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Cloud-Driven Transformation Of Banking Supply Chain Analytics Using Big Data Frameworks

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Abstract

Banks create and manage multi-facet, inter-firm supply chains with their suppliers, customers, partners, internal departments, and market regulators. Bank products include a cross-genres of earmarked entry threshold and generic systems of primary data generation, multi-variable, multi-facet price volatilities, multi-term maturity involvement, and fund utilization. Banks are large generators and utilizers of data that can be leveraged in near real time, to internally and externally optimize entire supply chains through a concentrated center of power. Perpetual technology advancements require finance professionals to study the effects of technologies on efficient banking operations, controlling risks, instituting policies, and fostering financial discipline. Big data analytics can be harnessed for market vision and insight through social media, and the study of financial consumerists behavioral response can impact market strategies, and increase both revenue and profitability. Various solutions on supply chain analytics can be solved using frameworks of Cloud Computing, Big Data, Data Storage, Data Mining, and Data Visualization. The impactful partner is Security Data Exchange Channels that utilize innovative storage management techniques to prescribe, follow, and deliver accurate and timely data on entire banking supply chains during all market cycles, and address the relevant questions of opportunistic timing risks and how to gather appropriate information about market conditions. Using these data management platforms, multi-facet banking supply chain analytic solutions can be developed, implemented, and deployed on all key banking processes, and results observed to impact timely and appropriately. This paper discusses the impacts of Cloud and Big Data driven transformation of Banking Supply Chain Analytics during all market cycles, covering all key parameters, and creating value-added actionable insights.

Keywords: Banks, Supply Chains, Inter-Firm Relationships, Data Generation, Price Volatilities, Fund Utilization, Data Analytics, Big Data, Market Insight, Financial Consumer Behavior, Revenue, Profitability, Cloud Computing, Data Storage, Data Mining, Data Visualization, Security Data Exchange Channels, Data Management, Banking Supply Chain, Risk Control, Market Cycles, Financial Discipline, Technological Advancements, Banking Operations, Market Strategies.

1. Introduction

The survival of banks approximately depends on how well they function in supply chain management. Banks remaining part of a bank-for-everything or mega banks realizes a huge shortfall by not putting in place an effective and efficient supply chain network that ultimately results in tangible profit. Banks are ideally expected to maintain a lights-on, lights-out approach providing services to the customers. Being a service Industry, banks have no particular control on the volumes of services required by the customers. Hence, banks do not have large excess capacities like manufacturers. Banks observe natural economies of growth at the outset, asymptoting towards steady states with increasing transactional volumes over a period of time. The network structures of Banks change often depending on a variety of factors like the geography of operations, customer groups serviced etc…

The emergence of big data frameworks as well, meant that now backend monolithic data warehouses can be replaced with cloud driven models that allow for a virtually limitless elasticity with pay-per-use APIs and cloud solutions. The availability of Supply Chain specific SaaS solutions from Banks has enabled intuitive supply-chain services management for Banks. Banks can utilize service-centers to minimize cost, track performance and manage risk with built-in Supply Chain monitoring and reporting capabilities. The huge coverage of front/back-end solutions from Bank based & other Vendors have enabled simplified Cloud-Driven Transformation of Banking Supply Chain Analytics without the support of specialized IT/Consulting Vendors. With Supply Chain Information Systems of Banks amalgamating with the collaborative products from Banks, Demand Data Warehouse Development Platforms can be created being the bedrock of Banking Supply Chain Demand Analytics.

1.1. Overview and Objectives of the Study

The technological capabilities of the new models of the data economy and the great vertical industry paradigms such as the Internet of Things, Artificial Intelligence or Big Data are quickly transforming elements as traditional as the world of industries. These capacities are triggering processes of digitization, virtualization, and data-driven transformation in global economic activity: how industries make products or provide services and how they integrate into supply chains. At the same time, these technological transformations are also taking place in a core element of all economic sectors such as finance, and more specifically, in those financial institutions that are the paradigm of traditional models. Financial institutions are not only increasingly affected by the data economy and technological developments, triggering their data-driven transformation, but they also become accelerators or enablers of the data-driven transformation of the other industries, through their financial intermediation role. This paper describes the state-of-the-art of the Cloud-Driven Data Analytics Frameworks for Banks, and its application to the Banking Supply Chain Sector, to enable their Cloud-Driven Transformation; and their Banking Supply Chain Analytics. Connecting top-down business concepts and bottom-up big data infrastructures and programming models, with the goal of establishing the basic elements for the implementation of an intelligent and scalable support model for the analysis in the Banking Supply Chain Sector. Emphasizing the growing Cloud-Driven Data Analytics demand for Banking Supply Chain Analytics from the Private Public Partnership; an essential conceptual support for European banking in the transition towards a responsible and sustainable model of data economy with long-term value generation.

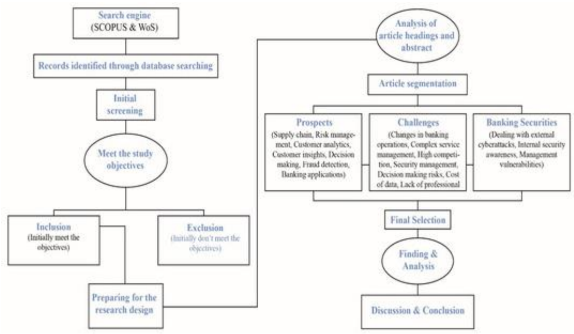

Fig 1 : Big Data-Driven Banking Operations

2. The Evolution of Banking Supply Chains

Banking is the center of the financial service industry. Today's financial institutions, both commercial and noncommercial, have expanded their product offerings to include a wide range of services including bountiful checking, savings, and loan products; mortgage origination and servicing; securities brokerage and trading; insurance product sales; small business loan services; and investment and financial advisory services. Banks are also taking on risks associated with financial services; providing, for a fee, large unsecured cash management accounts; and acting as conduits for funds to flow from borrowers directly to lenders, thus bypassing traditional intermediaries. Along the way to becoming full-service financial providers, banks and nonbank entities have been acquiring and merging into large-scale players. The goal has been to capture a significant market share, expand the geographic scope of a previously local or regional institution, and develop an economy of scale that will favor long-term profit requirements. Financial deregulation and new technologies, including communication techniques, automated clearinghouses, and worldwide wire transfer systems for long-distance funds and security transfers, have been central to this rapid evolution of supply chains.
Central banks exert authority over banks' product offerings and pricing. Typically, regulations have prescribed required reserve and capital-to-assets ratios for commercial banks and, in addition, mandated limit restrictions on bank holding company debt and bank loan to its holding company debt; specified deposit-insurance coverage; prohibited certain commercial activities, such as owning nonfinancial subsidiaries, as a means of controlling competition; and dictated what range of interest rates must be offered on a number of liabilities. More than any other economic institution, central banks have supported the work of monetary economists. Curiously, monetary economists have tended to neglect economic relations within banking and other financial institutions. Their focus has been on supply and demand for money, rather than on banks' money-creation activities.

