Tech Business Analytics in Quaternary Industry Sector

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ABSTRACT

Purpose: *The knowledge-based segment of the economy is referred to as the "quaternary sector," which comprises businesses like information technology, telecommunications, research and development, and other professional services. Businesses in this industry may find that technology-driven business analytics greatly aids in helping them to make data-driven decisions, optimize workflows, and enhance overall performance. Utilizing technology to analyse business analytics can significantly improve market trends, consumer behaviour, and an organization's operational performance. Through analysis of this data, companies can make more informed decisions that support expansion and competitiveness. Analytics tools assist companies in identifying inefficiencies in their processes and operations so they can make changes that reduce expenses, boost output, and ultimately boost revenue. Customer loyalty and satisfaction may rise as a result of this. Information regarding emerging technologies and their integration with data science and business analytics may support to prediction of market trends and could present companies with chances for growth and innovation.*

Methodology: *There are particular potential and challenges for business analytics in the Quaternary industry sector because of its emphasis on knowledge-based activities, innovation, and cutting-edge technology. Here, we present a methodical strategy for using technology for analytics in this industry, allowing businesses to obtain useful information for long-term planning calculations. This approach gives businesses in the Quaternary industry sector a methodical framework for utilizing technology-driven analytics. This framework helps them obtain competitive advantages in an increasingly data-driven business environment by helping them access important insights and spur innovation.*

Findings/Result: *The study looks at how digital business analytics have been used to control growth in the Quaternary sector from the birth of the industry to the present.*

Originality/Value: *An explanation of how tech business analytics differs from traditional business analytics within the Quaternary industry. It also includes a general design that can be used for technical purposes, and it examines thirty recently submitted research recommendations related to Tech Business Analytics in Quaternary industries.*

Paper Type: *Exploratory research.*

Keywords: Business Analytics (BA), ICCT underlying technologies, Tech-Business Analytics, TBA, Industry Performance, Data Science, Big Data Analytics, Research gap in Business Analytics, ABCD Listing, Service industry, ABCD Analysis, Quaternary Industry Sector.

1. INTRODUCTION :

Quaternary industry sector activities are knowledge-based and employ highly skilled staff and state-of-the-art equipment. Business analytics powered by technology is becoming a vital tool for companies

looking to expand and maintain their competitiveness in the ever-changing global market. The application of data, statistical and quantitative analysis, and predictive modelling tools to understand how businesses function and how their customers behave is known as technology-driven business analytics. Through sophisticated data analysis, businesses may spot patterns, trends, and anomalies in massive, complicated data sets that would be challenging to spot using more conventional techniques. Application areas for technology business analytics in the Quaternary industry sector include operations, finance, marketing, customer service, and research and development. Analytical tools can be used by businesses to understand customer preferences, spot areas for process optimization, and forecast consumer behaviour and market trends [1].

Thanks to technology-based business analytics, companies in the Quaternary industry can now make data-driven decisions that improve customer satisfaction, boost productivity, and cut expenses. Companies that employ innovative analytics technologies and procedures can gain a competitive advantage in the worldwide market and hold the top spot in their sector. In general, technology-based business analytics has grown to be a vital resource for companies in the Quaternary sector, giving them insight into their operations and the power to make choices that will fuel their growth and success [2].

1.1 About Quaternary Industry sector and its Importance:

In a society that values knowledge-based innovation and its production, application, and transmission, the quaternary industry sector represents the highest degree of economic activity. It is an arm of the university system that offers banking, medical, and educational services. Research and development, innovation, technology advancement, and information services are all part of the Quaternary sector. Because of its profound impact on economic expansion and job creation, it is frequently referred to as the cornerstone of modern economies [3].

Technology innovation, which has transformed how businesses function and engage with their customers, has been the driving force of the Quaternary industry. Product and service innovation, operational effectiveness, and customer pleasure all depend on this industry.

Contributing to a nation's total economic growth is one way to measure the significance of the Quaternary industry sector. Long-term economic growth and competitiveness are seen to be driven by it. In general, robust Quaternary industries are associated with higher levels of innovation, productivity, and overall economic growth [4].

The quaternary industry not only offers very lucrative prospects to proficient individuals but also facilitates the advancement of a knowledge-driven community. While companies in this sector typically place a high value on social and environmental responsibility, it also plays a critical role in advancing social and economic advancement. In general, the Quaternary industry sector considerably aids in the advancement of innovation, economic prosperity, and societal growth. It is an essential part of the contemporary global economy and will have a significant effect on future economic growth and productivity as well as the evolution of society and industry [5].

2. EFFECT OF ADVANCES IN TECHNOLOGY IN QUATERNARY INDUSTRY SECTOR :

To create and provide innovative goods and services, the Quaternary industrial sector mostly relies on technological advancements. Consequently, the industry has benefited from the new chances that technological advancements have given it to expand and innovate. The increasing ubiquity of digital platforms and services is one of the most significant implications of technological advancements in the Quaternary industrial sector. Artificial Intelligence, cloud computing, and big data analytics have completely changed the way businesses run. By managing and analysing massive amounts of data in real-time, these technologies can gain fresh insights into the tastes and behaviour of their customers. Increased client happiness and loyalty are a result of companies' capacity to provide more personalized experiences [6].

The growing importance of data privacy and cybersecurity is another way that technology has changed the Quaternary business sector. Businesses must safeguard their data and systems from cyberattacks and other security risks due to the growing prevalence of digital platforms and services. Consequently, modern technologies and protocols have been developed to safeguard data and shield systems from malicious users. Within the Quaternary industry area, technological advancements have also resulted in the development of new goods and services. As an illustration, the Internet of Things (IoT) has made it possible for companies to develop networked devices and systems that can rapidly gather and analyse

data, opening new possibilities for development and innovation. The Quaternary industry area has benefited from technological advancements, which have created new avenues for expansion, creativity, and consumer involvement. Businesses in this industry will need to constantly innovate and adapt as technology develops to stay ahead of the competition and satisfy shifting consumer needs [7].

2.1 Effect of ICCT including Business Analytics in Quaternary Industry Sector:

Businesses in this sector have seen substantial effects from the combination of business analytics and information and communication technology (ICT) in the quaternary industry sector. The use of ICT and business analytics has transformed how businesses function by allowing them to handle and analyse massive volumes of data in real-time and gain fresh perspectives on the behaviour and preferences of their clientele. As a result, there are now more chances for expansion, creativity, and a competitive edge. ICT and business analytics have had a significant impact on the Quaternary Industrial Sector, with the capacity to provide clients with more individualized experiences being one of their main effects. Businesses can use data analysis to better understand the preferences and wants of their customers, allowing them to design tailored goods and services that better satisfy those demands. Improving customer satisfaction and loyalty can lead to more sales and a larger proportion of the market. Moreover, the Quaternary Industrial Sector has profited from improved productivity and streamlined business procedures. Businesses can employ new protocols and technology to boost productivity and save costs by identifying inefficient regions through the analysis of operational data. Increased profitability, a quicker time to market, and better output could result from this. The Quaternary Industrial Sector has also seen the creation of new goods and services using IT and business analytics. Thanks to the advancements in cloud computing and big data analytics, businesses may now develop new data-driven services that can offer clients real-time insights and recommendations. Combining ICT and business analytics has typically given the Quaternary Industrial Sector new chances for expansion, innovation, and competitive advantage. Businesses in this industry will need to constantly innovate and adapt as technology develops if they want to stay ahead of the competition and satisfy changing consumer demands [8].

3. OBJECTIVES OF THE PAPER :

(1) To discuss the importance of technology in Quaternary Industry Sector
(2) To evaluate the concept of Tech-Business Analytics in Quaternary Industry Sector
(3) To review the model of Tech-business Analytics in Quaternary Industry Sector
(4) To analyse concept and model in Tech-business Analytics in Quaternary Industry Sector.
(5) To study the Advantages, Benefits, Constraints, and Disadvantages of Tech-business Analytics in Quaternary Industry Sector using ABCD analysis framework.
(6) To compare TBA in Quaternary Sector with respect to Primary Sector, Secondary Sector and Tertiary Sector.
(7) To predict the impact of Tech -business Analytics on Efficiency of Quaternary Industry Sector.
(8) To review suggestions in the form of postulates.

4. REVIEW BASED RELATED RESEARCH WORK :

It is reviewed here that all technologies related to Tech- Business Analytics w.r.t. quaternary sector with different sections and different research papers from google scholar search engine.

Table 1: Business analytics in quaternary industry

S. No.	Area	Issue	Outcome	Reference
1	Information, communication, and computation technology is the industrial sector's strategic tool (ICCT).	Potential applications of ICCT and its ten core emerging technologies—cloud computing, digital marketing, artificial intelligence, big data & business analytics, 3D printing, internet of things,	To help a variety of primary, secondary, tertiary, and quaternary enterprises thrive, grow, stand out, and adapt, the focus is on how ICCT can be strategically applied.	Aithal, P. S. (2019). [1]

		ubiquitous online education, optical computing, storage technology, virtual & augmented reality—are investigated.		
2	Novel Development, Distinguishing, Sustaining, and Domination of ICCT as an International Technology.	The ten core emerging technologies of ICCT—digital marketing, cloud computing, artificial intelligence, big data & business analytics, 3D printing, internet of things, online ubiquitous education, optical computing, storage technology, and virtual & augmented reality—as well as their potential applications are examined.	This article primarily focuses on the tactical applications of ICCT for business model creation, differentiation, and endurance. Lastly, projections and discussions on the various advancements in the underlying technologies mentioned earlier, together with the anticipated timeline for these developments, are held.	Aithal, P. S. (2018). [2]
3	An Account of Information, Communication, and Computation Technology's Industrial Applications (ICCT)	A recently constructed predictive analytic model is used to explore, assess, and forecast the developing patterns of applications of the ICCT's underlying technologies across the primary, secondary, tertiary, and quaternary industrial sectors of society.	An overview of ICCT's uses in various primary, secondary, tertiary, and quaternary organisations is given.	Aithal, P. S. (2019). [3]
4	Technology supporting the creation of digital services is provided by the ICCT management.	Because it can address a wide range of issues related to basic requirements, contemporary desires, and aspirational aims in human civilization, digital technology is seen as universal and all-purpose.	Applications for the ICCT underlying technologies may be found in several well-known service industry sectors, and this article looks at how tertiary sector firms manage the utilisation of these technologies for digital service innovation.	Aithal, P. S., et al. (2019). [4]
5	Using the basic technologies of ICCT and state-of-the-art digital services.	Potential innovations in the service industries are considered based on the key ICCT underlying technologies that are emerging as 21st-century technologies: the Internet of Things, digital marketing, blockchain technology, robotics and artificial intelligence, big data and	Forecasts and assessments are conducted regarding how tertiary sector firms would handle the utilisation of ICCT underlying technology for digital service innovation. Applications for ICCT underlying	Aithal, P. S., et al. (2019). [5]

		business analytics, cloud computing and storage, 3D printing, online ubiquitous education, optical computing, information storage technology, virtual and augmented reality.	technologies are discovered in various significant service industry sectors.	
6	Ideas and potential applications of green nanotechnology.	Progress in nanotechnology, a transdisciplinary frontier technology that may be used to creatively solve problems in the primary, secondary, tertiary, and quaternary industrial sectors, has been slow because of possible concerns regarding the technology's nontoxicity.	In this piece, we address the possibilities for green and environmentally friendly nanotechnology in the 21st century to help achieve a few goals, including the Sustainable Development Goals (SDG).	Aithal, S. et al. (2021). [6]
7	An analysis of the relationship between the ICCT's core technologies and related, up-and-coming research areas, with a focus on cyber security and forensic science.	As a result, the foundational technologies of ICCT are seen as emerging technologies of the twenty-first century, having the potential to transform the way the current human generation becomes a tech-generation and to alter the way many industrial and societal problems are now solved.	It is addressing new research possibilities in primary, secondary, tertiary, and quaternary industries that leverage a mix of two or more ICCT underlying technologies, with a focus on cyber security and forensic science.	Aithal, P. S., et al. (2020). [7]
8	The opportunities and difficulties facing ecologically friendly nanotechnology in the twenty-first century.	Technology can be utilised to solve issues and improve people's quality of life, but when misused, it can also have unfavourable consequences.	Employing sustainable and ecologically friendly nanotechnology as a component of 21st-century universal technology, it tackles the difficulties and possibilities of accomplishing the global SDGs in addition to far more.	Aithal, P. S., et al. (2022). [8]
9	The characteristics, implications, and implications of the online economy that is digital, quaternary, or 4.0.	The rapid advancement of information technology is causing a dynamic shift in the global economy. The emergence of smart manufacturing, driverless cars, smart e-commerce, and related technologies is upending not just the IT sector but also other economic sectors.	Examined is the governance of the quaternary economy, thin globalisation, and pertinent regulatory challenges of our digital age.	Cooke, P., et al. (2019). [9]

10	Information, communication, and computer technology (ICCT) is a driving force behind the development of global technology for social change.	A comfortable lifestyle can be achieved by using technology as a tool to alleviate various societal issues. Since the dawn of time, technological advancements have been made. There have been many technical generations that have elevated people's standards of comfort and fundamentally changed society.	Future opportunities and difficulties, as well as applications in the manufacturing and service industries to transform them into Intelligent Manufacturing Industries (IMI) and Intelligent Service Industries (ISI), respectively.	Aithal, P. S., et al. (2020). [10]

Table 2: ICCT in quaternary industry

S. No.	Area	Issue	Outcome	Reference
1	Industry uses information, communication, and computation technology (ICCT) as a strategic tool.	Information, communication, and computation technology (ICCT) and nanotechnology (NT) have been highlighted as two universal 21st-century technologies that, by satisfying both the most fundamental needs and the most ambitious goals of humanity, are predicted to make substantial advances.	It focuses on how different primary, secondary, tertiary, and quaternary enterprises can expand, remain unique, and survive by strategically utilising ICCT.	Aithal, P. S. (2019). [11]
2	A summary of the industrial applications of information, communication, and computer technology (ICCT).	The potential applications of ICCT as well as the ten key emerging technologies upon which it is built are examined: artificial intelligence, cloud computing, digital marketing, internet of things, big data & business analytics, 3D printing, online ubiquitous education, optical computing, storage technology, virtual & augmented reality, and cloud computing.	The underlying technologies of the ICCT are examined, assessed, and projected using a recently created predictive analytic model to illustrate the evolving patterns of applications in the primary, secondary, tertiary, and quaternary industrial sectors of society.	Aithal, P. S. (2019). [12]
3	The Development of ICCT as a Universal Technology for Monopoly, Development, Survival, and Differentiation.	Information, communication, and computing technology (ICCT) and nanotechnology (NT) are two ubiquitous 21st-century technologies that have recently become known. They are projected to dramatically progress society by meeting both basic requirements and more extravagant aspirations and expectations.	ICCT as a strategic instrument for the growth, distinctiveness, and longevity of numerous corporate models.	Aithal, P. S. (2018). [13]
4	The technology needed to	Several notable instances of published research on the	Applications for the ICCT underlying	Aithal, P. S. et al. (2019).[14]

	facilitate the creation of digital services is supplied by the ICCT management.	subject, as well as some traits of a high-quality digital service. A few noteworthy underlying technologies of ICCT that are becoming 21st-century technologies are thought to be potential innovations in these fields: digital marketing, cloud computing and storage, big data and business analytics, artificial intelligence and robotics, 3D printing, the Internet of Things, ubiquitous online education, quantum computing, information storage technology, virtual and augmented reality.	technologies may be found in several well-known service industry sectors, and this article looks at how tertiary sector firms manage the utilisation of these technologies for digital service innovation.	
5	Technologies based on ICCT are being used to deliver innovative digital services.	How well a digital service performs is determined by several quality characteristics. Several significant ICCT underlying technologies are beginning to emerge as 21st-century technologies: 3D printing, online ubiquitous education, artificial intelligence and robotics, big data and business analytics, blockchain technology, cloud computing and storage, digital marketing, Internet of Things, optical computing, information storage technology, virtual and augmented reality. Potential advancements in the service industry are being explored with these technologies.	ICCT underlying technologies have found applications in several of the main service industry sectors, and forecasts and analyses are conducted regarding the management of ICCT underlying technology utilisation strategies for digital service innovation in tertiary sector businesses.	Aithal, P. S., et al. (2019). [15]
6	Investigating the relationship between the technologies that support ICCT and related new research opportunities, with a focus on forensic science and cybersecurity.	The basic technologies of ICCT are seen as emerging technologies of the twenty-first century, with the potential to completely transform the way society and corporations approach a wide range of problems. Not only that, but they'll replace the existing human generation with the tech-generation, ushering in a new era of technology.	It incorporates two or more ICCT basic technologies focusing on cyber security and forensic science in the primary, secondary, tertiary, and quaternary sectors.	Aithal, P. S. et al. (2020). [16]
7	The current state of blockchain technology and its prospects for	With potential uses in primary, secondary, tertiary, and quaternary industry sectors, blockchain technology is one of the forefront fundamental	Research gaps, ideal state, and optimum state are highlighted regarding the implementation of	Aithal, P. S., et al. (2021). [17]

	future medical research.	technologies of Information Communication and Computation (ICCT) of the twenty-first century. We have selected and examined a few possible uses to show how blockchain technology may help the healthcare sector.	blockchain technology in various healthcare application sectors. There is also a long list of potential study subjects.	
8	Basics and applications of sustainable and green nanotechnology.	While there is a universal consensus that nanotechnology can improve people's lives and address issues, there are dangers and hazards associated with its use. Some of the 17 Sustainable Development Goals (SDG) that must be accomplished by 2030 can be helped by the appropriate use of nanotechnology.	Sustainable development goals cannot be achieved without ecologically safe and green nanotechnology technologies.	Aithal, S., et al. (2021). [18]
9	Analysing ICCT Underlying Technologies' Function in Environmental and Ecological Management.	Many approaches to solving environmental problems can be implemented with the help of technology. Both nanotechnology (NT) and information, communication, and computation technology (ICCT) are innovative fields that are creating all-purpose technologies with the ability to handle a wide range of social issues successfully and creatively. These technological advancements may be able to support resilient life forms by regulating the planet's natural and ecological settings.	The use of ICCT's underlying technologies in environmental and ecological management, as well as the technology's prospective contribution to ecological management, are investigated using a qualitative ABCD analysis methodology.	Aithal, P. S., et al. (2022). [19]
10	Information, communication, and computer technology (ICCT) is a driving force behind the development of global technology for social change.	A comfortable lifestyle can be achieved by using technology as a tool to alleviate various societal issues. Since the dawn of time, technological advancements have been made. There have been many technical generations that have elevated people's standards of comfort and fundamentally changed society.	Information, communication, and computation technology (ICCT), one of the major technological generations of the twenty-first century, is examined both in terms of its potential future opportunities and challenges.	Aithal, P. S. et al. (2020). [20]

