

## **Role of Data Science in Reshaping the Business Sectors: Opportunities and Challenges for India**

Cmde SL Deshmukh, NM (Retd)<sup>1</sup>

### **Abstract**

“Data is the new science. Big Data holds the answers.” Pat Gelsinger, CEO of VMware’s prophetic words speak volumes about the Data Science (DataFlair, n.d.), a field that has impacted the world.

Data Science, derived from merging of computer science and statistics- two related but distinct disciplines- is being extensively used today, to transform plethora of data into useful insights and predictions, converting something seemingly vague into meaningful information. Global use of Data Science has impacted everyday lives, industries, businesses well beyond the technical world and is helping in changing the world for better.

India too has made a modest beginning and has a long way to go in this field. Despite its limited use, Artificial Intelligence (AI) and Cognitive Technologies (CT), important constituents of Data Science, have helped Indian companies in reshaping their business processes and enhancing their efficiencies, analysis of which would form an important part of this paper.

However, to present a holistic picture, this paper will examine status of Global use of Data Science (scope, applications and limitations), India specific scenario related to Data Science, role of Artificial Intelligence (AI) and Cognitive Technologies (CT) in reshaping business processes and their impact on various sectors- specifically analysing E-Commerce sector, existing generic challenges, probable measures, ending with some viable recommendations.

**Keywords:** Data Science, Cognitive Technologies, Artificial Intelligence, Health, Climate, Industries, Business Processes

### **Introduction**

“Today it is said that data is the new oil. I will also add that data is the new gold. Industry 4.0 is focused on data” Prime Minister Narendra Modi had said about the power of data (Hebbar, September 27, 2019). It is well understood that organisations can have volumes of data- without information but cannot have information without data; this is where Data Science steps in.

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<sup>1</sup> Commodore SL Deshmukh, NM (Retd) served the Indian Navy for over three decades as a specialist in maintenance of fighter aircraft and ASW helicopters. He is currently the Senior Vice President of Sun Group’s Aerospace & Defence vertical.

Data Science has been globally progressing in leaps and bounds, finding applications in various fields like meteorology, agricultural/social/educational/health sciences et al. Many European countries have been leading in use and application of data science, in addition to UK and USA. Specifically, use of Artificial Intelligence (AI) and Cognitive Technologies (CT) - important parts of Data Science- has helped many businesses to grow exponentially in those countries. That, in turn, has resulted in increased demand for Data Science professionals globally (ELU, n.d.). Developing countries also have started realising prowess of Data Science and they need to ramp up their capabilities in this field, for accelerating development.

Fortunately India has already ventured into the field, but currently lacks prowess, pool of data scientists and infrastructure to train them. It needs to urgently augment relevant resources for overcoming the stated lacunae. It is opportune that despite limitations, many Indian industries have started adapting/taking help of Data Science for enhancing their operational efficiencies. This paper will take a stock of it.

With a view to present a holistic perspective, this paper will accordingly analyse various aspects related to global/Indian scenario, use of Artificial Intelligence and Cognitive Technologies by various Indian business sectors for reshaping their Business Processes and efficiency enhancement –specifically analysing the e-commerce sector, existing challenges and remedial measures and conclude with some viable recommendations.

### **Data Science- Role and Applications**

Before delving into the analysis, it would be important to briefly overview Data science scope, its role and applications. Data science has been defined as a field of study that combines domain expertise, programming skills, and knowledge of mathematics and statistics to extract meaningful insights from data (DataRobot, n.d.). Data Science applications follow a classic five stage operative cycle (Fig: I) - Capture, Maintain; Process; Analyse and Communicate – for facilitating intelligent decision making (Berkley, n.d.).

#### **Fig: I- Data Operative Cycle**

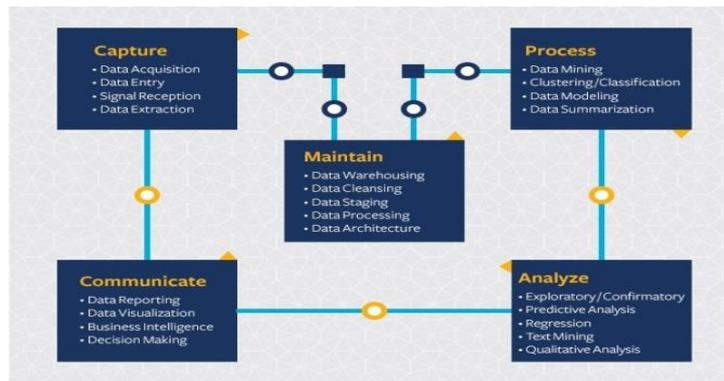


Image Courtesy: [datascience@berkeley](mailto:datascience@berkeley)

Owing to its capabilities, the role of Data Science has evolved over the years and now it finds inevitable applications in various fields- covering criminal investigations, health care, airline operations, advertising, businesses and Services sector including e-Commerce, to name a few.

