Adoption and Impact of Big Data Analytics: Review of Hydrocarbon Sector in India

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Abstract

Indian hydrocarbon industry plays a significant role globally since it's the 4th largest in terms of Refining capacity, 4th largest in Liquified Natural Gas (LNG) terminal capacity, and 7th largest exporter of refined products. India's Jamnagar refinery, one of the world's largest, establishes it's dominance in the global oil and gas refining sector.

Recent advancement in Big Data Analytics (BDA) adoption have impacted performance of the organization. To harness the best out of Big Data (BD) technologies, the Indian hydrocarbon industry must undergo significant transformation in operational efficiency, predictive maintenance, and decision making processes. This literature review examines the scenario of BD adoption in the Indian hydrocarbon industry, finding barriers, and drivers focusing on hydrocarbon (oil and gas) exploration, production, refining, and supply chain management.

Study identifies key areas where BD adoption plays a transformative role in data analysis for predictive maintenance, operational efficiency, enhancing personnel health & safety, and optimizing resource allocation. Findings suggest that BD adoption in the Indian hydrocarbon industry is still progressing, but there need for significant strategic investments in BD technologies and resource skill enhancement. This literature review contributes to academia and industry, by identifying gaps in current research and recommendations for integrating big data technologies in the Indian hydrocarbon industry, overcoming adoption barriers.

Key Words: Big Data, Big Data Analytics, Big Data Adoption, PRISMA, Hydrocarbon Sector, India, Impact, Predictive Maintenance, oil and gas.

1. Introduction

Indian hydrocarbon industry comprises of oil and gas exploration, production, refining, distribution, and marketing. First oil well drilled in 1867 at Digboi, Assam and exploration area is to be increased up to 1 million sq. km by 2030. Indian petroleum refining sector is set to increase crude oil refining capacity to 309.5 MMTPA by 2030. Jamnagar refinery with capacity of 68.2 MMTPA has established India as a refining hub. Indian government National Exploration Licensing Policy (NELP) has incentivized oil & gas exploration activities encouraging domestic and global players to invest in the country [1].

In order to optimize the operations, improve the efficiency, predicting maintenance requirements, resource optimization, complex logistics and supply chain management needed robust technology adoption. Big Data (BD) creates value to business processes by creating transparency, improve performance, decision making, and innovation [2].

Financial performance of firms are positively impacted by the Big Data analytics (BDA) [3] in turbulent markets and customer changes. Several implementation and adoption factors like organization size, management support, competitive pressure, supply chain management have been identified related to BD adoption and impact on Indian manufacturing and services firms [4], [5], [6], [7], [8].

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Oil and gas companies are using BDA for their operational efficiency, operating cost reduction and production gains due to falling prices of digital transformation as per report by Deloitte [9], still plant equipment & machinery equivalent of USD 3.4 trillion are untouched by digital solutions. Consulting companies are using BDA to implement and bring down the hydrocarbon plants operating costs [10]. New hydrocarbon deposits search demands huge manpower, time and logistics, hence precise determination of location is highly important [11]. Majority of crude oil export and import countries utilise crude oil price forecasting [12], for reserving the production quantity and maximising cost benefit.

Over the years BDA plays important role in inventory management, forecasting, revenue management, risk analysis and supply chain management [13]. Many companies are creating strategic business value from BDA [14]. All the major sectors like financial services, insurance, IT, energy sectors are trying to reduce operational risk using BDA [15].

Digital transformation and intelligent empowerment are being used by international manufacturing firms in developed countries for operational efficiency and production gains [16]. Technology like Digital twin in energy industry are being used for smart handling of parameters and efficient operation [17].

Purpose of this literature review is to visualize Indian hydrocarbon sector with increasing challenges in managing vast amounts of data generated from upstream (exploration and production), midstream (export through pipeline), downstream (refining and distribution). While BDA offers the potential to optimize operations, improve asset performance, and streamline decision-making, many organizations struggle to effectively adopt these technologies.

This study is significant to address the following questions: How adoption of BDA is helping Indian hydrocarbon industry eg. Decision making, innovation, resource allocation; What are the barriers and drivers of BD adoption in the Indian hydrocarbon industry; How BDA can positively impact on the performance of firms in the Indian hydrocarbon sector.

2. Literature Review

Literature review helps in understanding of context of the research. It helps identify research gaps and subsequently the research questions formation. It allows to extend previous works, challenges, builds on future research [18]. Study of previous literature helps understands the methodologies, analytical approaches and insights [19]. It establishes the foundation of a conceptual framework by reviewing existing theories and models [20].

2.1 Literature Search

Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) approach have been followed for shortlisting the final journals for literature review [21]. PRISMA approach is selected because it follows a systematic and rigorous method of shortlisting literature for robust review and reliable outcomes. The focus has been on the BDA, and hydrocarbon sector firm performance in India (primarily) based literature from various reputed journals.

For the literature review, major databases like ScienceDirect, SCOPUS, PROQUEST, and JSTOR were searched with various combinations of keywords “Big Data”, “Big Data Adoption”, “Big Data Analytics”, “impact”, “industry”, “India”, and “hydrocarbon sector”. Exclusions included options like non-English language and books.

Several steps were followed to finalize the relevant research papers for the Literature Review. Research Papers related to ESG [22], [23] [24] , Machine Learning [25], Big Data Analytics [26], [27], [28], [29], [30], [31], [32], from globally reputed journals were shortlisted for literature review, refer to Fig.1.

This literature review ground its analysis based on Dynamic Capabilities Theory (DCT) since it has direct link with organization innovation and performance with objective of sustainable business growth. Hence, DCT related literature [33], [34], [35], [36] were shortlisted for understanding the relation between BD technologies and dynamic capabilities (DC) of organizations.

