International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 8 Issue 6, Nov-Dec 2024 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Big Data in Telecommunications

Matthew N. O. Sadiku[1], Paul A. Adekunte[2], Janet O. Sadiku[3]

[1]Roy G. Perry College of Engineering, Prairie View A&M University, Prairie View, TX, USA
[2]International Institute of Professional Security, Lagos, Nigeria
[3]Juliana King University, Houston, TX, USA

ABSTRACT

Big data and the technologies it relies on, such as AI and ML, are the driving force behind progress in the telecommunications industry. Telecommunications companies have always managed enormous volumes of network activity data and find ways they can put it to good use. Big data for telecom is the fuel that can and will drive the entire industry toward higher revenues and better customer service. Telecom companies must be able to collect this massive amount of data from different sources, analyze it, and distribute the insights to disparate databases. This paper examines the roles of big data and big data analytics in telecommunications.

KEYWORDS: *big data, big data analytics, telecommunication industry*

How to cite this paper: Matthew N. O. Sadiku | Paul A. Adekunte | Janet O. Sadiku "Big Data in Telecommunications" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-8 | Issue-6, December 2024, pp.243-252, URL: www.ijtsrd.com/papers/ijtsrd71573.pdf

IJTSRD71573

Copyright © 2024 by author (s) and International Journal of Trend in Scientific Research and Development Journal. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0) (http://creativecommons.org/licenses/by/4.0)

INTRODUCTION

Every day, massive amounts of data are collected using various methods, and that amount is sometimes so large that it is hard to process and analyze using traditional means. Data consumption by users and data generation by corresponding software systems are steadily growing year to year. This huge trove of data is now presented under the umbrella term "big data." We are in the big data age, where businesses in every industry must deal with vast volumes of data. Several experts and practitioners have lately emphasized the need of understanding how, why, and when big data applications may be a valuable resource for businesses seeking a competitive edge. The cloud word for big data is shown in Figure 1 [1].

In today's digital age, the telecom industry has become a crucial pillar for global connectivity and communication, noted for its complex infrastructure, as shown in Figure 2 [2]. Big data in the telecom industry encompasses a wide range of information, including customer profiles, call records, network logs, location data, social media interactions, and more. The telecom industry is a leader in big data strategy because of the vast amount of data it gathers during normal business operations. The integration of big data analytics has revolutionized various facets of the telecom industry, from enhancing customer experiences to ensuring regulatory compliance and optimizing network operations [3].

The world has seen a digital revolution where more and more work is being conducted online. Storing this activity has led to the concept of big data, i.e., large datasets that are otherwise difficult to manage. Because of these characteristics, big data requires new technologies and techniques to capture, store, and analyze. Telecom companies generate huge volumes of data from mobile phone usage, call detail records, server logs, network equipment, social networks, and billing. The number of data sources is growing as well. Typical sources of big data are shown in Figure 3 [4]. The telecommunications industry is making significant strides in technological advancements, and big data analytics (BDA) is playing a crucial role.

WHAT IS BIG DATA?

Big data applies to data sets of extreme size (e.g. exabytes, zettabytes) which are beyond the capability of the commonly used software tools. It involves situation where very large data sets are big in volume, velocity, veracity, and variability [5]. The data is too big, too fast, or does not fit the regular database architecture. It may require different strategies and tools for profiling, measurement, assessment, and processing.

Big Data is essentially classified into three types [6]:

- *Structured Data:* This is highly organized and is the easiest to work with. Any data that can be stored, accessed, and processed in the form of fixed format is known as a structured data. It may be stored in tabular format. Due to their nature, it is easy for programs to sort through and collect data. Structured data has quantitative data such as age, contact, address, billing, expenses, credit card numbers, etc. Data that is stored in a relational database management system is an example of structured data.
- *Unstructured Data:* This refers to unorganized data such as video files, log files, audio files, and image files. Any data with unknown form or the structure is classified as unstructured data. Almost everything generated by a computer is unstructured data. It takes a lot of time and effort required to make unstructured data readable. Examples of unstructured data include Metadata, Twitter tweets, and other social media posts.
- *Semi-structured Data:* This falls somewhere between structured data and unstructured data, i.e., both forms of data are present. Semi-structured data can be inherited such as location, time, email address, or device ID stamp.