### **Global Use of Data Science- Current Status and Limitations**

#### ***Current Status***

Blet and Smith (August 15, 2017) and Eggers and his team (Eggers et al, April 26, 2017) had examined global reach of data science, and had observed that Competitive world has taken to as fish takes to water, as it's a powerful tool for integrating multi-dimensional inputs and offer insights applicable to statistical, computational, and human dimensions. There is no doubt that each of these dimension carries its own significance, but in reality ability of combining all three components is what has made Data Science a force multiplier for many sectors like businesses, governments, academics etc. Some examples of global use of Data science at genomic, social, galactic, industrial, and governmental scales, cited by them cover: -

- a) *At genomic level*, modern sequencing technology has enabled high-resolution genetic sequencing at massive scale, and geneticists have connected the genetic data to large databases of individuals' behaviours and diseases. These outcomes have enabled the researchers in better understanding the human genome, helping them in understanding how it evolves, and how it governs observed traits.
- b) *At social level*, Data Science has enabled the social scientists to study large archives of digitized texts, often with rich information about human behaviour and interactions, helping them to navigate and understand the contours of society, finding relevant sources to their work and identifying hard to spot patterns of language that suggest new interpretations and theories, more effectively.

- c) *At galactic level*, Data Science has transformed the field of Astronomy. Here modern telescopes create digital sky surveys that have transformed observational astronomy, generating hundreds of terabytes of raw image data about billions of sky objects. Data Science can help in cataloguing these objects, giving astronomers unprecedented insights into structure of the cosmos.
- d) *At industrial level*, Data Science, through its elements like Artificial Intelligence (AI) and Cognitive Technologies (CT), has helped in transforming business processes, enhancing efficiencies and changing the working environment.
- e) *At governmental Level*, artificial intelligence is already being used, with cognitive applications doing everything from reducing backlogs and cutting costs to handling tasks difficult to perform manually. Some examples would be predicting fraudulent transactions and identifying criminal suspects via facial recognition. AI-based technologies have started fundamentally transforming public-sector functioning and service delivery- eliminating some mundane jobs, redesigning many others, and even creating entirely new profiles thus revolutionizing facets of government operations. In case of India, the Indian government has effectively used Big Data Analytics in transparently executing schemes like Direct Benefit Transfer related to Scholarship/Gas and Fertiliser Subsidies as well as direct payment to farmers towards cost of procured goods.

### ***Limitations***

Though the above examples illustrate vast scope for Data Science applications, its use is still constrained by certain limitations like:-

- a) Problem of connecting genes and traits at large scale still goes beyond the limits of classical genome analysis, both computationally and statistically.
- b) Building tools for navigating large collections of documents, especially ones that reflect the priorities of social scientists has been problem which has not been resolved yet.
- c) Using digital sky surveys to understand the complex nature of the universe requires computational and statistical tools which are yet beyond the capabilities of data science.
- d) Tools for understanding and correlating intricacies of man-machine and spatial interphases are not available yet.

Broadly speaking, the existing methods from statistics and computing have still not matured, for solving the types of problems encountered by the modern scientists. Some issues are computational, such as working with massive volumes and complexities of metadata. Some others are statistical, such as the rich interactions of many related variables and the theoretical and practical difficulties associated with high-dimensional statistics. In addition, some issues are yet unclear, such as mis-specified models of the world, difficulties in identifying causality from empirical data and challenges to meeting disciplinary goals related to data exploration and understanding. These issues have created considerable consternation and tension amongst the Data Science Practitioners (Blei and Smyth, August 15, 2017a). In this context they also have rightly pointed out that:

This tension has become catalyst for the newer trajectory for data science. It now intensely focuses on exploiting the modern cascade of data for prediction, exploration, understanding, and intervention. It emphasizes the value and necessity of approximation and simplification. It values effective communication of the results of a data analysis and of the understanding about the world that we glean from it. It prioritizes an understanding of the optimization algorithms and transparently managing the inevitable trade-off between accuracy and speed. It promotes domain-specific analyses, where data scientists and domain experts work together to balance appropriate assumptions with computationally efficient methods.

The scientist world over are now working tirelessly- to overcome the existing limitations and significant breakthroughs are expected in the foreseeable future.

## **India- Opportunities and Challenges**

### **Opportunities: Transformation of India**

#### ***Evolution***

Data science has the potential to reshape India through improving quality of life and facilitating venturing into the fields hitherto considered impossible. Massive Data Science powered changes have been seen emerging in the way industries have started working in India. The Indian think-tank 'National Institution for Transforming India' (NITI Aayog), an initiative of the Indian government, has played a phenomenal role in advancing emerging technologies and putting in a roadmap for AI, including one for the business sectors (Roy, June, 2018).

With vast amounts of data now available, companies in almost all industry sectors, including service industry, have started focusing on exploiting data for competitive advantage. On one

hand the data volume and variety has far outstripped the manual capacity and capabilities, and in some cases has even exceeded the capacity of conventional computing mechanisms. On the other, computers have kept pace becoming powerful enough to use complex algorithms, making evaluation of mega-datasets feasible, enabling broader and deeper analysis than previously possible. A balancing mix of the two would be the key for India's success in this field.