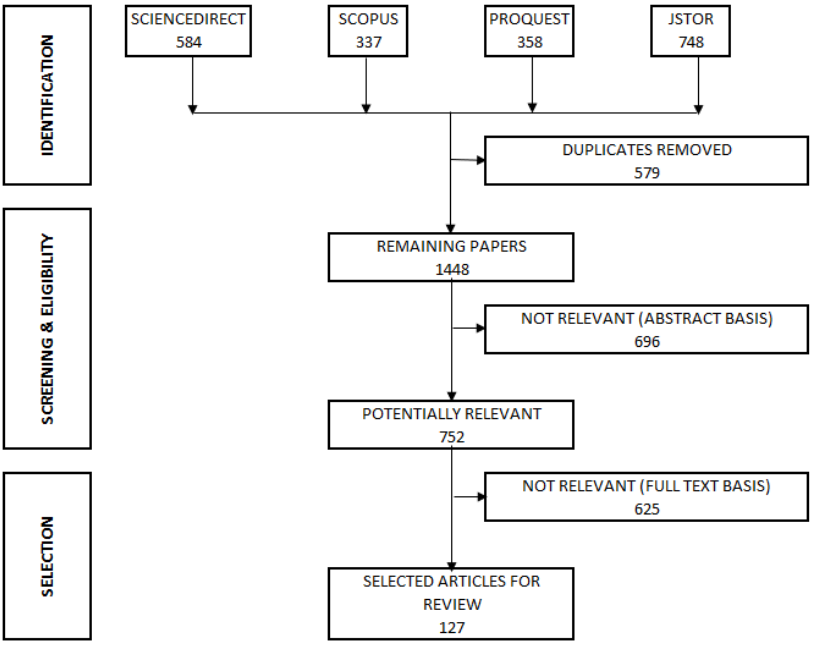

Figure 1: Steps for the Articles Selection Process

2.2 Distribution of Publication

This Literature review is based on the analysis of year-wise publication of research articles in Fig.2. Figure illustrates there is significant increase in number of research articles being published on BDA role in the global industry.

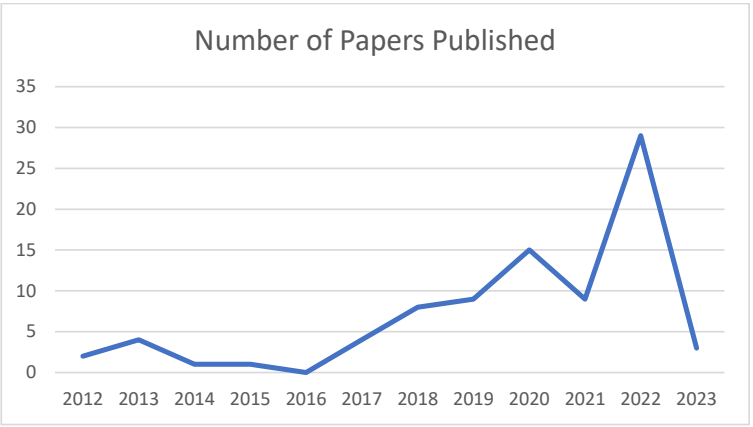

Figure 2: Number of Publications per Year

These articles are sometimes fully technical and beyond the scope of management studies. For this literature review, relevant articles concerning management studies have been shortlisted refer Fig.3.

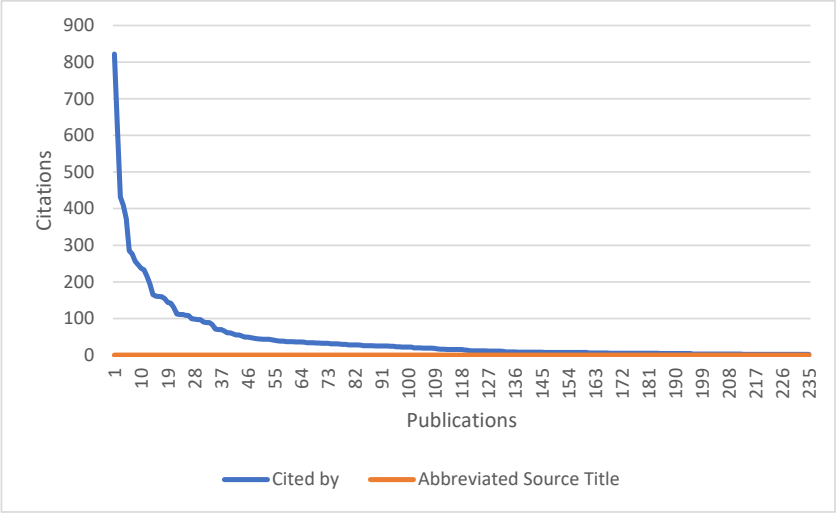

Figure 3 : Citations of the Literature Selected

BD adoption in various sectors related to articles published in the reputed international journals is shown in Fig.4. These articles highlight the significance of BD adoption, and steps being taken in the industries to increase productivity, operational efficiency, competitive advantage, and lowering future market risks.

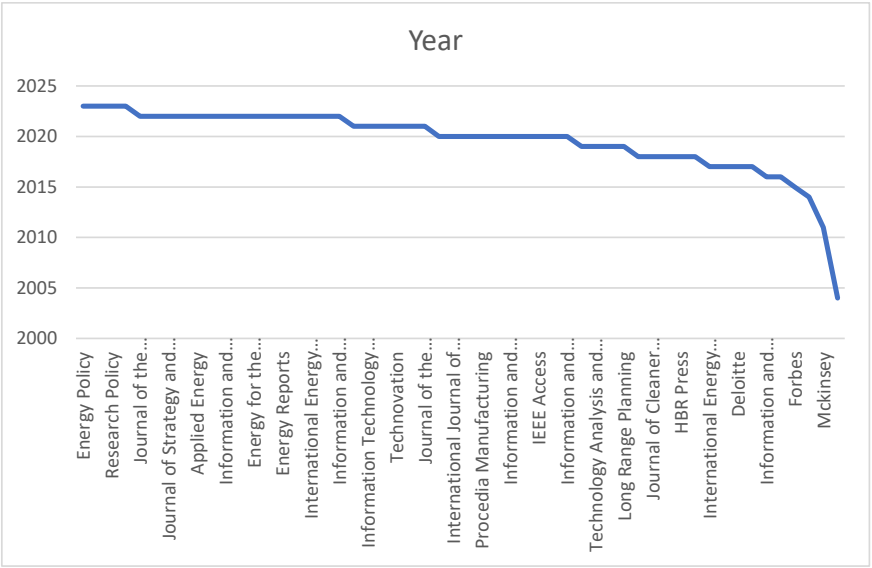

Figure 4: Journals shortlisted for Literature Review

Reviewed journals reflect various BD technologies being adopted by international firms [37]. Fig 5 represents the various methods being mentioned in these globally reputed journals.

