platforms track transactional data only (Song et al., 2018). That means that banks own more detailed data in the credit evaluation and can develop the Supply Chain Network for other applications (Sawers, 2017). Based on the results, relatively new existing customers (those with less than 4.5 year) with wiring transaction relationships showed the highest response rate. The second highest group was relatively older existing customers (those with more than 4.5 years) with more than 3.5 product holdings (no corporate loans). The third highest group was relatively new existing customers without a wiring transaction re- lationship. Therefore, for ABC Bank, attracting companies to open a checking or a saving account as a starting point is crucial, as these companies can start using the e- wiring service. On the other hand, older companies might have been contacted by the account officers, so the success rate is lower unless these companies had already made use of several of ABC's corporate banking services. In summary, the wiring transaction relationship promoted the success rate, especially when they potential loan customers were already existing ABC Bank customers. In addition, an increase in the number of relationships with the core companies, or with the bank, showed a higher response rate, as well. An intensive literature search has shown successful stories about the Fintech companies in SCF (Fenwick, McCahery, &Vermeulen, 2017; Song et al., 2018). Our study reveals how traditional banks can respond to challenges via analytics. Most banks should have more corporate customers and historical customer data than Fintech companies. The key becomes whether banks can convert data into revenue. 5.3. True and false supply chain relationship From the aspect of analysis, wiring transactions cannot always be regarded as a supply chain relationship. For example, a shipping com- pany might show many inbound wiring transactions, since it provides shipping services to the core company. Therefore, it cannot be regarded as a potential customer, due to its not having a supply chain relation- ship. However, if the wiring transactions occur among companies within the shipping industry, then these transactions can be regarded as supply chain relationships. Because the strength of wiring transactions was calculated by the wiring frequencies and the wiring amounts, non- supply chain transactions should be excluded from the computation. 5.4. Other possible applications The relationship network can have other possible applications. For example, in the constructed network, there were 117 companies which had wiring transactions with more than 100 companies. In addition, 95 out of the 117 companies had at least 10 million USD in registered capital. ABC Bank is contacting these companies for more advanced SCF. Because the process is sophisticated, and involves companies' ERP systems, the campaign (supple chain + sale chain finance) is sti on- going. 5.5. Implications The discussion presented in this paper provides several insights for both theory and practice. In terms of theoretical implications, the study provides a concrete real- world case to support the resource-based theory in the Big Data Era, which advocates that big

data analytics should be considered by banks as key resources in attaining a competitive advantage (Gupta & George, 2016). Since Big Data is a new source of capital in today's marketplace and is also a great source of idea generation for product development, customer service, and so on, organizations that do not develop the resources and capabilities to effectively use Big Data will have a hard time to survive the Big Data revolution (Erevelles et al., 2016). Due to the unique characteristics of corporate banking, marketing considerations are different from personal banking. Because corporate loan must be approved via credit evaluation, the selection of potential customer should take risk into consideration to raise the approval rate. In addition, the campaign response rate indicates the importance of customer relationship management in corporate banking. As marketing research in banking industry has been focused on personal banking, more research efforts are desired to focus on the B2B marketing In term of practical implications, banking firms can learn from our findings to improve their finance services providing convenient B2B e-wiring service and attracting potential customers in the supply chain to open a checking or a saving account. It is a good start point to manage potential corporate customers and these corporates can start to accumulate credits.; by 2) enhancing interactions with existing customers to strengthen relationships, as customers with higher numbers of product holdings also showing higher response rates; and by (3) better utilizing B2B data to generate more corporate banking applications.

5. CONCLUSION

In personal banking marketing, big data analytics has become increasingly used, particularly for customer segmentation and profiling, product affinity prediction, and customer attrition prediction. This study demonstrates how big data analytics may be applied by examining three different kinds of supply chain linkages in order to find possible corporate customers. Based on the results, the strategy can raise the approval rate and greatly increase the number of customers that respond to the marketing campaign. Thus, the relationship analysis can be expanded to more complex uses like supply chain risk assessment and financing.

6. LIMITATION AND FUTURE RESEARCH

This study demonstrates a potential application of big data analytics in identifying potential corporate customers. The authors compared different customer types to determine which had higher response rates and proposed their interpretation. However, we cannot validate our assumptions through interviews with account officers and customers. The relationship network identified numerous potential customers and applied filtering conditions to generate the campaign list. Future research might focus on alternative filtering approaches to achieve better outcomes. For instance, a study by Ghafari and Ansari (2018) highlighted the importance of big data analytics in personal banking for marketing purposes. Similarly, He, Wang, and Akula (2017) emphasized the role of big data in enhancing customer loyalty through personalized marketing strategies. Future research could explore how these approaches can be adapted for corporate banking to improve customer acquisition and retention. An example of a successful big data analytics application is Starbucks' use of data to personalize marketing efforts. By analyzing customer purchase history and preferences, Starbucks sends individualized offers via its app and email, increasing customer engagement and sales. This approach could be adapted for corporate banking to identify and target potential corporate customers more effectively.

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