Table 3: ABCD analysis in quaternary industry

S. No.	Area	Issue	Outcome	Reference
1	An analysis of the role of ICCT-related	Many approaches of addressing environmental concerns are made possible by	The possible contribution of ICCT to ecological	Aithal, P. S. et al. (2022). [21]

	technology in ecological and environmental management.	technology. Two new and quickly evolving general-purpose technologies that show promise for creative and effective solutions to a range of societal issues are information, communication, and computation technology (ICCT) and nanotechnology (NT).	management is investigated in this study along with the application approaches for the ICCT's underlying technologies in environmental and ecological management.	
2	Novel developments in ICCT as an all-encompassing technology for growth, uniqueness, longevity, and monopoly.	It is determined that information, communication, and computing technology (ICCT) and nanotechnology (NT) are two of the universal technologies of the twenty-first century. By satisfying both people's most inventive needs and aspirational ambitions, these technologies are expected to significantly enhance society.	Assuring the distinctiveness, sustainability, and viability of various business models can be accomplished by utilising ICCT as a tactical instrument.	Aithal, P. S. (2018). [22]
3	Systems for quaternary distillation that are thermally coupled but have separate functions combined.	The creation of the unique functionally for quaternary mixes thermally connected distillation setups is presented. To provide a separate separation process and a functionally distinct thermally connected arrangement for multicomponent distillation, the idea of planned individual splits has been put forth.	It offers a greater variety of potential research options by synthesising global optimal distillation systems for quaternary separations.	Rong, B. G., et al. (2003). [23]
4	Quaternary azeotropic mixtures: designing and optimising waste solvent recovery distillations.	The vast number of solvents used in the semi-conductor and display industries results in expensive solvents being wasted frequently, which creates complex azeotropic combinations. Using ethyl lactate, ethyl lactate monomethyl ether, and ethyl-3-ethoxy.	The suggested design procedure and short cut method satisfied all component purity requirements while handling the difficult separation paths with minimal computational work.	Chaniago, Y. D., et al. (2018). [24]
5	The B. Tech programme is creative. The curriculum for the B. Tech. (Hons.) programme currently incorporates IPR, ESEP, and STEAM courses.	The higher education system is always coming out with new curricula (HES). The HES curriculum for each course needs to be updated throughout time in terms of both breadth and depth due to the exponential expansion in the amount of public material. Due to the continuous growth of technologies in many sectors,	To determine whether the B.Tech. (Honours) model is effective in achieving its goal of improving graduates' competency and employability so they can look for better employment, the	Aithal, P. S., et al. (2019). [25]

		engineering education is one of the primary topics of science and technology education.	benefits, and drawbacks.	
6	High Temperature Self-Propagating Synthesis Mechanisms were Illustrated with Space Diagrams for Metal and Slag Systems.	To tackle these real-world issues and create fresh perspectives on phase transition studies in three- and four-dimensional (3D) spaces with T-x-y and T-x-y-z PD (as well as reciprocal systems with exchange reactions), more spatial model assembly and computer-aided design of the phase region boundaries are required.	Tie lines, crystallisation routes, and the implications of altering the type of phase reactions can all be computed using a computer model of a phase diagram.	Lutsyk, V., et al. (2015). [26]
7	Basic column designs for quaternary distillations modified.	The most expensive and energy-intensive separation technique is distillation. With quaternary distillation, four products of any desired purity can be produced using three columns in the traditional basic column configurations. To separate four components with any desired level of purity, two columns are used in modified simple column configurations, as examined in this work.	The suggested designs were shown to have better energy performance for the composition situations that were taken into consideration than the conventional basic column sequences.	Errico, M., et al. (2012). [27]
8	Creating the Best Array Formulation for Quaternary Zeotropic Distillation Sequence Synthesis.	The optimisation approach is employed in most works to provide a set of data about the presence or absence of equipment or stream statuses, typically in the form of explicit binary variables. This data is then correlated with a specific process structure.	Five excellent solutions (including stacked and non - stacked configurations) were examined in this case to show why the selected method was the best.	Zhang, X., et al. (2022). [28]
9	The level of arsenic in groundwater obtained from Quaternary alluvium varies stratigraphically depending on the Bengal Basin and the Ganga Plain in India.	Bengal Basin lowland clayey deltaic sediments that are rich in organic matter are a major source of arsenic contamination. Significant sources are also the deeply cut river basins of the Ganga Alluvial Plain, where locally similar faces exist. Pre- to mid-Holocene Sea level rise is when most of them were deposited.	Their original low stand setting and later highland terraced position, along with the high hydraulic head, flush these sediments free of any arsenic produced by groundwater flow.	Acharyya, S. K. (2005). [29]
10	The interdependency between the key ICCT technologies is	Twenty-first-century advances in computer science technologies and approximately twelve underlying evolving	The current state of affairs and potential new research prospects employing two or more ICCT	Aithal, P. S. et al. (2020). [30]

	examined to highlight new directions for forensic science and cyber security research.	technologies are referred to as information communication and computation technology (ICCT), replacing the term information communication technology (ICT). It is believed that the foundation of the Universal Technological System is made up of nanotechnologies and ICCT.	underlying technologies are evaluated, with a focus on forensic science and cyber security in primary, secondary, tertiary, and quaternary enterprises.	

Table 4: Artificial Intelligence and Robotics in quaternary industry

S. No.	Area	Issue	Outcome	Reference
1	Evidence from China on artificial intelligence's effect on the intensity of pollution emissions.	The next phase of technical advancement is heralded by artificial intelligence (AI), which is also a critical element of sustainable economic development. With China as a case study, this research investigates the mechanisms and impacts of AI on the intensity of emissions of pollutants.	An effective way to lower the intensity of pollution emissions is to apply artificial intelligence (AI) to technology-intensive businesses.	Zhao, P., et al. (2023). [31]
2	Artificial Intelligence and Robotics and their Impact on the Performance of the Workforce in the Banking Sector.	This study aims to explore the use of artificial intelligence (AI) and its effects on the Indian banking industry, with a particular focus on how AI may improve customer service and operational efficiency. The foundation of the study is the idea that artificial intelligence (AI), a technology characterised by intellect like to that of humans, has the potential to revolutionise a wide range of industries, including banking.	This study provides novel insights into the obstacles to AI's widespread adoption in India as well as how AI is changing conventional banking procedures. It adds value to the conversation on AI in banking by proposing a fresh strategy of forming alliances with fintech businesses to get beyond these obstacles.	Tad, M. S., et al. (2023). [32]
3	Examples of how machine intelligence and autonomous robotic technologies are being used in the corporate context of small and medium-sized organisations include Industry 4.0-Based Manufacturing Systems, Cyber-	This study looks at Industry 4.0-based technologies and focuses on the obstacles that European small- and medium-sized businesses (SMEs) face when implementing them. This study aimed to ascertain the main barriers that SMEs face when attempting to adopt smart manufacturing, as well as to pinpoint the key	The results verified Industry 4.00's crucial function in intelligent process scheduling, particularly for industrial production, offered by deep learning and virtual simulation techniques. Additionally, the	Nagy, M., et al. (2023). [33]

	Physical Production Networks, Deep Learning, and Virtual Simulation Algorithms.	elements of this operationalization and assess whether, considering the prohibitive costs associated with adoption, only large corporations can take advantage of technological advancements.	study covered the ways in which SMEs might improve their business productivity by utilising autonomous robotics and machine intelligence.	
4	The utilisation of robotics and artificial intelligence in the marketing of tourism and hospitality.	Technology is advancing quickly, which has an impact on industries and led to variations in goods and services. The use and significance of modern technologies have grown, and the tourism and hospitality sectors have also been impacted by these rapid advances. In this regard, the purpose of this research is to assess, using secondary data, the application of robotics and artificial intelligence in the marketing of travel.	According to the research, these big data-driven opportunities are critical for cutting operating costs, maintaining employee productivity, and creating a competitive advantage.	Kemer, E., et al. (2023). [34]
5	Systematic literature evaluation on the effects of artificial intelligence on primary and secondary school assessment techniques	Artificial intelligence (AI) has several applications that can improve the educational field. Artificial intelligence (AI) and its educational applications have given rise to a multidisciplinary discipline that combines education, psychology, statistics, and computer science. Considering this, the purpose of this review was to compile the body of research on the use of AI tools to enhance primary and secondary student assessment.	The primary uses of artificial intelligence (AI) in student assessment at these lower educational levels include performance prediction, automation and objectivity enhancement through neural network or natural language processing, learning process analysis using educational robots, and the identification of elements that attract students to a class.	Martínez-Comesaña, M., et al. (2023). [35]
6	A Scoping Review on Industry 5.0 and Thoughts on a New Paradigmatic Approach for the Industry: Neoindustrialization.	By emphasising sustainability, human-cantered methods, organisational resilience, and human-machine interaction as its basic ideals, Industry 5.0 emerges as a new paradigm for the sector. Neoindustrialization is the term used to describe this	Great jobs and economic expansion are the results of a well-executed neoindustrialization strategy. In the twenty-first century, Industry 5.0 is the dominant paradigm. It's an inescapable	Pereira, R., et al. (2023). [36]

		new trend for the industry's future. The topic of Industry 5.0 is still in its early stages of growth, thus there is still a lack of specific agreement on its definition.	and irreversible reality, not a subject of conjecture.	
7	Industrial robots' contribution to China's decarbonisation: Towards low-carbon development.	Energy efficiency and pollution reduction have benefited from technological developments, and industrial robots are crucial for intelligent production and industrial upgrading.	This work presents new concepts for reaching net-zero carbon emissions and empirically validates the beneficial contribution of industrial robots to the reduction of carbon emissions.	Yu, L., et al. (2023). [37]
8	Wireless network technology and artificial intelligence are the foundations of the design of the spoken English instruction robot.	AI in education can increase student motivation and provide a more engaging learning environment. It also continues study into the issue of human individuality in the contemporary world.	Because it will foster more critical and thorough thinking, this will help kids in primary and secondary education.	Liu, B., et al. (2023). [38]
9	Tech-Business Analytics: An Evaluation-Based New Model to Enhance Different Industry Sector Performances.	Big data technology and the underlying technologies of ICCT are integrated to create a new type of business analytics that can be applied to primary, secondary, tertiary, and quaternary industry sectors' semi-structured and unstructured challenges. Tech-business analytics (TBA) is the term for the latest study. Gaining more insight into TBA and its impact on a company's innovation outcomes is the aim of this research.	A new idea opportunity for boosting Industry Performance in Various Industries, based on reviews, is established in the form of the tech-business analytics model. Research with the purpose of improving technological efficiency can benefit.	Kumar, S., et al. (2023). [39]
10	Robots driven by artificial intelligence can transform waste into value by improving the circular value creation inside the municipal solid waste management ecosystem.	Building creative solutions and business models in a circular economy (CE) requires significant systemic transformation. Ecosystems that are creative and cooperative are the ideal places to accomplish this.	To fully utilise the CE, the results emphasise the importance of information exchange and communication between consumers, legislators, and business sectors.	Heikkilä, S., et al. (2023). [40]

Table 5: Blockchain in quaternary industry

S. No.	Area	Issue	Outcome	Reference
1	Tech-Business Analytics: An Evaluation-Based New Model to Enhance Different Industry Sector Performances.	However, the significance of products and services is also influenced indirectly by environmental scanning, which is further influenced by the utilisation of ICCT underlying technologies. In this study, a new concept in business analytics called Tech-Business Analytics has been produced by a thorough assessment, analysis of the current state, anticipation of ideal/desired status, identification of research gaps, and analysis of research objectives.	Tech-business analytics is set to revolutionise the industrial problem-solving landscape with its abundance of resources, templates, technologies, opportunities, and capabilities for merging Data science with other ICCT underpinning technologies.	Kumar, S., et al. (2023). [41]
2	The significance of the circular economy for resource optimisation across different industry sectors: an opportunity analysis based on a review.	The basic, secondary, tertiary, and quaternary sectors of the industry all place a great deal of weight on the circular economy concept. Because it encourages innovative thinking, resource efficiency, waste reduction, and sustainable practices, this idea has a significant impact on all industry sectors.	By understanding the current situation and utilising the SWOC and ABCD analysis frameworks, the significance of the circular economy is assessed in primary, secondary, tertiary, and quaternary businesses.	Aithal, S., et al. (2023). [42]
3	Improving Industry Automation with Effective Technology Management in Society.	With previously unheard-of levels of automation and efficiency, the rapid growth of technology has transformed industries all over the world. This research provides a thorough analysis of the important topic of technology management and its critical role in coordinating the efficient automation of primary, secondary, tertiary, and quaternary businesses.	The article discusses the implications of technology-driven automation in businesses on the socio-economic and environmental fronts, emphasising the need for ethical and sustainable technology management.	Aithal, P. S. (2023). [43]
4	An Exploratory Study of Tech-Business Analytics: A Novel Idea to Enhance	Data analytics and the underlying methods of ICCT are combined in a tool called tech-business	Tech-Business Analytics, a plan to enhance the attributes and calibre of goods	Kumar, S., et al. (2023). [44]

	Features and Quality of Products and Services in Different Industry Sectors.	analytics. From elementary to quaternary industry sectors, industry challenges can be simplified or solved. Aiming to enhance the characteristics and calibre of goods and services across a range of businesses, Tech-Business Analytics leverages technology and data analysis.	and services across several industries, would employ an exploratory study methodology that combines qualitative and quantitative research techniques.	
5	Blockchain technology applied from a financial standpoint to manage supply chain instability.	Any company's ability to create value and satisfy investors is primarily dependent on its ability to operate an efficient supply chain. Only when a supply chain can overcome process instability does it become effective. Using logical strategies, techniques, and technology to get around the SCV is necessary for managing the supply chain process efficiently.	This chapter discusses blockchain technology and its advantages in order to mitigate supply chain volatility and its effects. This chapter also emphasises the financial viewpoint and how the use of BCT makes it possible for the businesses to provide value addition to shareholders.	Pandikumar, M. P., et al. (2023). [45]
6	Manage weather data with blockchain technology.	It is quite difficult to get and distribute localised primary and secondary weather datasets in real time. Government-run weather stations go through a laborious manual bureaucratic process to gather, compile, and release primary datasets.	Because different sources provide different data formats, secondary datasets derived from main ones may result in a heterogeneous and non-standardized marketplace.	Grebovic, M., et al. (2023). [46]
7	Restructuring Economic Logic, Capital, Assets, Organisation, and Industry: The Metaverse's Inspiration for Sustainable Business.	The metaverse is synchronous, real-time, persistent, and has no restrictions on the number of concurrent users. It also boasts a fully functional economy, a wide variety of experiences, unparalleled interoperability, and a wide spectrum of content and experience providers.	The essay cautions that the metaverse's energy consumption cannot be disregarded and that the metaverse's sustainable growth must adhere to a carbon neutral development path.	Chen, Y. (2023). [47]
8	A Scoping Review on Industry 5.0 and Thoughts on a New Paradigmatic Approach	With sustainability, human-cantered methods, organisational resilience, and human-machine interaction as its guiding	Great jobs and economic expansion are the results of a well-executed neoindustrialization	Pereira, R., et al. (2023). [48]

	for the Industry: Neoindustrialization	principles, Industry 5.0 emerges as a new paradigm for the sector. Neoindustrialization is the term used to describe this new direction the industry is headed towards.	strategy. In the twenty-first century, Industry 5.0 is the dominant paradigm.	
9	Highlights on Blockchain and AI-Powered Programme Governance.	This study examines the impact of blockchain technology and artificial intelligence (AI), two of the most disruptive technologies, on programme governance and management. His goal is to draw attention to the advantages that digital transformation offers for governance techniques and approaches, including roles and duties.	The results of the study show that programme governance can be carried out without the need for a centralised organisation; this can help prevent conflicts between organisations and preserve a single source of data.	Al Zaabi, K., et al. (2023). [49]
10	A Comprehensive Survey for Blockchains: Manoeuvring the Quantum Computing Threat Landscape.	The security of blockchain technology, which primarily depends on hash functions and public-key cryptography, is seriously threatened by quantum computers. Blockchains rely on cryptographic algorithms that are based on huge odd prime numbers and discrete logarithms.	We stress the necessity of creating defences against quantum computing and investigate ways to lessen the threat that these machines pose to blockchains, such as the implementation of post-quantum and quantum blockchain architectures.	Khodaiemehr, H. et al. (2023). [50]

Table 6: Cloud Computing in quaternary industry

S. No.	Area	Issue	Outcome	Reference
1	The CFCS, CIC, CF, and TERESA models' χ-mapping variants are used for 210Pb-based dating of recent sediments.	Relative age in recent sediments can be determined to the centenary level using the 210Pb-based approach.	In addition to discussing the use of the palace records of fluxes, the paper also addresses the requirements for correcting model flaws in the chronologies.	Abril-Hernández, J. M. (2024). [51]
2	An extensive analysis of picture encryption, including its limitations,	Encrypting images is an essential part of contemporary data security, protecting private, confidentiality, and integrity of sensitive visual content.	To address the growing need for data protection and privacy in the digital age, this thorough survey is a useful tool for image security researchers, practitioners, and decision-makers.	Saberi Kamarposhti, M., et al. (2024). [52]

	future prospects, and taxonomy.			
3	The El Alto-Ancasti Mountain range in Catamarca, Argentina, has an NDVI reconstruction model that represents the dynamics of ecosystems and environmental management from 442 AD to 1980 AD.	Understanding the intricate relationships between climatic variability, ecological shifts, and human land use requires an understanding of vegetation dynamics.	Through the incorporation of multidisciplinary methodologies, we can gain a deeper comprehension of the intricate interplay among vegetation dynamics, climatic events, and human activities. This will augment our understanding of historical environmental shifts and their consequences for sustainable management tactics.	Meléndez, A. S., et al. (2024). [53]
4	A multi-frame velocity splicing technique for deformation across broad areas Guangdong, China: A case study of long-term deformation monitoring.	Because SAR images have a restricted swath width, joint monitoring for wide-area deformation assessments requires multi-frame InSAR datasets.	The updated Sentinel-1 data provide a greater than 19% increase in accuracy when compared with GNSS. By enabling the engineering use of wide-area InSAR measurements, the suggested method helps standardise the creation of InSAR deformations.	Wang, Y., et al. (2024). [54]
5	A geographical examination of China's largest metropolitan agglomerations reveals how the digital economy affects carbon total factor productivity.	The shift that China needs to make from its traditional development paradigms to new economic accelerators is crucial for achieving its transformative agenda in the face of global climate imperatives and growing economic rivalry.	Advanced, resource-free metropolises with muted innovation tendencies are more prone to this connection between the digital economy and carbon total factor productivity. In a sustainable framework, this talk offers subtle policy recommendations for shaping the course of the digital economy and increasing carbon TFP.	Chen, W., et al. (2024). [55]
6	Gamification and the Welfare of Workers	Gamification, which drives user motivations and offers game-like experiences, has been scientifically and practically studied as one of the most effective ways to engage users as the area of game and gamification study grows.	The purpose of this study is to investigate the following questions: what theories and methods have been used; what types of gamification forms and elements have been investigated across different industries, companies, and organisations; and what effect gamification can have on employee well-being?	Lehtoranta, S., et al. (2024). [56]