Equation 1 : Supply Chain Data Integration Efficiency (Cloud-Based):

$$E_d = \frac{\sum_{i=1}^{n} V_i}{T_c \cdot S_r}$$

E_d = Data integration efficiency

V_i = Volume of structured/unstructured data from source i

T_c = Total cloud compute time for data ingestion

S_r = Storage resource consumption

n = Number of data sources

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2.1. Historical Context and Milestones in Banking Supply Chain Development

The banking supply chain has been a critical aspect of the financial system for centuries, with roots tracing back to the establishment of early banks which acted as government banks responsible for issuing banknotes and collecting taxes. By the late 19th century, railways and steamers emerged as important service industries in the banking supply chain with little direct technological competition due to their massive upfront investment in labor and capital. The 1930s taxonomy illustrated banking services as “intervention” services, adding value to traditional commodity activities, but that taxonomy failed to capture why banking capital was different from all other capital and why other businesses could not enter banking and create virtually unlimited profits. Theoretical results on critical success factors in service industries later identified 9, including “cost advantage relative to competitors,” “access to resources and/or substitute activities to supply and serve the market,” and easy access to consumer information; however, several factors were linked to legislation and regulation–government imposed barriers to entry, consumer protection legislation, and attentive consumer checklists.
At first, banks regulated credit supply since credit was inelastic on the demand side–demand for loans was unrelated to interest rates. With the failure of the gold standard to act as a credit supply regulator, central banks were established as lenders of last resort to smooth fluctuations in the demand. The credit crunch of the 1980s saw banks charge exorbitant spreads, inflating loan service prices, limiting profit margins, and demolishing the mortgage banking companies specialized in originating and servicing loans. As a result, banking regulatory structure needs to be designed to facilitate the proper banking supply chain operations needed to reduce capital inflow and invest in causing deflation rather than fueling inflation. Recently increased outsourcing of bank services to large financial services warrants reconsideration.

3. Understanding Big Data in Banking

1. Definition and Characteristics of Big Data

In order to understand how Big Data analytics can be leveraged in the banking supply chain, it is important to know essential components and characteristics of Big Data. The definition of Big Data varies with the purpose for which it is being defined. Most of the definitions of Big Data focus on the Four Vs – Volume, Velocity, Variety, and Variability. For example, Big Data is high-volume, high-velocity, and high-variety information assets that demand cost-effective, innovative forms of information processing that enable enhanced insight, discovery, and decision making. In addition to Four Vs, some researchers have also proposed additional Vs such as Value, Veracity, Viscosity, Volatility, and Viability. The growing academic interest in Big Data has also led to the emergence of a number of enabling technologies that can be used to implement Big Data. In this research work, we use the definition of Big Data that describes it as the mass datasets collected through various means and requiring specialized techniques, technologies, and tools to realize their potential of supporting better decision-making.
The banking industry is exposed to many different types of datasets which are not only huge, but also need specialized tools for analysis. As such, the banking and financial services sector is one of the best placed to benefit from Big Data analytics. The core of banking service needs significant near real-time insights for analyzing and better managing transactions that could result in frauds costing substantial sums. Big Data analytics can help provide better insights and decision making across the various functions and divisions of banking services such as risk management, regulatory compliance, anti-money laundering, detecting account frauds, investigating insurance frauds, analyzing online and mobile banking activities, ATM withdrawal transaction monitoring, detecting credit and debit card frauds, performing market risk analysis, customer excellence initiatives, marketing and cross-sell initiatives, customer segmentation and personalized product offerings, portfolio analytics, and predicting customer attrition.

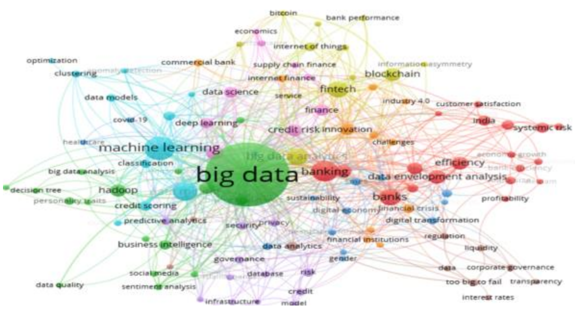

Fig 2 : Big Data-Driven Banking

3.1. Definition and Characteristics of Big Data

Big Data, as a term, became popular among organizations starting from 2010, similar to how the term "Digital Strategy" became popular around the year 2000 among organizations. Since then, it has been used in diverse fields and research. Big Data is an evolution from traditional data management to the plethora of diverse information that is currently available in vast quantities, and big data is what allows organizations to create a competitive advantage. Several definitions of Big Data exist with a wide variety of focus areas on the characteristics that are most relevant to the field of research. The definition of Big Data that is adopted and appropriate for the research focus in this essay is "Big Data is the new technological and architectural ecosystem used for data storage, transfer and analysis which allows organizations to make real time decisions based on current data and use predictions based on models AND uses several sources of structured and unstructured data allowing for the analysis of new types of questions relevant to the business that were previously impossible to analyze due to technology and cost limitations". Based on this definition, three characteristics or attributes of Big Data were identified; Volume and Variety of Data, a new Technological and Architectural Ecosystem for Data Storage, Transfer and Analysis, and current data and real time capability. We opt to expand further on these three characteristics that are critical to understanding what is currently meant by Big Data. Firstly, a large Volume and Variety of Data. A defining attribute of Big Data is its large and increasing volume. Sources of this new data come from the internet of things, social media and legacy internal data. However, increasing volume of data is not in itself unique to big data. The second is the increased Variety and velocity of this new data, which is important in order to answer key business questions relevant to the organization.