The different types of big data are depicted in Figure 4 [7].

The process of examining big data is often referred to big data analytics. It is an emerging field since massive computing capabilities have been made available by e-infrastructures [8]. Big data analytics is the application of advanced analytic techniques to large, heterogeneous data sets that comprise structured, semi-structured, and unstructured data from many sources with sizes ranging from terabytes to zettabytes.

Analytics include statistical models and other methods that are aimed at creating empirical predictions. Data-driven organizations use analytics to guide decisions at all levels. Several techniques have been proposed for analyzing big data. These include the HACE theorem, cloud computing, Hadoop, and MapReduce [9].

CHARACTERISTICS OF BIG DATA

Big data is growing rapidly and expanding in all science and engineering, including physical, biological, and medical services. Different companies use different means to maintain their big data. As shown in Figure 5 [10], big data is characterized by 42 Vs. The first five Vs are volume, velocity, variety, veracity, and value [2].

- *Volume*: This refers to the size of the data being generated both inside and outside organizations and is increasing annually. Some regard big data as data over one petabyte in volume.
- *Velocity*: This depicts the unprecedented speed at which data are generated by Internet users, mobile users, social media, etc. Data are generated and processed in a fast way to extract useful, relevant information. Big data could be analyzed in real time, and it has movement and velocity.
- *Variety*: This refers to the data types since big data may originate from heterogeneous sources and is in different formats (e.g., videos, images, audio, text, logs). BD comprises of structured, semi-structured or unstructured data.
- *Veracity*: By this, we mean the truthfulness of data, i.e. weather the data comes from a reputable, trustworthy, authentic, and accountable source. It suggests the inconsistency in the quality of different sources of big data. The data may not be 100% correct.
- *Value*: This is the most important aspect of the big data. It is the desired outcome of big data processing. It refers to the process of discovering hidden values from large datasets. It denotes the value derived from the analysis of the existing data. If one cannot extract some business value from the data, there is no use managing and storing it.

On this basis, small data can be regarded as having low volume, low velocity, low variety, low veracity, and low value. Additional five Vs has been added [11]:

- *Validity:* This refers to the accuracy and correctness of data. It also indicates how up to date it is.
- *Viability:* This identifies the relevancy of data for each use case. Relevancy of data is required to maintain the desired and accurate outcome through analytical and predictive measures.

- *Volatility:* Since data are generated and change at a rapid rate, volatility determines how quickly data change.
- *Vulnerability:* The vulnerability of data is essential because privacy and security are of utmost importance for personal data.
- *Visualization:* Data needs to be presented unambiguously and attractively to the user. Proper visualization of large and complex clinical reports helps in finding valuable insights.

Instead of the 10V's above, some suggest the following 5V's: Venue, Variability, Vocabulary, Vagueness, and Validity) [12].

Industries that benefit from big data include the healthcare, financial, airline, travel, restaurants, automobile, sports, agriculture, and hospitality industries. Big data technologies are playing an essential role in farming: machines are equipped with sensors that measure data in their environment. Structured and unstructured data are generated in various types [13-15].