7	Evaluation of the potential for groundwater resources using the entropy weighted TOPSIS model.	Groundwater quality evaluation and pollutant detection are crucial in places where groundwater is the primary water supply due to the rise in groundwater use in recent decades.	The rankings derived from both approaches are significantly connected ($p<0.01$), according to the correlation between these two indices, with an R2 value of 0.94.	Dehghan Rahimabadi, P., et al. (2024). [57]
8	Map soil sodicity by combining time series remotely sensed imagery with proximally sensed data in a synergistic manner.	Reduced plant emergence and root extension are two ways in which these can impede sugarcane growth. A map showing the exchangeable sodium percentage (ESP) of the topsoil (0–0.15 m) can be used to estimate how much gypsum is needed to enhance the quality of the soil.	In accordance with the Six-Easy-Steps Management Guidelines, the DSM of ESP was created based on the best results to suggest gypsum application rates to ameliorate sodic soils. Gypsum was needed in the northern fields at varying rates (5, 7.5, and 10 t ha 1), but not in the southern fields.	Wang, J., et al. (2024). [58]
9	Timing climates, modelling futures: Temporality and environmental history in the Anthropocene.	A lengthier prehistory exists in the environmental sciences, where the need to reconcile human and non-human periods has been a fundamental concern for decades, notwithstanding the relative recentness of this turn towards integrated human-planetary timelines.	The Earth Systems' ascent the idea to bring climatological studies together under a single temporal framework came from science. The spatial integrity of the "globe" or the "planet" may imply something different from the histories of climatological temporalities, which reveal a more complex and processual earth system.	Flatø, E., et al. (2024). [59]
10	AI-Powered Customised Physio-Care System	AI refers to methods that let computers carry out a series of tasks without the assistance of humans. While artificial intelligence (AI) cannot fully replace the human intellect, it may simulate it.	Data sets like BP, Barthel index, pain, etc. are covered by the predictive model that uses a decision tree classifier. This model's output provides results that show the deviation from the norm as well as recommendations for therapy.	Deoskar, A., et al. (2024). [60]

Table 7: Forensic Technology & Cyber Security in quaternary industry

S. No.	Area	Issue	Outcome	Reference
1	Development of a Heuristic Based Mixed Integer	One of the biggest issues that people and financial organisations in this digital age	Additionally, it can be utilised to create the strongest possible	Akinbowale, O. E., et al. (2024). [61]

	Linear Programming Model for Resources Allocation During Cyber Fraud Mitigation.	continue to face is cyber fraud. The success rate in fighting crime is impacted by the absence of appropriate decision support tools for efficient resource allocation.	link between these facilities to guarantee a prompt incident response in the event of a cyberattack.	
2	Requires strong frequency stabilisation to protect a micro grid from many cyberattacks at once.	Cyber resilience is essential for component coordination in micro grids (MGs), which are cyber-physical systems that are part of smart grids. The MG's secondary frequency control is susceptible to several cyber-attacks because to inadequate communications, protocols, and tools, which presents new difficulties and stability issues.	Despite hostile attacks and disturbances from loads and renewable energy sources, the MG can efficiently sustain consistent frequency levels.	Kerdphol, T., et al. (2024). [62]
3	An efficient allocation technique for smart grid defence resources against cyberattacks, based on game theory.	Significant risks and security issues in the new power system will result from a deep integration of cyber and physical systems. An approach to proactively thwart prospective cyberattacks on smart grids is the optimal defence resource allocation strategy, which is based on game theory.	To measure player gains in the interim, quantum response equalisation is introduced. Certain algorithms are utilised to illustrate the practicability and efficiency of the approach suggested in this manuscript.	Ge, H., et al. (2024). [63]
4	A improved consortium blockchain diversity mining method for aggregating IoT metadata.	The Internet of Things (IoT) has experienced exponential growth in the past 20 years. Nodes are generating a lot of data even if their memory, resources, and computing power are comparatively low. To supply storage capacity in this situation, cloud technology is utilised. A large network using cloud support may be vulnerable due to its robustness and centralised structure.	This motivates academics to look into a more efficient lightweight block verification method for the blockchain's functional framework that significantly reduces processing requirements, network latency, and overhead.	Chithaluru, P., et al. (2024). [64]
5	Insurance Policies Regarding Cyber Risk.	Technology malfunctions can lead to cyber vulnerability. Cyber danger has always been since humans have used computers; thus, it is not necessarily a recent phenomenon.	In addition to serving as a helpful discussion starter for a variety of subjects among insurers, brokers, policyholders, and industry.	Corbett-Wilkins, et al. (2024). [65]
6	A comprehensive overview of the literature on	This is the first comprehensive study of fraud in the hospitality industry that identifies gaps in	The study points out several gaps and offers fresh ideas for	Kassem, R. (2024). [66]

	fraud risk in the hospitality industry	the literature, offers a comprehensive picture of the crime, and proposes fresh lines of inquiry for further study.	further investigation. The results have theoretical and practical ramifications that will be covered later.	
7	Application, summary, and case studies of forensic isotope provenance for undocumented border crosser human remains.	This chapter's main motivations are to familiarise the reader with the use of isotope analysis in forensic anthropology and the humanitarian situation along the US southern border. The chapter specifically addresses the use of stable isotopes in the identification process of deceased undocumented border crossers (UBCs).	In forensic anthropology and isotope research, we highlight the necessity of publicly available data to advance not just the field but also the global scientific community's humanitarian endeavours.	Ammer, S., et al. (2024). [67]
8	A preliminary study on the incorporation of cyber security into English secondary education curriculum	The bulk of cyber security incidents are still caused in part by human mistake. As a result, there is a dearth of cyber security experts and poor cyber hygiene since the educational system does not provide people with the knowledge and abilities, they need to defend themselves against online attacks.	Cybersecurity is an essential subject that is missing from secondary school curriculum, as revealed by the content analysis of secondary education computing qualifications in relation to CyBOK and the thematic analysis of interview data.	Stepney, O., et al. (2023). [68]
9	A new protocol called D2WFP is designed to forensically identify, extract, and analyse browsing activity on the deep and black web.	Over the previous ten years, there has been a significant surge in the use of the unindexed web, also referred to as the deep web or dark web, for illicit behaviour. One risky location where various illicit activity occur is the dark web.	According to rigorous quantitative and qualitative research that was carried out by evaluating the D2WFP in various scenarios through a comprehensive and scientifically sound process.	Ghanem, M. C. et al. (2023). [69]
10	Infrastructure for smart cities: Internet of Things security threats and solutions: Innovative	All physical objects, or "things," that have been implanted with electronics, software, sensors, and connection are part of the Internet of Things (IoT), which is a network that uses various communication technologies to facilitate data flow between them and servers, centralised	For smart city applications and Industry 4.0, this study also thoroughly examines several security flaws at every layer and offers solutions. This study also compares the security issues in IoT systems and their	Sharma, R., et al. (2023). [70]

		systems, and other connected devices.	wireless communication features with those of IoT.	

Table 8: Digital Marketing and Business in quaternary industry

S. No.	Area	Issue	Outcome	Reference
1	The use of digital marketing in Covid-19 by Culinary Micro Small and Medium-Sized Businesses.	The purpose of this research is to comprehend the efforts made by the MSMEs in the culinary cluster in Cimahi City to use digital marketing in the year 2019—Covid-19.	There was room for improvement in both the business performance and digital marketing implementation.	Martadikusumah, T. A. A. (2024). [71]
2	A thorough examination of the effect of marketing strategies and policies on the achievement of sustainable development goals.	It has been demonstrated that businesses who incorporate sustainability into their marketing campaigns receive higher levels of appreciation than those who do not.	This study's primary goal is to use the systematic review approach to comprehend the precise role that marketing strategies play in the realisation and advancement of a more sustainable planet.	Marco-Gardoqui, M., et al. (2024). [72]
3	Using Big Data Mining and Communication Technology Support, Digital Marketing Evaluates Applied Undergraduate Talent Training with E-commerce.	E-commerce is a type of business activity that is facilitated by network, computer, and communication technologies. The knowledge economy and information society have produced it, along with a new business model that integrates the flow of capital, materials, and information. It is also an inevitable trend for how businesses will operate in the future and how networks of organisations will operate.	In order to take advantage of the chance to make a change and take the lead in creating a higher education system that drives the advancement of the times, it offers a fresh perspective, a novel approach, and a platform for sharing ideas on talent nurturing reform.	Zhang, L., et al. (2024). [73]
4	In the Age of Climate Change: Digital Marketing and Sustainability.	In order to better understand the buying habits and awareness of the 4.54 billion active online users (or 59% of the world's population), this paper looked at their concerns regarding climate change.	The opinions of the experts provide an inclusive history on important aspects of this crucial topic, along with perspectives on related issues such as artificial intelligence, digital and social	Fazel, H. (2024). [74]

			complexities of Green Marketing.	
5	What are some ways that businesses might involve customers more effectively in the shift to circularity? Studies of the marketing mix's and nudges' effectiveness	This study aims to examine how businesses use the seven components of the marketing mix to adopt or shift to circular business models, using the use of "nudges" as a tool to help engage customers.	To operationalize circular business models and better engage consumers in circular systems, this research adds evidence to the ongoing discussion about the "intention-behaviour" gap issue in the transition to a circular economy.	Rainatto, G. M., et al. (2024). [75]
6	China's peaking carbon emissions and the use of industrial intelligence	The potential of industrial intelligence to facilitate decarbonisation in China's low-carbon transition is still unknown, even as it drives technical and economic development.	Additionally, industrial intelligence reduces carbon emissions significantly in labour- and technology-intensive businesses, but not in capital-intensive ones.	Wang, L., et al. (2024). [76]
7	Marketing Strategy Approach: The Impact of Micro-Influencers on the Sustainability of Small and Medium-Sized Businesses	Half of small businesses were also affected by this epidemic and filed for bankruptcy as a result of several issues, including poor application of marketing strategies, particularly regarding sustaining relevant existing markets.	Using a quantitative methodology, this study finds that micro influencers are crucial to the survival and quality of small businesses, which has theoretical ramifications.	ABDULLAH, S., et al. (2024). [77]
8	Marketing Frameworks and Approaches for Agricultural Products Based on Frozen Food in the New Normal	Given that global product consumption per capita is rising annually and that people's demands for practical, hygienic, and healthy living are increasing, frozen food goods derived from agriculture and fisheries are being well-marketed.	According to the findings, for a frozen food-based agricultural product company to thrive in the new normal era, five (five) marketing tactics are applied in conjunction with the ice cream business model.	Zam, W., et al. (2024). [78]
9	The Strategies and Business Impact of Social Media Marketing	Using social media, people may remain in touch with their friends, family, and the larger community. Social media is an inexpensive way for businesses of all shapes and sizes to engage with their clientele and build brand awareness.	As a potent instrument for businesses, particularly micro and small firms, to contact and interact with their clientele, social media marketing is significant, as	Ballabh, S. (2024). [79]

			demonstrated by the study's findings.	
10	Digital Marketing with AI-Powered Products	This book chapter investigates, through qualitative research methods, the effects of artificial intelligence (AI) applied to digital marketing at a time when AI is becoming increasingly popular and is widely seen as the start of the 4th Industrial Revolution.	This study confirms that the use of AI in digital marketing can result in more successful and efficient marketing campaigns, a global audience view, and real-time experience personalisation and customisation.	Aleixo, J. E., et al. (2024). [80]

Table 9: 3D Printing in quaternary industry

S. No.	Area	Issue	Outcome	Reference
1	Developing palatable bio-inks: Enhancing 3D printing through the use of medium-internal-phase emulsion gel that incorporates microgel particles isolated from soybean protein.	The food business is gradually shifting towards edible bio-inks that are healthier and more effective in response to consumers' shifting dietary habits and growing health consciousness. In this work, dynamic high-pressure micro fluidization (DHPM) was used as a pre-treatment technique to produce soybean protein isolate microgel particles (SPIMP).	The reduced-fat surimi products made from medium-internal-phase emulsion gel were found to be more suitable for 3D printing in actual food systems than regular surimi goods.	Song, J. R., et al. (2024). [81]
2	Applications of 3D printed polylactic acid film treated with cold atmospheric plasma for thin-film solid phase micro extraction of anticancer medicines	One pharmacological class of targeted therapies used to treat malignant diseases is Tyrosine Kinase Inhibitors (TKIs). Therapeutic drug monitoring (TDM) becomes crucial when considering the adverse effects of this class of medications on people.	Cold atmospheric plasma (CAP), a quick, clean, dry process with minimal chemical and energy usage, was used to modify the surface of a 3D printed polylactic acid film.	Rezaei, H., et al. (2024). [82]
3	Easily creating a Ticagrelor extended-release tablet with three-dimensional printing technology	With additive manufacturing, the study's goal was to create customised extended-release Ticagrelor blood thinner tablets for once-daily dosage, improving patient compliance with heart failure treatment.	It holds promise for customised medicine, enhancing point-of-care adherence by offering precise dosages with customised kinetic release.	Rastpeiman, S., et al. (2024). [83]
4	The most recent developments and uses of gel-based membranes.	Gel-based membranes, which combine liquid components and polymer networks, are very adaptable and have found use in numerous technical	However, difficulties still exist in gel-based membrane research, especially regarding scalability and long-	Ungureanu, C., et al. (2024). [84]

		fields because of their distinct structural and functional features.	term stability, despite tremendous advancements in the field.	
5	Screening Mo-Si-Ta glassy alloy films for biocompatibility before sputtering them onto PCL scaffolds and prototype Ti-6Al-4V implants made via additive manufacturing	The implant prototypes were produced using a 3D metal printer and metal powders of Ti6Al4V alloy. To sputter the films onto the implant prototypes, a DC magnetron is utilised. X-ray photoelectron spectroscopy, electron/atomic force microscopy, and X-ray diffraction analysis were used to thoroughly investigate the elemental composition, amorphous nature, surface chemistry, and topography of the as-fabricated microstructure films.	The coatings were found to be cyto compatible. The customised 3D printed Ti-alloy implants coated with thin film metallic glass (TFMG) exhibited greater corrosion resistance than the pristine specimen, according to electrochemical corrosion investigations conducted in SBF.	Divyasri, R., et al. (2024). [85]
6	Photo generated carrier separation and dye adsorption capability were improved by quaternized hollow TiO2 for effective reactive dye removal.	Reactive dye is frequently used to dye cellulose fibres, but single TiO2 cannot remove the dye with a sufficient level of effectiveness due to the rapid recombination of photo generated carriers and electrostatic repulsion with reactive dye.	It was discovered that larger mass and electron transport channels were made possible by the grafting of the quaternary ammonium group, which accelerated dye adsorption and photo generated carrier separation. In order to achieve high-performance organic dye removal.	Wang, L., et al. (2024). [86]
7	Characterization of oxidation in quaternary Zr-based diboride thin films produced using hybrid high-power impulse/DC magnetron co-sputtering technique	Protection from abrasion is gaining interest in transition metal diborides deposited by sputtering. They oxidise quickly and are very fragile, though. Their oxidation resistance needs to be improved further, even though alloying with Ta makes them more durable.	Since the B and Si contents of these quaternary alloys are insufficient to generate oxidation protective barriers, the oxidation rate increases for the 60 W/200 Hz series.	Bakhit, B. (2024). [87]
8	Nanomaterials are being researched to speed up fracture healing.	A growing number of patients are suffering from non-union or delayed union following their bone fracture, and the incidence of bone fracture cases has been rising annually.	In treating fracture delayed union, this paper examines the progress made using nanomaterials.	Zhang, M., et al. (2024). [88]

9	CoCrFeNi high-entropy alloy additively produced by laser powder bed fusion and Nano twining caused by tensile fatigue	The face-cantered cubic (FCC) crystal structure of the CoCrFeNi high-entropy alloy (HEA) produced additively by laser powder bed fusion (L-PBF) exhibits superior complete mechanical characteristics in the building direction (BD). Interesting microstructural evolution characteristics are displayed along the BD of the L-PBF processed HEA because of dynamic fatigue, loading quasi-static, and dynamic separated Hopkinson press bar (SHPB) impact stress conditions.	To further prevent dislocation movement during strain hardening, there are more twin barriers. The research of HEA parts made by additive manufacturing and used in harsh environments can benefit from these discoveries.	Huang, G., et al. (2024). [89]
10	2D and 3D Modelling of Airborne Magnetic Data to Estimate Depth to Basement at the Southeastern Part of Egypt.	To determine the thickness of the sedimentary layer and the depth of the basement, airborne magnetic data across the southeast region of Egypt was interpreted using 2D and 3D modelling approaches. Finding suitable groundwater exploration sites is the main goal, as it is necessary for Egypt to have sustainable development.	The current study is significant because it addresses desert areas in Egypt that could be developed as agricultural zones, specifically in relation to the country's 2030 sustainable development strategy.	Abdelaal, G. Z. et al. (2024). [90]

