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Big Data Analytics enabled Smart Financial Services: Opportunities and Challenges

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Abstract. Of late, the financial services industry is fast moving away from the traditional paradigm to the sophisticated digital way of dealing and the customer. Both the facets of the financial service industry, viz., the financial service provider and the customer are going through a digital evolution. In particular, banking industry has evolved from just journal and ledger entry paradigm to data and analytics driven banking operations, which subsumes online as well as offline customer behavior. This paper discusses various scenarios in baking, finance services and insurance (BFSI) areas, where big data analytics is turning out to be paramount. The paper also highlights the potential benefits, of the new-age technologies viz., Internet of Things (IoT), Blockchain, Chatbots and robotics.

Keywords: Big Data Analytics, Digital Banking, Financial Services, IoT, Chatbot, Insurance, Hadoop, Spark.

1 Introduction

Financial transactions evolved over time from the ancient barter system to today's state-of-the-art e-commerce system. With the rapid advancement of human civilization and the associated stellar technological achievements, the finance services industry (also known as banking, financial services and insurance -BFSI- industry in India) has thrived significantly. Earlier to the digital era, all the transactions and the business intelligence thereof had excessive human involvement. The digital world, while making the transactions clear and transparent, generated large amount of digital data. These digital footprints have become amenable for rigorous analysis using the new field called analytics in order to make clear and right business decisions. Over a period, with the ever-growing young customers, their increasing needs & desires and globalization, financial services industries produced humongous amount of varieties of data at a breakneck speed leading to a new generation of data analytics paradigm called Big Data Analytics (BDA).

1.1 Introduction to Big Data

Data-driven technologies and decision making is often called fourth paradigm of science, the theoretical, experimental and computational paradigms being the other three. Over the past two decades, many science & engineering disciplines, medicine, business, economics produced vast amounts of data in various forms thanks to the proliferation of sophisticated instruments, cheap hardware and novel business processes. This trend is exacerbated by the rampant use of social media via Web 2.0. Analyzing this huge data and providing a better consumer experience with better data management have led to the genesis of Big Data Analytics (BDA). These monetary transactions in banking, finance, service and insurance sectors generate a huge volume of data in less span of time from different digital devices involving different types of data formats. The big data is best characterized by 5Vs. They are Volume, Velocity, Variety, Veracity, and Value. *Volume* refers to the vast amount of data generated every second. The huge amount of transactions result into a humungous datasets, which are difficult to store and analyze with the help of conventional storage and computational technology. The big data paradigm allows us to store these datasets and facilitates their computation by employing the distributed storage and parallel computational framework. *Velocity* dimension refers to the speed at which new data is generated and the speed at which data moves around. *Variety* refers to the different types of data that is generated. The big data technology deals with different types of data including text data viz. SMS, social media conversation, feedbacks in websites, tweets in twitter, image data viz. photos posted on Facebook, Instagram, and images gathered from satellites, sensor or sensor embedded device data, and video or voice recordings; and unite them with traditional structured data. Thus, this dimension subsumes unstructured, semi-structured and structured data from various sources. *Veracity* dimension presents the degree of reliability of the data. The presence of structured, unstructured, and semi-structured data in big data renders its quality and correctness less controllable. Therefore, this dimension concerns the uncertainty associated with the data. Finally, *Value* dimension refers to the business value that can be extracted from the data [1]. Very often, the noise component in the data collected is disproportionately more compared to the useful data present thereof. Thus, these five dimensions succinctly capture the entire characteristics of big data.

1.2 Introduction to Apache Hadoop

As the data generated by the Banking, Finance sectors and Insurance is of large scale, with different data formats, which are not possible to handle with the traditional relational database. Here comes the open source Apache Hadoop framework, which can store a large volume of data with the help of distributed storage file system and process or analyze them in a distributed manner with the help of parallel MapReduce computational architecture.

The base Apache Hadoop framework comprises the following modules: (i) Hadoop Common, (ii) Hadoop Distributed File System (HDFS), (iii) Hadoop Yarn, and (iv)

Hadoop MapReduce. The Hadoop common module contains libraries and utilities required by other Hadoop modules. The HDFS is the distributed file system, which stores the data distributed over several commodity machines present in the cluster. YARN is the platform that allows the management of computational resources pre-sent in the cluster and scheduling the users' application. MapReduce provides the computational framework implementing distributed processing for large-scale data [2].

1.3 Introduction to Apache Spark

Apache Spark is a fast, distributed computing technology. It employs horizontal clustering for fast and efficient computation. Apache Spark provides its computational framework on top of Hadoop MapReduce (MR) model, and it employs MR model for an extended computational framework subsuming interactive database queries and online processing through streaming. The most striking attribute of Spark is in-memory computation, which reduces the read/write latency of intermediate data during processing.

Spark can handle different workloads such as batch program, iterative codes, interactive database queries and streaming data. The Spark is faster than Hadoop distributed processing, and it is attributed to the reduced amount of read/write tasks to the hard disk. It stores the intermediate value of the variables in memory during the execution [3].

The Spark core is the computational framework that provides in-memory computation. Spark core engine supports APIs in Scala, Java, Python or R. Spark also supports 'Map' and 'reduce' operations. In addition to it, Spark supports Machine learning (MLlib), SQL queries (Spark SQL), Streaming data for online processing, and Graph algorithms (GraphX). The shared memory facility of sharing the same data among multiple applications is achieved through Tachyon now called, Alluxio. The cluster management in Apache Spark is performed in three different ways viz. Standalone, Hadoop Yarn, and Mesos. Spark can access the data from local file system or any distributed file system like Hadoop Distributed File System (HDFS).

2 Current works and recent trends

The current scenario of the financial world reflects the utility of data and analytics carried out on them for the insights. The analytics, and in a more formal way the big data analytics has paved a path to present another dimension to the business. The big data analytics can be implemented to address several problems the financial industries are facing during their operation.

2.1 Digital Banking

The digital world has made a revolution in the banking industry. Initially starting with core banking now the banking industry has moved to multichannel banking industry with different types of devices. In general, a bank has external and internal aspects. The

external facet refers to the customers (both retail and corporate) of the bank, the regulator and other competing banks and partners; the internal facet includes treasury, back-office operations, and HR department. Considering these two aspects, a digital bank has eight predominant dimensions that form the complete umbrella for a digital banking system (Fig. 1).

The external aspect subsumes regulatory and operational aspects of banking. In turn, operational aspect subsumes the dimension of customer/sales and services. These are the first two circles in Fig. 1.