BIG DATA IN TELECOMMUNICATIONS INDUSTRY

Big data analytics is revolutionizing the telecommunication industry by enabling targeted marketing and enhancing customer behavior insights. This technology continues to be integral in shaping the future of telecom, providing innovative solutions. Figure 6 shows the big data impacts on telecommunications industry [16], while Figure 7 illustrates big data analytics use cases in telecommunication industry [17]. Telecom startups and companies can take advantage of big data analytics in the following main areas [18,19]:

- *Customer Experience*: Big data analytics in the telecom industry can help companies improve customer experience. Maintaining a current customer relationship is considerably cheaper than acquiring a new one, and this improves the company's profitability in the long term. Processing big data can help with personalizing the customer experience. It also empowers telecoms to streamline their service portfolios, design, and implement new features, and provide the best customer support possible. For example, a telecom company can collect information from users regarding various service issues and then create an automated chatbot that will assist customers to resolve these issues immediately whenever possible. Figure 8 shows a typical Telco customer [20].
- *Network Optimization*: Network optimization stands as a cornerstone for telecom companies aiming to enhance service quality, maximize efficiency, and meet the ever-growing demands of users. It entails complex and quick evaluation of large volumes of data in real-time mode. Big data helps telecom operators in optimizing the quality of provided services by integrating network optimization. When combined, network telemetry, CDRs, data statistics, and equipment alerts enable communications service providers (CSPs) to set up and maintain effective network self-diagnostics and self-configuration tools. With big data analytics, telecom companies can monitor their network performance. For example, companies can record and gather issues raised by users from a particular area and look for solutions to resolve these issues, such as improving the connectivity.
- *Operational Analysis:* Companies can use big data for both analyzing and modifying operations as the need arises. Analysis can also be used to monitor the telecom's usage of resources and thereby prevent waste, which leads to savings of both resources and money. Real-time operational analysis also helps set the timetable for data updates and define other parameters so a company can best adapt the data analysis system to their unique business requirements.
- *Data Monetization:* Big data collected by telcos can be sold to or shared with third parties interested in monetizing it. Big data allows companies to gather a lot of user-related information, like demographics and location info, network and application usage, details about used devices, various preferences, and more. After processing, this data has value that extends beyond the companies that gathered them, opening a possibility for data monetization. Telecom companies can sell this data – without violating users' privacy – to companies from other industries like healthcare, financial services or advertising. For example, insurance companies, marketing agencies, banks, and other financial institutions may be interested in the behavior of a particular cohort of users, which will help them optimize their service offerings, and, thus, boost big data monetization in telecoms.
- *Fraud Detection:* Most fraud cases in the telecom industry are illegal access, fake profiles, authorization, cloning, or behavioral fraud. Each of these frauds affects the relationship established between the company and the customer directly. Therefore, fraud detection tools and techniques

are needed. Big data analytics helps to monitor behaviors in real-time, thus preventing fraud. This technique has extremely high efficiency because it allows an almost real-time response to any suspicious activity. AI tools working on top of layers of accumulated and constantly updated relevant big data help telcos live up to high security standards and retain their customer base. Cybercriminals are raking millions of dollars by employing sophisticated scams across different geographies and vanishing even before the communication service provider knows. The revenue lost through Telco fraud amounts to billions of dollars each year.

- *Price Optimization:* The number of customers in the telecom industry customers is growing extremely fast. Therefore, pricing optimization becomes an important factor. The telecom industry is rife with cutthroat competition among different service providers, competing to have the largest subscriber market share. Product pricing is a key factor for operators competing to gain more subscribers. Telecoms use big data technologies to review several real-time metrics and settle on a particular product's price. For example, an operator may announce that users would get free minutes daily for calls made at a particular time frame under a particular voice bundle subscription. This sort of product offering comes about after analyzing data sources and then deriving actionable insights from them. The providers can set the optimal service prices to gain and retain customers.
- *Customer Churn Prevention:* Churn rate, also known as attrition rate, refers to the percentage of customers that stop using a particular service within a forecast period. In a recent study, the telecom industry has a churn rate of 21 percent, closely linked to poor customer service. Engaging new customers takes a lot of time and effort, and so does retaining customers. Companies have to analyze customers' behaviors and take corresponding actions to prevent customer churn. Telecom data analytics use cases give insights into this data, help disclose customers' feelings regarding services they receive, immediately address satisfaction issues, and prevent churn.
- *Product Development:* Developing a product is a complex process requiring proper control and management. It is a time-consuming. However, the integration of big data analytics ensures high-performing and quality products for the consumers, as per their needs and requirements. As a result of telecom data analysis, companies can develop data-driven products with internal feedback and marketing strategies. Big data analytics use cases in telecom companies can greatly assist with data-driven product development, internal feedback, and marketing intelligence.