3.2. The Role of Big Data in Financial Services

Big Data supports and fulfills the greater business needs of financial institutions and banking organizations by providing accurate and up-to-date information on the vast amounts of transactions being processed. The databases of the financial sector are enriched because they associate information related to banking operations performed by their partners, their clients or third parties, with their clients. This guarantees an extensive transactional history and the incorporation of information coming from many other sources, which provides banks with a unique perspective regarding the profiles, services, and products their clients wish to use. Nowadays, having a good profile of a particular firm or retail client is crucial for banks. This is important for risk purposes but also has great commercial implications, due to the opportunities generated by having a unique way to access the behavior of clients who are related through transactions.

Another consequence of the large number of data flows processed by banks comes from the ease of reaping information to design clusters. The most profitable activities for banks with retail clients are usually seasonal, and the volume of operations rises quickly, but falls at particular periods of the year. The fees explained here provide banks with opportunities to develop viable and attractive services related to the push and pull seasonal operational behavior of their clients. Banks should also identify clusters of banks with a longer lifetime. Wealth management units are already aware of how important this would be in offering services that help wealthy clients manage their wealth in tax-advantageous sectors. Surely, wealth management should be a priority for Private and Business banking services.

4. Cloud Computing: A Paradigm Shift

Emerging in the past decade, cloud computing has become one of the most discussed IT breakthroughs, significantly impacting all layers of enterprise IT. Despite apprehensions from many IT managers regarding the perceived security and reliability risks associated with cloud solutions, companies are increasingly looking for simplification and innovation in IT, while at the same time reducing costs. Across business sectors, firms have been moving essential functions to the cloud on a large scale and this is especially true for financial firms such as banks that have migrated legacy applications to common multi-use platforms. Cloud computing is fast becoming the primary delivery model for IT services.

Cloud computing allows for provisioning of IT resources and applications that are accessible by users on-demand through the Internet, in a self-service manner. These resources are managed, governed and maintained by cloud service providers. Cloud computing is quickly becoming the preferred operating model for enterprise business applications. Cloud solutions offer firms the benefit of no hefty start-up costs of procuring hardware or installing software on-premise. Innovative firms are renting enterprise resource planning-associated cloud services. These suppliers set all the necessary interfaces to interact with their services and some firms have been able to implement these services for a fraction of what the traditional on-premise deployment cost. Risks associated with cloud solutions are less due to the upside of having more modern and sophisticated security infrastructures associated with large service provider data centers that specialize in supporting enterprise customers across industries.

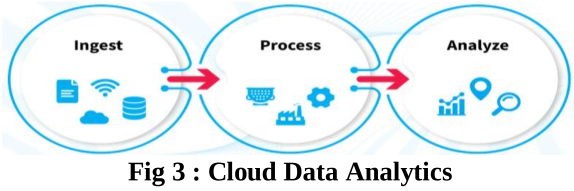

Fig 3 : Cloud Data Analytics

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4.1. Overview of Cloud Computing

In recent years, cloud computing has emerged as one of the most sought-after concepts in the information technology (IT) field. It provides an entirely new way to deliver and consume IT services through the Internet. Cloud computing provides IT solutions for a particular project and allows clients to pay on a pay-as-you-go basis. It has moved away from the concept of on-premises IT infrastructure that is technology driven and capital-heavy to a utility model that is client-driven and consumption-based. The very definition of cloud computing varies widely based on the diverse formation of the cloud computing environment and thus creating different types of natures. Cloud computing is viewed differently by the public and the private sector; by business and technical folks; by technology vendors and service users.
For the public, cloud computing represents a new service delivery model that reduces the complexity of solution and service deployment. With all the deployment efforts handled and supported by cloud service providers, customers avoid the troubles of investment in middleware, system integration, and solution customization. For the business and technical people, however, the introduction of cloud computing creates completely new classes of business opportunities and offerings. Business folks see this service model as one that is suitable for resource-intensive types of services that are characterized by extreme scale, low margins, and limited business returns. By using the cloud, corporations can access and develop massive software platforms at relatively low costs without having to manufacture them.
Technical people see cloud computing services as infrastructures that abstract the internet at different levels: from the infrastructure layer, such as network devices, data centers, computing resources; to the platform layer, such as application development; to the application layer, such storage; to the industry, enterprise as a service, whether horizontal or vertical industry-focused.

Equation 2 : Predictive Risk Score Using Big Data Analytics:

$$R_p = \sigma\left(\sum_{j=1}^{m} w_j \cdot f_j(X_j)\right)$$

R_p = Predictive risk score (normalized using sigmoid σ)

X_j = Feature vector from banking supply chain

f_j = Feature transformation function

w_j = Learned model weights

m = Number of input features

4.2. Benefits of Cloud Solutions in Banking

It is important for any new technology to justify its cost. In the banking industry, public infrastructure costs are high, and the structure of the industry cost functions means that even modest additional costs can have a massively disproportionate effect on profitability. Thus, before cloud solutions can be universally adopted across the industry, they need to be both cheaper and more flexible than the current IT systems, or provide clear additional business benefits.
Several features of cloud solutions suggest they could offer better financials: pay-as-you-go business models mean that banks do not need to invest huge amounts in in-house infrastructure that depreciate over time, and infrastructure elasticity permits rapid scale-up or scale-down of services depending upon business needs. This is particularly relevant given how volatile or cyclical commercial results can be in some areas. By virtue of being a shared infrastructure, clouds can ensure greater utilization of in-house hardware than bare-metal banks currently have.
Public clouds are typically shared environments, where processing from any company may be stored on the same physical hardware as other companies, with security guaranteed and resources allocated by setting up logical partitions. Large banks often have more resources on the same scale as commodity clouds or may even have greater resources; for them, this kind of shared environment does not happen. However, the hybrid or private cloud concept, where banks can keep critical data or applications at in-house data centers and use the cloud for non-critical activities, can deliver some of the additional cost- and risk-efficiencies.
Because of these hybrid cloud environments, private clouds have found significant acceptance in the banking sector. With a private cloud, banks can run services on dedicated IT designed specifically for their requirements while still taking advantage of cloud benefits such as service self-provisioning, service capacity-on-demand, and greater operational efficiency around service management.