### ***Impact***

The above developments have given rise to the increasingly widespread business applications of data science. Companies across industries have realized that they need to hire more data scientists, thus opening an ocean of opportunities for accelerated use of data science and associated job opportunities (Provost and Fawcett, March, 2013). The scenario is well applicable to India, which is as of now struggling to meet the rising demands for qualified data scientists. It would, therefore, be necessary to briefly examine the India's demand/availability/problems/solutions, as related to Data Scientists.

### ***Demand for Data Scientists***

With the COVID-19 pandemic impacting business organizations on many fronts, application of 'data science' has accelerated considerably, as it has been able to assist organizations in automating complicated business processes-connected with extracting, analysing, and presenting raw data. This in turn has been facilitated by impressive advancements in computer vision, natural language processing, speech recognition, and robotics, among other areas and the benefits accruable from their use (Deloitte India, 2021). This has exponentially increased the demand for qualified data scientists, which is expected to grow further as an eight-fold increase in volume has been forecasted in the big data analytics sector- from current USD 2 billion level to USD 16 billion, by 2025 (PTI, July 02, 2017).

As an indicator of the emerging trend, major companies like Amazon, Cisco were hiring data scientists, with various capabilities, even during the lockdown. Amazon has been looking for data scientists, experienced in applying machine learning strategies to drive business, prototyping solutions, building machine learning models, and test them for better performance. Cisco-on the other hand, has been recruiting senior data scientists to work on analytical platforms, defining and designing overall architecture for their processes, chalking out an implementation plan, based on the business requirements.

Other Indian companies too have been looking for data scientists, having expertise in programming languages such as Python, Java and R, for scripting data analysis processes. In addition, hand-on skills in Matlab, Scala and Julia languages have also been in demand (Costa, August 24, 2020).

### ***Factors driving High Demand for Data Scientists***

An analysis undertaken to understand various factors driving the demand for qualified data scientists and it has been observed that the phenomenon can be attributed to the following important factors (Dialani, August 05, 2020):-

- a) *Rising applications of Artificial Intelligence (AI) and Cognitive Technologies (CT) for Reshaping Business Processes-* Automation of tasks requiring human exceptional abilities became much easier, with advancement in AI techniques. Machines now can and do perform activities like manipulating tools, extracting data from documents and other semi-structured data sources, making tacit judgments and even sensing emotions- better/cheaper compared to the cost of human intervention. Combination of AI and CT, for example, IBM Watson, Stanford's Deep-dive, and Google's Deep-mind, has empowered companies to comprehend unstructured information through natural language processing (NLP). To cite an example, Bangalore-based Talview uses IBM Watson to speed up hiring for its clients. Various aspects related to use of AI for reshaping the business processes will be examined in more details- later in the paper.
- b) *Need of Data Science for Security Professionals-* Significant AI and machine learning (ML) adoption in the IT and innovative industries and increasing need for data protection has resulted in numerous new roles and increasing the demand for data science security professionals. Many businesses have started approaching experts in AI, machine learning, data science, and computer science for devising methods for effective utilisation of data and its protection.
- c) *Cloud-first Strategy Adoption-* A study by Forbes has observed that at least 32% of business information is expected to go through cloud in the foreseeable future (Columbus, August 02, 2020). Businesses would thus need ability to efficiently analyse multiple sources of data for arriving at intelligent decisions across functions and efficiency enhancement, needing cloud first strategy. For example, Xerox uses

the ‘cloud-first strategy; to efficiently investigate data and decrease the attrition rate by 20% at its call centers. Organizations like KPMG and IBM also have adopted the “cloud-first” strategy. In this context, KPMG and CII report (KPMG-CII, October 2018) has pointed out that:

India, as a country of more than a billion people, would need to understand and appreciate the significance and challenge of connecting the ‘Bottom of the Pyramid.’ Cloud can drive this comprehensive development plan by giving a platform, to scale the reach of education, healthcare, financial services, industries, entrepreneurship and governance, among other areas.

It is thus clear Data Science would be an inescapable need to transform the nation. India would thus need to put various measures in place, which would help in meeting rising demand for data scientists as well as help businesses in faster adaption of various AI applications, enabling to remain competitive and sustainable. For better appreciation of the emerging scenario, it would be important to analyse how Data Science (AI and CT) has helped Indian companies in reshaping their business processes and enhancing the efficiencies, despite limitations.

#### ***Correlation: AI- CT and Business Processes***

Before delving into use of AI/CT for reshaping of business processes, subtle difference between them needs to be understood. AI basically pertains to simulation of human intelligence processes by machines and is important to service-oriented industries such as Manufacturing and Customer Service. In contrast, CT (which also includes Cognitive Computing) pertains to individual technologies that act as smart decision support systems, aiding human intelligence, and is important for data intensive industries such as Finance, Marketing, Government and Healthcare (Wu, June 03, 2019).