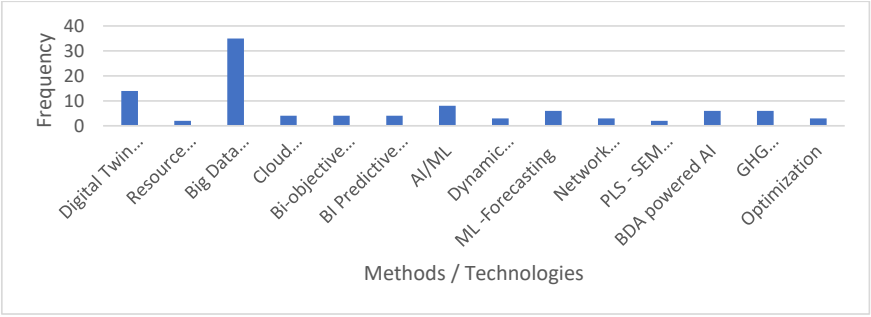

Figure 5: Methods / Theories / Technologies in Various Research Journals

The literature identifies various sectors and subject areas in which the adoption of BD is being studied around the globe. These are summarized in Fig 6, highlighting the major domain of various studies.

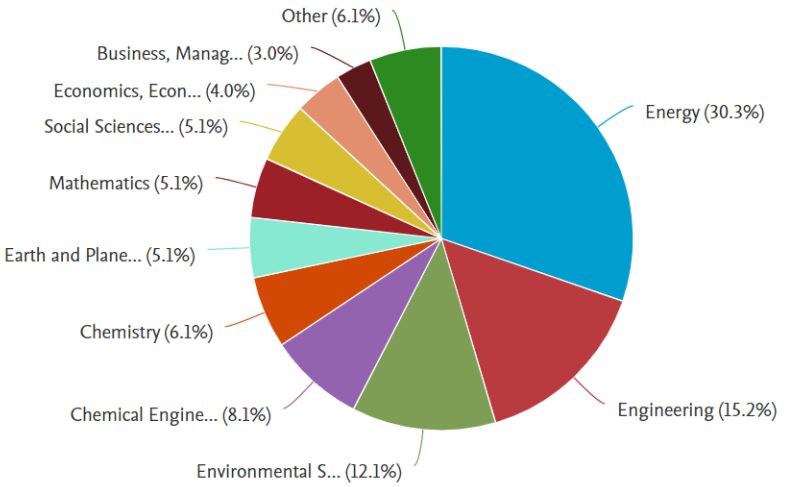

Figure 6: Big Data Application Area of Journals

Table 1 below presents the major hydrocarbon sectors areas where BDA adoption is impacting in their operations, health & safety risk management, and decision making.

Table 1 : Big Data Analytics in Hydrocarbon Industry

Hydrocarbon Industry	**Big Data Analytics Major Functions**
Upstream	Exploration & drilling data analysis [38]
	Surface engineering data analysis [39]
Midstream	Pipeline leak detection [40]
	Predicting maintenance [41]
Downstream	Energy efficiency improvement [42]
	Operational efficiency improvement [13]
	Downtime prediction
	Health, Safety, Environment risk management [43]

	Financial & Marketing decisions [44]

Literature shortlisted for this study was analyzed based on Title and Abstract word analysis, results in the seven number of clusters as shown below Fig. 7.

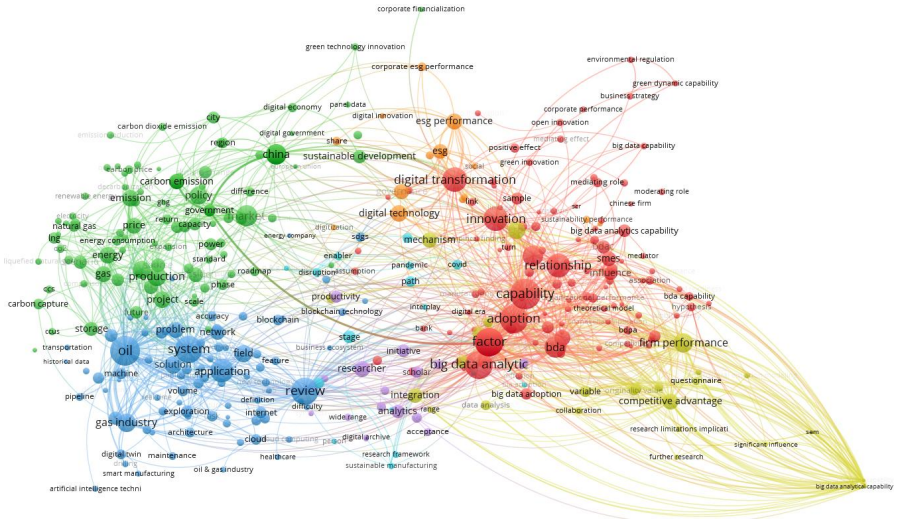

Figure 7: Title & Abstract Word Cloud

Fig. 8 below highlights the major keywords among the shortlisted literature for the review. Keywords like Big Data, Big Data Analytics, Firm Performance, Artificial Intelligence, Industry 4.0, digital transformation dominate over the other words in the word cloud.