5. Integrating Big Data Frameworks with Cloud Computing

One of the inherent challenges surrounding both big data and cloud computing is that, while they exhibit many similarities, they exist separately. Big data frameworks were optimized over years of specific use case and design consideration to best spout the power of big data at specific deployments. Meanwhile, cloud computing, initially developed for widely different aims, is rapidly converging to the point of becoming a suitable option for big data, while continuing to expand rapidly into new areas. Those considering entering big data should carefully balance the deep integration of the two available at cloud computing examples against the additional effort needed to implement the unique options offered by the big data-specific frameworks.

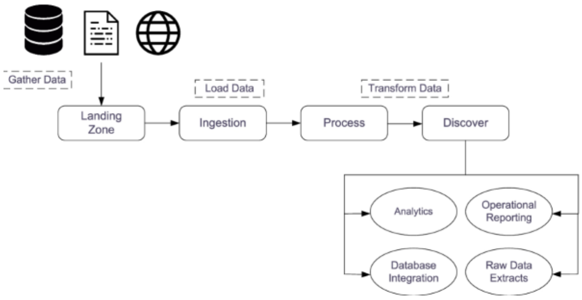

Fig 4 : Big data analytics in Cloud computing

Cloud-based big data services have a number of key benefits. The first is speed: the multi-teaming offered by cloud computing enables rapid parallelization, allowing very large data sets to be processed quickly. The second is ease of use: For someone without much experience in parallel programming and in data-intensive problems in particular, using a cloud computing service is almost certainly much easier than developing an application using a big data framework from scratch. Finally, cloud-based big data processing can occasionally provide very low financial costs for those who have little flexibility in their timing. Because cloud computing service providers tend to price their services according to supply and demand dependencies, the financial cost of processing a ton of data may vary widely over a 24-hour span. During the night, it may drop significantly below the bulk price offered by a big data framework. The optimized little-cost option for big data processing is then to use cloud computing services for the lower-cost night periods.

5.1. Key Big Data Frameworks

Cloud computing and big data are two emerging fields of computing. Cloud computing is intentionally architected to deliver scalable, on-demand, shared resources to support various applications for businesses and consumers alike, while big data refers to massive amounts of data generated by individuals, organizations and applications that present challenges in storage, processing and governance. Big data analytics deals with the difficulties of acquiring, managing and analyzing such big datasets and aims to enable organizations to better leverage their data. Organizations cannot just rely on traditional databases and tools for big data analytics as these are likely to perform poorly with big data. They, therefore, look for new ways of handling big data more effectively and efficiently as it continues to grow at an unprecedented pace. New programming models are being developed to meet this challenge which rely on the underlying infrastructure comprising big data frameworks. These frameworks are based on the principles of distributed storage and parallel processing and are designed to specifically handle big data with its rich variety.

The concept of a big data framework is derived from parallel processing and distributed storage methods. Enabling the handling of big data for various analytics workloads, big data frameworks form the basis for building companies' analytics solutions. Hadoop and MapReduce are two terms often used interchangeably. Hadoop is an implementation of MapReduce and it provides the storage capability needed to be able to manage big data. Hadoop also provides a resource manager that schedules resources required for applications wishing to use MapReduce for parallelized processing. However, Hadoop is not the only big data framework. Other frameworks used for big data analytics include Spark and Flink. These frameworks are designed more for streaming and iterative workloads, where quick responses are essential.

5.2. Cloud-Based Big Data Solutions

The evolution of cloud computing as a convenient IT deployment model, wherein the management of IT infrastructure is entrusted to external cloud service providers, frees organizations from incurring direct capital investments in critical IT tools and platforms. Thereby, cloud computing helps organizations of all sizes to implement, try out, and use critical big data infrastructures with minimum time lag and reduced costs. Furthermore, cloud service providers are offering a variety of cloud-based big data platforms as products for organizations to select from, making it easier for organizations to experiment with selecting their requisite big data platform.

In keeping with the cloud computing exposure- and delivery-models evolution, big data frameworks are also evolving towards becoming cloud-specific solutions. Industry players are offering big data deployment models on popular public cloud platforms. These popular cloud-specific big data platform solutions reflect the bundling together of these leading big data frameworks along with open-source big data-related utilities/tools and deployment orchestration utilities into generics, templates, and Data-Analytics-as-a-Service and Infrastructure-as-a-Service offerings. These solutions enable quick and economical deploying, managing, and running of big data-related operations and analytics by organizations on public clouds without incurring direct investments in on-premise data infrastructure and expertise. Cloud-based solutions provide organizations cheap access to big data capabilities, enabling them to derive timely business insights which, in turn, make them responsive to continuously changing conditions in business markets on which they operate.

6. Impact of Cloud-Driven Analytics on Banking Supply Chains

Cloud technologies have transformed the accessibility of disruptive analytics capabilities. Businesses can now automatically deploy the latest machine learning algorithms without additional cost and complex procedures. Cloud computing enabled the ease of big data storage and transfers, increased the computing power of applications, and changed business architecture from centralized to distributed. In this regard, the use of cloud computing is having a major impact on supply chain analytics. Cloud computing and analytics is increasingly moving data processing and running application logic from local corporate servers to remote servers where employees can access via web interfaces.