Table 10: The Internet of Things (IoT) in quaternary industry

S. No.	Area	Issue	Outcome	Reference
1	Methodological Considerations of the Internet of Things in Education.	Numerous announcements have been made on the use of technology to enhance education, particularly for administrative duties in higher education and K–12 settings. Because of the new potential of this technology, the field of education is extremely interested in it. We still don't know much about how to use IoT as instructional material at the K–12 level, even though its function in sustainable education is established.	This initially developed the requirements, aim, and research approach to do that. Next, we have provided a conceptual understanding (model) of this domain by defining the fundamental concepts and relationships through their attributes.	Štuikys, V., et al. (2024). [91]
2	Internet of Things (IoT) applications for preserving security and	Evaluating the effects of IoT adoption in smart cities was the primary objective of this study. Finding out what strategies and how IoT was	By using this technology, municipalities are able to focus on improving their	Ahamad, S., et al. (2024). [92]

	privacy in smart cities.	being implemented in smart cities were the main objectives. Determining the worth of IoT was the third objective. The qualitative method was selected for the collection of secondary data.	infrastructure. Numerous aspects related to the Internet of Things have resulted in substantial changes to the lifestyles of the populace.	
3	Internet of things effects on smart product-service systems' perceived quality and consumer engagement.	There is a noticeable dearth of research analysing the customer experience and quality attributes in Smart Product-Service Systems (SPSS) and their relationship to the Internet of Things (IoT) technologies, even though emerging business trends are using disruptive digitalization technologies to reshape business strategies.	Using a technique to evaluate the perceived quality determinants in SPSS enabled by IoT technologies, the study closes the existing knowledge gap between quality determinants and future IoT technologies in SPSS business.	Sassanelli, C., et al. (2024). [93]
4	What is the impact of the industrial internet of things on the bioprocess industries?	The Industrial Internet of Things, or IIoT, is a network of networked devices that allows real-time insight into the workings of any industrial process, from product development and manufacturing to supply chain management, by utilising a variety of technologies, including soft sensors, cloud computing, data analytics, machine learning, and artificial intelligence.	All-encompassing solutions are currently required to expedite IIoT adoption and get over the industry's general resistance to the technology.	Borgosz, L., et al. (2024). [94]
5	The Garang Watershed has an Internet of Things-based water quality monitoring system for temperature, pH, turbidity, DO, BOD, and COD parameters.	Untreated wastewater is increasingly being dumped into water. Together with the expansion of the world's population, land usage has changed, mostly becoming industrial regions and communities. Potentially more wastewater from both domestic and non-domestic sources could be produced because of these land use changes.	Specifically, for temperature, pH, turbidity, and DO, the real-time water quality sensor tool that was built was able to transmit data on water quality online and in real-time with success.	Syafrudin, S., et al. (2024). [95]
6	The function of innovative organisational predictor in the chemical manufacturing	With a particular focus on the mediating function of organisational innovation, this study attempts to explore the linkages between employee behaviour and the adoption of	To stimulate innovation and improve OCB, companies in the chemical manufacturing sector	Nuryanto, U., et al. (2024). [96]

	industry: the impact of big data and IoT deployment on organisational citizenship behaviour.	the Internet of Things (IoT) and Big Data in the chemical manufacturing sector. Employee surveys, statistical analysis, and mediation testing are all part of the quantitative research technique.	should strategically incorporate Big Data and IoT technologies, according to the research's practical implications.	
7	An industrial wireless sensor internet of things technique that uses minimal energy and delays data transmission.	The Internet of Things (IoT) has been widely used in smart cities, industrial settings, healthcare, and other fields in recent years, and it is an essential tool in these fields. Due to their self-organizational characteristics, wireless sensor networks (WSNs) have become an essential technique for gathering auxiliary environmental data in various industries when it comes to Internet of Things systems.	Making efficiency a top priority and optimising energy use are essential to addressing these issues. Enhancing energy efficiency in the context of the Industrial Internet of Things (IIoT) is also highly dependent on data transmission types and cluster head node distribution.	Liu, D., et al. (2024). [97]
8	Internet of Things resources are used in a secure collaborative federated learning system that protects privacy for malware detection models.	In today's digital world, the prevalence of malware attacks poses an increasing security risk, underscoring the necessity of sophisticated malware detection techniques. Even though a lot of detection systems have been developed that use techniques like machine learning (ML), they frequently fall short when it comes to real-time malware detection of unknown or novel threats.	It is possible to increase IoT device involvement and decrease device dropout during model updates with the proposed incentive system. According to a security analysis, PPFL-SC satisfies every security need for federated learning that protects privacy.	Alamer, A. (2024). [98]
9	Cloud applications based on the Internet of Things using decentralised and distributed computing.	Cloud computing is often employed by information services. On the other hand, cloud computing infrastructures face new challenges because of the proliferation of Internet of Things applications.	HCloud gathers each cloud's status before distributing serverless services, based on the scheduling strategy, to the best cloud.	Roopa Devi, E. M., et al. (2024). [99]
10	The Big Data Computing World and Next Generation IoT.	The Internet of Things (IoT) and big data are rapidly expanding and upending many aspects of industry and technology, improving services for both individuals and enterprises. Massive amounts of data have been	The variety of IoT domains has caused a division in the advancement of big data techniques, even if big data analytics is a well-researched issue. Therefore,	Venkatachalam, N., et al. (2024). [100]

		produced over the past few years as an increase in the miniaturisation of IoT devices has occurred.	collaboration across IoT disciplines may facilitate the growth of big data research in the field.	

Table 11: Data Storage in quaternary industry

S. No.	Area	Issue	Outcome	Reference
1	Investigating, using density functional theory, the characteristics of quaternary X2NaTlF6 (X= Cs, Rb) halide double perovskite materials for energy conversion, harvesting, and storage.	Thanks to their potential in thermoelectric and optoelectronic applications, double perovskites (DPs) have garnered a lot of interest.	Because of their UV-Vis range absorption characteristics, estimations of optical properties for both compounds point to their applicability in optoelectronic devices, especially LEDs.	Ayub, G., et al. (2024). [101]
2	Future energy storage devices: polystyrene sulfonate/CuO-based quaternary nanocomposites based on polyethylene oxide, polyvinyl alcohol, and poly (3, 4-thylenedioxythiophene) and their preparation and tuning of optical and electrical properties.	Due to their flexibility, versatility, and prominent level of intelligence, polymeric nanocomposites have several industrial and scientific uses. Copper oxide nanoparticles (CuO NPs) of varying concentrations (0.4, 0.8, 1.2, and 1.6 wt.% to the host blend weight) were added to polymer nanocomposite films consisting of a blend of polyethylene oxide, polyvinyl alcohol, and poly(3,4-ethylenedioxythiophene) polystyrene sulfonate (PEO/PVA/PEDOT: PSS) using the solution-casting technique.	Using the impedance components Z′ and Z″, the corresponding electrical circuit was presented. The utilisation of PEO/PVA/PEDOT: PSS/CuO nanocomposites in the development of flexible optoelectronic and energy storage devices is suggested by their tunable optical energy gaps, frequency.	Morsi, M. A., et al. (2024). [102]
3	Ammonium salt coating on a quaternary air filter to remove bio aerosols from indoor air in buildings.	The public's protection against infectious respiratory disorders depends on the development of air filters having biocidal properties. To create antimicrobial air filters and eliminate bio aerosols, a straightforward spray-coating method was developed.	Over 99.9 percent of coated charged polypropylene filters were able to filter out both bacteria and viruses. The coating did not significantly impact the filters' ability to filter out NaCl aerosol.	Jiang, H., et al. (2024). [103]
4	Carnivores played a significant role at the	Because human groups and carnivores have been	Thus, identifying the sources of these	Sanz-Royo, A., et al.

	Aurignacian Delta level, according to techonomic data from the transitional Aurignacian of El Castillo cave in Spain.	present at these sites repeatedly over time—as evidenced by several European caves and rock shelters—Palaeolithic sites are intricate palimpsests.	occupation events requires the use of techonomic investigations. In the so-called Transitional Aurignacian stage.	(2024). [104]
5	Production and description of quaternary clinker-free cementitious materials with met kaolin, calcium carbide slag, phosphorus slag, and desulfurization gypsum.	Phosphorus slag (PS) builds up extensively and contaminates the land and surrounding waterways. The current work employed metakaolin (MK) to supply extra Al2O3 for the cementitious system in addition to using calcium carbide slag (CS) and desulfurization gypsum (DG) to activate PS in a synergistic manner.	In addition to having the best compressive strength at all ages—32.8 MPa at 28 days—the cementitious system made with 40% PS, 25% CS, 15% DG, and 20% MK also satisfies all applicable regulatory requirements for the leaching concentration of heavy metals.	Cui, S., et al. (2024). [105]
6	Synergistic impact of ternary, quaternary, and binary binders on the mechanical, microstructural, and durability aspects of the EAF aggregate HPC system.	This study examines the combined impacts of binder composites on the mechanical, microstructural, and durability properties of high-performance concrete that contains aggregate from electrical arc furnace slag (EAF) and manufactured sand (M-sand).	In order to create HPC combinations with the effect of mS at three different levels—5%, 10%, and 15%—a quaternary binder system with 1% nS is added to an optimised ternary system with 10% mS.	Rao, K. B., et al. (2024). [106]
7	In blown films made of starch and poly (butylene adipate-co-terephthalate), quaternary ammonium salts with varying N-alkyl chain lengths were used as antimicrobials.	Packaging that is both biodegradable and antimicrobial is much sought after as a dual defence against plastic and microbiological threats. The starch/poly (butylene adipate-co-terephthalate) (PBAT).	Results indicated that starch/PBAT antimicrobial packaging may be made with QAS; however, cytotoxicity and release kinetics still need to be thoroughly investigated before use.	Gao, S., et al. (2024). [107]
8	Effectiveness of New Quaternary Ammonium and Phosphonium Salts on Antibiotic-Resistant Staphylococcus aureus Depending on Cation	Bacterial infection prevention and treatment are made more difficult by antibacterial resistance, which is a danger to public health. Quaternary heteronium salts (QHSs), as	The compounds 1e, 3e, and 5e showed good elimination of S. aureus CECT 976 at low concentrations, according to survival	Nunes, B., et al. (2024). [108]

	Type and Alkyl Chain Length.	in quaternary ammonium and phosphonium compounds, have attracted a lot of attention as novel antibacterial agents. The cation type and alkyl chain length were varied to create a library of 49 structurally similar QHSs in this work.	curves. Furthermore, at concentrations < 2 µg/mL, compounds 2e, 4e, and 5e demonstrated favourable safety profiles, according to in vitro human cellular data.	
9	The triethanolamine ester quaternary ammonium compounds: method validation and environmental monitoring.	Triethanolamine quaternary compounds (TEAQ, ester quats) were examined in this study using water and sediment samples taken from the river Nene (Northamptonshire) at several locations close to the Great Billing sewage treatment plant (STP).	TEAQ have never before been accurately measured across a wide range of environmental matrices (STP influent, STP effluent, surface waters, and sediments).	Sparham, C., et al. (2024). [109]
10	Creation of a quaternary system based on cells to reveal how pectic polysaccharides affect mouth astringency.	Because of their propensity to interact with oral components and salivary proteins, phenolic compounds are the cause of unpleasant taste qualities in food, including astringency. Being astringent is essential for gaining the acceptance of consumers.	The impact of the polysaccharide is dependent on the structural characteristics of the molecules involved, according to the results.	Brandão, E., et al. (2024). [110]

Table 12: Quantum Computers in quaternary industry

S. No.	Area	Issue	Outcome	Reference
1	Spin-torque based n-qubit architecture: optimisation and performance study of 1-Toffoli gate quantum full adders.	Reversible computing can benefit from quantum computing (QC) because of its rapid speed and innate capacity for parallel processing. It also aids in resolving the problem of classical computing's significant power dissipation.	Comparing QFA1 and QFA2 to 2-Toffoli QFA, the improvement in fidelity is 0.7% and 0.57%, respectively. For the QFA2 compared to the QFA1, an increase in execution time of 9.97% is required.	Kulkarni, A., et al. (2024). [111]
2	An extensive analysis of picture encryption, including its limitations, prospects, and taxonomy.	Encrypting images is an essential part of contemporary data security, protecting private, confidentiality, and integrity of sensitive visual content.	As the need for data protection and privacy in the digital age grows, this thorough survey is a useful tool for researchers, practitioners, and decision-makers in	Saberi Kamarposhti, M., et al. (2024). [112]

			the field of image security.	
3	The physical and thermoelectrical properties of the recently developed full-Heusler alloys Ag2TiGa and Ag2VGa are compared using ab initio calculations.	Comparative analysis of the structural, electrical, magnetic, optical, and thermoelectric characteristics of the two Heusler systems, Ag2TiGa and Ag2VGa, in the inverse L21 Hg2CuTi structure will be the main emphasis of this work. employing the wien2k code, which implements the computational techniques employed in this work and is based on density functional theory.	A viable option for room-temperature thermoelectric applications could also be the full-Heusler Ag2TiGa material. Analyses of the two novel Heusler alloys could serve as a theoretical guide for further theoretical investigations and practical synthesis of Heusler alloys based on silver.	Elkoua, I. A., et al. (2024). [113]
4	Irradiation with charged particles: effects on the transport characteristics of topological insulators of bismuth chalcogenide	A unique platform for attaining fascinating applications like quantum computation, spintronics, and low-power electronics is provided by topological insulators, or TIs. Therefore, the research and development community many desires the topologically nontrivial surface state of TIs that is trapped in spin-momentum.	This study aims to compile the existing literature on the modulation of topological surface states in TI and Fermi energy tuning caused by particle irradiation. In order to produce magnetic topological ordering and surface selective topological superconductivity.	Abhirami, S., et al. (2024). [114]
5	The antimicrobial properties of terpolymers based on guanidines: synthesis, molecular docking, quantum chemical analysis, and spectroscopy (FT-IR, 1H, and 13C NMR).	Using a combination of theoretical and experimental approaches, this work provides a thorough evaluation of the antibacterial activity of a guanidine-based terpolymer (DGF). Mass spectra and experimental investigations, including 1H, 13C, and FT-IR data, provided structural insights.	This investigation suggests DGF as a possible antibacterial agent, particularly against Gram-positive bacteria like Staphylococcus species, and is consistent with previous antimicrobial studies. This is because DGF has a high binding affinity for S. aureus	Mujafarkani, N., et al. (2024). [115]

			and traditional hydrogen bonding.	
6	Strategies for spatial multiplexing in multiplexing fibre optic communications in the future.	Based on duration, polarisation, and frequency, multiplexing techniques will be used to meet the growing need for broadcast bandwidth. There are several ways to address any bandwidth issues with transmission networks by including time as an extra component.	The main classifications and features of novel SDM fibres, such as coupled-core MCFs, fewer-mode MCFs, multiple-core MCFs, and multiple-mode fibres, are first explained.	Shafiq, M., et al. (2024). [116]
7	Impact of inertinite on the physical and chemical properties of coal during thermal transformation and its liquefaction behaviours.	Although the composition of coal varies, its inertinite content hinders its liquefaction, which lowers the amount of coal-liquefied oil that is produced. Here, low-density inertinite (LDI) and high-density inertinite (HDI) coal samples were obtained by floating and sinking coal to examine the liquefaction performance of inertinite.	The TGA results showed that LDI's thermal breakdown reactivity was better than HDI's and comparable to raw coal. The X-ray data showed that, in comparison to raw coal and LDI after liquefaction, the size and number of aromatics in raw coal residue (RCR), LDI, and LDI residue (LDIR) increased.	Qian, W., et al. (2024). [117]
8	Phase equilibria modelling of cross-associating systems guided by a quantum chemical multi-conformational framework.	Molecules can cross-link to produce weakly bound molecular complexes in a variety of conformations with varying association energies. But the standard combining rules in state equations only take one conformation into consideration.	Liquid-Liquid Equilibrium (LLE) of water–alcohol–hydrocarbon mixes and the VLE of water–acetic acid–CO2 mixtures, based on the revised results for the binary systems.	Grigorash, D., et al. (2024). [118]
9	A review of recent developments in the fractionation of lignocellulosic components using deep eutectic solvents (DES).	Achieving total carbon transformation and carbon neutrality requires high-value utilisation of plant resources. The thorough utilisation of plant resources has already made significant strides thanks to pretreatment techniques, especially the deep eutectic solvent (DES) approach for pre-treating plant fibres.	Quantum chemistry, molecular simulation simulations, and the DES recycling effects (optimal 10 cycles) are used to assess the DES functionality. There is an explanation of the DES mechanism in lignocellulosic extraction, along with an outline of the opportunities for sustainable development.	Xiao, T., et al. (2024). [119]

10	Developing a molecular structure-based collector property index as part of the second quantitative assessment of collector flotation performance.	In order to effectively separate low-grade complicated ores by flotation, one of the most important steps in the creation of high-performance collectors is the assessment and forecast of flotation performance.	In contrast to most conventional QSAR models, which only apply to collectors with comparable skeletons or kinds, our QSAR model shows transferability by being able to forecast collectors with a wide range of skeletons or types.	Zhang, W., et al. (2024). [120]

Table 13: Online Education in quaternary industry

S. No.	Area	Issue	Outcome	Reference
1	Creation and assessment of salt- and temperature-resistant organic/inorganic composite copolymers.	Because of these characteristics, ordinary polymers are not as adaptable in high-temperature and high-salt reservoir settings. Because of their combined advantages, organic/inorganic composite copolymer microspheres are predicted to overcome their applicability restrictions in these types of oil reservoirs.	The outcomes demonstrated that, in situations with high Na+ and Mg2+ contents, quaternary copolymers could raise the viscosity retention rate by 10% in comparison to ternary copolymers.	Zhang, Y., et al. (2024). [121]
2	Gamification and Workplace Health	Gamification, which drives user motivations and offers game-like experiences, has been scientifically and practically studied as one of the most effective ways to engage users as the area of game and gamification study grows.	30 empirical studies on gamification and employee well-being are thoroughly reviewed in this study to answer several research questions.	Lehtoranta, S., et al. (2024). [122]
3	The distinct roles played by various stressors, the underlying degradation mechanism, the characterization of degradants by LC-MS/MS, and the development of an analytical method for duvelisib.	2018 saw the global approval of duvelisib (DUV). The results of a thorough literature search indicate that no degradation medium has been found to yet to have a distinct function in modifying the shelf-life of DUV because of exposure during storage. In addition, neither the degradation process nor its impurities are understood.	The scientific community and manufacturers can utilise this knowledge to optimise the formulation parameters and/or storage conditions.	Tapkir, N. T., et al. (2024). [123]
4	The geo ethics, ecotourism, and geo conservation	A number of degraded geological features and sceneries may be found on	Many of the sites have scores between moderate and high,	Sen, S., et al. (2024). [124]

	perspectives are used to assess the geo heritage of the geo sites in Tuwaiq Mountain, Saudi Arabia.	Tuwaiq Mountain, which is in the centre of Saudi Arabia. For the quantitative evaluation, ten geo sites in total have been identified.	according to the survey. The necessity for geo conservation is suggested by the geo sites' low to high loss risk.	
5	Mixtures of cationic and anionic surfactants with two head groups that resemble wormlike micellar solutions.	The creation of soft materials with unique qualities requires advancements in surfactant molecule structure.	When preparing extremely viscoelastic solutions in the future by combining cationic and anionic surfactants, this study will be a valuable reference.	Li, H., et al. (2024). [125]
6	Tectono-Stratigraphic Perspectives on the Behaviour of a Complex Subduction Zone in the Northern Peruvian.	Worldwide, accretionary, and erosive subduction are the two primary forms of subduction that are acknowledged. Although the northern Peruvian margin is a well-known example of a margin experiencing subduction erosion, the temporal variations in the subduction process and the history of the forearc basin, as well as the along-margin variability have not yet been thoroughly studied.	Combining magnetic anomaly data with current transpressional system activity suggests that the seismicity gap in southern Ecuador and northern Peru could be explained by the tectonic escape of the Nazca Sliver towards the northeast.	Lajo-Yáñez, J. A., et al. (2024). [126]
7	Geological maps and services offered by the Geological Survey of Norway during the past 165 years are functional, significant from a scientific standpoint, and honourable for the nation.	For societies, businesses, and individuals in general, geological maps record knowledge that is highly valuable from an economic, cultural, and aesthetic standpoint.	Important topics to think about include how geological mapping can be used to track national agendas such as Blue Growth and Green Shift.	Smelror, M. (2024). [127]
8	Late-stage modification of bioactive molecules can be achieved through the allylation of C, N, and O nucleophiles using a Tsuji-Trost reaction that is driven by mechanochemistry.	An alternate alkylating agent, solid allyl trimethylammonium chloride, is described as a nontoxic method for Tsuji–Trost allylation of O–, N–, and C–nucleophiles by mechanochemical processes without the need for solvents.	This process is amazingly effective and safe for the environment because it requires no air or moisture precautions and has exceptionally low catalyst loadings (0.5 mol %), quick reaction durations (<90 min), and a	Templ, J., et al. (2024). [128]

			straightforward setup.	
9	Advancements in Effective, Specific, and Eco-Friendly Recovery of Priceless Metal from e-waste and Industrial Catalysts.	One of the most important strategies for using metal resources is recycling metals from waste materials; the most significant recycling resources are waste catalysts and electronic debris, or "e-waste."	Certain fusion technologies have been created in order to solve these problems. When used extensively in industry, electrodeposition offers substantial benefits in terms of metal separation and purification, but it also consumes more energy.	Zheng, S., et al. (2024). [129]
10	Considering geoethics, geotourism, and geoconservation, a geoheritage assessment of the geosites in Tuwaiq Mountain, Saudi Arabia, is conducted.	Several degraded geological features and sceneries may be found on Tuwaiq Mountain, which is in the centre of Saudi Arabia. For the quantitative evaluation, ten geosites in total have been identified.	Based on the analysis, most of the sites have scores between moderate and high. The geosites' low to high degradation risk points to the necessity of geoconservation.	Sen, S., et al. (2024). [130]