#### ***Impact of AI/CT on Reshaping of Business Processes of Various Sectors***

It is encouraging to see that the pace of AI/CT adoption in India has been accelerating and a sizable number of institution have leveraged automation- to drive value and reshape their business models. According to the McKinsey Automation Survey, 57 percent of 1,300 institutions surveyed had already embarked on this journey, with another 18 percent planning to kick off- in the coming years. More than 400 data science use cases, across 19 industries and nine business functions were also analysed. The survey provided an insight into the areas, where deep ‘neural networks’ were able not only in creating value add in various business processes but also making an efficiency enhancing impact on many business sectors (Chui et

al, February, 2019). Examples pertaining to the e-Commerce and some other important business sectors, where AI-CT impact has been indubitable, have been enumerated in the succeeding paragraphs.

### ***E-Commerce/Retail/Logistics Sector***

#### ***Historical Perspective***

India needed financial crises and technocratic convictions to formulate and push policies, which were financially prudent and were keeping pace with times. This was true of the green revolution, changes in trade, infrastructure and industrial policies. In was in 1990s, economic reforms and the gradual implementation of growth oriented policy changes (kicked off in the 1980s) spurred the policy makers to look into trade reforms. Commendable rise in economies of China and Southeast Asia and simultaneous decline in Russia's then archaic economy, finally convinced the Indian policy elite that implementation of substantial reforms in trade, industry, and infrastructure would be essential, if India wanted to remain relevant in the global scenario (Mukherji, February 19, 2009), and various trade reforms were implemented. Implementation of reforms in e-Commerce sectors did have an appreciable impact on merchandise trade volumes in India, as depicted in Fig: 2 below:-

Figure 2: Measuring India's Merchandise Trade/GDP (%)



Image Courtesy-tandfonline

Though E-Commerce showed signs of great potential for growth and consequential impact on Indian economy, the sector still had its own impediments- in terms of technological limitations.

#### ***Generic Challenges for the E-Commerce Industry prior to Digital Revolution (1995-2005)***

Electronic commerce (e-commerce), as part of the information technology revolution, became an essential part of the world trade and inevitably made inroads in India, sometime in mid -

1990s. Introduction of internet in India in 1995 marked both- growth of the IT industry and the beginning of e-commerce in the country. The IT industry and small companies were early adopters of internet, leading to limited development of e-commerce sector. Interestingly the early e-businesses in India were B2B directories, job searches and marital portals (Mahipal and Shankaraiah, 2018).

Growth of e-commerce was hampered, between 2000 and 2005, by various problems like low internet penetration- reliability and speeds, low consumer acceptance of online shopping- resulting in low user base and inadequate logistics infrastructure. In addition, limitations of telecom industry/infrastructure available to serve vast expanse of the country, high internet surfing charges coupled with minimal availability of smart handsets/computers due to technology handicap and high cost factor were other issues which impacted growth of the e-commerce sector in India (Panigrahi et al, January 2016).

### ***Progress of E-Commerce in India (2005-2020)***

During the period 2005 to 2020, rising internet connectivity and reliability coupled with smart mobile phone penetration changed the way of communication and businesses. That took the world of retail by storm and e-commerce in India witnessed a significant growth. India is now one of the fastest growing markets for the e-commerce sector. Revenues from the sector have increased from USD 39 billion in 2017 to USD 120 billion in 2020, growing at an annual rate of 51 percent, the highest in the world (CCI, January 08, 2020). To cite an example, Indian online grocery market, currently valued at USD 1.9 billion, is estimated to reach USD 18.2 billion by 2025, averaging a CAGR of 57%, driven by strong adoption of online e-commerce services (IBEF, September 22, 2021).

This occurrence and unstoppable furtherance of growth of e-commerce would be attributable to many contributory factors like rapid adoption of technology by Indian consumers, large increase in the number of internet users, *new enabling technologies, innovative business models and alternative payment options* offered by E-commerce companies.

### ***E-Commerce: Business Challenges and Adaption of AI aided Business Processes***

#### ***Business Challenges***

India's E-commerce sector has been facing multiple challenges in its business operations also like mapping of customer preferences, taxation issues, incidents of fraud, issues related to cyber

security, intense competition, customer preference for payment on delivery (COD), coupled with still inadequate infrastructure and comparatively low digital literacy. Increasing incidents of distribution of counterfeit goods, through E-commerce platform, further added to the woes of E-commerce companies. This was mainly attributable to the absence of trustworthy mechanism - which would allow authentication of sellers or their products. In addition, higher return ratio for goods sold online, dealing with wrong addresses, size matching were some other problems proving expensive as well as challenging for e-commerce companies (Kumar, 2017).