Specifically, cloud-based analytics in banking provides three key advantages. They include enhanced data processing capabilities, real-time decision-making, and cost-efficient scalability. Banks handle heavy IT loads driven by the massive scale and volatility of big data. Organisation and operations solutions are mainly at the forefront, and risk management analytics are data intensive as banks consume thousands of internal and external data to monitor their risk profiles and predict future risks. Cloud-based analytics provide additional processing power to digest these rapidly growing piles of raw data. Aided by high-speed mobile internet access, cloud-driven analytics has dramatically sped up decision-making through enhanced near real-time, within a day, or even ‘in-flight’ on a transaction. Yet this near real-time access has not fully applied to large value transactions or the most sensitive transactions exposed to money-laundering risks. Cloud technologies provide scalability for banks on an unparalleled scale, at an optimized cost. Banks still need to invest upfront on hardware for on-premise big data capabilities. So there is a clear balance sheet benefit for banks looking to run their analytics through the cloud.

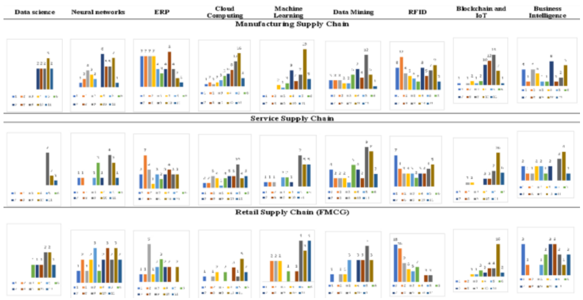

Fig 5 : Impact of big data analytics on supply chain performance

6.1. Enhanced Data Processing Capabilities

A major feature that Analytics-as-a-Service (AaaS) capabilities help supply chain practitioners is making it possible to meet the traditional technology and resources cost and complexity barriers for using advanced computational analytics. Supply chain decision makers and analysts at services and product firms alike are using cloud-based big data analytics solutions on AaaS without needing to acquire the expertise, develop the IT infrastructure, and bear the ongoing costs of systems development and maintenance on their own to leverage analytics that previously required specialized technical skills and scarce, and expensive, computing resources to harness insights from small sized data sets. Offered in a much more consumable and less costly manner than private cloud-enabled massive network storage and processing, public clouds have opened up the use of big data analytics hosted on shared, scalable infrastructures run by specialized vendors who have deep expertise in the design and usability of underlying components and tools, and the necessary hardware power and storage capacity to also operate specialized analytical processes in a cost-effective manner. Execution of specialized complex analytical functions, such as statistical models and operations, as well as custom-developed code written in R and Python scripts, among various code libraries, and even executing machine learning workflows operationalized through tools also broadly available, as well as enabling cheap access to data storage and processing on-demand, AaaS takes typical supply chain analysis processes that have in-house typically required a lot of specialized staff trained in big data techniques and models to do in weeks or longer and greatly enriches and sometimes automates them so businesspersons can do themselves in hours, increasing both bandwidth and capability of insights.

6.2. Real-Time Decision Making

Cloud computing supplies the architecture, tools, applications, and services to scale and support massive processing and storage challenges that were previously reserved for the largest, most sophisticated banks. One result of this wide-ranging effect is the democratization of advanced analytics. Enabled by the power of cloud computing, small and medium-sized banks can analyze comparable amounts of data as larger banking institutions, albeit with very different execution

capabilities. As supply chains become increasingly reliant upon speed to market or service, they expect better access to real-time data in order to effectively manage both internal operations as well as communications with external partners and customers. Customers expect instantaneous service, and are willing to take their business to engage with other banks or financial service providers if they do not receive current data or timely responses.
Big data and analytics in the cloud enable faster, more flexible, and lower-cost ongoing processing and monitoring of business activities. With the economies of scale that cloud provides, fusing analytics into analytic ecosystems enables all entities along the supply chain to not only interact, but also share updated transaction information. Leveraging real-time data streams helps banks ensure liquidity is optimally utilized throughout the supply chain. Throughout the last five years, we have seen the emergence of several new design principles for establishing data provenance and reliability, and integrating distributed processing of these high-frequency data streams for uses such as risk monitoring, compliance verification, and credit approvals of supply chain members.

6.3. Cost Efficiency and Scalability

The cloud-computing environment enhances the cost efficiency of banks' supply chain operations and analytics, since the Information and Communications Technology capabilities can be utilized and only a necessary fee is paid. Cloud leasing diminishes hardware investment of banks, provides better speed and processing power, and supplies storage at much lower per-gigabyte rates compared to traditional data warehousing solutions. Thus, banks can run advanced analytical models that would be too expensive to build without the cloud. Additionally, since more structured data from transactional processing are available to banks, they can use prescriptive analytics for more elaborately orchestrated integrated design of supply chain using sophisticated optimization models.
The cloud-based architecture is horizontally scalable and can be elastically scaled up to deal with peak volumes of messages and traffic, and then scaled down to save costs when that peak is over. Thus, the cloud can support real-time streaming of data messages from multiple sources to provide an enterprise-wide view of ongoing supply chain operations. The cloud can make the essential infrastructure of a bank's supply chain analytics more agile and responsive to its changing needs. Banks can acquire ICT resources at much less than with existing conventional in-house infrastructure in very little time. Specialized key ICT service providers of banks can centrally host their infrastructure cloud services, through which banks access computational resources that are cheaper and more powerful than resources of most banks at much more affordable prices.

7. Challenges in Implementing Cloud-Driven Analytics

Cloud computing is revolutionizing banking analytics business applications. It brings agility, infrastructures and service platforms in use; and operational expense with an end result of a floor of regulatory compliance services up and running much quicker than traditional IT would ever permit. On the other hand, the cloud offers reduced operational costs on the back of multi-tenancy sharing of the same cloud which brings up the issue of securing sensitive banking data in a multi-tenant environment, where other organizations with as little as public records financial data on other service tenants who share the same cloud resources as banks, are probably housing in the same cloud. The same environment has proven to be susceptible to cloud blueprinting exploits by attackers, which gives them the ability to discover associations and create predictions about sensitive banking data.
For privacy protection using cloud resources, security services preserve confidentiality by splitting sensitive banking data into fragments using secret shared cryptography and then encrypting the fragments. By protecting sensitive banking data confidentiality in this way, fraudulent cloud and compromised cloud service tenants remain blind to the data being housed in the shared co-tenancy operation. This provides a solution to the first risk problem highlighted earlier, though the attack surface for the multi-tenancy authorization problem is much larger. The solution however becomes vulnerable to attacks such as the Man-in-the-Middle attacks and Eavesdropping which can compromise service security, user privacy and service authentication – integrity and availability.
The second challenge and obstacle is regulatory compliance. Regulators throughout the world are enforcing their banking related legislation as well as issuing fines related to setbacks in banks’ implementations and awareness of new and revised banking rules to a good measure. The classification of bank data by application has to be mapped to the cloud’s classification in order for the cloud to be used and comply with data privacy regulations and for the bank to remain current. Finally, banks are reluctant to move to the private cloud if not storing all their applications there, due to the costs associated with it.