Table 14: Virtual and Augmented Reality in quaternary industry

S. No.	Area	Issue	Outcome	Reference
1	Studying Augmented Reality Technology's Use in Teaching Tourism in Secondary Vocational Schools.	Because the state places such a high value on tourism, the sector's growth has revealed a trend towards a fast-growing need for professional skills. To develop tourism experts, some secondary vocational schools yet cling to antiquated ideas and conceptions, which means that the educational process still employs the original, conventional teaching methodologies.	This study outlines the use of augmented reality technology in secondary tourist teaching research. Augmented reality technology has become increasingly prevalent in the field of education in recent years due to the ongoing development of information technology.	Qiu, C., et al. (2024). [131]
2	Building Information Modelling: Innovative Uses of Digital Art and Augmented Reality in the Construction Sector.	The building life cycle is integrated with BIM, and the information management and application of the building life cycle are realised with the visual 3D model as the carrier.	Building information and models are seamlessly integrated into the real world through BIM+AR technology, which maximises the benefits of using BIM	Ma, X., et al. (2024). [132]

			technology on construction sites.	
3	Showing off augmented reality's real capabilities and prospects in the classroom.	One of the newest technologies that is gaining increased attention is augmented reality (AR). To find out how beneficial it is when used in education, a lot of worldwide research is done.	Often cited as the most common impediments are technical issues and equipment restrictions.	Koumpouros, Y. (2024). [133]
4	In low- and middle-income countries, virtual and augmented reality is used in cardiovascular care.	Augmented Reality (AR) and Virtual Reality (VR) technology are being increasingly integrated into the global health sector, especially in high-income nations. Applying this state-of-the-art technology to Low- and Middle-Income Countries (LMICs) is becoming more commonplace, especially in the field of cardiovascular care.	Because they provide regulated and immersive learning settings, AR and VR are also beneficial for life support training. Because AR and VR are more accessible and affordable, they have the potential to have a major influence on healthcare in low- and middle-income nations.	Shrestha, A. B., et al. (2024). [134]
5	Shop floor visualisation assessment and user research for pervasive augmented reality to facilitate real-time data monitoring in industrial applications.	A crucial tool in the shift to Industry 4.0 and smart manufacturing, augmented reality (AR) is becoming increasingly well-known across numerous industrial domains. One interesting usage for AR is in data monitoring, another area of Industry 4.0. Here, it may be applied to visualise and interact in real time with large and complicated data sets, thereby increasing decision-making accuracy and efficiency. In this initiative, we collaborate with industry partners to develop a Pervasive AR solution for data monitoring.	For comparison, the same data monitoring feature is also developed as a web application. These technologies were developed after the needs and requirements of industrial analysts were determined using a Human-Centered Design (HCD) methodology.	Maio, R., et al. (2024). [135]
6	Augmented Reality Based Immersion Framework for Trajectory Designing.	Astrodynamics and space mission planning require sophisticated spatial representations to be solved, and augmented reality's intuitive interaction capabilities make this possible. An interactive technique for creating orbit	This endeavour investigates the previously mentioned use of the Microsoft Hololens 2, along with its potential uses in both business and education.	Anderson, J. D., et al. (2024). [136]

		solutions and spacecraft missions is developed by utilising both simple and sophisticated orbital mechanics algorithms in augmented reality.		
7	A review of mobile learning environments that use augmented reality.	Through improved learner motivation and engagement as well as an engaging and productive learning environment, mobile learning environments based on augmented reality can aid in meeting learning objectives.	To make AR applications in education an efficient teaching tool, this systematic review outlines the main advantages and difficulties associated with their use.	Mirza, T., et al. (2024). [137]
8	3D printing and augmented reality combined with interactive fast prototyping.	An industry-wide fast prototyping phase is advised in the creation of new goods to enable the evaluation of an early version. By doing this, design flaws can be avoided in the finished product by making any necessary adjustments while the prototype is still being created.	It recognises the motions made by the user on the tangible prototype, translating touches and clicks into actions that may be carried out on the AR virtual prototype, giving it functionality and interactivity.	Omaia, D., et al. (2024). [138]
9	A comprehensive multi-site feasibility, usability, acceptability, and efficacy study was conducted on smartphone applications that combine augmented reality and virtual reality to train care home staff in hand hygiene.	To upskill care home employees in hand hygiene, it is necessary to evaluate the viability, implementation, usability, acceptance, and efficacy of smartphone applications that combine virtual reality (VR) and augmented reality (AR). Additionally, it is important to investigate the underlying mechanisms of learning.	Using a combination of pre-test and post-test methodologies, it examined the uptake and completion rates of AR, immersive VR, and non-immersive VR training, as well as validated and customised questionnaires, films, observations, and interviews. A descriptive analysis was performed using quantitative data. A mixed inductive and deductive method was used to analyse qualitative data.	Gasteiger, N., et al. (2024). [139]
10	An RCT was conducted to examine how augmented reality affected children's and teenagers'	Research has demonstrated that the use of virtual reality as a non-pharmacological intervention can effectively reduce anxiety in paediatric patients. In addition to having certain useful	This is the first large-scale randomised controlled research that, to the best of our knowledge, offers empirical proof of a reduction in anxiety in	Chamberland, C., et al. (2024). [140]

	preoperative anxiety.	advantages over virtual reality, augmented reality is a more recent immersive technology that also has positive effects on anxiety.	kids and teens who use augmented reality before getting general anaesthesia.	

5. METHODOLOGY :

The exploratory research method is used where the relevant information is collected through keyword-based search using search engines like Google, Google Scholar, and AI-driven GPTs and analysed, compared, and evaluated using suitable analysing frameworks. The results are interpreted as new knowledge obtained from this research and suggested in the form of outcome postulates.

6. CONCEPT OF TECH-BUSINESS ANALYTICS IN QUATERNARY INDUSTRY SECTOR :

In the Quaternary Industrial Sector, "tech-business analytics" refers to the application of data, technology, and analytical techniques to influence business choices and outcomes. Insights and data-driven decisions that can improve performance, productivity, and profitability must be gained from massive amounts of data that must be collected, processed, analysed, and understood. Tech-Business Analytics can be utilized in the Quaternary Industrial Sector to accelerate business processes, find new markets, enhance customer happiness, and comprehend client wants and preferences. Businesses may create more efficient operations, cut expenses, and make wiser decisions by leveraging technology and data analytics. There are various steps in the Quaternary Industrial Sector's tech-business analytics process, such as

Data Collection: To do this, information from structured and unstructured sources, including social media, customer reviews, sales data, and operational data, must be collected.
Data Preparation: To get rid of mistakes, inconsistencies, and duplication, data must be cleaned and processed.
Data Analysis: Data is searched for patterns, trends, and connections using analytical techniques such as machine learning algorithms, statistical models, and other strategies.
Data Visualization: To make the data easier to obtain and comprehend, graphical representations are employed.
Insights Generation: This entails interpreting the study's findings to produce knowledge that helps with decision-making for the company.
Decision-Making: Productivity, profitability, and performance may all be enhanced through data-driven decision-making by utilising the insights provided.

Enterprises operating in the Quaternary Industrial Sector must use tech-business analytics to enhance customer behaviour, accelerate operational procedures, and foster innovation. Businesses in this industry will have to constantly innovate and adapt as technology develops if they want to be competitive and satisfy the changing wants of their clients.

7. MODEL OF TECH-BUSINESS ANALYTICS IN QUATERNARY INDUSTRY SECTOR :

The "quaternary industry sector," also referred to as the knowledge-based economy, includes R&D, consultancy, information technology, and other high-tech services. Technology and data analytics are critical to the success of businesses in this industry. The following essential elements might be taken into consideration when creating a tech-business analytics model for the Quaternary industry sector:

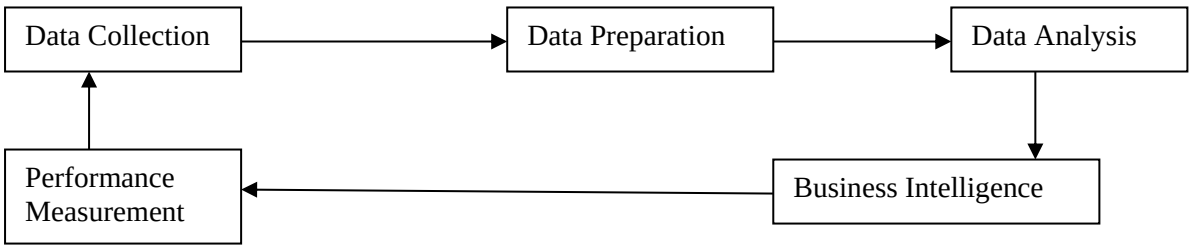

Fig.1: Tech-business analytics model for the Quaternary industry sector

Data Collection: Acquiring data is the initial stage of any analytics project. It can be required to gather information for this from both internal and external sources, such as government statistics, financial records, personnel files, social media, and trade magazines.
Data Preparation: Data gathering must be followed by processing and preparation for analysis. This can be achieved by sanitising the data, getting rid of mistakes and duplicates, and formatting it consistently.
Data Analysis: This is the first phase in the analytics process, which involves analysing the data and finding patterns using a range of statistical and machine learning approaches. Data visualisation, predictive modelling, and cluster analysis are a few of these tools.
Business Intelligence: Business decisions and plans can be better understood by utilising the data analysis results. This can only be done by transforming the data into insights that businesses can use to boost sales, reduce costs, and gain a competitive advantage.
Performance Measurement: Finally, it is imperative to monitor and assess the analytics project's progress throughout time. Monitoring key performance indicators (KPIs) such as employee productivity, revenue growth, and customer satisfaction are necessary to achieve this. These measurements can then be used to evaluate how the analytics project might affect the company's revenue.
Thus, data collecting and processing, analytics tools for extracting insights, turning insights into feasible plans, and evaluating the effect of these strategies on business performance make up a tech-business analytics paradigm for the Quaternary industry sector. Using data-driven decision-making, this paradigm may be used in a variety of industries, such as technology, banking, and healthcare, to achieve economic success.

7.1 Integration of BA with ICCT Underlying Technologies in Quaternary Industry:

The Quaternary Industry requires a complex fusion of data analytics, communication technologies, and cutting-edge service-sector strategies to integrate Business Analytics (BA) with Integrated Circuit Communication Technology (ICCT). Suppose this integration looks like this:

Table 15: Integration of BA with ICCT Underlying Technologies in Quaternary Industry

S. No.	Aspects	Description
1.	Data-Driven Decision Making in Services	Data play a critical role in the Quaternary Industry, which concentrates on knowledge-based services like financial services, R&D, and information technology. Big data analysis is possible using BA technologies, which can help with decision-making and reveal current information. BA can evaluate risks, forecast market trends, and personalise investment strategies, for instance, in the financial services industry.
2.	Enhanced Communication Technologies	Enhancing communication within these services is a major function of ICCT. The Quaternary Industry relies heavily on cloud computing, remote collaboration, and real-time data transfer; these functions require dependable and fast communication networks. Coordinating remote teams and overseeing massive digital projects, for example, requires effective communication in the IT and R&D industries.
3.	Automation and Efficiency	Automating repetitive processes can improve accuracy and efficiency when BA and ICCT are integrated. Under certain conditions, automated algorithms can process data, analyse trends, and even manage sophisticated decision-making. Operations in sectors like financial services, where quick decision-making and data analysis are essential, can be accelerated by this connection.
4.	Customization of Services	Services can be tailored based on data-driven insights thanks to the integration of ICCT and BA. Customers' experiences and business success can be improved in industries like e-commerce and digital marketing by using data analysis to understand customer preferences and behaviour and

		then communicating customised offerings through sophisticated communication technology.
5.	Security and Compliance	Security becomes critical as our reliance on data grows. To safeguard sensitive data, strong security measures must be incorporated into the BA and ICCT integration. Furthermore, it is imperative to adhere to rules, particularly in sectors such as finance and healthcare. Security and regulatory compliance are guaranteed by the advanced encryption and secure communication channels that ICCT offers along with compliance-focused data analytics.
6.	Innovative Service Development	And last, this integration may result in the creation of novel goods and services. Businesses in the Quaternary Industry can develop innovative, data-driven services that satisfy changing consumer and market demands by utilising the insights from BA and the capabilities of ICCT.

The Quaternary Industry's integration of BA with ICCT, thus, signifies the confluence of data analytics and innovative communication technologies to improve service delivery, efficiency, customisation, security, and innovation. To remain competitive in the quickly changing knowledge-based services industry, this integration is essential.

7.2 Integration of BA with AI & Robotics Technologies in Quaternary Industry:

The Quaternary Industry, which focuses on knowledge-based services including information technology, education, research, and development, can significantly increase efficiency and creativity by integrating Business Analytics (BA) with AI & Robotics technologies. This integration may appear in the following ways:

Table 16: Integration of BA with AI & Robotics Technologies in Quaternary Industry

S. No.	Aspects	Description
1.	Advanced Data Analysis and Predictive Modelling	When paired with AI, BA can conduct complex data analysis to provide prediction models and deeper insights. For the purposes of predicting consumer behaviour, evaluating risk, and analysing market trends, this integration is especially helpful in industries like financial services.
2.	Automation of Complex Processes	The Quaternary Industry can automate difficult operations with robotics and artificial intelligence. For instance, in research and development, artificial intelligence (AI) may automate data processing, accelerating the process of innovation, while robots can carry out dangerous or repetitive activities.
3.	Enhanced Customer Service	Chatbots and virtual assistants driven by AI can offer effective, round-the-clock client care in industries like IT and customer support. With the support of strong BA, these systems can provide individualised support through the analysis of client data.
4.	AI-driven Decision Making	AI algorithms can analyse large volumes of data to produce actionable insights that support leaders in making well-informed decisions in strategic planning and decision-making. For instance, AI in education can customise instructional strategies and resources by analysing data on student performance.
5.	Robotic Process Automation (RPA)	RPA may improve efficiency and decrease human error in operational and administrative duties by streamlining procedures. Particularly in sectors like financial and IT services that handle a lot of data, this is important.
6.	Personalized Services and Products	Highly customised services and goods can be produced by combining AI and BA. AI can be used to create personalised purchasing experiences in e-commerce, for instance, and to assist in the creation of personalised treatment plans in the healthcare industry.

7.	Enhanced Research and Development	AI in R&D can process and analyse scientific data faster and at a scale that is not possible for humans, which expedites the pace of breakthroughs. The R&D process can be expedited even more by using robotics to help with experiments and simulations.
8.	Ethical and Responsible AI Use	To ensure justice, accountability, and transparency in AI decision-making processes, integrating AI in the quaternary industry must be done ethically and responsibly. This is especially important in fields where choices can have an enormous influence on people's lives, including healthcare and education.
9.	Training and Development	To ensure that human capabilities match technology improvements, the integration of these technologies calls for ongoing workforce development and training to help employees adjust to new tools and procedures.
10.	Security and Privacy	Data security and privacy must be guaranteed in light of the growing usage of AI and BA. To prevent breaches and misuse of sensitive information, strong cybersecurity measures are required.

Thus, in the Quaternary Industry, combining BA with AI and Robotics technologies might completely transform the way knowledge-based services are provided, making them more inventive, efficient, and customised. But it is imperative that this integration be approached with a focus on data security, ethical behaviour, and ongoing learning and adaptation.