### ***Use of AI driven remedial Business Processes***

To overcome the above mentioned challenges, e-commerce companies started adapting AI based business processes- to increase user friendliness, user satisfaction and business efficiencies. Studies undertaken by Baruah (Baruah, March 11, 2020) and Analytics India Magazine (AIM, September 08, 2020) had examined applications of AI in redefining the business processes and some examples pointed out by them covered: -

- a) *Mapping consumption Patterns*- Keeping in mind rising income levels, which are making India one of the fastest-growing consumer markets in the world, companies have started using AI for mapping changes in lifestyle and shopping patterns.
- b) *Innovating Easy-to-use Technologies*- The E-commerce companies in India have been focusing on developing new AI applications, suitable for mobiles/smart phones, enabling users to make online transactions through their devices with ease. Mobile applications also assisted companies to enhance their geographical outreach and increase their communication level with the end-users- through exchange of regular service updates and messages.
- c) *Digital Advertisements*- These have enabled E-commerce players to reach out to wider audience/customers. Similarly, adoption of Search Engine Optimization (SEO) as an internet marketing strategy helped E-commerce companies in improving their search engine rankings.
- d) *Choices of Payment Options*- E-commerce companies in India have started promoting /linking digital payment products and electronic wallets to ease the payment process in

E-commerce transactions. This is being done as ‘cash-on-delivery’ has higher administration costs. However, most e-commerce companies still allow COD transactions as this is still the most preferred mode of payment among consumers.

- e) *Online Instore Experience*- E-commerce companies have been plagued with reported 10-11% return rate, which adds to costs. Some companies undertook studies and realised that a large percentage of returns could have been prevented -by asking one or two simple questions to the customer, before their purchase. Use of new AI enabled process has empowered the companies to ‘offer in-store experience of having a ‘sales associate’ – but via artificial intelligence and through digital channels.
- f) *Product Size Recommendations*- Often customers were confused by different brands of shoes and other apparel, having different size conventions. For example, a catalogue size 6 may correspond to a physical size of 15 cm for Reebok, while for Nike a catalogue size 6 may correspond to a physical size of 16 cm. E-commerce companies have now started using machine learning to recommend product sizes that would best fit the customers, when the customers visit a product page. Here AI program algorithms leverage past customer purchase and returns data (e.g. product size was too large/small) to infer the best size for the customer.
- g) *A deal for Events*- Machine Learning (ML) is now being used to identify relevant products for specific events such as Diwali, Christmas, etc. Machine Learning algorithms predict the deals and discounts to offer on the products to achieve a certain sales forecast- that helps in better planning.
- h) *Leveraging Holiday Purchases*- By training machine learning systems on past holiday purchase data and current purchase activity, companies have been able to calibrate demand more accurately, in order to sell products at the right prices to either move certain items at high volume, or maximize profit margins by matching the highest margin products to users, during the holiday season.

- i) *Logistics*- As customers have often been complaining about late deliveries/ refunds, e-commerce companies have started using AI-based systems that enable faster refunds for customers- having good buying-return behaviour- on one hand and providing correct addresses to delivery personnel to meet delivery schedules, on the other, adding to the company reputation.

Some of the companies using AI based applications in this sector include (Baruah and AIM, *ibid*): -

- i) Domestic E-Commerce Players: Flipkart, Myntra
- ii) Domestic Retail Players: Trent Retail (Tata Group), Reliance Retail (including Reliance Digital, AJIO, and Jio Mart), Aditya Birla Retail
- iii) International Retail and e-Commerce Players / Operations: Amazon (India and International), Walmart Labs, Walmart Retail, Target, Tesco, Lowe's
- iv) Market-place and Retail Aggregators: BigBasket, Grofers, Olx
- v) Boutique AI and Analytics: Firms, such as Mad Street Den, that provide AI services to the Retail sector

It would be interesting to note that many of the companies mentioned above are using indigenous pioneering solutions for e-Commerce delivery and logistics management, provided by COGOS Technologies (COGOS, n.d.).

### ***Use of Digitally Disruptive Business Models***

In addition to AI based business processes analysed above, many e-commerce companies have also started using digitally disruptive technologies for improving their prospects. Some of the emerging digitally disruptive business models and users are illustrated in the Table below (Deloitte-CII, November,2017): -

**Table- Emerging Digitally Disruptive Business Models**

SI No	Model	Description	Examples
1	Subscription	Disrupts through “lock-in” by taking a product or service that is traditionally purchased on an ad hoc basis, and locking-in repeat customer by charging a subscription fee for continued access to the product/service	Netflix, Dollar Shave Club, Apple Music
2	Freemium	Disrupts through digital sampling, where users pay for a basic service or product with their data or ‘eyeballs’ rather than money, and then charged to upgrade to their full offer. Works where marginal cost for extra units and distribution are lower than advertising revenue or the sale of personal data	Spotify, LinkedIn, Dropbox
3	Free	Disrupts with an ‘if-you’re-not-paying-for-the-product you-are-the-product’ model that involves selling personal data or ‘advertising eyeballs’ harvested by offering consumers a ‘free’ product or service that captures their data/attention	Google, Facebook
4	Market Place	Disrupts with the provision of a digital marketplace that brings together buyers and sellers directly, in return for a transaction or placement fee or commission	eBay, iTunes, App Store, Uber, AirBnB
5	Access-overOwnership	Disrupts by providing temporary access to goods and services traditionally only available through purchase. Includes ‘Sharing Economy’ disruptors, which takes a commission from people monetizing their assets (home, car, capital) by lending them to ‘borrower’	Zipcar, Peerbuy, AirBnB
6	Hyper Market	Disrupts by ‘brand bombing	Amazon, Apple