7.1. Data Security and Privacy Concerns

The increasing use of cloud-based tools and services for data management, analysis, and visualization raises important security and privacy issues that organizations must consider while developing their cloud analytics strategy. Organizations transfer their business-related data to a third party, thereby losing some control over that data, which raises security and privacy concerns. Besides confidentiality, integrity and availability have also become a major concern for cloud users and vendors. The characteristics of cloud computing, such as multi-tenancy and security and privacy regulatory issues, further complicate the security and privacy landscape surrounding cloud services.

Organizations have little to no control over security and privacy in the cloud and rank the risk of loss or theft of data as a top concern with most worrying about the security of applications and infrastructure. Organizations do not know where their data will be stored physically or where it is located. They do not understand how cloud services apply data encryption and identity and access management. Providers may be slow or reluctant to share security documentation and inquiry to address security and privacy concerns. Organizations want to know if their service host has ever suffered a major security breach. This is especially a concern for organizations embarking on a cloud initiative for disaster recovery, services backup, or data storage, who want providers that are fully invested in encryption and other best practices. They want to know what type of customer data the service stores and which aspects of security and data privacy are the organization's responsibility versus the provider's.

7.2. Integration with Legacy Systems

Modern cloud technologies allow for large scale, low-cost processing of data analytics workloads. Unfortunately, enterprise-scale deployments of cloud-based analytics in many industries, including Banking, remains stubbornly low. This is attributed to a combination of data access latency, security policies, complex integration with existing enterprise systems and technology stacks and, in particular, rough edges with cloud-driven big data analytics and cloud pipelines. The challenge for organizations is how to utilize the skills and best practices that have supported big data and cloud initiatives elsewhere as a means to accelerate the use of cloud analytics in Banking.

Analytics efforts within organizations quite often are driven through Data Lakes that store high volumes of both structured and unstructured data. Optimized for data durability and low-cost storage, organizations deploy and provision Data Lakes. As the initial usage grows to use Cases that are more operational in nature, these scalable Enterprise Data Lakes evolve into Data Hubs. Operating Data Hubs as a solution, which will scale to meet transactional bears and whose data is "data available anytime for everyone," is neither easy nor cheap.

Data Lakes built with cloud infrastructure initially focused on batch-oriented append-once types of workflows. Cloud adaptation of proposed solutions, such as Data Lake Architecture and Tactical Blueprint for Enterprise Data Hubs. Cloud-driven Data Hubs emphasize the ability to deliver near real-time freshness, and the consideration of Data Hub workloads. Leveraging workflows designed to discover, cleanse, profile, and catalog data are a large unmet requirement for Data Hubs. It differs in key aspects, including a need to work closely with data integration specialists to ensure that Data Hub sources and changes are both clean and managed appropriately. They can safely access legacy systems with a great deal of support from enterprise and third-party vendors that deliver architecture and modeling best practices.

7.3. Regulatory Compliance Issues

All organizations that operate in a highly regulated environment see compliance as a major concern. Certain services and infrastructures must meet requirements and regulations established by legislation or authorities to guarantee the confidentiality and integrity of sensitive data such as Personally Identifiable Information, Protected Health Information, or payment card information. Organizations in the banking and financial services sector face privacy-related concerns on a number of different fronts. First, bank supervisors may expect organizations to comply with specific regulations that apply to deposit-taking and payment services, focusing on preventing money laundering, terrorist financing, and system abuse. Second, many local laws, monetary authority regulations, and self-regulation establish requirements focused on data security and confidentiality. Third, activities that fall outside the regulatory ambit of the monetary authority are still obliged to comply with other local laws, such as the Personal Data Protection Act or the Spam Control Act.

Some industry regulations dictate where the data must be physically located, while other regulations may relate to how the data is handled or accessed. For example, organizations in the banking and finance sector are responsible for understanding where their data resides and how it is secured and protected once entered into a cloud environment. For certain organizations, the delegation of some services to a cloud service provider operating with a shared responsibility model might reduce their ability to comply with certain regulatory constraints. Because of the sensitive data these organizations handle and the importance of mitigating risks around the publication of those data, their lapses when using cloud services may lead banks and third-party banking service providers to contemplate with caution the strategy for using the cloud for banking-critical activities.

8. Case Studies

There are many banking cases implementing big data technology in supply chain analytics. Here we share five successful case studies to briefly analyze how cloud-driven big data technologies help banks obtain advantages. Meanwhile, there are failure cases as well. The banking industry needs to address the key factors for failure to avoid these challenges.

Bank of America Merrill Lynch provides a user-friendly portal for banking services on supply chain management. The portal publishes research documents freely to cover many topics, industry analysis in global and local economic analysis,

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and supply chain and logistics company earnings preview and reconciliation. People can find research documents in an easy search engine with comprehensive search criteria like time, keyword, document type, industry, company, region, and country. The report topics cover chain topics including market update, supply and demand analyses, chain stock on the way indicators, earnings, random, illegal labor issue, and chain production. The research reports help bankers, brokers, logistic companies, analysts, and people in other industries to understand their sector and its connections with the overarching economic framework.

Deutsche Bank paid nearly 300 million dollars to build and implement a new middle and back office after its venture capital-backed debacle in 2014. The middle and back office for the bank's retail unit provides support for payment services. The middle and back office functions enable Deutsche Bank to develop an agile service to adapt to quickly changing business environments by leveraging cloud and automation for the back office. The Deutsche Bank case shows that banks could use the cloud to build a data factory to centralize existing supply chain data that is fractally integrated into the middle and back offices with a fully searched and analyzed data tool.