7.3 Integration of BA with Blockchain Technologies in Quaternary Industry:

Blockchain technology and Business Analytics (BA) integration offer a unique potential to transform data management, security, and operational efficiency in the Quaternary Industry, which includes knowledge-intensive industries like IT, banking, education, and research. The following describes the general course of this integration:

Table 17: Integration of BA with Blockchain Technologies in Quaternary Industry

S.No.	Aspects	Description
1.	Enhanced Data Security and Transparency	Data security in BA processes can be improved by utilising blockchain's intrinsic decentralisation, immutability, and transparency features. This is particularly important for sectors managing sensitive data, including finance and healthcare, where upholding data integrity and trust is critical.
2.	Improved Supply Chain Management	Blockchain integration with BA can improve supply chain management in industries like manufacturing and logistics. A tamper-proof ledger is provided by blockchain, and BA may use this data to analyse inventory levels, optimise delivery routes, and forecast potential supply chain interruptions.
3.	Smart Contracts for Automated Transactions	Blockchain-based smart contracts can automate transactions in industries like real estate and law by setting conditions ahead of time. To maximise these smart contracts' efficacy and efficiency, BA tools can examine historical transaction data.
4.	Decentralized Finance (DeFi) Services	Combining blockchain and BA in the financial industry can result in the creation of DeFi services, which provide financial services that are easier to obtain, transparent, and effective. To customise these services, BA can aid in the analysis of market trends, risk assessment, and consumer behaviour.
5.	Enhanced Customer Insights and Personalization	Customer data may be safely stored on blockchain, and BA can then use this data to analyse it and get insights into the preferences and behaviour of its customers. This combination allows for highly personalised customer experiences, making it particularly effective in marketing and e-commerce.
6.	Traceability and	Blockchain ensures product legitimacy by providing a verifiable history in areas such as luxury goods and pharmaceuticals. Inventory

	Authenticity in Products and Services	management, customer trends analysis, and product movement tracking are all possible with the help of BA's data analysis.
7.	Streamlining Intellectual Property Management	Blockchain can be used to handle intellectual property (IP) in the creative industries, such as music, art, and literature, in a transparent and safe manner. BA can assist with strategic analysis of market trends and customer preferences.
8.	Enhancing Research Data Management	Blockchain technology can be used in the academic and research industries to safely handle research data, guaranteeing its integrity and correct attribution. Research management decisions can be improved by using BA to examine funding trends, publication metrics, and research trends.
9.	Transparent and Efficient Healthcare Data Management	By producing a safe, unchangeable record of patient data, blockchain technology has the potential to completely transform healthcare data management. Personalised treatment plans, effective resource management, and improved healthcare delivery are all possible with the help of BA's analysis of this data.
10.	Regulatory Compliance and Reporting	Reporting and regulatory compliance can both benefit from the connection. Because blockchain technology is transparent, it is simpler to audit transactions and data; BA can assist in understanding this data to make sure that industry norms and regulations are being followed.
11.	Energy Sector Optimization	Blockchain can be used to facilitate efficient and transparent energy trading and distribution in the energy sector. BA can forecast demand, examine trends in energy use, and improve distribution systems.
12.	Real Estate and Property Management	Blockchain technology has the potential to simplify real estate transactions and administration while establishing an open record of property ownership and history. Investment prospects, property valuations, and market trends can all be examined with BA.
13.	Collaboration and Innovation in Quaternary Industry	Innovation and new types of collaboration are made possible by this convergence. To promote additional innovation, blockchain, for example, can be used to securely share knowledge and data between institutions, and BA can examine collaboration patterns and results.
14.	Challenges and Considerations	It is imperative to tackle issues like data protection, blockchain solutions' scalability, and the assimilation of these technologies into current systems. Ethical issues are also quite important, particularly when it comes to managing and using data.

Thus, improved data security, operational effectiveness, and innovation can result from combining blockchain technology with BA in the quaternary industry. To reach its full potential, though, significant thought must be given to the technological, moral, and legal ramifications.

7.4 Integration of BA with Cloud Computing Technologies in Quaternary Industry:

Efficiency, scalability, and innovation can be greatly increased in the Quaternary Industry, which is defined by knowledge-intensive activities including IT services, research and development, teaching, and consulting, by integrating Business Analytics (BA) with Cloud Computing technology. Below is a thorough analysis of the potential benefits of this integration:

Table 18: Integration of BA with Cloud Computing Technologies in Quaternary Industry

S.No.	Aspects	Description
1.	Scalability and Flexibility	Because cloud computing provides scalable resources, BA tools and apps may be simply scaled up or down in response to demand. This is especially helpful for sectors like digital marketing and e-commerce where workloads are inconsistent.

2.	Enhanced Data Storage and Management	Cloud computing offers advanced data management methods and a great amount of storage capacity. Businesses in the Quaternary Industry can now efficiently store and handle massive amounts of data, which is necessary for BA to produce insightful findings.
3.	Advanced Analytics Capabilities	Cloud computing gives firms access to cutting-edge analytics tools and technology. These solutions provide deeper insights for decision-making in industries including financial services, healthcare, and IT by processing and analysing massive datasets more quickly.
4.	Cost-Effectiveness	Pay-as-you-go cloud computing offers an economical alternative to on-premises infrastructure maintenance. Because it enables them to use sophisticated BA tools without making a substantial initial expenditure, this is especially advantageous for start-ups and small firms in the Quaternary Industry.
5.	Real-Time Data Processing and Analysis	Cloud computing makes real-time data processing and analysis possible, which is essential for sectors like stock trading, online retail, and emergency medical services that need quick insights.
6.	Collaboration and Accessibility	Collaboration is facilitated by cloud services that enable numerous users to share, edit, and view data at any time and from any location. In industries where teamwork is essential, like research and development, this boosts productivity and innovation.
7.	Data Security and Compliance	In sectors like healthcare and finance that handle sensitive data, reliable cloud service providers are essential because they provide strong security measures and compliance with different requirements.
8.	Integration with IoT and Other Technologies	Artificial Intelligence (AI), machine learning, and the Internet of Things (IoT) may all be easily combined with cloud computing to improve business analytics. Cloud-based data analysis of various IoT devices can be utilised in smart cities or smart healthcare systems to enhance their operations and services.
9.	Customization and Specialized Services	The unique requirements of various Quaternary Industry sectors can be catered to through the customisation of cloud-based BA tools. This enables the provision of specialised services that are catered to the particular difficulties and demands of every industry.
10.	Agility and Competitive Advantage	Businesses may respond swiftly to shifts in the market and client demands because to the agility that comes from integrating BA with cloud computing technology. With industries like technology and consulting changing quickly, this agility can be a big competitive advantage.

Therefore, the Quaternary Industry can reap several advantages by combining Cloud Computing and Business Analytics, including as increased collaboration, cost effectiveness, scalability, and sophisticated analytical capabilities. This integration is essential for companies looking to stay competitive in the knowledge-based economy by using data-driven insights for strategic decision-making.

7.5 Integration of BA with Cyber Security Technologies in Quaternary Industry:

In order to protect data and improve decision-making processes, the Quaternary Industry—which comprises knowledge-based industries like IT, banking, education, and research—must integrate Business Analytics (BA) with Cybersecurity Technologies. The benefits of this integration can be as follows:

Table 19: Integration of BA with Cyber Security Technologies in Quaternary Industry

S.No.	Aspects	Description
1.	Enhanced Threat	Through the integration of BA with cybersecurity technology, entities can scrutinise extensive datasets in order to discern trends and anticipate any

	Detection and Response	security hazards. By taking a proactive stance, possible harm can be reduced by responding to cyber threats more quickly.
2.	Risk Management and Compliance	By examining recent patterns and historical data, BA can assist in identifying and mitigating risks. This is crucial since there are strict legal requirements for data protection in industries like finance and healthcare.
3.	Customized Security Solutions	Customising cybersecurity solutions to meet unique organisational demands is made possible by BA. Businesses can create customised security plans that are more successful at reducing threats by examining historical events and present technologies.
4.	Data Breach Analysis	Using BA, one may assess the scope and consequences of a data breach. In order to improve security measures, comprehend vulnerabilities, and fulfil legal and regulatory reporting obligations, this study is essential.
5.	Predictive Analytics for Cybersecurity	By spotting irregularities and out-of-the-ordinary trends, behavioural analytics used to predictive analytics can forecast possible security incidents. This plays a critical role in defence fortification and proactive threat detection.
6.	Enhancing User Behaviour Analytics	To find compromised credentials or insider threats, BA can monitor and examine user behaviour. In sensitive industries like the government and defence, this is essential for preventing data leaks and unauthorised access.
7.	Optimizing Resource Allocation	When deciding how best to deploy their cybersecurity resources, businesses can benefit from Big Analytics. Businesses are able to more effectively allocate their cybersecurity technology investments by knowing which regions are most vulnerable.
8.	Improved Incident Response and Recovery	BA can improve incident response and recovery by offering data-driven insights into the characteristics and consequences of cyberattacks. This helps reduce downtime and create more effective recovery programmes.
9.	Training and Awareness Programs	By analysing cybersecurity events and patterns, BA can provide insights for the creation of more efficient training and awareness initiatives that inform staff about emerging threats and target particular vulnerabilities.
10.	Integration with Emerging Technologies	Using Blockchain with cybersecurity technologies can offer a strong defence mechanism as they develop. This is especially true now that AI and machine learning are becoming more and more prevalent in cybersecurity, providing sophisticated tools for threat identification and reaction.
11.	Continuous Monitoring and Improvement	Through integration, security systems and protocols may be continuously monitored to make sure they continue to work over time. By identifying areas for development, BA can maintain security measures current with emerging threats.
12.	Legal and Ethical Compliance	In sectors like healthcare and education that handle sensitive data, in particular, BA can help make sure cybersecurity solutions adhere to ethical and regulatory requirements.

For this reason, it is crucial to integrate business analytics with cybersecurity technologies in the quaternary industry in order to improve security protocols, manage risks, and guarantee compliance. Organisations can anticipate and address threats more effectively, allocate resources more effectively, and make well-informed decisions thanks to this integration, all of which are essential for safeguarding data and preserving confidence in knowledge-based industries.

7.6 Integration of BA with Internet of Things (IoT) Technologies in Quaternary Industry:

In the quaternary industry, Business Analytics (BA) and Internet of Things (IoT) technologies are integrated through a sophisticated synergy. Knowledge-based activities including information creation,

sharing, and administration are the main focus of the quaternary sector. In this industry, combining IoT with BA improves data-driven decision-making and streamlines operations.

Table 20: Integration of BA with Internet of Things (IoT) Technologies in Quaternary Industry

S.No.	Aspects	Description
1.	Data Collection and Analysis	IoT devices generate large amounts of data by gathering data in real time from multiple sources. These could include data from financial markets, academic studies, IT systems, and more in the Quaternary sector. With the use of BA tools, this enormous volume of data may be analysed to reveal trends and insights that were previously unavailable.
2.	Improved Decision Making	Faster and more informed decision-making is made possible by the integration. Companies in the Quaternary sector can forecast market trends, comprehend consumer behaviour, and make strategic decisions based on actionable insights by utilising the power of BA to analyse IoT-generated data.
3.	Enhanced Efficiency and Innovation	Operations are more efficiently run as a result of this integration. For example, predictive maintenance of IT services can be carried out through IoT data analysis, which lowers expenses and downtime. By discovering new markets and opportunities through the study of intricate data sets, it also promotes innovation.
4.	Customization and Personalization	Applying IoT to BA allows for more individualised approaches in fields like teaching and research. One way that BA can customise instructional content is by analysing learning patterns that students exhibit, which can be tracked by IoT devices.
5.	Security and Privacy Concerns	A lot of advantages come with the integration, but data security and privacy become serious issues as well. Protection from breaches and unauthorised access is necessary for the massive amounts of data that IoT and BA systems gather and analyse.
6.	Regulatory Compliance	Particularly in sectors handling sensitive data, organisations need to remain comply with changing legislation around data handling, privacy, and security as both BA and IoT technologies advance.
7.	Skills and Infrastructure	It takes money to provide the proper infrastructure and a team with the skills to handle and understand complicated data structures for BA and IoT to be integrated successfully in the quaternary sector.

Therefore, the Quaternary sector's integration of BA with IoT technologies promises increased productivity, innovation, and data-driven decision-making; but it also dictates that security, privacy, and regulatory compliance issues be carefully considered.

7.7 Integration of BA with 3D Printing Technologies in Quaternary Industry:

A ground-breaking development in the Quaternary industry is the combination of Business Analytics (BA) with 3D Printing technologies, which bridge the gap between data-driven analysis and decision-making and advanced production capabilities. This combination will be very beneficial to the Quaternary industry, which is knowledge- and information-centric. What are the effects and advantages of this integration for the industry?

Table 21: Integration of BA with 3D Printing Technologies in Quaternary Industry

S.No.	Aspects	Description
1.	Enhanced Design and Development	Rapid prototyping and production of intricate designs are made possible by 3D printing technologies. Businesses can better inform and optimise their product designs to better meet market demands by incorporating business analytics (BA) to analyse customer preferences, market trends, and performance data.

2.	Customization and Personalization	The capacity to customise things using 3D printing is one of its biggest benefits. When paired with BA, businesses may use consumer data analysis to develop customised goods that are catered to specific requirements, interests, and behaviours. This is particularly useful for industries like technology, healthcare, and education.
3.	Supply Chain Optimization	When it comes to supply chain optimisation for 3D printing, BA can be extremely important. Businesses can optimise their supply chains, cut waste, and boost productivity by analysing data on material usage, production schedules, and logistics.
4.	Predictive Maintenance and Quality Control	Predictive maintenance for printing equipment is made possible by combining BA with 3D printing. Through operational data analysis, businesses may minimise downtime by anticipating when maintenance is needed. The quality of printed goods can also be monitored and ensured with the aid of BA.
5.	Cost Reduction and Resource Optimization	Substantial cost savings are possible when 3D printing and BA are used together. While 3D printing minimises surplus inventory by reducing material waste and enabling on-demand production, BA aids in selecting the most cost-effective materials and procedures.
6.	Market Trend Analysis	It is easier to comprehend customer behaviour and market trends with BA. Because they can swiftly adjust to shifting market demands and provide timely, relevant products, organisations that use 3D printing will find this information to be vital.
7.	Security and Intellectual Property Concerns	Data security and intellectual property protection are becoming increasingly important issues with the growth of digital manufacturing. Businesses need to make sure that intellectual property rights are upheld and that the data used in 3D printing and BA processes is safe.
8.	Skill Development and Workforce Transformation	A staff with expertise in both data analytics and 3D printing is necessary for the integration of both technologies. Training and development initiatives are becoming more and more important in order to provide employees with the skills they require.

Thus, new opportunities for creativity, personalization, and efficiency arise when analytics are combined with 3D printing in the quaternary industry. In addition to promoting a more flexible and rapid response to market needs, it helps organizations make data-driven decisions for operations and product development. The difficulties of data security, intellectual property, and workforce skill development must also be addressed to fully implement this integration.

7.8 Integration of BA with Mobile Communication & Marketing Technologies in Quaternary Industry:

A potent combination is created in the Quaternary sector, which mostly deals with information services and knowledge-oriented activities when Business Analytics (BA) is integrated with Mobile Communication and Marketing Technologies. The integration of mobile technology with BA's pervasiveness facilitates improved customer engagement, optimized marketing strategies, and innovation in service delivery. These are some of the integration's main features:

Table 22: Integration of BA with Mobile Communication & Marketing Technologies in Quaternary Industry

S.No.	Aspects	Description
1.	Targeted Marketing Strategies	Businesses may learn more about customer behaviour, preferences, and trends by using business analytics to examine customer data obtained via mobile engagements. With this information, marketing efforts may be developed that are more specialised, more successful, and appealing to particular clientele.

2.	Enhanced Customer Experience	Engaging with clients directly and continuously is made possible by mobile communication technologies. Businesses can provide recommendations, services, and content that are tailored to the needs of individual customers by combining BA with customer data analysis.
3.	Real-Time Data Analysis and Responsiveness	A plethora of real-time data is produced by mobile technologies. Businesses may react swiftly to shifts in the market, client demands, or developing trends by using BA technologies to process this data fast.
4.	Location-Based Marketing	Location-based marketing is made possible by smartphones with GPS. By using location data analysis, BA may offer geo-specific promotions that increase the efficacy and relevancy of marketing campaigns.
5.	Improved Customer Insights through Social Media Analytics	Through the integration, businesses can participate in social media conversations on mobile devices. By using BA tools to analyse this data, marketing and product development plans can be guided by the insightful information that is obtained about customer opinions, preferences, and feedback.
6.	Personalization and Segmentation	Customers can be divided into groups according to their preferences, past purchases, and mobile usage habits thanks to BA. By allowing for more customisation of offerings and marketing messages, segmentation aids in improving conversion rates.
7.	Cost Efficiency in Marketing	Businesses can optimise their marketing expenditure by using BA to assess the performance of mobile marketing initiatives and concentrate resources on the most successful channels and tactics.
8.	Enhancing E-commerce and M-commerce	By evaluating consumer preferences and behaviours discovered through mobile interactions, the integration helps to improve e-commerce and m-commerce platforms by analysing user behaviour and optimising user interface and user experience.
9.	Challenges in Privacy and Data Security	This connection creates privacy and data security issues, as it does with any system that handles personal data. Companies need to make sure that consumer data is managed safely and morally, as well as to comply with data protection laws.
10.	Need for Continuous Innovation	Businesses need to constantly innovate and modify their business analytics strategies to remain competitive and relevant in the market, given the swift evolution of mobile technologies.

So, there are a lot of chances for improved customer interaction, tailored marketing, and data-driven decision-making in the Quaternary sector when Business Analytics is integrated with Mobile Communication and Marketing Technologies. Still, it necessitates constant innovation and adaptation, as well as close consideration of privacy and data protection.

7.9 Integration of BA with Information Storage Technologies in Quaternary Industry:

The Quaternary industry, which is focused on knowledge and information-based services, has made significant progress with the integration of Business Analytics (BA) with Information Storage Technologies. To improve data-driven decision-making, streamline information management, and promote innovation, this synergy takes advantage of the advantages of both fields. This integration has the following important components:

Table 23: Integration of BA with Information Storage Technologies in Quaternary Industry

S.No.	Aspects	Description
1.	Efficient Data Management	Large volumes of data produced by numerous sources can be stored thanks to information storage technologies. This data can be efficiently managed, retrieved, and organised with the aid of integrated BA. This data can be processed and analysed by analytical tools to provide valuable insights that enhance data accessibility and usefulness.

2.	Enhanced Data Analysis Capabilities	Businesses can handle and analyse big data more efficiently when they combine BA with cutting-edge storage technology. Making well-informed decisions requires a greater grasp of the patterns, trends, and anomalies present in huge datasets.
3.	Scalability and Flexibility	Data analysis and storage requirements change as Quaternary sector organisations expand. Data infrastructure may adjust to shifting demands without sacrificing effectiveness or performance when scalable storage solutions are integrated with BA.
4.	Improved Security and Compliance	Data security and compliance can be improved using information storage solutions that are connected with BA. Data protection rules can be complied with, possible security risks may be identified, and data access patterns can be monitored and analysed with the use of analytical tools.
5.	Predictive Analytics and Forecasting	Advanced storage systems like this can hold historical data, which BA programmes can use for predictive analytics. Businesses may plan and strategy ahead of time with this, which is especially helpful for predicting trends, customer behaviour, and market dynamics.
6.	Cost Optimization	Organisations can find opportunities to cut expenses, allocate resources more efficiently, and improve operational effectiveness by combining BA with information storage technology. For instance, data analysis can identify storage resources that are underutilised and should be reduced or moved.
7.	Enhancing Data-Driven Culture	Organisations that embrace this integration are more likely to have a data-driven culture, where choices are decided using analytical insights and empirical facts rather than gut feeling or conjecture.
8.	Innovation and New Opportunities	Finding new business prospects, developing cutting-edge services, and improving current offers are all possible with the insights obtained from the integration of storage and business analytics.
9.	Challenges in Data Integration and Quality	An issue is making sure that data from different sources are integrated into a high-quality, coherent dataset that can be analysed efficiently. For analytics to be dependable, data integrity and quality are critical.
10.	Skills and Knowledge Requirements	Information storage technologies and integrated BA require specific knowledge and abilities to be used effectively. To properly utilise these technologies, organisations might need to spend money on hiring or training qualified staff.