Fig. 1. Dimensions of a Digital Bank

Customer/Sales/Services. It is the predominant pillar of any digital banking framework. For providing the financial services and sales to the customer, a digital bank is supposed to implement holistic CRM (subsuming operational, analytical and collaborative CRM). Customer-centric business models are established based on an exhaustive knowledge of the customer. Such a model demands tactical planning on:

- Establishing an omnichannel integrated platform – to facilitate seamless and consistent user experience across all the channels, i.e., internet, banking app over smart phone and social networking services.
- Developing the competence to collect, incorporate and analyze numerous sources of internal and external data – to comprehend the customer for a personalized solution.

- Comprehending and interpreting relevance and timeliness for the customer – to customize processes from the perspective of the customer. Analytical and prescriptive CRM play a predominant role in the digital banking journey.

Regulatory/Other Banks. It comprises a seamless communication at several business levels and fraud-related reports to the regulatory board, e.g., RBI. It also involves seamless communication between various commercial banks to have smooth banking operations.

Internal. It comprises applications for analytics with measurement and management of different types of risks a bank can face during its day-to-day operation. These includes credit risk, market risk, operational risk at the highest level and many other risks at a lower level.

Technology. This aspect involves core banking, internet and mobile banking, e-wallets, m-wallets, Omni-channel data warehouse, Data Lake and service oriented architecture.

Data. The data dimension deals with the quality of the data that is present within the bank. This deals with data governance and data quality management.

Business Process Reengineering (BPR). This dimension deals with redesigning and reengineering the existing business processes in order to be more customer friendly and profitable.

Analytics. This dimension drives the bank towards profitability while making it customer friendly simultaneously. This dimension involves three types of analytics viz. (i) descriptive, (ii) predictive, and (iii) prescriptive. The descriptive analytics presents the information content available in the historical and current data by answering complex, high dimensional queries in pictorial forms viz. bar chart, line chart, pie chart, histograms, heat chart, box plots, etc. The predictive analytics solves various business problems faced by a bank based on historical data and utilizing several applied statistical and machine learning models. It helps the organization to proceed in the right direction and take right step at right time. The prescriptive analytics consists of applying optimization techniques to recommend future course of action based on the predictions made in predictive analytics stage.

People. This dimension deals with the manpower involved in the banking industry to lead to a digital banking era. For that, the bank requires the recruitment of qualified and trained specialist manpower for transforming the bank into a revenue generating organization as well as a customer friendly one.

The digital banking generates a large volume of digital data from which meaningful predictions and insights can be obtained using predictive and prescriptive analytics. Analytics in digital banking manifests in six distinct ways, viz., customer analytics, fraud analytics, risk analytics, operational analytics, security analytics, and HR analytics (Fig. 2).

Fig. 2. Analytics through Digital Banking

Customer Analytics. It is also known as analytical CRM (ACRM). It produces the 360° view of a customer through dashboard tool. The dashboard presents the different derivable insights for the customer utilizing Marketing Analytics, Channel Analytics, Social Media Analytics, Collections or Recovery Analytics, Collaborative CRM, etc. All these flavours of analytics provide instant decision-making ability on the part of bank agent for an operational task. The research community has contributed in the Customer Analytics domain.

Jayakrishna and Ravi [4] surveyed the evolutionary computing methods applied to analytical CRM. They found that the evolutionary computing has been applied to single as well as multi-objective problems in analytical CRM. The review work presents the maximum work has been carried out in market basket analysis, followed by credit scoring and fraud detection. According to the review work, the most explored technique is Genetic Algorithms.

Erevelles et al. [5] proposed consumer analytics in big data paradigm for gaining the sustainable competitive advantage for the business over the competitors. The customer insights will result in value creation concerning product, price, place, and promotion.

There are many research works carried out in customer analytics, which involve text analytics analyzing the textual data generated through multiple channels. These involve tweets, Facebook posts, WhatsApp messages, feedback at call centers and e-mails posted by the customers related to financial products and services.

Fraud Analytics. It covers cyber (online) and offline frauds perpetrated in the cyber interface of banks viz., ATM, internet banking, mobile banking and credit/debit cards or in the physical branches of banks. Thus, fraud can be perpetrated by employees from within the bank branch in collusion with customers/ third parties or outside the bank's purview. In general, the sophisticated cyber frauds involve a group of fraudsters from various geographical regions linked together through telephones, social networks, e-mails etc. The social network analytics, social media analytics, and text analytics come in handy to detect and jeopardize the fraudsters' plans.

Risk Analytics. It comprises all types of quantifiable risks viz. credit risk, market risk, and operational risks. All these types of risks are quantifiable via analytical models and thanks to the vast amount of data can be predicted using the data-driven methods. These risks are modeled and analyzed for different operations in banking such as granting a personal loan to a customer by the computation of credit risk involved in granting the loan.

Kshetri [6] presented how big data is utilized in appraising, evaluating and filtering the creditworthiness of customers for loan and minimizing the transaction costs. The author also presented how the different features of big data such as volume, velocity, variety, etc. are related to the assessment of the creditworthiness of low-income families and micro-enterprises present in China.

Sun et al. [7] analyzed big financial data utilizing wavelet-based methods for predicting the change in the price of equities. They proposed a new wavelet-based method called GOWDA, which forecasts the volatility of equities in an efficient manner.

Operational Analytics. It covers all operational problems of a bank viz., ATM cash replenishment strategy, ATM/branch location problem, balanced scorecard based assessment of a bank's growth, assessment of a bank's performance w.r.t profitability, solvency, productivity, liquidity, etc., modeling gridlock scenario in inter-bank payments, etc.

The financial operations generated huge amounts of digital data where a major portion is from the payment channels used for transactions. There is a huge change in the preference of usage of payment channel from 2007 to 2017 (Fig. 3). Here it is clear that the new-generation, young customers prefer not to go to the branches or the ATMs. Instead, they prefer to perform their transactions at their convenience with their own time. This change of preference has made a great shift in Internet and Mobile banking

penetration from a mere 19% in 2007 to 80% in 2017 [8]. Therefore, the banking industry can leverage the huge amounts of digital data generated thereof to discover the valuable insights. These insights, in turn, will be financially beneficial to the bank and eventually may improve customer experience.

Akter et al. [9] proposed a model for Big Data Analytics Capability (BDAC) for enhancing the firm performance. The BDAC subsumes BDA Management Capability (BDAMAC), BDA Technology Capability (BDATEC), and BDA Talent Capability (BDATLC). BDAMAC is responsible for right business decisions by employing proper management framework. BDATEC refers to the capability of the model to connect multi-source data, to work on cross-platform to develop, deploy and support a firm's resources. BDATLC refers to the ability of the analytics professionals to carry out the tasks in the big data environment. This model ensures the enhancement in firm performance.