BENEFITS

Big data can help the telecom industry in a myriad of ways. Big data is helpful for telecom operators in optimizing the quality of provided services by integrating network optimization. Companies can harness big data's potential by investing in custom data solutions that will help them with optimizing analytics to increase profitability. Big data opens up a sea of opportunities in the telecom industry, including improved customer experience, fraud detection, network optimization, risk mitigation, data monetization, and more. If done right, big data is the fast route to customer retention, growing subscriber base, and profitability. Other benefits include [21]:

- *Improved Customer Experience:* Competition within the telecom industry is fierce. Rival companies are always seeking opportunities to win over clients in ways besides decreasing prices or offering bonuses. And that is what makes big data so appealing; it opens new possibilities in improved customer experience, more personalized marketing, reducing churn rate, and generating new streams of revenue. Big data allows telecom companies to gather and categorize vast amounts of user information, enabling them to personalize customer experiences. By analyzing customer data, telecom companies can provide proactive assistance, resolve issues quickly, and offer tailored services.
- *Targeted Products:* Out of the customer micro-segments, you can tailor targeted and relevant product offerings that entice the customer. By leveraging customer behavior patterns, billing information, and issue resolution data, telecom companies can not only resolve customer problems and improve services but also target customers with relevant offerings. For example, a customer who makes frequent calls to a specific country can be targeted with a specific marketing campaign in real-time.
- *Predictive Capacity:* Big data can also help with developing predictive capacity models to predict network problems that may arise in the future. This includes predicting peak network loads and allocating adequate network resources to relieve congestion.

- *Personalized Offers:* Telecoms can use big data to segment customers into special categories based on their network usage data. This helps them present deeply personalized offers and services to the respective customer micro-segments, promoting customer retention and halting growing churn trends.
- *Targeted Marketing:* Under target marketing, the companies utilize big data network analytics in telecom to provide consumers with customized services on the basis of their purchase history, preferences, and feedback. Technology also helps companies identify customer behavior by evaluating their service usage.
- *Preventive Diagnostics:* Preventive diagnostics involve identifying the pattern of the service behavior to avoid system failures. Business analytics in telecom industry performs preventive diagnostics to analyze consumer intention
- *Enhanced Customer Experience:* The ultimate goal of telecommunication is to build a positive customer experience. By using data analytics systems, companies can use big data analytics system that uses comprehensive analysis to provide creative workflows using infographics. Besides, it also allows the industries to personalize the customer experience by sorting and separating the data into diverse categories.
- *Predictive Analysis:* The predictive analysis applied by telecom companies uses historical data to predict future behaviors and get valuable insights into customer data. With gathered insights, companies can become faster, more efficient, and better. It also helps with making data-driven decisions. For example, by analyzing customer preferences, companies can have a better understanding of each customer.
- *Customer Segmentation*: The content and strategy need to be tailored to the specific market. Therefore, telecom companies segment their customers and then target campaigns accordingly. Segmentation and targeting help with predicting customers' needs, preferences, and reactions to services and products.
- *Predicting Churn*: Churn refers to is a measure of the number of individuals or items moving out of a collective industry over a specific period making it a real issue of any business or industry. This can be due to several reasons like quality of service, network issues, social media trends, availability of other better options, sudden price hikes, unresolved queries. Understanding such scenarios with the data available can always be a preventive way of reducing churn.
- *Network Security:* Network security is of paramount importance in the telecom industry, given the sensitivity and value of the data transmitted over telecommunications networks. Big data analytics serves as a powerful tool for identifying and mitigating security threats, enhancing cybersecurity measures, and safeguarding network integrity and data confidentiality
- *Data Governance:* Data governance is very essential to protect the data and assets of telecom operators. It refers to the policies and procedures adopted in order to define how data assets could be accessed and manipulated and by whom in the organization. A common mistake that telecom operators makes is that they confuse data quality management, which comprises activities for the improvement of data quality, and data governance. This can be explained by the close connection between data governance and data quality management results from a data perspective as a company asset.