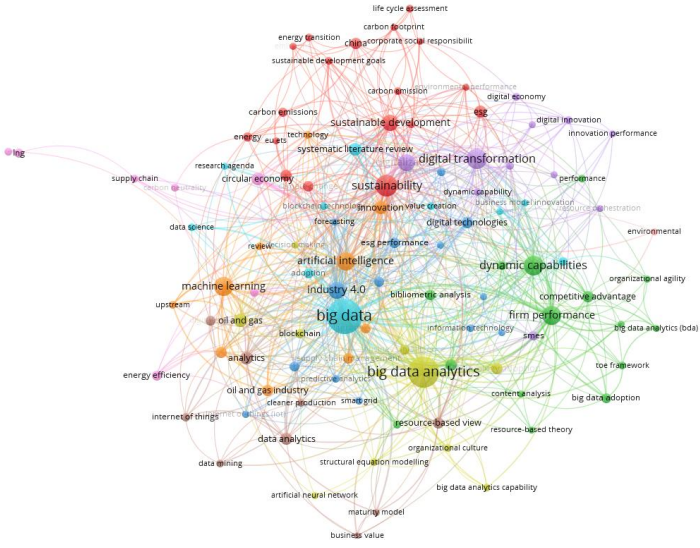

Figure 8: Keywords Word Cloud

Fig. 9 represents the co-author networking amongst the research papers used for this literature review. This network diagram indicates total eight clusters has been drawn through VOSviewer. Research papers mainly from 2010 to 2025 have been shortlisted for the review. Majority of the significant work is post 2020 which are relevant to the review objective.

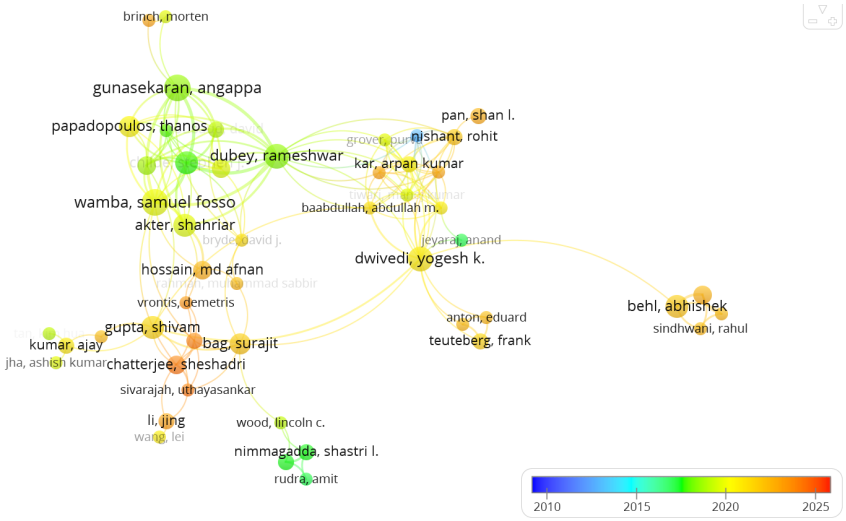

Figure 9 : Co-author Network Visualization

2.3 Big Data Adoption Literature and Research Gaps

There exists a large amount and variety of online and offline data from various industries. Industries are utilizing this data to predict the business and ways to mitigate the risks. Big Data [45] has been useful in the energy industry [46], [47], especially in the petrochemical and petroleum industry, to resolve financial and productivity issues.

BD driven models and text based analytics are helpful in effective crude oil price forecasting [12], which industry and importing countries may adopt to gain in their trade deals.

Insurance service firms [48] have been using BDA for building organizational capabilities and gaining a competitive advantage. Supply chain management [49], [50], as part of any industry, is using data to optimize its procurement and logistics processes.

Carbon emissions and pollution related environmental management [51], [52] concerns are being handled with BDA based solutions. Digital marketing [53] uses BDA capabilities for building competitive advantages over its market competitors.

BDA capabilities are being used for strategic business decision making [26] for sustainable business growth. Dynamic capabilities (DC) are enhanced by the adoption of BD, ultimately helping firms meet business objectives and opportunities [54]. BD and DC are related to each other for any organization. Organizations with DC have BD driven innovation, resulting in better prediction, helping strategic decision-making. It is evident that BD impact on the firm's digitalization priorities. BD gathered from more than one source improves the digitalization awareness of firms.

BDA may help firms perform better. DC play a mediating role in establishing BDA and firm performance, having a strong relationship [55]. BD and predictive analytics have a significant impact on manufacturing industries' production performance with sustainable consumption [56]. BDA and Predictive Analytics help managers to improve collaboration in supply chain networks. Oil and gas production prediction through linear regression model [57] and BD tools plays a significant role in the oil & gas industry.

BD adoption helps in the reduction of energy consumption and limits the emissions from manufacturing industries through the BD analytical framework. This can be applied in Pulp & Paper, Glass, Cement, Petroleum, Ceramic, Nuclear, etc. energy energy-intensive plants to limit emissions. Energy BD Acquisition and Energy BD Mining [58] are being used in the oil and gas industry.

BDA is useful in the healthcare sector [59], based on a theoretical framework using resource-based view (RBV) theory. BD resources are utilized to enhance organizational capabilities. BD adoption helps in technological improvements, healthcare organization process improvement, and research improvement. Firms' capabilities, which are market-directed, are enhanced by investment in BDA capability (BDAC). Investments in BD have enhanced the firm's performance [60]. Another theoretical framework is DCT i.e. adaption, integration, and reconfiguration of internal and external competencies in response to the rapidly changing environments by the organization. It inlcudes sensing opportunities and threats, seizing the opportunities through resource mobilization, and transformation of the the organization to maintain competitiveness.

Table 2 below identifies the research gaps from the key literature reviewed.