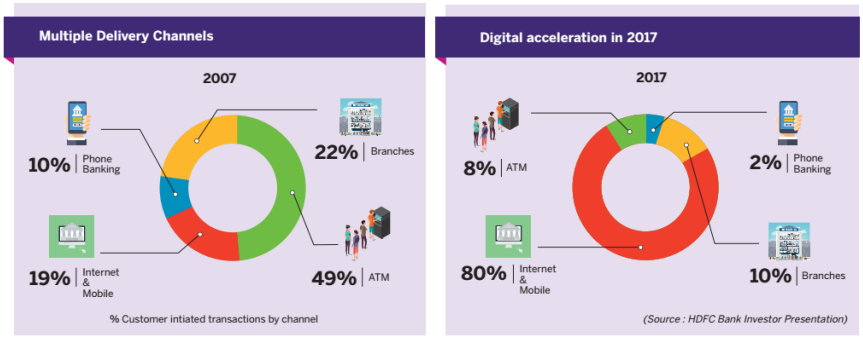

Fig. 3. Trend of Payment Channel usage [8]

Social Network Analysis (SNA) in Banking for Fraud Detection. The Social Network Analysis (SNA) is posing itself as a vital tool for financial fraud detection. The different fraud statistics show that the credit card fraud is increasing with the card-not-present (CNP) type of fraud. This type of fraud involves a group of fraudsters working in collaboration, where the SNA method is establishing an impressive fraud identification technique. The social network is a network of entities all connected in a particular way. The entities can be credit cards, companies, merchants, fraudsters, or others. It can include transactional data, such as online transactions and banking data, social media data, call behavior data, IP address information, geospatial data, etc. This data is often stored in unstructured formats in environments like social media, telecom registries, payment gateways or bank servers.

Storing and retrieving interconnected information in a native 'network graph' format can deliver interactive network visualizations to discover hidden structures, locate clusters and patterns, identify links in transaction chains, and apply specialized algorithms to identify suspicious patterns.

Traditional methods for detecting fraud involve analysis of the risk score of the retail of enterprise customer for the creditworthiness. Banks use applications that would set some decision rules into a model, and the model would scrutinize to determine whether

to approve or disapprove a transaction based on these rules. The SNA method tries to predict what constitutes fraudulent behavior. It provides a method for analysis of the relationship among the fraudsters across multiple channels through the link analysis in a social network graph. In simpler words, it is the representation of distinct subjects (nodes) and their association (edges) through a graph [10].

SNA can furnish effective insights from large-scale datasets along different dimensions viz. network, spatial and time. It is based on the analysis of interconnectedness of the subjects present in the social network graph [11].

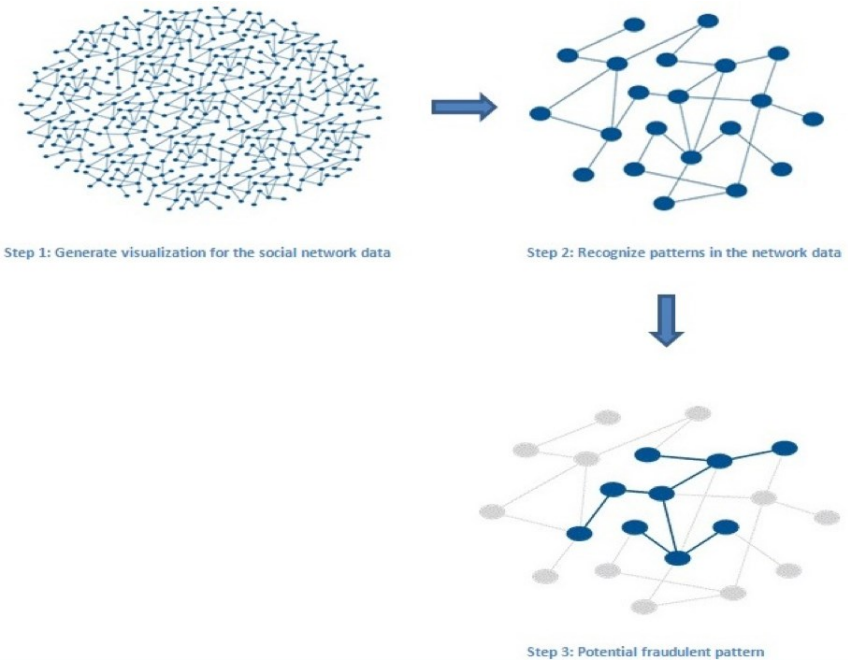

Fig. 4. Detection of Fraudulent patterns through SNA [12]

For the financial service industry, SNA has to play a key role in recognizing fraud. This is because frauds are to a large extent being perpetrated by organized networks. In payments and banking sector, the social networks comprise an account number, card number, customer name, email address, phone number and so on. Relationships (edges in the graph) between these various nodes can be scrutinized to diagnose patterns that could reveal fraudulent behavior (Fig. 4).

Chau and Faloutsos [13] had made a case study for discovering financial frauds employing a method utilizing the *belief propagation* algorithm [14].

Saidi et al. presented a review paper reviewing the different approaches for analyzing cyber terrorist communities. The relational analysis and positional analysis can reveal the terrorist network by analyzing the social network graph. The relational analysis studies the interactions between network members, between nodes within a graph. The positional analysis focuses on how two members within a network are similar taking

into account their connections to other members to discover a social structure in a network. The different SNA measures like Size, Density, Degree of connection, Centrality like the Degree centrality, Betweenness centrality, Closeness centrality, Eigenvector centrality are used for terrorist network analysis. [15]

Text mining also plays a major role in fraud detection and prevention. The text can be analyzed from the online feedbacks, social sites, etc. Shravankumar and Ravi [16] reviewed the applications of text mining for cybersecurity in the financial domain by covering Malware detection, Phishing detection, Spam detection, Fraud and Intrusion detection. The review finds that the most explored techniques are Decision Tree, Support Vector Machine, Naïve Bayes, k-nearest neighborhood for cybersecurity detection.

West and Bhattacharya [17] reviewed the different types of financial frauds. The different types of financial frauds reviewed were credit card fraud, securities and commodities fraud, financial statement fraud, insurance fraud, mortgage fraud, and money laundering. In literature, both the statistical and intelligent methods were proposed for financial fraud detection. The reviewed articles present Credit card fraud has been analyzed with Support Vector Machine (SVM), Decision Tree (DT), Self-organizing Map (SOM), Fuzzy logic, Artificial Immune System (AIS); securities and commodities fraud has been analyzed with Bayesian Belief Network (BBN), Process Mining; insurance fraud has been analyzed with Logistic model; and financial statement fraud has been analyzed with Neural Networks (NN), DT, BBN, SVM, GA.