7	On Demand Model	Disrupts by monetizing time and selling instant-access at a premium.	Uber, Taskrabbit
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To summarise, AI techniques such as continuous customer mapping, estimation of logistics, disruptive technology models etc. have helped e-commerce companies in reshaping their business processes and enhancing efficiencies, thereby adding substantial value and making their contribution quite significant. Use of AI systems in e-commerce sector currently accounts for USD 317.8 Mil in AI market value and 5.0% in AI market share (Deloitte-CII, ibid).

### ***Brief analysis of other Business Sectors***

In addition to the e-commerce sector, many other sectors have started using AI based solutions to reshape their business processes and enhance their efficiencies. Some of the sectors are:-

- a) ***Predictive maintenance***- Here the power of machine learning -to detect anomalies and analyse very large amounts of high-dimensional data- has helped in raising the bar for preventive maintenance systems to new levels. Industries with high maintenance requirements (including airlines) have immensely benefitted from this. To cite an example-Sense Hawk-a pioneering company offering Life Cycle Management for Solar Power Plants, has helped solar power sector in improving its viability (Ganguly, September 20, 2020)
- b) ***Airport Security***- Artificial Intelligence powered systems are now being used for baggage screening at airports. AIM (AIM, January 14, 2020) has reported that AI-powered systems have been found effective in strengthening security efforts at the airport, by Airports Authority of India.
- c) ***Education***- India has one of the largest student populations in the world. There are approximately 290 million students in schools, with more than half that number, enrolled in government schools across the country. However, providing quality education has not been an easy task. AI has been a great tool for the education sector to address this problem (Indiaai, August 10, 2021). To cite an example, TagHive has introduced ‘Class Saathi’- a quiz-based EdTech solution- for in-class and at-home

learning, for use by students, teachers, parents, and administrators, through an AI-powered smartphone app (TAGHIVE, n.d.),

- d) **Healthcare-** Health care sector has also immensely benefitted for AI/CT applications especially in activities like patient monitoring, on-line consultations, treatment management, new drug research etc. To cite an example, a team of experts from a renowned technology institution in India, working alongside a Kolkata based medical centre, has devised an AI-assisted model for automatically grading the aggressiveness of breast cancer. The solution relies on deep learning algorithms to identify high-risk and normal tumour types, overcoming the human error (ASSOCHAM-PWC, April,2018)
- e) **Computer Applications-** CA Technologies India Pvt Ltd and Bizzflo India Pvt Limited have employed AI and CT tools to improve their software business processes and efficiencies (Applied Roots, n.d.)

Based on the capabilities of AI and CT for improving the business processes, NASSCOM (NASSCOM, 2021) has opined that India as of now has just scratched the surface in this field, and its contribution to India's GDP is expected to rise to ~ \$ 500 billion, by 2025.

It is important to note that with increasing use of data science, demand for data scientists has been rising at an unprecedented rate, across the sectors. The demand is most among BFSI (38%), followed by Energy (13%), Pharma and Healthcare (12%), and E-Commerce (11%), among others (NASSCOM-FICCI-E&Y, September 2017). The analysis above undoubtedly shows the impact of AI and CT on various business sectors in India. Despite this phenomenal impact the wide spread Data Science adaptation has been hampered by many factors. Some generic challenges and remedial measures have been highlighted in the succeeding paragraphs.

## **Generic Challenges**

### ***Challenges related to Critical Shortage of Data Scientists in India***

India has been unable to meet the huge demand for qualified manpower creating an appreciable 'demand and supply' gap, thereby making the task of finding qualified data scientists quite strenuous. Studies carried out by Dialani (Dialani, August 05, 2020a) and Kumar (Kumar, December 04, 2020) had examined various reasons for shortage of qualified human resources. Some of the important reasons were: -

- a) Data Scientists have a fairly steep learning curve, in that they need to learn the underlying mathematics, statistics, and computer science and not just the syntax of the related languages.
- b) Despite huge influx of data scientists every year, very few of them have proper expertise in the subject. In a world of self-taught coders, most data scientists tend to have formal degrees in computer science, statistics, or mathematics- which cover only one aspect of Data Science.
- c) Only a limited number of Data Scientist have proper knowledge of Python or the other most commonly used languages in data science and data analysis.
- d) India is way behind the western world in terms of universities and boot-camps offering degrees in data science. As a result, not many knowledgeable data scientists are available in India, to meet even the existing demand.