8.1. Successful Implementations in Banking

With increasing pressure on profits and top lines, the banking industry has rushed to respond to customers' rising expectations for service and increased regulation around risk and compliance. As a result, many banks have embarked on large projects to transform themselves into 21st-century financial institutions, investing billions of dollars to improve the quality of their products, accelerate the speed of their services, and implement multi-channel distribution strategies, all while making themselves less vulnerable to hackers trying to breach their security. On the road toward transformation, the banking industry looks to big data for insights into customers' desires and actions, as well as ways to improve risk assessment, compliance, and other functions.

A large number of analytics use cases live within banking. These cases serve a variety of functions, such as giving recommendations for cross-selling based on customer engagement metrics, and storing segmentation profiles that contain data synonymous with product website interactions. From a risk and compliance perspective, they implement account alerting based on fraud detection algorithms, and model embedding for compliance issues like Anti-Money Laundering and Know Your Customer regulations. But in a growing ecosystem, the expectation is that more exploration will take place, resulting in a higher volume of production use cases being deployed and operationalized. This section presents survey data about successful implementations in banking, along with projected growth in adoption, technologies, size, and spending. It concludes with a summary of successful use cases. Solutions for fraud detection and risk modeling lead the way for enterprise deployment in size and spending, and are built on traditional data and analytic priorities of transaction history data modeling and predictive analytics.

8.2. Lessons Learned from Failures

The failure and success stories of some prominent implementations of supply chain analytics are highlighted in this section. A case in point is the Massachusetts Bay Transportation Authority. They planned to build a system that would streamline its maintenance of subway and commuter rail vehicles. Despite their consulting partners and the vendor developing a clear design, assembling the necessary technical infrastructure, conducting countless meetings and walkthroughs, enlisting a bevy of in-house advocates, and eventually building an outstanding system, it all fell on deaf ears once the system went live. Why? Simple. The project wasn't approved by the appropriate authorities, and therefore there was no follow-up and no expectation that important reviews would take place. When you're dealing with systems that save an organization millions of dollars a year, every major decision must go to the top and stay at the top. The commitment from the highest levels must be firm. The need for the commitment is especially true when a system that will radically alter work practices is to be built.

A corporation had many failures before making a financial analytic success with its own company. For many years, the firm failed to link convincing segmentation with a presentation of the products and solutions that met the specific analytical needs of each segment. As a consequence, almost half of the existing customers using its basic financial, human resources, payroll, and bookkeeping programs were convinced that they would have to implement a different supplier's systems if they wanted to use anything more sophisticated than the basic tools for enterprise calculation and data display. As the sharpest analyst in marketing, Anton and his colleagues worked long and hard to solve the segmentation problem by translating its successful personal computer model to the new market for high-analytical-business-systems. They took every significant type of business-user-listened to its needs-and used that information to redefine its software attributes like never before.

9. Future Trends in Banking Supply Chain Analytics

The banking industry has undergone tremendous changes over recent years with the adoption of numerous futuristic and innovative technologies. As the industry attempts to reinvent itself in a world characterized by an ever-increasing digital ecosystem and banking being transformed into a stage for co-creation, there is a shift in focus toward enhancing the level of service provided to clients. This change in trends is forcing banks to go beyond traditional boundaries for innovation and take service provision to a different dimension altogether. Innovations in supply chain technologies like blockchain, cloud computing, big data analytics, artificial intelligence, machine learning, and robotics process automation have enormous potential to transform banking practices leading to collective efficiency benefits for companies and their stakeholders. With supply chain and operations serving as an essential hub of innovation, banks are increasingly dependent on these areas for innovation and value creation. Some innovative technologies have been described before and would certainly influence the supply chain of banks in the future. For example, one of the most promising recent trends with big multinational companies has been the interest in machine-driven artificial intelligence applications to speed up the supply chain, reduce costs, and gain visibility through the automation of repetitive, tactical supply chain activities.

Artificial Intelligence and Machine Learning

Technological innovation is at the heart of new banking services. The Industry 4.0 phenomenon is provoking real disruption and the entry of so-called fintech companies is shaking up the entire supply chain of banking services. The industry is being forced to invest large-scale in the supply chain of banking, making it accessible and attractive. Banks are rethinking the service distribution models and relationships with their customers and users, adopting the model of digital platform. The customers of the banks are becoming customers of the platforms, taking advantage of a supply of banking and financial services in synergy with other digitized services. On these platforms fintech companies can offer their products, developing collaboration partnerships with banks. Customers, consequently, benefit from a model of integrated services that can be customized, more attractive, safer and lower cost; banks and fintech companies would consequently judge the business model profitable through an increase in demand and turnover.

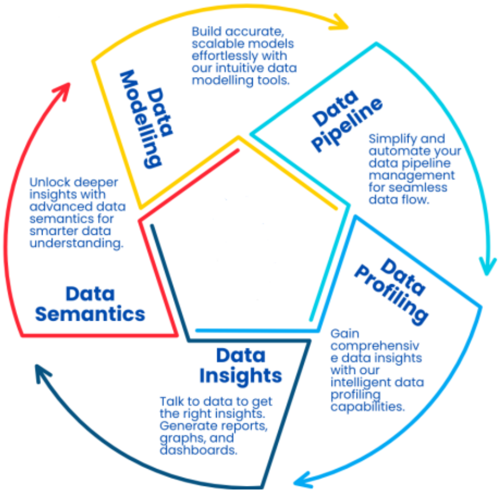

Fig 6 : Banking Analytics

The Role of Blockchain Technology

The new blockchain technology is altering the traditional process of disintermediation. Through decentralization, instruments that are totally detached from the monetary policy of governments and central banks are being created: the cryptocurrencies. The millennials, however, are showing greater interest in an approach to banking based on a model of collaboration between banks and fintech companies, seeing the former as holding the safe vault. The combination of expertise in the field of managing deposits, collection, and regulation by banks with the technological capabilities and flexibility of the fintech companies and of new digital platforms can guarantee the basis for efficient, trustworthy, digital services that can win the competition with the online giants of the Web. By applying data science algorithms to huge amounts of big data, banks are increasingly able to accurately define the profile of their customers, improving the service and creating relationships of trust based on the protection of privacy. The gathering of user feedback can help to customize the solutions offered to users: virtual financial advisors, skill-based call centers, and cognitive computing. Furthermore, on the basis of information gathered from transactions made, it is possible to develop artificial advisor systems able to increase the customer-satisfaction rates.