Security Analytics. It incorporates vulnerability analysis, advanced persistent threat prediction, intrusion detection, data exfiltration detection, anomaly detection, phishing detection, spam detection, malware detection, DDoS detection, SQL injection attack detection etc. The Fig. 5 succinctly captures the multi-disciplinary nature of cyber security, wherein multi-pronged strategy is proposed to be adopted to predict and prevent cyber security incidents. Of the six different, albeit slightly overlapping dimensions, data analytics play a significant role because they heavily depend purely on the various types of data generated and found around security incidents.

Digital Forensics in Banking and Financial Services. It is also known as cyber forensics is a branch of forensic science comprising the collection and analysis of the materials found in digital devices, basically related to online or offline computer crime [18].

In simpler words it can be also defined as the science of identifying, preserving, recovering, analyzing and presenting facts about digital evidence found on computers or digital storage media devices [19].

The process of digital forensics can be broken down into five parts. They are as follows.

Identify. The digital forensic process starts with identification. On every crime scene, the evaluation of environment is started with identification of the data, which is also known as *artifacts*. The different devices and data transfer among them leaves a different type of artifacts, which has to be identified as the first part of the process.

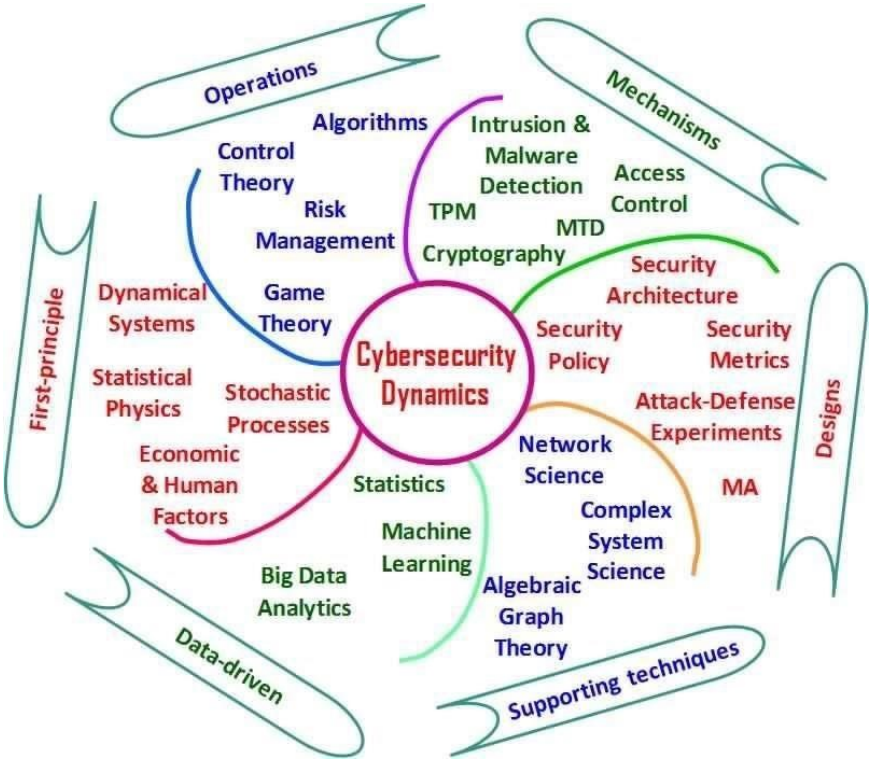

Fig. 5. Cyber Security Dynamics [20]

Preserve. It is the crucial part of the digital forensics, which ensures the integrity of the evidence. As without integrity an evidence loses its value. Hence, utmost care should be taken to ensure the artifacts are not altered and preserved in its original state.

Recover. The recovery process deals with recovering (i) intentionally deleted files from the system, (ii) data from password-protected files, (iii) even from damaged or corrupted files or devices.

Analyze. This phase starts only when artifacts are identified and recovered. Analysis is the main part of the investigation. This analysis involves recovery of artifacts from the linked or synced devices viz., search history, download or upload history, chat history, etc.

Present. Finally, when the analysis is over, the findings are presented in the form of a case report. This part presents the facts precisely and concisely.

HR Analytics. It provides insights on the possible attrition by performing social media analytics. It can also help the HR in recruiting the right person for the right job at right remuneration.

The digital payment channels are making a gradual paradigm shift from personal banking to digital banking. The customers now prefer to digital banking due to the busy life schedule, less convenience to move to the bank premises and the high availability of smart phones. Some banks saw opportunity here and made a complete banking solution through digital banking and in particular through mobile banking. Table 2 presents products offered by some of the mobile-only banks. More details can be found at [21].

There are several Apps, which incorporate the Artificial Intelligence (AI) to ease the human day-to-day life activities. The apps can also be utilized for decision making in BI. These are also known as a virtual personal assistant. They are listed in Table 3.

Apart from the above-listed apps, there are some more apps which use AI to achieve their objectives. Such apps are viz. Braina, PAN, Wipro Holmes, Kinect, Wolfram Alpha.

2.2 Digital Financial Trading and investment strategies

This section pertains to financial services including share trading, forex trading, investment management, etc. The digital world has made a significant impact on the traditional trading system with many new digital technologies. Algorithmic trading is one of them.

Algorithmic trading is also called algo-trading. It is the process of employing computer programs comprising instructions for issuing a trade to generate profit for the business with speed and frequency, which is impossible to do for any a human being. The predefined instructions are based on the timing of purchase or sell, price the count of stocks to trade or any mathematical model. The algo-trading provides an opportunity to increase the profit, and the trading becomes more systematic by ruling out the impact of human subjectivity emotion on trading activities [22].

Any rule-based trading strategy can be completely automated. The market data in the digital form is furnished to the rule-based trading models running inside an algorithmic trading system. Trading methodologies filter, process, analyze market data, and generate trading signals. Based on trading signals, actions are executed (e.g., submitting an order or terminating a position) and orders are directed to respective markets [23].

In digital financial domains, algorithmic trading means the utilization of algorithms or programs to automate one or more phases of the trading procedure like pretrade analysis of the data, trading signal generation, i.e., recommending for a buy or sell action, and finally trade consummation. Trade execution is additionally partitioned into agency/broker execution, i.e., when an algo-trading system optimizes issues signal for the trade on behalf of a client and principal/proprietary trading, i.e., when a business organization trades on its account. Each phase of this trading process can be carried out by human agents and trading-algorithms, or solely by trading algorithms.