Table 2: Literature & Research Gaps

Objective	Theory Basis	Methodology	Geographies	Timeframe	Future Research Opportunities	Reference
Social performance and resilience in supply chain through through digitalization	Dynamic Capability	Quantitative method: Survey Data, PLS-SEM	France	Dec'21-Mar'22	Cross-sectional data-based empirical investigation. Longitudinal data for the long-term effect of digitalization on SPR.	[61]
Approaches to measuring Dynamic Capabilities (DC)	Dynamic Capabilities	SLR, Measuring DC from an empirical perspective	Global	Jul'1987-Dec'2017	Measuring DC based on dimensions of organization knowledge, learning, and technology	[62]
How do dynamic capabilities affect performance	Dynamic Capabilities	Scientific Procedures and Rationales for Systematic Literature Reviews (SPAR4-SLR)	Global	1996-2021	Research other than Individual, organization, and environment (IOE) levels as mediating variables.	[63]
Dynamic capabilities building and sustainable products	Dynamic capabilities	Qualitative - Gioia Methodology Case study of 19 firms using MAXQDA	Europe	2022	Focus other than electronics, automotive, and machinery manufacturing industry. Quantitative research is needed. Social	[64]

					and economic aspects of research other than environmental.	
Assessing the impact of Big Data analytics on forecasting, decision-making on firm performance	Resource-Based View, Dynamic Capabilities	Qualitative: Survey, PLS-SEM	India	2022	Collect longitudinal data, across the world. Build a Rival model for comparison.	[65]
Big Data Analytics and innovation impact on firms' decision-making processes.	Dynamic Capabilities	Qualitative: Survey, Covariance Based-SEM, purposive sampling method.	India	2023	Multidimensional constructs, moderating factors, and rival models can be considered.	[66]
Big Data Adoption research & challenges	Technology-Organization-Environment, and Diffusion of innovations	Shortlisted Articles published	Multiple	2015-2018	Impact of theoretical models on firm performance, selecting larger sample size for research.	[67]
Big Data impact on organizations' financial performance	Task Technology Fit Theory, Dynamic capabilities	Survey Data	USA	2023	The study should also focus on emerging economies Organizations; Big Data with dynamic capabilities like market, operational, and innovation capabilities is important to study the impact on financial performance; secondary data-based research is needed.	[3]
Big Data Analytics & firm performance, and effect of Dynamic Capabilities	Resource-Based View, Dynamic Capability Theory	Survey Data	China	2016	Further research is needed with panel data, objective measures study with BDA impact on firm performance, context-specific BDAC eg. Supply chain analytics, and customer analytics.	[55]

Big Data analytics, innovation, and dynamic capabilities in organizations	Dynamic Capabilities Theory	Survey Data	USA	2022	Survey data to comprise more than one employee per organization for rational data. The moderating effect of organizational (size, age, centralization, etc) and environmental contingencies (region, industry context, etc) are to be studied.	[68]
Big Data and dynamic capabilities relation to digitalization	Dynamic Capability Theory	Survey Data	Italy	2018	Only Italy-based organizations' data, need to be expanded to another part of the world. Panel data can be considered.	[69]
Importance of ESG	NA	Social Trading Platform Data	Global	2024	Trading behaviour, sustainability study on Social Media about ESG concerns on Climate	
Digital Transformation impact on ESG	Scale Effect Theory	Public Listed Companies Data	China	2022	Digital Transformation and achieving ESG Goals	
ESG Disclosure	Stakeholder Theory Legitimacy Theory	Theoretical	NA	2022	Block Chain , AI technology in ESG Disclosure	

Enterprises like Banks [70], [71], [72] are nowadays adapting BD Analysis to gain a competitive advantage and enhancing financial performance. Research findings indicate that DCT and resource-based theory (RBT) have different dimensions that directly and indirectly affect the competitive advantage. Literature presents various paths of resources and DC affecting competitive advantages like IT technology capabilities [73]. Recruitment of skilled resources and proper training will lead to the development of Information Technology capabilities. Progressively, BDA capabilities will directly and positively affect the dynamic capabilities, resulting in a competitive advantage.

Literature highlights the challenges faced by organizations and how to drive digital strategy to excel in business [74]. The main challenge of the digital transition is existing business management and building capabilities for the future. The New York Times and Adobe adapted the digital transition to build their capabilities for future business.

Researchers have tried to find out the contexts that may influence the adoption of BDA [75]. Findings from a structured questionnaire-based survey analysis indicated that the technological context, organizational context, and environmental context impact firms' adoption of BDA.

Bibliometric analysis of BDA adoption [76] highlights that the BDA adoption literature was published mainly in manufacturing, supply chain, service, and health care sectors. Literature addressed IT

capabilities for organizational agility, analytical tools providing real-time insight into the performance of firm decision making, safety management, data management, organizations' decision-making process, and statistical challenges with BD.

BDA adoption is well explained with the technology-organization-environment (TOE) model. Findings highlighted that determinants of technological and organizational elements are more dominant for BDA adoption among SMEs in Iran.

Dynamic resource capabilities related model was developed [55], using Resource Based View (RBV) and sociomaterialism theory. A relation between BDA infrastructure capability, management capability, technology management knowledge, BDA planning, and business knowledge was established.

Another study uses Resource Orchestration Theory (ROT) for the development of a BDA Model for air pollution management [77]. BD applications for sustainability have been well presented in terms of a framework.

A study of pollutant emissions from a multi-energy power generation related framework has been developed [78], providing a predictive model to make decisions regarding thermal power, renewable energy production for minimizing pollutant (CO2, SO2, NOx) emissions from this multiple energy plant.

BD based predictive analytics have a significant impact on collaborative performance in manufacturing industries for sustainable consumption and production [56]. Dynamic Capability view and Contingency theory have been studied for the Indian Auto components manufacturing organisation. It has been observed that the BDA and Predictive Analytics positively improve the collaboration in supply chain networks.

The Resource-Based View (RBV) Theory defines the VRIN resources i.e. valuable, rare, inimitable, and non-substitutable, provides the foundation for sustainable competitive advantage to the organization. Structured review of BDA in the health care sector [59] provides a theoretical framework using RBV theory. It presents big data resources that are utilized to enhance organizational capabilities. It identifies that future research can be in technological improvements, healthcare organization process improvement, and research improvement.

Dynamic and operational capabilities play a mediating role between BDA capability and competitive performance [79]. BDA may help a firm perform better. A BDAC Model was developed from qualitative analysis of 274 BD analysts in various firms. The findings highlight that there is a strong relation between firm performance and Big Data Analytics, with the mediating role of dynamic capabilities [55].

The investments in BD and interviews with 301 senior marketing managers' data were collected and analyzed. It indicates that the resource BD capability enhances firm performance [60]. Knowledge sources and activities can influence dynamic capabilities e.g. BDA capabilities [80]. It also highlights that social capital can enhance knowledge-based dynamic capabilities (KBDCs) in big data governance. Social factors like management capabilities, human resources, and organizational culture positively impact the business value more, in comparison to technical aspects [81] of business analytics.