CHALLENGES

Like any other industry, the telecom industry is faced with many challenges. Competition in the telecommunications market has never been more vicious. The industry has every chance of beating these challenges. These challenges include the following:

- *Predicting Churn:* Churn, the number of customers leaving a service, poses a significant challenge for telecom companies. Big data analysis allows companies to understand the reasons behind churn, such as service quality, network issues, social media trends, price changes, and unresolved queries.
- *Detection of Fraud:* The most common types of fraud in the telecom business include unauthorized access, false profiles, authorization, duplication, behavioral fraud, and more. Fraud has a direct impact on the relationship that has been built between the organization and the user. As a result, big data analytics aids in real-time monitoring and fraud prevention. This technology is extremely efficient since it enables real-time response to any suspicious activity.
- *Talent Capability:* Talent capability in the context of analytics refers to the expertise of data analyst or scientists in executing tasks related to big data analytics. This capability is one of the defining components in creating and sustaining a

competitive advantage. A close relationship between data scientists and other people within the organization can be very important. Figure 9 shows big data analytics talent capability pillar [22].

- *Skills Shortage:* Lack of talented resources is a key challenge. The most challenging in BDA (big data analytics) projects is finding a qualified team. This can be explained by the fact that BDA is always considered as new technology compared to business intelligence, which most organizations have built over decades. Advanced analytics requires staff with deep knowledge in different domains, from data science to worldwide privacy laws, along with an understanding of the telecommunications business.

CONCLUSION

To cope with all the changes, companies have to stay alert to the newest trends in big data analytics in the telecom industry. Today, the application of big data in the telecom industry is multi-fold. Telcos can leverage big data technologies to turn vast amounts of raw data into actionable insights.

Big data analytics in the telecom industry refers to the process of analyzing large volumes of data generated by telecommunications networks and services to extract valuable insights. It is revolutionizing the telecommunication industry by enabling targeted marketing and enhancing customer behavior insights. The application of big data in telecom companies is crucial for success in the current and future telecom industry. The synergy between big data analytics and emerging technologies like artificial intelligence and machine learning continues to redefine the possibilities within the telecom sector, paving the way for innovation and growth. More information about big data in the telecommunications industry is available from the books in [23-25].

REFERENCES

[1] R. Delgado, "The challenges of bringing BYOD to the military," https://socpub.com/articles/the-challenges-of-bringing-byod-to-the-military-11272

[2] M. Atherton, "Telecom infrastructure vulnerabilities: Assessing and enhancing resilience," January 2024, https://www.linkedin.com/pulse/telecom-infrastructure-vulnerabilities-assessing-dr-marlon-atherton-c2rpe/

[3] A. Pareek, "Global examples of telecom companies using big data analytics," July 2022, https://customerthink.com/global-examples-of-telecom-companies-using-big-data-analytics/

[4] J. Moorthy et al., "Big data: Prospects and challenges," *The Journal for Decision Makers*, vol. 40, no. 1, 2015, pp. 74–96.

[5] M. N.O. Sadiku, M. Tembely, and S.M. Musa, "Big data: An introduction for engineers," *Journal of Scientific and Engineering Research,* vol. 3, no. 2, 2016, pp. 106-108.

[6] "The complete overview of big data," https://intellipaat.com/blog/tutorial/hadoop-tutorial/big-data-overview/

[7] R. Allen, "Types of big data | Understanding & Interacting with key types (2024)," https://investguiding-com.custommapposter.com/article/types-of-big-data-understanding-amp-interacting-with-key-types

[8] P. Baumann et al., "Big data analytics for earth sciences: the earthserver approach," *International Journal of Digital Earth*, vol. 19, no. 1, 2016, pp.3-29.