Table 1. Mobile-only Banks with Products or Services

Region	Name of the Bank	Description
UK	Atom Bank	• It provides usage of biometrics instead of passwords in the mobile app for banking. • It offers convenient banking methods to manage money.
	Monese	• It offers the customers regardless of their citizenship, to open an account using the mobile banking app in minutes. • It performs targeted marketing by allowing and helping the immigrants to open a UK bank account, e.g., a current account and also the issue of a Visa debit card in 3 minutes with a snapshot of their passport and a selfie.
	Osper	• It provides debit card and mobile banking service to manage one's finance. • It offers accounts with separate logins for minors and their parents.
	Mondo	• It offers the banking app in iPhone and a prepaid debit card for managing the account. • The banking app provides real-time feedback regarding customer's spending.
	Starling	• The bank provides a high-quality current account service.
US	Simple	• It combines user's experience and behavioral economics with technology, to result in proper insights to allow the customers spend intelligently. • The account offered by the bank has all the variety of tools that a customer may need to manage his finance, which can be accessed through internet, and smartphones using iOS or Android OS.
	Moven	• Its app and debit card provide insights from the transaction history on a real-time basis to the customers to make proper decision to manage their finances.
	BankMobile	• It is the first bank of its kind that provides free savings accounts and a line of credit. A customer can avail access to more than 55,000 surcharge-free ATMs.
	GoBank	• It is the first bank that offers an account to be opened and managed from only an app installed on a smartphone. • It facilitates to check balances on the account, transfer funds or to observe transaction history.
India	digibank by DBS	• It is founded in the year 2016. It permits to deposit, withdraw and transmit money. It allows a customer to set financial targets and outline an action plan to achieve them. • It is the first bank in India that allows opening of an account without paperwork. It requires Aadhaar number and biometrics for authentication. • It allows the customers to experience the banking facilities with an e-wallet and later transform to a full-fledged bank account at one's convenience.

Table 2. Some Popular Virtual Personal Assistants

Virtual Personal Assistant	Features and Functionality
Siri	It is developed by Apple for iPhone users. It is a voice-activated virtual assistant. It returns customized answers after learning from a user's language. As of 2016, Siri is available in 20 languages. Performing online search, making calls by the voice commands with the name or number, tweeting with voice commands, setting reminders and events in the calendar, setting the alarm are a few things that Siri can perform nicely. It can also launch applications from the device, find and readout emails with the audio. It works only on iOS operating system.
Google Now	It is an intelligent personal digital assistant (PDA) by Google, which uses NLP, enabled interface. It can perform actions based on voice commands or typed commands. It runs on devices with different architecture and OS. It performs quite similar to Siri such as reading out texts and emails, performing an online search, making an online reservation on flight or train, updating the real-time score from stock and sports, etc. Google Now fetches desired results by utilizing a lot of personal information, which brings privacy concerns into the picture.
Cortana	It is the PDA developed by Microsoft. It can recognize both voiced and typed commands. It facilitates NLP based search, detects songs in the playlist of the device and plays it. In addition to, it can open websites in the browser, send emails, create alarms and chat with. It cannot launch applications from the device like Siri and change settings of any device or any application. It has most powerful AI in the form of Adam's deep learning. Cortana can also analyze an image, e.g., it can inform the user about the amount of calories present in the food from its image.
Alexa	Alexa is the voice service created by Amazon for Amazon Echo intelligent speaker. It can book a cab ride, play music by selecting the song from a playlist, store and remind the appointments from the calendar, read a book from kindle and audio bookstore on the device, and more. It is quicker to respond and understand commands with the Echo implemented with advanced, accurate voice recognition. Its functionality is not comparable with Siri, Google Now and Cortana. It is not good at responding complex queries.

Fig. 6 depicts the major elements of an algorithmic trading system. It also depicts the stages at which they prevail in a trading process. The pretrade analysis encompasses three mathematical models:

- The alpha model, which predicts the upcoming performance of the financial instruments in the trade.
- The appraisal of the degree of exposure/risk correlated with the financial instrument is achieved by the risk model.
- The transaction cost model finds out the costs associated with the trading of the financial instruments.

Trading signal generation phase includes the portfolio construction model. This model accepts inputs the outputs of the previous phase viz., pretrade analysis encompassing alpha model, risk model, and transaction cost model. It carries out a decisive step with what portfolio of financial objects should be possessed while going forward and in what quantities. In the trade execution phase, the execution model carries out the trades, making several decisions with constraints on (actual) transaction costs and the duration for trade. The most common decision is the strategy building for trading followed by the venue and order type. The result of the execution model is analyzed in the real world context and the data again incorporated into the database for future analysis. In this way, the algorithmic trading system enhances its intelligence for future trading signal prediction [24].

There are several scientific articles involving algorithmic trading. Hu et al. reviewed 51 articles involving algorithmic trading utilizing evolutionary algorithms such as Genetic Algorithm (GA), Genetic Programming (GP), Learning Classifier System (LCS), and Particle Swarm Optimization (PSO) [25].

Seddon and Currie [26] developed a conceptual model for big data analytics to reap better benefits from high-frequency trading (HFT). The features of big data are categorized into big data, fast data, and big compute categories, and different priorities are accorded to the categories to produce the high performance of HFT. The work presents an understanding of algorithmic trading in global financial markets.

3 Futures of Digital Banking

The advanced, cutting-edge computer technologies, high-end computational power enabled digital devices with the state-of-the-art applications are proving their presence and influence in the modus-operandi of the banking industry and affecting the banking ecosystem. The most predominant leading-edge technologies include Big Data Analytics (BDA), Cloud Computing, Artificial Intelligence (AI) and Machine Learning (ML), Robotic Process Automation (RPA), blockchain and the Internet of Things (IoT).

The banking system or at a large the financial services industry is embracing new technologies and setting trends in that. The banks have used private clouds in the past years, but they will be moving towards the hybrid and public cloud implementation, which can lead to the development of agile applications. Financial institutions like,