Therefore, the Quaternary sector can reap substantial advantages from the integration of Business Analytics with Information Storage Technologies, such as better security, cost optimization, and more effective data administration. The problems that come with it, meanwhile, are achieving the necessary skill requirements and guaranteeing data quality for successful implementation.

7.10 Integration of BA with Ubiquitous Education Technologies in Quaternary Industry:

A revolutionary shift in educational paradigms is marked by the combination of Business Analytics (BA) and Ubiquitous Education Technologies in the Quaternary industry, which is cantered on knowledge and information services. This combination improves educational opportunities, streamlines the learning process, and creates new paths for individualized instruction. An examination of this integration is provided below:

Table 24: Integration of BA with Ubiquitous Education Technologies in Quaternary Industry

S.No.	Aspects	Description
1.	Personalized Learning Experiences	The limits of the traditional classroom are broken down by ubiquitous education technology, which allow learning to occur anytime, anyplace. Through the integration of BA, learning environments and platforms can examine student data to comprehend unique learning obstacles,

		preferences, and styles, enabling the development of tailored learning paths.
2.	Data-Driven Curriculum Development	For the purpose of guiding curriculum creation, BA may evaluate a broad variety of data from pervasive learning settings. Teachers can better adapt the curriculum to the changing needs and interests of their students by having insights into popular courses, student performance, and engagement levels.
3.	Enhanced Student Engagement and Performance Tracking	Teachers may monitor and evaluate student performance and engagement in real time with BA. This data can be used to track progress, identify students who might require more help, and modify instructional strategies to improve learning results.
4.	Predictive Analytics for Early Intervention	Early intervention measures to support students who are at risk of falling behind can be enabled by using BA to analyse trends and patterns in student data. This helps detect probable learning challenges.
5.	Optimizing Educational Resources	The effective distribution of educational resources is aided by BA. Institutions can better manage their resources and save money by determining which ones are most effective or in demand by analysing usage statistics.
6.	Facilitating Collaborative Learning	Working together is facilitated by ubiquitous education technologies. In order to enhance collaborative learning environments and results, BA can examine patterns of cooperation and their results.
7.	Improving Accessibility and Inclusivity	When it comes to educational platforms and material, BA can be used to find gaps in accessibility and diversity. This guarantees that a wide variety of students, including those with disabilities, may access instructional resources.
8.	Feedback and Continuous Improvement	The constant improvement of teaching strategies and curriculum is made possible by the feedback that BA tools provide. With this flexible strategy, educational opportunities are guaranteed to stay useful and current.
9.	Challenges in Data Privacy and Security	Security and privacy of data are major problems when integrating BA with educational tools. Adhering to legal and ethical norms and safeguarding sensitive student data are critical.
10.	Need for Skilled Professionals	Proficient experts with knowledge of both analytics and education are needed for successful deployment. This could call for recruiting specialist people or additional training.

Therefore, there is a great deal of promise for more engaged learners, tailored instruction, and efficient use of educational resources in the Quaternary industry when Business Analytics and Ubiquitous Education Technologies are integrated. It does, however, also present issues with security, privacy, and the requirement for certain expertise.

7.11 Integration of BA with Virtual & Augmented Reality Technologies in Quaternary Industry:

The Quaternary sector, which primarily consists of information services and knowledge-based operations, offers a cutting-edge possibility to revolutionise numerous industry processes through the integration of Business Analytics (BA) with Virtual and Augmented Reality (VR/AR) technologies. This connection offers useful insights for data-driven decision-making in addition to improving user experiences. An outline of the effects this integration has on the quaternary sector is shown below:

Table 25: Integration of BA with Virtual & Augmented Reality Technologies in Quaternary Industry

S.No.	Aspects	Description
1.	Immersive Data Visualization and Analysis	Data visualisation may become an immersive experience when paired with VR/AR and BA. An easier way to help analysts and decision makers

		find patterns, trends, and anomalies in complex data sets is to portray them in three-dimensional areas.
2.	Enhanced Training and Education	For the purpose of training and teaching, VR/AR technology may produce lifelike simulations. Through the use of BA, user performance in these simulations can be monitored and analysed, revealing areas that require more training and offering insights for individualised learning.
3.	Improved Customer Engagement and Experience	By combining BA with VR/AR, businesses in the marketing, retail, and tourist sectors can create incredibly personalised and engaging customer experiences. Businesses may enhance engagement and satisfaction by customising VR/AR content to individual tastes through the analysis of client data.
4.	Product Development and Prototyping	The fabrication of virtual prototypes is made possible for industries engaged in product development by the combination of VR/AR and BA. Analytics can offer perceptions into consumer preferences and market demands, directing the development process and cutting down on the expense and duration of physical prototypes.
5.	Market Research and Consumer Behaviour Analysis	Research on consumer preferences can be done via VR/AR experiences. Consumer behaviour, preferences, and feedback can be obtained through the analysis of user interaction with virtual environments by BA tools.
6.	Operational Efficiency in Manufacturing and Design	VR/AR technologies can be used to visualise complete production processes or architectural designs in the manufacturing and design industries. These visualisations can be used to pinpoint areas in need of cost cutting, efficiency gains, and operational improvement by applying BA.
7.	Real Estate and Urban Planning	Urban designs or real estate properties can be virtually explored thanks to VR/AR technologies. Analysing prospective market demand, pricing tactics, and consumer preferences in the real estate industry can be aided by integrating BA.
8.	Challenges in Integration and Data Management	Challenges with data management, processing power, and guaranteeing smooth system and platform integration arise when integrating BA with VR/AR technology.
9.	Privacy and Security Concerns	Using BA with VR/AR creates privacy and security issues, as it does with any technology that handles personal data. Adhering to privacy laws and standards and managing user data in an ethical manner are crucial.
10.	Skillset and Infrastructure Requirements	Specialised knowledge of analytics and these cutting-edge technologies are needed to apply BA with VR/AR technology effectively. Furthermore, notably for high-quality experiences, a substantial infrastructure may be required to support VR/AR applications.
11.	Accessibility and Inclusiveness	It is essential to guarantee that VR/AR experiences are inclusive and accessible to all users, including those with disabilities. Any accessibility limitations in these technologies can be found and fixed with the aid of BA.
12.	Innovative Marketing and Advertising	VR/AR has the potential to produce immersive advertising experiences in the marketing domain. In order to provide insights for upcoming marketing efforts, BA can examine how customers interact and engage with these experiences.

Because of this, the Quaternary sector has a lot of opportunities for innovation, improved user experiences, and more individualised and efficient services when Business Analytics is combined with Virtual and Augmented Reality technologies. The issues of data management, privacy, skill

requirements, and guaranteeing accessibility and inclusivity are some of the difficulties technologies also presents, though, and they must be resolved.

7.12 Integration of BA with Quantum Computing Technologies in Quaternary Industry:

This ground-breaking invention with far-reaching ramifications is the combination of Quantum Computing technologies and Business Analytics (BA) in the Quaternary sector, which offers knowledge- and information-based services. The processing capability of quantum computing is significantly increased due to its capacity to process enormous volumes of data at previously unheard-of rates. The way data is studied, understood, and used across a range of knowledge-driven industries could be completely transformed by this collaboration. The possible effects and advantages are examined here:

Table 26: Integration of BA with Quantum Computing Technologies in Quaternary Industry

S.No.	Aspects	Description
1.	Exponentially Faster Data Processing	The primary benefit of quantum computing is its substantially faster execution of intricate computations compared to conventional computers. This feature makes it possible for BA tools to examine massive datasets in a fraction of the time now needed, facilitating data analysis and decision-making in real-time.
2.	Enhanced Predictive Analytics	Predictive analytics in BA can be considerably more accurate and comprehensive thanks to quantum computing's improved processing capability. In a variety of industries, including market research, finance, and healthcare, this translates into more accurate projections, risk evaluations, and trend studies.
3.	Complex Problem Solving	Beyond what regular computers can accomplish, quantum computing can tackle extremely complicated, multidimensional issues. Intricate optimisation issues in resource management, logistics, and strategic planning could be resolved with the use of this BA skill.
4.	Revolutionizing Machine Learning and AI	Machine learning algorithms can be expeditiously accelerated by quantum computing, resulting in increasingly complex and effective AI systems. By providing deeper insights and more precise forecasts, these developments help improve BA skills.
5.	Security and Cryptography	In terms of data security and cryptography, quantum computing provides new paradigms. The possibility for almost unbreakable encryption is also present, which is important for safe data analytics even though it presents hurdles to existing encryption techniques.
6.	Challenges in Integration	There are many technological obstacles in the way of integrating Quantum Computing with BA tools. Since quantum computing is still a relatively new technology, a lot more research and development will be needed to modify present business analysis methods in order to fully utilise it.
7.	Specialized Skill Sets Required	Precision and expertise are required due to the intricacy of Quantum Computing. To make the best use of this technology, professionals in the BA industry will require training in quantum computing and quantum mechanics.
8.	Ethical and Privacy Considerations	More accountability follows from enhanced data processing capabilities. The sophisticated capabilities of quantum computing make ensuring the moral use of data and upholding privacy rules considerably more important—and possibly more difficult.
9.	High Costs and Infrastructure Requirements	For many organisations, quantum computing technology is currently out of reach due to the large infrastructure and resource investments required.

10.	Potential for New Services and Products	Innovative services and goods may be developed as a result of integrating BA with quantum computing technology, especially in sectors where sophisticated data analysis and modelling are crucial. This can lead to the opening of new markets and expansion possibilities.

A future of enhanced data processing, sophisticated predictive analytics, and creative problem-solving skills is thus made possible by combining Business Analytics and Quantum Computing in the Quaternary business. But these technological changes, the need for specialised knowledge, infrastructure expenditure, and ethical issues all present obstacles to seamless integration. The technology known as Quantum Computing is showing signs of great promise in terms of revolutionising knowledge-driven industries and greatly enhancing the capabilities of Business Analytics.

8. ABCD ANALYSIS FRAMEWORK ON TECH-BUSINESS ANALYTICS IN QUATERNARY INDUSTRY SECTOR:

8.1 ABCD Analysis of TBA IN QUARTERNARY INDUSTRY as from supplier POINT OF VIEW:

8.1.1 Advantages on Tech-business Analytics in Quaternary industry sector from supplier point of view: There are several advantages to using tech-business analytics in the Quaternary industry.

Table 27: Advantages on Tech-business Analytics in Quaternary industry sector from supplier point of view

S.No.	Aspects	Description
1.	Better decision-making	Using analytics, managing and analysing vast volumes of data can lead to more informed and data-driven business decisions. Better results, such higher revenue, increased efficacy, and happier clients, could result from this.
2.	Competitive advantage	Gaining market and customer insights through analytics can help organisations outperform their competitors. When they spot new trends and market opportunities ahead of their rivals, for instance, they can seize the chance to increase their market share.
3.	Cost savings	Businesses can reduce expenses and boost their bottom line by identifying areas where savings may be realised, such as through more effective workflows or less waste. Businesses can also find underutilised resource locations by employing analytics to find ways to make the most of the assets they currently have.
4.	Improved customer experience	Companies that use analytics can gain a better understanding of the needs, preferences, and routines of their customers. Consequently, enterprises may find themselves in a more advantageous position to tailor their offerings to the specific needs of their clientele, thereby elevating consumer satisfaction and loyalty.
5.	Innovation	Innovative products and services as well as new market niches can be found by firms with the aid of analytics. Through the application of analytics, companies can identify untapped areas and prospects for growth by examining consumer and market trends.

Taken together, tech-business analytics is a potent tool that companies can leverage to enhance learning, make smarter choices, and get a competitive edge in the Quaternary market. Businesses can open up new growth and success opportunities by utilising the power of data analytics.

8.1.2 Benefits on Tech-business Analytics in Quaternary industry sector from supplier point of view:

Sometimes referred to as the Quaternary industry sector, the knowledge sector is made up primarily of companies that deal with information, technology, and innovation. This industry covers a variety of disciplines, including software development, data analytics, technology consulting, and research and

development. Businesses in the quaternary industry can gain the following advantages by employing tech-business analytics:

Table 28: Benefits on Tech-business Analytics in Quaternary industry sector from supplier point of view

S.No.	Aspects	Description
1.	Improved decision-making	By giving them insights into industry trends, consumer behaviour, and other important variables, tech-business analytics can assist companies in making data-driven decisions. Through improved decision-making and overall performance, businesses stand to gain from this.
2.	Increased efficiency	Business IT analytics can be used to improve productivity and simplify processes. Through process automation and improvement identification, firms can lower costs and increase profitability.
3.	Enhanced customer experience	Businesses may better understand the needs of their clients and give them a more individualised experience by utilising tech-business analytics. Utilising consumer data, businesses may customise their goods and services to the unique requirements and tastes of their intended market.
4.	Competitive advantage	Companies that use tech-business analytics can outperform their competitors. By leveraging data to enhance decision-making and streamline processes, companies can surpass rivals and increase their market share.

Improved decision-making, increased productivity, improved customer satisfaction, and increased competitiveness are just a few advantages that businesses in the quaternary sector can reap from tech-business analytics in general.

8.1.3 Constraints on Tech-business Analytics in Quaternary industry sector from supplier point of view:

Although there are several advantages to using tech-business analytics in the quaternary industry, there are also some potential drawbacks for companies, such as:

Table 29: Constraints on Tech-business Analytics in Quaternary industry sector from supplier point of view

S.No.	Aspects	Description
1.	Data quality	The accuracy and completeness of data can affect the effectiveness of tech-business analytics. Inadequate or erroneous data may lead to poor decisions and actions.
2.	Data privacy and security	Businesses gather and keep enormous volumes of data, making data security and privacy crucial. A company's reputation may suffer in the event of costly data breaches.
3.	Skilled personnel	Employers that are extremely proficient in data analysis and data-driven project implementation are the key to implementing tech-business analytics. A shortage of competent workers could arise from the high demand for certain skills.
4.	Cost	It could be expensive to apply tech-business analytics, especially for smaller businesses. This also includes the cost of purchasing equipment for data processing and collection, in addition to the cost of hiring appropriately qualified employees.
5.	Resistance to change	A company may need to alter its procedures and culture in order to implement tech-business analytics. The execution of new initiatives may be hampered by employees who are averse to change.

Tech-business analytics can have a number of drawbacks in addition to its numerous potential advantages for companies in the quaternary industry. Several limitations encompass the requirement for experts, costs, reluctance to adapt, and concerns regarding confidentiality and safety.

8.1.4 Disadvantages on Tech-business Analytics in Quaternary industry sector from supplier point of view:

There are certain drawbacks to using tech-business analytics in the Quaternary industry sector, in addition to the previously stated restrictions. These are a few of these flaws:

Table 30: Disadvantages on Tech-business Analytics in Quaternary industry sector from supplier point of view

S.No.	Aspects	Description
1.	Dependence on technology	Advanced platforms and technologies with state-of-the-art capability are needed for tech-business analytics. Organisations with a high reliance on technology may be more susceptible to technical problems such as data breaches and system failures.
2.	Overreliance on data	Even in situations when data might yield insightful information, an over-reliance on it can result in tunnel vision and a restricted concentration on quantitative measurements at the detriment of qualitative aspects. Consequently, one's capacity to solve problems may be hampered by a lack of imagination and ingenuity.
3.	Inability to capture all relevant data	Obtaining all pertinent information is not always possible, despite advancements in data collecting and processing. This could lead to inadequate understanding and bad decision-making.
4.	Ethical concerns	Data security, privacy, and ethical use of data are becoming more and more of a problem as corporations gather and analyse massive volumes of data. A person's legal position and reputation could be jeopardised by this.
5.	Inability to predict future trends accurately	Though it might not be able to accurately forecast future trends, tech-business analytics can assist organisations in identifying patterns and trends that already exist. As such, a firm might find it more difficult to formulate a strong long-term plan.

Consequently, there are a number of drawbacks that need to be taken into account even if tech-business analytics can give companies in the Quaternary sector useful information and a competitive edge. Some of these drawbacks include an inability to predict future trends with accuracy, moral quandaries, data excess, insufficient data collection, and dependence on technology.

8.2 ABCD ANALYSIS OF TBA IN QUARTERNARY INDUSTRY AS PRODUCER POINT OF VIEW:

8.2.1 Advantages on Tech-business Analytics in Quaternary industry sector from producer point of view:

The implementation of Technology-driven Business Analytics (Tech-BA) offers numerous benefits to producers in the Quaternary industry, which is centred on knowledge-based services including information technology, consultancy, research, and education. Given that this industry is information-centric and data-intensive, these advantages are especially important. The following are some significant benefits:

Table 31: Advantages on Tech-business Analytics in Quaternary industry sector from producer point of view

S.No.	Aspects	Description
1.	Data-Driven Decision Making	Producers may make well-informed decisions more rapidly because to Tech-BA's real-time data and analytics capability. This capability is essential in a market that is changing quickly, where

		making decisions quickly and with data can provide you a competitive edge.
2.	Enhanced Customer Insights	Producers can learn more about the needs, preferences, and behaviours of their customers by utilising Tech-BA. Developing focused marketing campaigns, enhancing customer service, and producing customised goods and services all depend on this realisation.
3.	Operational Efficiency and Cost Reduction	Tech-BA solutions can help producers cut costs and streamline operations by detecting inefficiencies in business processes. This includes streamlining resource distribution, automating repetitive processes, and optimising supply networks.
4.	Market Trend Analysis and Forecasting	With Tech-BA, producers may predict future consumer behaviours and analyse market patterns. This is particularly helpful in the Quaternary sector, where staying on top of trends is frequently essential to remaining relevant and competitive.
5.	Innovative Product Development	Producers are better equipped to innovate and create new goods and services that cater to the changing demands of the market with the knowledge they get from Tech-BA. In addition to encouraging creativity, this may result in advances in technology and service provision.
6.	Risk Management and Compliance	Tech-BA helps to make sure that industry laws are followed and to identify possible dangers. In sectors where compliance and risk management are critical, such as finance and healthcare, this is especially significant.
7.	Improved Collaboration and Communication	Tech-BA can facilitate better departmental and stakeholder engagement by integrating many data sources and offering easily accessible analytics. Project management and execution become more unified and effective as a result of the enhanced communication.
8.	Customer Relationship Management (CRM)	Tech-BA may improve CRM systems by offering information on customer interactions, sales patterns, and customer feedback. This would enable manufacturers to forge closer, more lucrative bonds with their customers.
9.	Scalability	Tech-BA solutions can expand with the company because they are frequently scalable. Because it allows them to modify their analytical skills as their firm grows, scalability is crucial for producers in the rapidly changing Quaternary sector.
10.	Competitive Advantage	In the end, applying Tech-BA can offer a notable edge over competitors. Producers who successfully use these technologies can keep ahead of market trends, adjust faster to shifting consumer needs, and provide more inventive and responsive goods and services than their rivals.