9.1. Artificial Intelligence and Machine Learning

The term "artificial intelligence" (AI) can be defined broadly, but generally refers to the development of tools or solutions that allow machines or systems to perform tasks that would normally require human intelligence. These include tasks such as problem solving, decision making, and the use of natural language. More specifically, AI involves the process of developing computer software, or a complete system, that demonstrates behaviors commonly associated with humans, such as learning, memory, reasoning, perception, and language comprehension. An AI system relies on knowledge about

the characteristics of the particular instance of a type of task to augment its cognitive abilities. Such knowledge consists of general knowledge about the world, and specific knowledge about the task to be performed, the type of data corresponding to that task, and the effect of performing the task. AI is related to, yet distinct from, other areas of computer science such as machine learning or expert systems. Expert systems focus on solving specific problems in a particular domain, while machine learning deals with the development of algorithms that allow computers to learn from and adapt to data without being influenced by traditional statistical techniques.
Machine Learning (ML) is a specific sub-field of AI that has grown increasingly popular in recent years. ML involves the development of algorithms that allow computers to learn from and adapt to data. Such algorithms allow the computer to solve the problem without being directly programmed. ML techniques are being increasingly used to solve specific problems, and typically without any human intervention, in the banking and supply chain domain. Business and system managers should be aware, however, that such ML solutions are typically generating better initial results than traditional statistical solutions, but that the state of the art in this new paradigm is less well-defined than in more traditional statistical solutions.

Equation 3 : Cloud Cost-to-Performance Ratio in Supply Chain Analytics:

$$C_p = \frac{C_u + T_l}{\Gamma}$$

where:

- C_p = Cost-to-performance ratio
- C_u = Cloud usage cost
- T_l = Latency for data processing
- Γ = Performance throughput

9.2. The Role of Blockchain Technology

Future Trends in Banking Supply Chain Analytics 9.1. Artificial Intelligence and Machine Learning
Blockchain technology is a disruptive innovation that helps to reshape the current supply chain mechanisms in several industries around the world. For banks, offering blockchain solutions that enable companies to create value in their supply chains could lead to substantial profits. Estimates suggest that between 10 percent and 15 percent of the world trade volume, representing about one trillion dollars, could be processed on the blockchain. With Blockchain, all parties in a supply chain could access an immutable and frequently updated transaction process; this transparency would enhance trust in the supply chain and reduce costs. Error correction and reconciliation steps would become decentralized, real-time settlements of transactions would be possible, and unused intelligence from a company's supply chain could become anonymized and easily shared among supply chain members.
Blockchain-based banking supply chain solutions would especially benefit environmentally and socially sustainable supply chains. Manufacturers could guarantee that, for example, only sustainably sourced palm oil is used in their products, retailers could relay that information to customers, and banks could verify the product’s origins and, if necessary, offer loans at lower interest rates to players in that supply chain. Ideally, when lending money to supply chain companies, banks could be confident that the supply chain is functioning correctly. When creating digital identities for supply chain participants and designing new local regulations, banks could team up with NGOs and the academic community. One of the biggest motivational obstacles to the expansion of blockchain use in supply chain banking is that setting up supply chains on the blockchain will not be done for free. Reconciling legacy systems with the blockchain will, for instance, require considerable resources.

10. Conclusion

The banking supply chain (BSC) is poised to play a pivotal role in overcoming major roadblocks, such as risk mitigation, compliance and more efficient fund operation, faced by the banking industry when dealing with big data. However, the current BSC analytics applied by banks are limited in their ability to fully explore data-centric methods for innovative BSC modeling because they are primarily maintained in-house or focused on reporting tools. They should instead be expanding their operations into the cloud enabled big data domain. Hence, the contribution of this paper is emphasizing a cloud-enabled transformation of real-time BSC analytics.

Despite the shift from in-house solutions to bank-cloud solutions affecting a wide range of functions and industries, no significant player has emerged on the market in the area of BSC support. This is mainly due to the conservative nature of the banking sector coupled with the costs of moving from on-premise solutions to cloud solutions. Another reason is that unlike the travel supply chain, which is relying on standardized electronic interfaces for information sharing, the BSC is not yet sufficiently mature to allow large-scale deployment of cloud-enabling concepts for SC management. Nevertheless, if banks want to remain competitive and realize the full potential of big data capabilities they will have to innovate their SC operability from inside-out to outside-in via an internal and external collaborative BSC approach. This means they have to rely on cloud-enabled platforms. However, this step is not sufficient. Developing a customized model of parameters enabling the BSC to play an innovative role based on cloud capabilities is a prerequisite for a successful BSC transformation.

10.1. Final Thoughts and Key Takeaways

In this work, we presented a paradigm shift from traditional banking organization towards cloud-driven banking systems and processes. This paradigm shift is necessary if banks want to embrace the latest technology, especially in the big data domain. In order to realize this transformation in a banking analytics-related environment, we espoused the key principles belonging to the new data stack – that is the modernized big data core processing components of cloud-managed distributed processes operating on real-time data streams or batch data files, using the latest algorithms that form the data-driven programming model called data flows. The outcomes from this new approach can be new intelligence that drives business actions that generate business outcomes.

We also laid out the high-level architecture and programmatic approach that banks – especially their banking operations and analytics teams have to undertake in order to realize this cloud-driven transformation of their supply chain analytics operations. There are two aspects of this process that are germane to the banking teams: the design of elite supply chain analytics processes and the corresponding development and deployment pipelines that enable the banking teams to be able to build and maintain these analytics solutions throughout their life cycle – from inception to adoption and to extensions. We stressed that the realization of the optimized analytics processes depends very much on the careful selection of the cloud-hosted data stack components that are best suited to meet the business performance, capability, scalability, and resource utilization goals for the banking institution linking the data to insight to outcomes continuum of bank operations and decision-making.

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