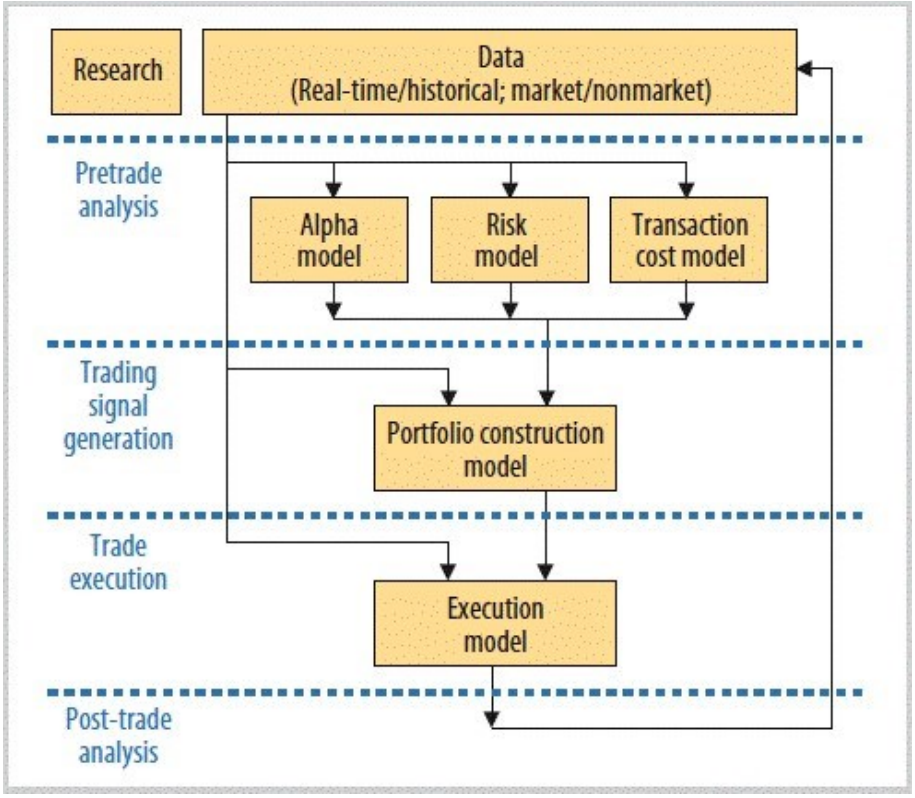

Fig. 6. Components of Algorithmic Trading System [24]

banks, payments, traders, credit card providers, insurance carriers have gathered a huge volume of historical data. These institutions have evolved themselves to handle real-time data. They can leverage on historical and real-time data by integrating operational and analytical system together to gain insights of the business value. One such example can be an algorithmic trading system, which uses both historical data of customer behavior and trading pattern as well as real-time data of trading. Also, the credit card transactions should include historical as well as real-time data to deal the fraud cases. The financial services are moving towards IoT and streaming for generating data from various devices embedded with sensors to generate real-time data and which is ingested to the system through streaming for real-time analytics [27].

3.1 Internet of Things (IoT) in Banking

In IoT, different types of sensors are embedded into the Internet-connected devices that gather data and share it over the internet with people, applications, and other devices. The ability to analyze the collected data to explore the business insights and apply the insights contextually has the potential to enhance the business of the banking industry.

The IOT devices can be any digital device, e.g., tablet, smartphone, wearable sensors or industrial sensors. It can send data to anyone over the network through any network path, e.g., wired or wireless. These IOT devices can be deployed anywhere for transmitting data related to many contexts employing the different services or applications related to different businesses.

The prominent players such as Apple, Google, Amazon, and Samsung have developed wearable gadgets and voice-first devices for personal assistance. A voice-first device is an always-on, intelligent piece of hardware where the primary interface is a voice for both input and output. This innovation has a continuous effort in the collection, analysis of the data for the application that can build consistent connections among solutions to augment the comfort level in a client's life. A brilliant example of this innovative technology can be the way Uber has amalgamated geospatial analytics, real-time pricing/demand analytics, and unified payment system to deliver a superior short-range transportation solution. The apex IoT platform providers for storage and analytics of the big data for insights are provided by Amazon Web Services (AWS), IBM's Watson, and Microsoft Azure.

Use Cases of IoT in Banking

The banking industry has started to reap the capabilities of IoT. A survey was conducted on a global scenario, and it was found that 64.5% of banking executives tracked their customers through the mobile apps used on different digital devices like smartphones, tablets and other digital devices where the apps can run. In addition to that, 31.6% of banking institutions utilized the IoT to observe retail locations, e.g., bank branches, 21.1% used sensors to collect product performance data and 15.8% executives employed IoT sensor embedded wearables to pursue customer product utilization. [28]

Financial companies have started to give utmost priority to the customer, and product monitoring due to the increasing incidents of online and offline frauds. Identity verification has become a hectic task as identity theft also plays a major part in global fraud and the fright of computer system and network breach. Customers' financial transactions are tracked, and data are collected thereof by utilizing the IoT devices. Sensor data is also used for monitoring assets and evaluation of collateral while issuing loans.

The banking industry also uses IoT embedded in a wearable i.e., smartwatch or fitness band for basic banking.

Different research works have been carried out in BFSI sector employing IOT devices. Dineshreddy and Gangadharan [29] have proposed a framework for investment management using IOT.

3.2 Blockchain, AI and its role in Banking Industry

As we know, the Blockchain has come up as the next generation of payment channel without the involvement of any controlling third party. A Blockchain is a public ledger of all cryptocurrency (e.g., Bitcoin) transactions that have ever been executed. A Block

is a unit of the Blockchain, which contains some or all of the recent transactions. It is the current part of a Blockchain, which once completed enters into the Blockchain as its permanent storage. The completed blocks are appended to the Blockchain in a linear, chronological order. The blocks are connected to each other by retaining the hash of the previous block. Each node in the Bitcoin network authenticates and broadcasts the transactions to the other nodes present in the network. The node receives a replica of the Blockchain, which is downloaded automatically upon connecting to the Bitcoin network. The Blockchain has comprehensive information such as the addresses and their balances starting with the inception block to the most recently appended block. Whenever, a block gets completed, a new block is generated [30].

The inclusion of ML to the Blockchain technology presents a new paradigm by providing Artificial Agents on the Blockchain technology rendering security and ensuring the immutability of all data.

It provides opportunities for financial firms to overhaul existing banking infrastructure and speed settlements. It immediately transfers funds securely, with no wait for confirmation. The Blockchain can handle electronic-Know Your Customer strategy, trade finance, cross-border payments, clearing and settling bond or equity trades. Thus, the combination of Blockchain technology with ML takes the banking technology to the next high level

The ICICI bank branch in Mumbai is the first Indian bank that made the cross-border payment through Blockchain payment to the largest bank of Dubai Emirates NBD. The banks have partnered with banking solution Infosys Finacle for this [31].
Reuters reports that several banks have announced plans to use Blockchain technology, with Microsoft teaming up with Bank of America [31].

3.3 Chatbots

A chatbot is a service or tool that you can communicate with via text messages. The chatbot understands what you are trying to say and replies with a coherent, relevant message or directly completes the desired task for you.

The services a Chabot can deliver are diverse. Important life-saving health messages, to check the weather forecast or to purchase a new pair of shoes, etc., are some example tasks they can perform.

The chatbot can talk to you through different channels; such as Facebook Messenger, Siri, WeChat, Telegram, SMS, Slack, Skype and many others.

The first chatbot ELIZA, created in 1966 by Joseph Weizenbaum [32] could recognize certain keywords and pattern and answer accordingly, mimicking conversation with a psychotherapist. The timeline of the development of chatbots is depicted in Fig. 7.