In addition to above, many researchers like Deoras (Deoras, February 25, 2019), Analytics Data Magazine research teams (AIM, February 27, 2020, and March 05, 2021) had analysed various challenges, including those for industry and data scientists. A gist of those challenges is presented below: -

### ***Industry Level Challenges***

- i) *Ability of Finding the Right Data & Right Data Sizing*- As data science applications are still comparatively in nascent stage, most common problem currently being faced by the industry pertains to availability of right data - a crucial requirement for building the right model. Further where appropriate data is available, data scientist in India are constrained due to their limited ability for processing large volume and velocity of data, for arriving at profitable business decisions.
- ii) *Ability for Consolidation of information*- Industries in India currently possess voluminous but scattered data. Consolidation of information thus remains one of the biggest challenges.
- iii) *Lack of Public Awareness*- Despite growing importance of analytics and data science, there is still a need to educate the industry about immense utility of accumulating and analysing the right data.
- iv) *Lack of Stakeholder Commitment*- In spite of the fact that data analytics solutions help enterprises in business process transformations, unfortunately

there is lack of involvement and commitment from the key stakeholders. This is crucial for moving a project in the right direction and delivers the right business impact.

- v) *Utilisations of Data Science Models* – Currently the data scientists in India find entire process of adoption of data science solutions to execution quite intimidating. It requires professionals with a strong problem-solving capability to make that happen, root cause going back to non-availability of right talent, coupled with archaic education system in India and availability of limited training infrastructure.
- vi) *Identifying Appropriate Analytics Use Cases* - As the analytics industry is still evolving non-availability of appropriate cases studies, which serve as a potent decision making tool for the stake holders, is also one of the biggest problems. It is a challenge to identify correct data for the appropriate analytics use case. Preparing sound simulation models and use of other statistical tools could be a solution, till enough case studies become available.
- vii) *Lack of Agility* - Currently due to limited data availability, the analytics functions are being structured in a way that restricts interaction with the end user. Many experts believe that for analytics to become more user friendly, it needs to be more agile and in sync with businesses, during the decision-making process.
- viii) *Apprehensions about Security of Data*- As analytics demands handling huge volume of data, which could be company or sector sensitive, ensuring security of the data remains a big challenge- especially in today's world. Thus availability of wherewithal for ensuring privacy and making data as safe as possible from any wrong use is a must.

### ***Data Scientists Level Challenges***

Lack of appropriate skills with the Data scientist in India have created many difficulties for them in relation to application of data science. Some major ones are:-

- i) *Getting Data from Multiple Sources*- While building the models or anomaly detection system, data scientists get bogged down with huge amount of data coming from different sources/databases. The biggest challenge they face is finding ways to consider all forms of data and convert it into one single format

to centralize the observation. A real-time querying production database also poses a problem. A probable solution could be inculcating ability to acquire unstructured data and convert it into one meaningful database.

- ii) *Unlocking value out of Unstructured Text Data*- It has been observed that major chunk of data that is currently being stored by enterprises around the world-including India, is unstructured text data. Traditionally, an enormous amount of time, effort and resources are required to be spent by analysts in data processing by transforming unstructured text data into a standardized format to find insights out of it. Sometimes lack of right expertise results in benefits being outweighed by the cost. Fortunately, enterprises have realized the impact of using Ontologies (a set of concepts and categories in a subject area or domain that shows their properties and the relations between them) in reducing the burden on data processing thereby making data analysts more efficient.
- iii) *Inability of Setting up the Infrastructure/Tools for handling High Velocity of Data*- Data Scientists also face challenge in setting up the infrastructure/tools for handling modern data requirements (especially streaming), due to high volumes and velocity of data. This issue can be efficiently handled by using data streaming cloud PaaS services like Azure Stream Analytics and Azure Databricks.
- iv) *Understanding the Quality based on the Semantics of Data*- Enterprises use Big Data Analytics by integrating data from both internal and external sources of data -including structured, semi-structured (weblogs) and unstructured data (Social media feeds), to enhance customer satisfaction. But due to lack of expertise, data scientists in India find it difficult to do Sentiment Analysis using Customer Feedback arising from the processing of unstructured data coming from call logs or chat-bots. These provide vital insights into why a customer is not happy about the services provided or a product and the feedback can be used to improve service quality and enhance customer satisfaction. The data scientists thus need to be trained for this capability.

### ***Other Challenges***

- i) *Lack of Training Infrastructure*- As data science field is still evolving in India the training infrastructure is inadequate to meet the requirements. Though beginning has been made lot more needs to be done. Due to its criticality, this issue will be examined separately later.
- ii) *Last Mile Connectivity Limitations*- This is due to basic limitations of the telecom sector in India. Government needs to take cognisance of this factor and initiate remedial measures.
- iii) *Relatively high costs related to deployment of Data Science* – As the use of Data Science is still evolving the initial costs for deployment of Data Science are relatively high but these are expected to come down as uses increases, thus patience would be key.