2.4 Big Data Analytics and the Hydrocarbon Sector

Data management practices in the oil and gas upstream industry are leading the way in BD [82] but are still limited and practiced only by top global companies. As per the International Energy Agency Report 2022, Digital technologies can help reduce production costs by 10% to 20% in the oil and gas industry [83].

BDA Machine Learning techniques in the upstream and downstream O&G industry [84] have the utilization of BDA technology, handling large datasets with volume, variety, velocity, veracity, value,

and complexity. BDA has helped the oil & gas sector in improving the drilling time, drilling safety, optimization of process equipment, production allocation, oil & gas transportation, and Health, Safety & Environment.

The hydrocarbon industry is utilizing Digital Twin Simulation of the real-world data to improve productivity, minimize operating and capital costs, increase efficiency, health, and environmental safety, operational safety, and variability in oil and gas project life cycles [85] Literature evaluates opportunities and challenges of adopting BD technologies in the O&G industry 4.0 using BDA and Systematic Review [86]. BDA has an important role in the digitalization of the oil & gas industry. It helps in gaining operational efficiency, strategic decision making, production gains, mitigating risks, and safety at the workplace.

2.5 Big Data Adoption Hindrance Factors

The main factors affecting new technology adoption are environmental concern, technology awareness, openness to experience, and technology benefits [87]. Literature has identified, these factors positively affect consumers' desire to adopt new technology like green energy technology. However, factors like green energy technology, discomfort, and costs have negative impacts. Indian manufacturing and services sectors' BD adoption depends on factors like higher management support, organizational size, data management, market pressure, data privacy, complexity, and competitive advantage [4].

It has been seen that the firms are reluctant to adopt new technology. There are psychological factors like personality, attitudes, and motivation influencing technology adoption [88]. Hence, innovativeness, technology attitudes, and trust in the technology will influence a decision to adopt a new technology. Similarly, dynamic capabilities have a positive impact on the Indian manufacturing sector [89]. Subsequent sections highlight the various factors that are of main concern in BD adoption by various firms.

2.6 Technological Factors

Big Data Integration

BD technology, which handles large datasets, helps companies identify the digitalization factors to prioritize and recognize their competitive relevance [69]. Integration with the existing IT platform becomes complex. Hence, integration is a big challenge.

Big Data Quality

There is a need for clean and quality BD for further analysis. Hence, the companies must be able to collect and clean data for advanced data analysis to gain insights. Companies develop AI capability to use BDA to leverage volumes of data from a variety of sources. AI is being used to achieve sustainability by companies [90], [91]. AI has huge potential to add value to the BD ecosystem.

Decision Support

Firms leverage BDA capability as a decision support facility across functional and cross-functional processes like inventory management, forecasting, revenue management, risk analysis, and supply chain management [13]. Predictive Models help decision makers to avoid future undesirable events [92].

Extant literature evidences usage of BDA by a company empowers firms across levels and supports functional level performance [93]. BDA addresses concerns related to efficiency optimization [94] and

automation of work processes [27]. The majority of export and import countries utilize product price forecasting [12], for reserving the production quantity and maximizing cost benefit using BDA. Companies in emerging economies are utilizing big data and digital technologies to a limited extent in decision-making [95].

Perceived Cost

Many companies are still not using BD technologies in emerging economies due to cost. Sometimes they delay their decisions in utilizing BDA. In developed economies, BD technologies are being used on a grand scale with various BD cases in the healthcare sector [96]. It is necessary to study readiness, factors, process aspects, and performance impact are essential for studying the adoption of new technologies in any sector-specific research.

Services like data, advisory, safety, and security by Mastercard in 2010 accounted for 7% of the company's revenues, but now it's more than 25% [74]. It is possible only due to digital transition strategic moves. Hence, organizational readiness for new technology adoption matters and can help the organization reach on top.

Earlier, Goldman Sachs was working on the phone to deliver clients' products to meet their satisfaction level. Now, just like Google, Goldman is providing direct access to the platform to its clients. SIMON (platform for structured Notes) and Marcus (online consumer lending unit) were developed by Goldman Sachs, which has raised its revenues multifold since the 2008 financial crisis. Three broad phases of new technology adoption were: building a technology platform.

Hence, emerging economies organizations should learn from international firms and identify the comparative benefits of adopting BD technologies and building dynamic capabilities to overcome the costs incurred.

2.7 Organizational Factors

Infrastructure and Organizational Readiness

Organizational readiness for new technology adoption can be developed in various stages. These stages can progressively build the BDA capabilities of the firm. Identification of various resources is significant in the firm as per resource-based theory, combined to build BDA capability [97]. Resources can create an instrument to measure the BDA capability of the firm.

Organizations have many barriers to the implementation of BDA [98]. These barriers can be categorized as infrastructure & technology related, Organizational related, knowledge & skill related, management-related, financial, and data related. Reference literature highlights the Indian manufacturing industry, implementing BDA techniques and tools to remain competitive. Firms need to maintain sustained operations and performance through BDA technology in manufacturing industries.

Infrastructure should help in the adoption of BDA powered artificial intelligence for sustainable manufacturing practices [99].Further, Organizational readiness for new technology adoption is influenced by consumer attitude, perception, government policy implications, incentives for manufacturers, and enabling eco-system [100].

Top management Support

Organizational strategic decisions are governed by the goals set by top management [101]. Hence, any organization must adopt BD technologies with full support from its management and goals aligned with the business. Leadership plays a significant role in building firm-level capabilities towards BD value creation [102]. Competitive advantage is attained with the implementation of emerging technologies as per top management directives in the firm [48].

Skilled Resources

The Human Resource team of firms must organize periodical skill development training for the adoption of BD technologies in the organization. Existing human resource skills may not be adequate to use the latest BD tools and technologies [73]. Resources with knowledge, skill, and experience always act as a key to adopting new technologies for better firm performance [103]. It helps in upgrading the innovation capabilities of the firm in the long run.