The chatbots with AI derive their knowledge through machine learning and Deep learning running in the backend. The chatbots employ Natural Language Processing (NLP) in the frontend for interpreting the human language and then presenting it to the backend knowledge extraction process.

The chatbots can be employed in different fronts of business. They will come handy and reduce time, labor cost and increase efficiency leading to business value enhancement. In finance services industries we can employ a chatbot as an HR assistant, Market intelligence assistant, Workflow assistant, Social media channel assistant, Financial analyst assistant, Scheduling assistant and overall can be employed as the Brand ambassador for the business.. These are the different dimensions of a business where usage of a chatbot can bring a paradigm shift.

According to a research study, 80% of global financial institutions regard chatbots as a golden opportunity to enhance business productivity. Only 16% view chatbots as both a threat and opportunity, whereas only 2% believe that chatbots could be a threat to the business being a loophole for breaching to vital business data (Fig. 8) [33].

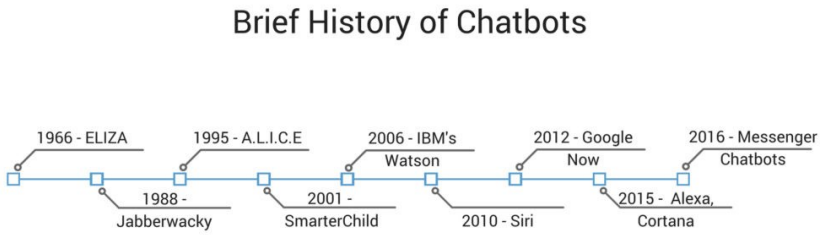

Fig. 7. Timeline of Chatbot development [34]

Requirements of Intelligent Chatbots

The advanced intelligent based chatbots should fulfill the following eight requirements.

1. **Carry an intelligent conversation** – The chatbots should be equipped with good NLP components so that it can understand the context and any out of context statements like sarcasm and converse accordingly.
2. **Comprehend individual context** - An intelligent bot can comprehend each client's financial condition, along with current account holdings, the latest and expected financial behaviors, etc. to furnish financial advice and offers that are personalized in real time.
3. **Utilize real-time transactional data** - If the information presented by the bot is obsolete then the insights drawn from it will be inaccurate, clients will rapidly lose confidence in the information and stop further use of the bot. Therefore, chatbots should be designed such that they get access to the real-time transactional data in order to be relevant and current in replying.
4. **Reuse existing content** –A chatbot should be able to draw the existing insights in real-time from different channels so that duplication of effort can be avoided.
5. **Be useful** – The chatbots should not be just efficient to tell the balance of an account. It should give some predictive and prescriptive insights to the queries of the customer from his contextual transactional data.

6. **Perform seamlessly across channels** – Clients anticipate a seamless experience across the entire digital channels viz. internet, mobile app, chatbots, virtual personal assistants. A conversation may start in Facebook Messenger, move to Amazon's Alexa, and continue in the bank's online or mobile app. Hence, the bot should be enabled with integration to Omni-channel strategy.
7. **Get smarter over time** – The bot must gather knowledge by continuous interaction with the client. The bot should be able to recollect and derive insight from the reactions made by the client when he/she was assisted with some information or advice and the feedback provided by the client. Thus, the bots will enhance their knowledge and deliver a personalized experience over time.
8. **Anticipate customer needs** – The usage data present that almost 50% of all bots are contacted only once and never again. This is certainly due to the shortcomings in the early implementations, discussed above. The bots should enthusiastically contact the right customers with the right information, at the right time with an individualized catering of the need based on predictive analytics [35].

The Future of Chatbots

The AI-enabled chatbots ineract in real-time and assist with personalized and contextual answers to customer queries. It can inform the balance in the current account, transfer money to another account, pay a utility bill, and report recent spending activities.

It will be eventually equipped with the knowledge about the customer in fulfilling his/her requirement and also can look out for some better options and rewards for him/her based on the insights gathered from the deeper learning about him. Finally, the bot will influence with an Omni-channel presence by integrating with the virtual personal assistants like Facebook Messenger, Amazon's Echo, etc.

3.4 Robotics in Banking and Finance industry

Robotics, empowered with AI (ML), is proving to be the most effective tool that can produce operational efficiencies to the entire financial services industry.

Robots come with unique advantages – they are time and cost efficient, improve productivity, deliver superior results, and can work without rest over repetitive tasks. When enabled with cognitive computing, AI (ML) capabilities, robots can be trained to operate autonomously. They can also learn how to improve performance and accuracy with little human input. Further, multi-lingual language processing and voice recognition capabilities allow robots to interact and conduct seemingly intelligent, coherent and meaningful conversations with customers.

For example, Bank of Tokyo- Mitsubishi UFJ (MUFG) introduced Nao, a 58-centimetre (1ft 11)-tall, 5.4 kg robot developed by Aldebaran Robotics – a France-based subsidiary of Japanese telecom and internet giant SoftBank. It is equipped with a camera and microphone and has visual recognition and remote control capabilities. It can recognize 19 spoken languages, interact and communicate with customers in branches, and provide a response to queries.

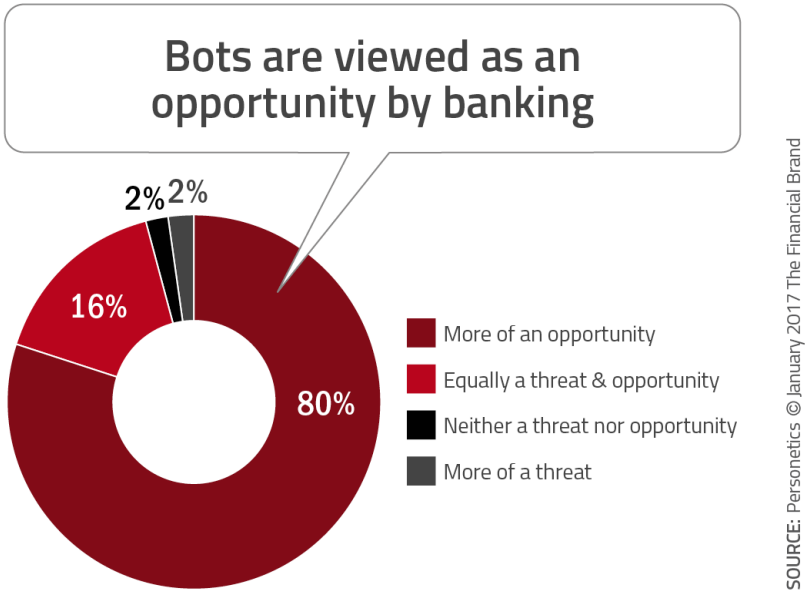

Fig. 8. Response to employment of Chatbot in Banking industry [33]

The first banking robot of India is Lakshmi, launched by the Kumbakonam-based City Union Bank. It is the artificial intelligence powered robot which is the first on-site bank helper. Lakshmi can answer intelligently on more than 125 subjects [37].