### ***Infrastructural Challenges***

IBM Chief Ginni Rometty has rightly pointed out problems being faced by Indian data scientists due to lack of skills, by stating that ‘the Indian IT workers are getting affected because of their massive skill gaps’. To close that gap, employees would need to be well-versed in various technologies related to data (PTI, March 13, 2019). Imparting that deep knowledge would, in turn, demand basic skills set for the aspirants along with availability of qualified instructors and adequate infrastructure (Kumar, December 04, 2020a).

Many reputed institutions like IIM Calcutta and IIT Kharagpur have started offering courses related to Data Science, amongst others (DST, n.d.). In addition, Tata Consultancy Services (TCS) has partnered with four colleges across the country that would offer courses in Big Data Analytics (AIM, July 09, 2016). Though the above measures have helped in mitigating the training challenges, they are still inadequate and much more needs to be done, to meet the emerging requirements.

### ***Reformative Measures***

To address the above challenges appropriate reformative measures would need to be put in place, that too on priority. The enormity and complexity of these reformative measures would demand joint efforts by the Government, Industry, Academia and Individuals, to be effective.

Some of the segment wise reformative measures required for improving the situation need to cover:

**a) Government-**

- i) Policy-* The governmental policies need to offer incentives to companies entering data science field for efficiency enhancement, creating better working conditions, creating new skilled jobs. It should also provide support for leveraging latest technologies through technology transfer during FDI deals in key sectors.
- ii) Skilling and Re-skilling Initiatives-* Data Science usage demands availability of highly skilled personnel. Government needs to provide adequate facilities for technical skill upgradation. It may also collaborate with and incentivize industry for offering their infrastructure for skilling the Indian personnel in across the country. This would enable the MSME sector, backbone of Indian economy, to adopt Data Science techniques.
- iii) Establishing Centers of excellence (CoES)-* Government may establish CoEs in AI and CT which would help in transforming unorganized sectors to organized ones.

**b) Industry**

- i) Vision-*Formulate vision for industry 4.0- Create a vision for exponential technologies for industries ( including small scale) both in organised and unorganised sectors
- ii) Gig Economy-* Encourage and use the gig economy approach- to leverage the competencies of the existing workforce, by reskilling them.
- iv) Ecosystem-* Create collaborative learning ecosystems for each industry /Develop workforce re-training programs across organization levels/Partnering with Government for various reformative measures.

**c) Academia**

- i)* Focus on cognitive/judgment-driven skills
- ii)* Offer tailored courses with flexible completion timings will enhance students' inclination towards learning

*iii)* Offer appropriate courses for existing workforce- for reskilling

*d) Individuals*

- i) Understand multifaceted skill requirements for working in data science field and upskill accordingly.
- ii) Be prepared to follow a long learning curve, while on job
- iii) Be prepared to embrace the gig economy due to dynamics of the emerging market

Note: Gig Economy relates to a labour market characterized by the prevalence of short-term contracts or freelance work as opposed to permanent jobs, requiring frequent re-skilling (Madell, 2021)

In summary, it is clear that India needs to adapt Data Science, in a big way, sooner than later, to ensure progress and competitiveness in the global arena. In the words of Moore “Without big data analytics, companies are blind and deaf, wandering out onto the web like deer on a freeway.” (DataFlair, n.d. b)

### **Conclusion and Recommendations**

Data Science with its abilities has become powerful tool for transformation for governments as well as businesses. Many companies/organisations in UK, USA and Europe have adapted Data Science to improve their decision making abilities and enhance their efficiencies.

India too has become cognisant of Data Science field and Government (Department of Science and Technology) and authorities like NITI Aayog have started seriously looking into it. Many sectors like Health, Education, Manufacturing, E-Commerce, Banking and Finance, Power, Transportation, MRO have imbibed AI and CT to improve their business processes and in turn efficiencies. There is now a huge demand for qualified Data scientists, with expertise in various domains/associated languages and same is expected to increase exponentially, which is unlikely to be met with the current wherewithal.

India thus needs to put various remedial measures in place, to overcome the limitations. As India has already created its own niche in the IT field, effectively entering the Data Science field should not be a difficult task. Some specific thoughts that could be considered are:

- a) Government, industry and academia together should create public awareness about Data Science and its prowess, channelize efforts for not only introducing but propagating Data Science in various sectors and provide incentives /adequate funding.
- b) Government, industry and academia should consider creation of Centers of Excellence and institutions. It would be important for imparting quality training in the Data Science field and making training affordable.
- c) Government should consider incentivising telecom companies stepping into 5G Network technology, Further, as wide spread data science applications would demand excellent network connectivity,

Some additional requirements would cover:-

- a) Recognising and rewarding institutions and individuals making substantial contribution to the field.
- b) Simplifying processes related to approvals/monitoring/reporting and creating a dedicated channel for resolution of problems.

To conclude, collective efforts- by all the above stakeholders- would be necessary for India, for making its mark felt in Data Science arena.

### **Acknowledgment**

The author would like to thank Dr R Srinivasan for his valuable guidance during compilation of this research Paper.

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