Firm Size

Small and medium-sized firms normally fail to adopt BD technologies due to various cost-benefit analyses and factors [104]. Hence, it should be identified by firms in advance to gradually move towards digitalization to maximize business growth. Technological innovations of the firm are related to the firm size [105]. It was found that the number of innovative firms increases with the firm size.

2.8 Environmental Factors

Competitive Pressure

Organizations are under constant pressure to upgrade and enhance their decision-making capabilities [106] through the adoption of digital technologies. Firms understand the need for BD technologies through their peers in the market [107].

Government Policy and Support

Socioeconomic characteristic factors influence the adoption of new technology eg, electric vehicles [108]. Adoption of electric vehicles is growing rapidly in countries like Germany, Sweden, the Netherlands, China, and France. However, adoption growth in Italy, Greece, New Zealand, and Switzerland is slower. There are institutional pressures, government regulations, and policies that positively impact firms to adopt BD technology for sustainable growth [109]. The Indian government is using BD for unique identity number generation for each citizen and public policy implementation [110].

Cybersecurity

Organizations are facing cybersecurity challenges [111], hence they are cautious about the usage of BD technologies, which may pose threats to their IT systems from international cyber attacks. Hence robust network of tools and technologies should be in place before adopting BD technologies, especially in emerging economies.

2.9 Enablers of Big Data Adoption and Building Dynamic Capabilities

Impact on Decision-Making Processes

BD technologies have a positive impact on decision-making [112]. Tools like Interactive Digital Twin (InDiT) help decision-makers through step-by-step communication with the help of visual aids.

Decision-making processes get support from predictive analytics. This helps plan the required workforce and idle time of operations. Such tools can help in decision-making regarding personnel deployment during plant shutdown and maintenance, which are part of the manufacturing industry.

Implementation of financial analysis tools that can directly give information on return on investment, payback period, cost-benefit analysis, NPV, etc, can be helpful in decision-making in the industry. There are existing traditional methods of financial analysis that help in decision-making and strategic project management in the manufacturing sector [113]. Advanced BDA capabilities may directly indicate financial analysis results for easy reference to decision-makers.

Impact on Performance

For the organizations' competitive advantages, BDA's capabilities generate superior business performance. Value creation mechanisms are implemented by the BDA approach [114]. Value creation mechanisms like transparency, access, discovery, and proactive adaptation, and their relationship with targets like business performance, business process improvement, and product and service innovation. Transparency mediates the relationship for all the value targets.

Considering mediating roles of dynamic and operational capabilities, there exists a relationship between BDA capability and competitive performance [79]. Operational capabilities like marketing and technological mediating BDAC and competitive performance have been useful for organizations [36]. Resource-based view and dynamic capabilities highlight that BDACs enable firms to generate business insight to help in their marketing and operational capabilities.

Applying the knowledge-based view and contingency theory, it has been found that BDA influences market performance and is dependent on competitive intensity and disruptive business models [115]. However, when the competitive intensity increases, this positive effect is strengthened. These findings can help organizations maximize their market share and increase the value of returns from BDAC investments. Research related to green process innovation in the manufacturing sector using BDAC [116] has established the relationship between the scale of the organisations with respect to green process innovation.

Digital transformation has a positive impact on corporate performance [117] in manufacturing companies. There is huge potential scope for implementing BDA in the hydrocarbon sector in the areas of carbon capture, enhanced oil recovery (EOR), offshore platforms, subsea pipelines, drilling wells, Liquified Natural Gas (LNG) production, and Refineries [118], [119].

Big Data Adoption and Dynamic Capabilities

It has been found that BD capabilities with dynamic capabilities can be influenced through activities and knowledge sources [80]. DCT is based on Sensing, seizing, and transformation, which is ultimately linked with business performance. DC with BD technology confirm the direct and indirect impact on the firm's performance [55].

DCT indicates that BDAC enable firms to reposition in the changing business environment [36]. Firm's dynamic capabilities and operational capabilities are renewed by strong BDAC.

Dynamic Capability Theory in Various Innovation Adoption

Ordinary capabilities are doing things right in an organization, but dynamic capabilities mean doing the right things [120]. Innovation is significantly impacted by technological capability in an organization [34]. To lead the expansion of innovation capabilities, the organization needs to apply dynamic capabilities [121]. Firms are using a dynamic capabilities approach through digital transformation and mobile app implementation for their organizations. Dynamic capabilities like adaptation and innovation can be utilized to achieve sustainable business growth and competitive advantage [122]. Hence, to gain a competitive advantage, managers must pay attention to both adaptation and innovation for firms to advantage over others in similar domains.

3. Discussion

3.1 Contribution to Academia & Industry

Hydrocarbon Sector Readiness Assessment: The research will offer a comprehensive assessment of the hydrocarbon sector's readiness for adopting BDA, highlighting areas for improvement and potential challenges.

Sector-Specific Adoption Decision Insights: The study will provide sector-specific insights into the factors influencing the adoption decision-making process in the hydrocarbon industry.

Impact on Decision-Making Processes: The research will analyze how BDA integration transforms decision-making processes within oil and gas companies, providing actionable insights for decision-makers.

Performance Improvements Analysis: By evaluating the performance improvements achieved through BDA adoption, the study will quantify the impact on operational efficiency, cost-effectiveness, and sustainability in the hydrocarbon sector.

This research endeavours to contribute valuable knowledge to the hydrocarbon sector by evaluating the readiness for BDA adoption and its impact on monitoring and reduction of carbon emissions from digital transformation technologies. The findings will enable oil and gas companies to make informed decisions about adopting BDA, ultimately leading to enhanced operational efficiency and sustainability in the hydrocarbon sector.

3.2 Scales to Measure the Big Data Adoption Impact

Post literature review, we have identified the following major scales to measure the impact of BDA usage on companies in emerging economies.

Organizational Readiness: This scale will assess the level of organizational preparedness for adopting BDA. It includes dimensions such as technical infrastructure, data governance, employee skills, leadership support, and organizational culture. Based on the Dynamic capabilities-based data analysis, these factors are used for the assessment of BD Analytics' impact on firm performance [55]. There is research considered for BDA analysis on firm performance [81].