[9] X. Wu et al., "Knowledge engineering with big data," *IEEE Intelligent Systems*, September/October 2015, pp.46-55.

[10] "The 42 V's of big data and data science," https://www.kdnuggets.com/2017/04/42-vs-big-data-data-science.html

[11] P. K. D. Pramanik, S. Pal, and M. Mukhopadhyay, "Healthcare big data: A comprehensive overview," in N. Bouchemal (ed.), *Intelligent Systems for Healthcare Management and Delivery.* IGI Global, chapter 4, 2019, pp. 72-100.

[12] J. Moorthy et al., "Big data: Prospects and challenges," *The Journal for Decision Makers*, vol. 40, no. 1, 2015, pp. 74–96. https://www.grandviewresearch.com/industry-analysis/industrial-wireless-sensor-networks-iwsn-market

[13] A. K. Tiwari, H. Chaudhary, and S. Yadav, "A review on big data and its security," *Proceedings of IEEE Sponsored 2nd International Conference on Innovations in Information Embedded and Communication Systems*, 2015.

[14] M. B. Hoy, "Big data: An introduction for librarians," *Medical Reference Services Quarterly*, vol. 33, no 3. 2014, pp. 320-326.

[15] M. Viceconti, P. Hunter, and R. Hose, "Big data, big knowledge: Big data for personalized healthcare," *IEEE Journal of Medical and Health Informatics*, vol. 19, no. 4, July 2015, pp. 1209-1215.

[16] K. Goworek, "The big impact of big data on the telecom industry," January 2021, https://tasil.com/insights/big-data-in-telecoms/

[17] S. Srivastava, "How telecom companies use big data analytics – Top 10 use cases," August 2024, https://appinventiv.com/blog/big-data-analytics-for-telecom-industry/

[18] "Big data in the telecom industry: A golden harvest on the digital fields," June 2024, https://startups.epam.com/blog/big-data-analytics-for-telecommunications

[19] R. Makarchuk, "Big data in the telecom sector: Trends, use cases & case studies," https://intellias.com/big-data-telecom/

[20] "Big data analytics in telecom industry. Use cases," April 2024, https://addepto.com/blog/the-role-of-big-data-in-the-telecom-industry/

[21] A. Kumar, "10 Use cases of data analytics in telecom industry," September 2024, https://www.appventurez.com/blog/big-data-analytics-in-telecom-industry

[22] H. Keshavarz et al., "The value of big data analytics pillars in telecommunication industry," *Sustainability,* vol. 13, no. 13, June 2021.

[23] Y. Ouyang and M. Hu (eds.*), Big Data Applications in the Telecommunications Industry.* Information Science Reference, 2016.

[24] R. He and Z. Ding (eds.), *Applications of Machine Learning in Wireless Communications (Telecommunications).* The Institution of Engineering and Technology, 2019.

[25] A. K. Bashir et al. (eds.), *Implementing Data Analytics and Architectures for Next Generation Wireless Communications.* IGI Global, 2021.

Figure 1 The cloud word for big data [1].

Figure 2 The telecom industry is noted for its complex infrastructure [2].