All financial services companies operate in a highly regulated environment. They have to meet the demands of auditable, have security in a complete scenario, maintaining information-enriched data and operational resilience. Robotic Process Automation (RPA) allows modern banks to fulfill these requirements and achieve high operational efficiency.

Besides the cost savings, efficiency improvements through higher productivity, ability to work 24x7, and greater accuracy by reducing human errors can be achieved. Their ability to collect and mine vast data and complete audit ability are especially useful in areas like compliance and regulatory reporting. Furthermore, these robots can be deployed and scaled with ease and agility. Utilizing the RPA the financial service institutions can achieve the major activities those were otherwise human error prone with the human interface. The robotic skills those earlier relied upon human skills, and manual effort only are as follows.

- Collecting, collating and validating the data from the customers.
- Synthesizing, and analyzing the structured and unstructured data.
- Calculations and based on the result decision-making capability.
- Communciations with NLP and assisting clients and customers.
- Orchestrate and manage both robotic and people-based activities.

- Monitor, detect and report the operational activities.
- Learning, anticipating, and forecasting behaviors and results.

4 Insurance and Analytics

Insurance, another sub-domain of the financial services, generates a huge amount of data, which can be analyzed by employing descriptive, predictive and prescriptive analytics to derive business insights for enhancing business while rendering better service to their clients.

4.1 Descriptive Analytics and Insurance

Descriptive analytics provides the results that further help the organization to enhance their benefit. This type of analytics uses the historical data present with the organization such as weblog, interactions on social media, interaction with chatbots, online feedbacks, and sensor data and so on.

For instance, a sensor device is attached to the car, which will monitor different activities such as total amount of distance traveled, a sudden change in speed, duration of high-risk driving, and number of the time hard brakes are applied. These events will be treated as predictor variables while pricing the insurance premiums.

4.2 Predictive Analytics and Insurance

Using predictive analytics, insurance companies can predict trends in various activities. For instance, predicting possible fraudulent claims, various health care frauds, insurance needs based on customer data etc. Thus, predictive analytics brings in revenue for the company.

4.3 Prescriptive Analytics and Insurance

Prescriptive analysis suggests some optimized solutions to a problem based on other analytical results. Prescriptive analytics is always evolving and of crucial importance to the business values.

Example of prescriptive analytics are as follows: (i) Casualty insurance providers can use historical climatic data for catastrophe modeling and prediction thereby recommending the right price for the insurance. (ii) It can present policy conditions and optimize portfolios to keep a check on the rise of risk. (iii) Recommending optimal price plans, establish policy conditions, and optimize portfolios to keep the accumulation of risk in check. Prescriptive analytics empowered by data can shape the future of the insurance industry [38].

A lot of research has been carried out for boosting the insurance industry. The insurance customer profitability is the benefit that the insurance company is going to receive based on the premium profit and claim risk for the customer. Fang et al. [39] implemented random forest for forecasting insurance customer profitability using big data

analytics which turned out to be superior to traditional forecasting methods, such as linear regression, decision tree, and SVM.

Big data analytics plays a major role in the insurance industry in its different aspects. The insurer performs risk analytics for issuing any insurance. Predictive analytics can be used to fix the premium value of vehicle insurance by analyzing the historical data of the driver, i.e., predicting the probability of the driver to meet an accident. Similarly, in case of health insurance, the wearable IoT gadgets involving health-monitoring sensors, gathers historical health data of the customer, which can predict the customer profitability to the insurer. For claim fraud detection, the claims are matched against the profiles and with the past claim patterns which were fraudulent or those that are deviating from the pattern of genuine claims. This may involve the behavior of the claimant, the people connected with him through his social network and the agencies involved in the claim. Customer insights can be gained from interactions through multiple channels. This can help provide relevant product and identify the right segment for up-selling / cross-selling [40].

A brand community is a group formed based on attachment to a product or brand. This also represents highly valuable marketing, innovation management, and CRM tools. The brand communities bring the brand and community together to a single platform. The social interaction among the members of the community members influences the customer relationship and perspective towards the product. Hence, the social network analytics will result in enhancement of the business value for the financial service industries. Zaglia [41] presented how brand communities are embedded in social networks and how to leverage it.

5 Discussion

The big data analytics is changing the face of financial services industry. In the banking industry, huge amount of system-generated and customer-generated data propels of growth of the business. The following are the different ways that big data analytics can bring forth a new face to the banking industry. Various forms of analytics discussed in the paper indeed can benefit immensely from the big data available in the respective business/operational problems including the new technologies IoT, Blockchain, Robotics, Chatbots and data lake.

- The customer analytics provide a 360-degree view of a customer to make a proper decision for personalized marketing.
- The risk analytics helps to determine credit score of a customer to take decisions on granting a loan.
- The social analytics provides the insights for cross-selling also it can help in preventing frauds.
- The analysis of customer interaction over multiple channels can help the bank to present some personalized offers.
- The sensor data from IoT devices can be analyzed for a better understanding of the customer behavior pattern.

- The online footprints on the bank's website and spend pattern analysis will provide the insight for cross-selling.
- The banks can also analyze the offline interaction of the customer with the bank through the ATM data, credit or debit card transaction data.
- The data from online and offline interaction with the bank can be analyzed for churn prediction, market basket analysis, increasing the customer life period.
- The security analytics helps to provide a fraud-free environment, which helps in building the brand community.

Despite the quintessential benefits of data analytics/big data analytics in the financial services industry, a lot of challenges still remain, which impede its full-scale implementation: Lack of

- good data quality is the biggest hindrance in implementing BDA.
- analytical-savviness in an organization is an equally important roadblock.
- qualified and well-trained manpower is another stumbling block.
- participation of the business or user departments stymies the implementation of BDA.
- executive support in the makes the BDA implementation a non-starter.
- phased approach in implementation
- change management planning in terms of mindset change across organization

These can be considered critical success factor for the BDA implementation.

6 Conclusions

The paper presented the current digital trends in financial services industry with a particular emphasis on the banking industry, where several business problems solved by big data analytics are highlighted It also covered some state-of-the-art technologies, which together with big data analytics brought a substantial change in the quality and productivity of the banking industry. The stock market and insurance disciplines were also explored, where predictive and prescriptive analytics play a paramount role. This paper concludes with some challenges, which impede full-scale implementation of big data analytics in financial services industry to enhance the business value.

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