Adoption Decision Factors: This scale will measure the factors influencing the decision to adopt BD technology. It will include dimensions such as perceived benefits, perceived risks, financial constraints, regulatory compliance, and competitive pressures.

Decision-Making Transformation: To assess the impact of BDA on decision-making processes, this scale will capture changes in decision-making speed, accuracy, cost-effectiveness, and alignment with strategic goals.

Performance Evaluation: This scale will measure the performance improvements achieved through the adoption of BDA in the hydrocarbon sector. It will include metrics related to operational efficiency, asset performance, cost reduction, and sustainability outcomes. Participants will provide quantitative data to evaluate the improvements.

4. Limitations

Based on the literature review, it was identified that the literature related to the comparative study of applying BDA and dynamic capabilities in industry is limited.

Literature is available regarding BDAC and market-directed capabilities, decision strategy, and their effect on firm performance [60]. However, these are limited to large US-based firms working in B2C. Secondly, the data used in multiple research studies were cross-sectional; hence causal relationship couldn’t be established. There is limited research on emerging economy-based companies like India. Cross-sectional data-based research can be replaced with panel data to investigate the stability of the findings, like BDAC's impact on firm performance [55].

Studies are available for limited manufacturing industries like automotive, using exploratory qualitative methods rather than quantitative methods to measure organizational growth or performance. Ordinary

capabilities' interaction with dynamic capabilities for environmentally sustainable product development over time needs to be explored further with the adoption of BD technologies [123].

More research related to all three sustainability aspects, environmental, social, and economic, to support firms on their sustainability journey [64] is needed. There are limitations in applying BDA due to cybersecurity issues in various manufacturing sectors [124]. Still, there need for better data privacy protection and improved supply chain BD technologies for usage by manufacturing companies globally. Future work should focus on integrating BD with other advanced technologies under one environment.

Air Pollution management using BD [77] indicates BDA application in the social domain. A similar framework for air pollution management for polluting sectors of industry needs to be explored. Further, literature related to BDA in the clean energy sector for exact measurement on a real-time basis for demand and supply, forecasting for adequate needs of the citizens, is also limited.

It has been found that the assumptions and findings of the dynamic capabilities literature in developed markets may not be equally valid for emerging/developing markets. Further Web of Science database for literature review can be used, including word searches like AI/ML applications in developing dynamic capabilities models in emerging economy companies.

5. Implications

5.1 For Theory Development

Based on this literature review, it is evident that BD technology adoption has a direct influence on the dynamic capabilities [125] of the organization, which will impact firm performance. These are essential for emerging economies. This literature review highlights the dynamic capability theory, which helps organizations inculcate competitive advantages [126] over others. This study offered general adoption and decision insights through several research areas publications in the last ten years. These sector-specific insights are related to the factors influencing the adoption as well as decision-making [127] using BD technology and dynamic capabilities in the industry.

5.2 Business and Management Practice

This study, through various literature, provides the BD technology usage impact on decision-making processes by the organization's business management. It implies that BDA integration transforms decision-making processes within various domains of companies [128], providing actionable insights for decision-makers.

The performance improvements [63] achieved through BDA adoption by the companies can be measured and quantified to determine the impact on operational efficiency, cost-effectiveness, and sustainability in the environmentally challenged sector.

6. Future direction

Future research may involve other specific sectors like healthcare, IT, Banking, tourism, environment, and academic institutions from emerging economies. Future studies may collect data to assess the BDA usage impact on an organization's decision-making quality [129], BDA capability, and correlations between these variables [60]. Literature can be shortlisted from other databases like SCOPUS and Web of Science.

There can be a detailed analysis of results for the Firm's performance based on the quantitative data collection by survey [69]. Despite the popularity of BD technology, some of the firms that have not benefited from its usage may also be analyzed [130] for emerging economy companies.

7. Conclusion

Based on the extant literature review, it can be summarized that the BD adoption by emerging economy companies [8], firstly shall lead to improved decision-making, by providing insights that inform strategic decisions, leading to better outcomes; secondly, enhance customer understanding, which helps firms understand customer behaviour, preferences, and needs; thirdly Increased operational efficiency, which optimizes processes, reduces costs, and improves productivity; and fourthly, innovation, which enables firms to develop new products, services, and business models.

Dynamic Capabilities positively impact the firm's performance in terms of adaptability, i.e., allowing firms to respond to changing environments [131] and customer needs; secondly, innovation, i.e., facilitating the development of new products, services, and business models. Thirdly, competitive advantage, i.e., helps firms differentiate themselves and establish a competitive edge [132]; and finally, resilience, i.e., enables firms to adapt and recover from disruptions and crises [133].

The overall impact on Firm Performance with BD adoption and dynamic capabilities can be summarized prominently as improved financial performance with increased revenue, profitability, and market value [134]; secondly, enhanced competitiveness with a better position to compete in today's fast-paced business environment [80]; thirdly, increased innovation which drives innovation, leading to new products, services, and business models [135]; and finally, better decision-making i.e. strategic decisions, reducing risks and improving outcomes [8].

Hence, companies based out of emerging economies must adopt BD technologies and dynamic capabilities. These are essential for firms to remain competitive, innovative, and resilient in today's rapidly changing business environment. By leveraging BD and developing dynamic capabilities, firms can improve their performance, drive innovation, and establish a sustainable competitive advantage.

This research endeavours to contribute valuable knowledge to emerging economy companies by evaluating the readiness for BDA adoption and its impact on decision-making processes. The findings will enable companies to make informed decisions about adopting big data technology, with dynamic capabilities enhancement, ultimately leading to higher firm performance.

BDA can help the Indian hydrocarbon sector, leading to low low-carbon economy [136], which India has declared to meet Net Zero by 2070. Path forward in this direction needed like skill enhancement of resources in BD technologies, data-driven decision-making skills, implementation of BDA in upstream, midstream, and downstream of hydrocarbon sectors in India to mitigate the operational and capital risks. Future research can also be related to the implementation of generative AI in handling supply chain management and marketing areas of the hydrocarbon industry in India.

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