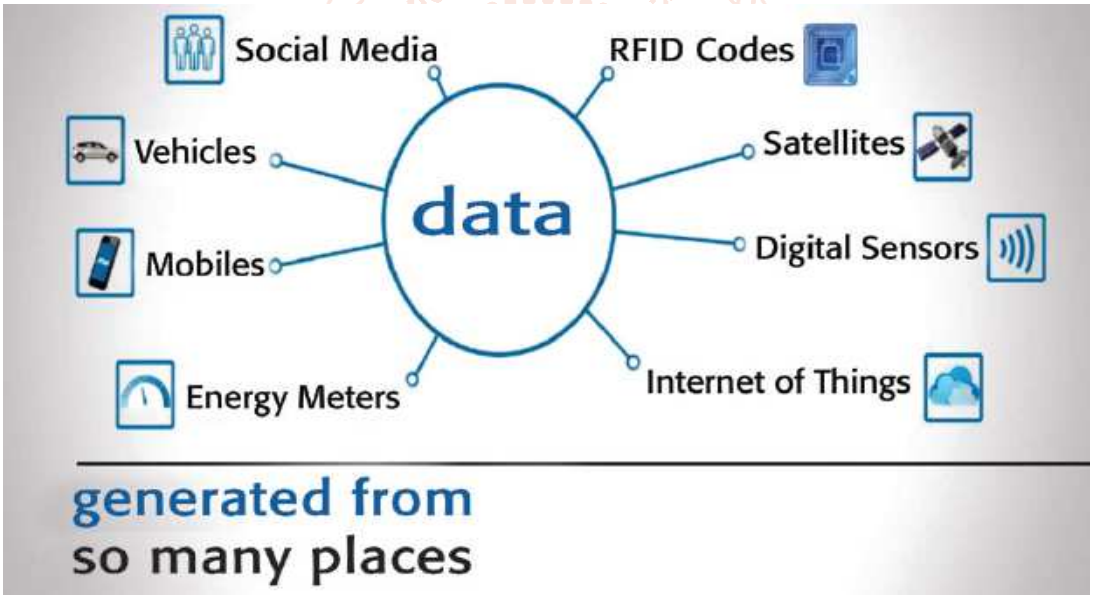

Figure 3 Typical sources of big data [4].

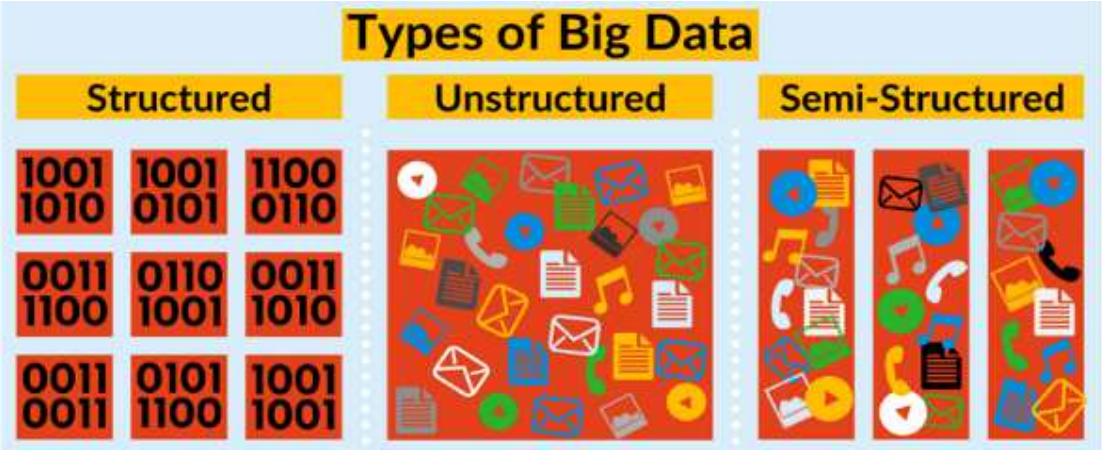

Figure 4 Types of big data [7].

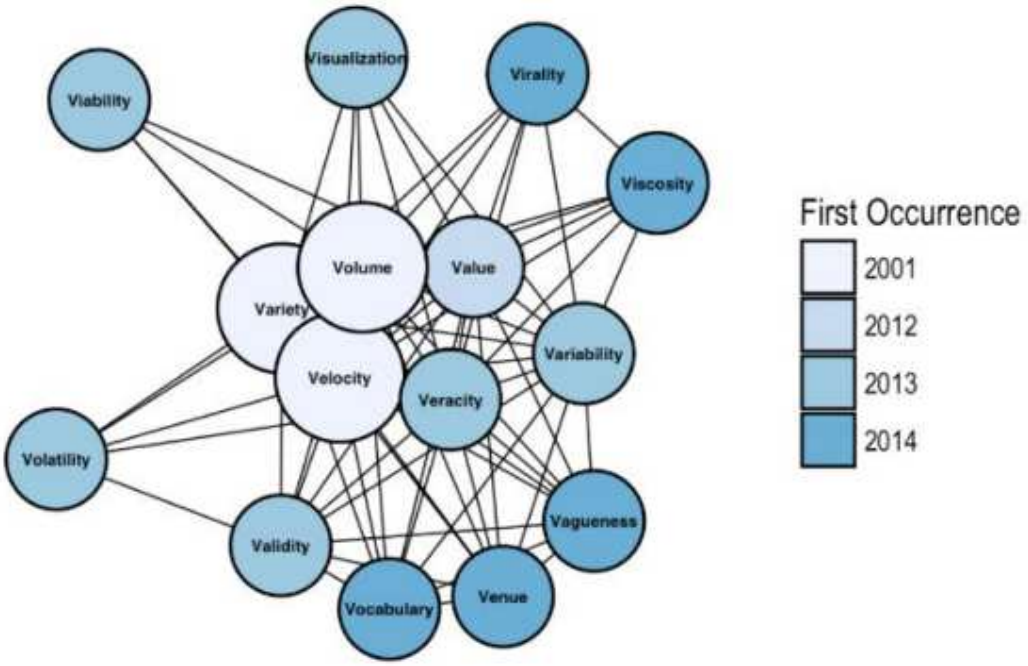

Figure 5 The 42 V's of big data [10].

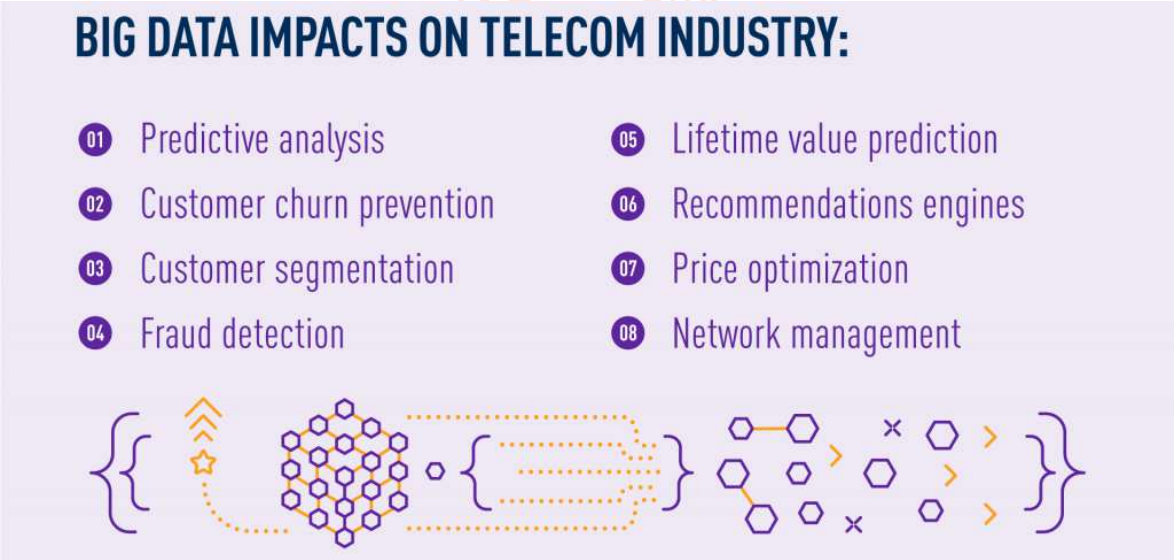

Figure 6 Big data impacts on telecommunications industry [16].

Figure 7 BDA use cases in telecommunication industry [17].

Figure 8 A typical Telco customer [20].

Figure 9 Big data analytics talent capability pillar [22]