Therefore, incorporating technology-driven business analytics is essential for manufacturers in the quaternary sector to remain competitive in a market that is continually changing and driven by data, rather of just being a value-added tool. Producers can ultimately achieve sustainable development and success by leveraging Tech-BA to improve decision-making, optimise operations, stimulate innovation, and manage risks.

8.2.2 Benefits on Tech-business Analytics in Quaternary industry sector from producer point of view:

The advantages of using technology-driven business analytics (Tech-BA) are numerous and significant from a producer's perspective in the Quaternary industry area, which comprises intellectual activities, knowledge-based services, and information services. The following are some of the main advantages:

Table 32: Benefits on Tech-business Analytics in Quaternary industry sector from producer point of view

S.No.	Aspects	Description
1.	Improved Decision-Making	Producers are able to make more strategic and informed decisions because to Tech-BA's insightful data analysis findings. From market research to internal process enhancements, this covers it all.
2.	Enhanced Product Development	Manufacturers may utilise Tech-BA to innovate and create goods and services that are more suited to consumer demands and new market opportunities by examining market trends, consumer feedback, and existing demand.
3.	Efficient Operations	Tech-BA is able to uncover operational inefficiencies and offer data-driven suggestions for improvement. Processes are streamlined as a result, and operating expenses are decreased and productivity is raised.
4.	Predictive Analytics for Proactive Strategies	Producers in Tech-BA can be proactive in their approach instead of reactive by using predictive models to foresee changes in the market, client wants, and potential dangers.
5.	Targeted Marketing and Personalization	Tech-BA makes it possible to create marketing campaigns that are specifically targeted by knowing the preferences and behaviours of the customers. Increased sales, more customer happiness, and higher engagement rates can result from this.
6.	Competitive Advantage	Producers might have an advantage over competitors in the market by utilising the insights obtained from Tech-BA. They are better able to innovate, provide better consumer experiences, and quickly adjust to changes.
7.	Risk Management and Compliance	By guaranteeing adherence to industry rules and standards, Tech-BA assists in risk identification and mitigation. Reputation management and avoiding financial or legal repercussions are dependent on this.
8.	Customer Insights and Relationship Management	Producers may boost customer retention and forge better bonds with their customers by delving deeper into the wants and preferences of their audience through the analysis of customer data.
9.	Data-Driven Supply Chain Management	Demand forecasting, inventory control, and determining the most effective logistics routes are all ways that Tech-BA may enhance supply chain management.
10.	Scalability and Flexibility	Tech-BA solutions offer flexibility and adaptation in a dynamic market context by being scalable to meet the size and evolving needs of the organisation.

Therefore, the incorporation of technology-driven business analytics in the quaternary sector provides producers with a host of advantages, such as improved decision-making skills, increased operational effectiveness, innovative product development, and a competitive edge in the marketplace. These instruments support both strategically planning for future growth and success as well as managing the difficulties of the present market.

8.2.3 Constraints on Tech-business Analytics in Quaternary industry sector from producer point of view:

Although producers in the Quaternary industry sector can reap substantial benefits from Technology-driven Business Analytics (Tech-BA), there are also noteworthy limitations and difficulties that must be addressed. From a producer's point of view, knowing these restrictions is essential to using Tech-BA effectively. The following are some of the main limitations:

Table 33: Constraints on Tech-business Analytics in Quaternary industry sector from producer point of view

S.No.	Aspects	Description
1.	Data Quality and Availability	The availability and quality of data have a major impact on Tech-BA's efficacy. Decision-making and strategy creation can be impacted by inaccurate, incomplete, or out-of-date data, which can produce deceptive analytics results.
2.	High Costs and Investment	Advanced Tech-BA system implementation and upkeep might be expensive. Investments in software tools, IT infrastructure, and qualified labour are necessary. This can be a major financial obstacle for some companies, particularly smaller ones.
3.	Complexity and Technical Challenges	Because tech-BA systems can be intricate, managing and interpreting the data successfully requires specific expertise and abilities. It can be difficult to deal with this complexity, especially for producers that don't have internal data analytics skills.
4.	Integration with Existing Systems	It can be difficult to integrate new Tech-BA technologies with current IT systems and procedures. In order to guarantee interoperability and smooth data transfer between various platforms, meticulous design and implementation are needed.
5.	Data Privacy and Security Concerns	Privacy and security issues arise when handling vast amounts of data, particularly sensitive or personal data. Producers are responsible for making sure that data privacy laws are followed and for putting strong security measures in place to guard against breaches and unwanted access.
6.	Scalability Issues	Although Tech-BA systems can typically manage larger data volumes or more complicated analytics, scaling them up to fulfil these tasks can be difficult and resource-intensive.
7.	Change Management	Processes and workflows inside organisations must frequently be significantly altered in order to implement Tech-BA. It can be quite difficult to manage this transition, which includes educating employees and changing current procedures.
8.	Reliance on External Vendors	For Tech-BA tools and services, a lot of producers depend on outside suppliers. This dependence may run the risk of limiting the ability to tailor the tools to meet particular requirements and introducing uncertainties around the stability of the vendor and cost variations.
9.	Ethical and Bias Concerns	Algorithms used in data analytics may have underlying biases that provide immoral results or judgements. Producers should be mindful of these concerns and endeavour to guarantee that their analytics tools are as impartial and morally sound as feasible.
10.	Keeping Pace with Technological Advances	Keeping up with the newest advancements in the continuously growing field of Tech-BA can be difficult. To fully take advantage of evolving technology, producers need to continuously spend in staff training and system updates.
11.	Analysis Paralysis	The risk of being paralysed by the sheer amount of data and analytical capabilities is that it can cause hesitation or delays in decision-making, a condition known as "analysis paralysis."
12.	Cultural Resistance	Adopting new technology or altering long-standing procedures may encounter resistance in some organisations. It will take strong leadership and change management techniques to overcome this cultural inertia.
13.	Limited Interpretability of Complex Models	These days, machine learning and advanced analytics can be "black boxes," with little explanation of how they arrive at particular

		results. For producers who must comprehend the reasoning behind analytics-driven choices, this lack of openness may be concerning.
14.	Ensuring Continuity and Support	Due to their reliance on sophisticated BA solutions, manufacturers must establish strategies for backup and support in the event that a system malfunctions or is interrupted.
15.	Balancing Automation and Human Insight	Many procedures can be automated with Tech-BA, but it's important to balance this automation with human insight and intervention. The subtle insight that human judgement brings can be overlooked by an over-reliance on automation.

As a result, although Tech-BA offers manufacturers in the Quaternary sector a number of options, it also has limitations and difficulties of its own. In order to realise Tech-BA's full potential and succeed in the knowledge-driven economy over the long run, it is imperative that these problems are resolved.

8.2.4 Disadvantages on Tech-business Analytics in Quaternary industry sector from producer point of view:

The application and utilisation of Technology-driven Business Analytics (Tech-BA) might provide several drawbacks and difficulties for producers operating in the Quaternary industry sector, which is highly dependent on knowledge and information-based services. A few of the main issues are as follows:

Table 34: Disadvantages on Tech-business Analytics in Quaternary industry sector from producer point of view

S.No.	Aspects	Description
1.	High Implementation Costs	It is frequently necessary to make large investments in both technology and human resources when setting up Tech-BA systems. The expenses cover the cost of technology, software, and employing or educating employees who possess the required analytical abilities.
2.	Complexity and Skill Requirements	To function properly, tech-BA systems might be complicated and necessitate certain expertise. This raises operating expenses and complexity by requiring either retraining of current staff members or employment of new hires with the necessary experience.
3.	Data Privacy and Security Risks	Managing large data sets presents serious privacy and security issues, especially when dealing with sensitive or personal data. Data breaches are possible, and they carry the potential of negative legal outcomes as well as reputational harm to the business.
4.	Dependence on Data Quality	Data quality is a major factor in Tech-BA effectiveness. Inaccurate, outdated, or insufficient data can result in poor data quality, which can affect business choices and cause wrong assessments.
5.	Integration Challenges	It can take a lot of effort and time to integrate Tech-BA technologies with the current IT architecture. Operations may be disrupted because it frequently calls for significant modifications to current systems and procedures.
6.	Potential for Over-reliance	It is possible to rely too much on algorithms and analytical tools, which could result in a lack of important human oversight. This over-reliance may lead to lost chances or the inability to recognise new patterns that algorithms could overlook.
7.	Cultural Resistance	Workers may object to the implementation of Tech-BA, particularly if it means major adjustments to work procedures or jeopardises job security. It takes rigorous change management to handle this cultural transformation.
8.	Analysis Paralysis	A situation known as "analysis paralysis," in which decisions are postponed because of an excessive amount of data analysis or

		waiting for additional information, can occasionally result from the availability of data and analytical options.
9.	Maintaining and Updating Systems	To be secure and functional, tech-BA systems need regular updates and maintenance. Time and financial resources may be heavily depleted by this continuing necessity.
10.	Ethical Concerns and Bias	Data and algorithms utilised in Tech-BA may contain ingrained biases. These prejudices may result in immoral choices or deeds that may not be immediately apparent but may have detrimental long-term effects.
11.	Limited Flexibility and Customization	The particular requirements of an organisation could not always be perfectly met by off-the-shelf Tech-BA solutions. These systems might be expensive and time-consuming to customise.
12.	Technology Obsolescence	Tech-BA tools run the risk of fast becoming outdated given the speed at which technology is advancing. To keep up with the times, companies may have to make costly, ongoing investments in new technologies.
13.	Difficulty in Measuring ROI	It can be difficult to calculate the Tech-BA initiatives' return on investment (ROI). Especially in the near run, the benefits—which are frequently expressed as enhanced decision-making or better efficiency—can be ethereal and difficult to measure.
14.	Handling Large Data Volumes	The overwhelming amount of data that Tech-BA technologies create and must handle can necessitate the use of additional resources for data management and storage.
15.	Disconnect from Ground Reality	If Tech-BA is used excessively, it can lead to a detachment from the real-world business environment since statistics and algorithms may miss the subtle, qualitative components of customer interactions and business processes.

Thus, manufacturers in the Quaternary business confront major problems even as Tech-BA offers several advantages in terms of improved decision-making, efficiency, and competitive advantage. High expenses, complexity, worries about data security, a possible over-reliance on technology, problems with integration, and the requirement for ongoing system administration and adaption are a few of these.

8.3 ABCD ANALYSIS OF TBA IN QUATERNARY INDUSTRY FROM CONSUMER POINT OF VIEW:

8.3.1 Advantages on Tech-business Analytics in Quaternary industry sector from consumer point of view:

Particularly when considering the consumer, the following are the benefits of tech-business analytics in the quaternary industry sector:

Table 35: Advantages on Tech-business Analytics in Quaternary industry sector from consumer point of view

S.No.	Aspects	Description
1.	Personalized Experience	Businesses can gain a better understanding of client preferences and behaviours by utilising advanced analytics. This improves consumer involvement and happiness by resulting in customised goods, services, and marketing tactics.
2.	Improved Product and Service Quality	Businesses can improve their products by using analytics, which offer insights into user input and product performance. Customers directly gain from this quality increase since they get better goods and services.
3.	Efficient Customer Service	Employing tech-business analytics, organisations can anticipate and address client problems earlier, resulting in more effective and efficient customer care.

4.	Innovative Solutions	Insights derived from analytics promote creativity. Quaternary industry businesses frequently use these data to create new technologies and solutions that meet changing customer needs.
5.	Cost Savings for Consumers	Cost savings are possible through more cost-effective operations and enhanced supply chain management, both promoted by analytics. More value for money or cheaper prices are frequently offered to customers as a result of these savings.
6.	Enhanced Security and Privacy	Analytics has the potential to enhance cybersecurity protocols, safeguarding customer information and building confidence.
7.	Better Decision Making	Data-driven decision-making by businesses that prioritise market trends and customer needs results in more appealing and relevant goods and services, which benefits consumers.
8.	Economic Benefits	Through a better economy, the effective functioning of quaternary sector businesses, bolstered by analytics, contributes to economic growth and stability, which in turn benefits consumers.

Therefore, tech-business analytics in the quaternary sector can result in improved decision-making, cost savings, enhanced security, more individualised and high-quality goods and services, effective customer service, and innovative solutions.

8.3.2 Benefits on Tech-business Analytics in Quaternary industry sector from consumer point of view:

From the standpoint of the customer, quaternary industry tech-business analytics provides the following advantages:

Table 36: Benefits on Tech-business Analytics in Quaternary industry sector from consumer point of view

S.No.	Aspects	Description
1.	Personalization of Products and Services	Businesses may better grasp the unique tastes and behaviour patterns of their customers with the use of analytics. A more customised and fulfilling customer experience is ensured by the resulting tailored products and services.
2.	Enhanced Product Quality and Innovation	Companies can innovate and enhance the quality of their offerings by evaluating market trends and customer feedback. This implies that customers will have access to better, more sophisticated goods and services.
3.	Improved Customer Service	Businesses may anticipate client wants and proactively handle difficulties with the help of data analytics. Customer satisfaction is increased overall as a result of the faster and more effective customer service.
4.	Competitive Pricing	Gaining insights from analytics into the workings of the market and optimising operations can save companies money. Prices that are competitive can be the result of passing these savings on to customers.
5.	Data-Driven Recommendations	Customers gain from recommendations that are customised to their requirements and interests, based on data-driven analysis of their prior actions and preferences.
6.	Increased Security and Privacy Protection	To fortify data security protocols, protect customer data, and foster confidence, advanced analytics can also be utilised.
7.	Better Accessibility	Analytics may assist companies in streamlining their supply chains and distribution networks, increasing the accessibility of their goods and services to a larger group of customers.

8.	Informed Decision	Customers can now make better judgements about the goods and services they use since more businesses are utilising analytics to exchange data and insights.
9.	Sustainability and Ethics	Modern consumers place an increasing amount of importance on firms adopting more ethical and ecological practices, and analytics may help.
10.	Economic Advantages	Through a stronger economy and possibly more job possibilities, consumers will indirectly benefit from the effective application of analytics in the quaternary sector, which can promote economic growth and stability.

Thus, in the quaternary industry sector, tech-business analytics results in better customer service, competitive pricing, enhanced security, and more accessible, high-quality, and customised goods and services. It also fosters an ethical and knowledgeable consumer environment.

8.3.3 Constraints on Tech-business Analytics in Quaternary industry sector from consumer point of view:

Although tech-business analytics in the quaternary industry sector has many advantages, there are drawbacks and difficulties as well, particularly for consumers:

Table 37: Constraints on Tech-business Analytics in Quaternary industry sector from consumer point of view

S.No.	Aspects	Description
1.	Privacy Concerns	Privacy concerns may arise from the widespread usage of data analytics. Customers may be apprehensive about the methods utilised to gather, store, and exploit their personal data.
2.	Over-reliance on Automated Systems	An excessive dependence on analytics and automated systems may result in less personalised customer care, which may turn off some customers.
3.	Data Accuracy and Bias	Analytics are only as good as the information that is entered. Customers' quality of experience with goods and services might be negatively impacted by inadequate, biased, or inaccurate data that produces false insights.
4.	Security Risks	There's more of a chance of data breaches because of the increased data collection. Customers' personal information may become public as a result of this.
5.	Complexity and Overwhelm	Customers who are not tech-savvy, in particular, may find the complexity of goods or services powered by sophisticated analytics to be too much to handle.
6.	Lack of Transparency	Customers may become sceptical of businesses if they don't always understand how their data is being utilised to make judgements.
7.	Ethical Concerns	In particular, if algorithms discriminate against specific customer groups, using analytics in decision-making processes may give rise to ethical questions.
8.	Dependency on Technology	An excessive reliance on analytics has the potential to reduce human decision-making skills by making consumers and enterprises unduly dependent on technology.
9.	Digital Divide	Access to digital technologies is not universal among consumers. Differences in the advantages of tech-business analytics may result from this division.
10.	Manipulative Marketing Practices	There is a chance that highly focused and convincing marketing strategies could be used to influence consumer decisions using analytics.

Because of these limitations, it is more important than ever to utilise analytics responsibly and ethically, keeping in mind the rights and interests of consumers while maintaining a focus on consumer privacy, security, and transparency.

8.3.4 Disadvantages on Tech-business Analytics in Quaternary industry sector from consumer point of view:

Tech-business analytics in the quaternary industry sector has a number of drawbacks from the consumer's point of view.

Table 38: Disadvantages on Tech-business Analytics in Quaternary industry sector from consumer point of view

S.No.	Aspects	Description
1.	Privacy Concerns	Large-scale privacy problems may arise from the gathering and processing of consumer data. Customers could be concerned about who has access to and how their personal information is used.
2.	Data Security Risks	Data breaches are more likely to occur when data collecting increases. Customers could run the danger of having their private data stolen.
3.	Over-Reliance on Automation	A deficiency of customisation in customer service might result from an over-reliance on automated methods and algorithms. Customers may feel less satisfied and that interactions are impersonal as a result.
4.	Bias in Data and Algorithms	Data collecting and computational procedures carry the potential of introducing inherent biases, which can result in unfair or discriminatory behaviours that target particular customer groups.
5.	Loss of Human Touch	Many customers may find it off-putting when customer service and business interactions become more about analytics and technology.
6.	Complexity and User Unfriendliness	A consumer may find it challenging to comprehend and utilise certain analytics-driven products or services if they become unduly complex.
7.	Misuse of Consumer Data	Constant misuse of customer data is a possibility, whether deliberate or not, and can result in intrusive situations such as targeted advertising or manipulative marketing.
8.	Transparency Issues	There is a lack of transparency and trust when companies don't explain how they use customer data or how their algorithms operate.
9.	Potential for Erroneous Insights	Analytics are not infallible; occasionally, they can produce inaccurate insights or forecasts that negatively impact customer satisfaction or result in poor judgements.
10.	Digital Divide	Not every customer experiences the same level of benefit from tech-business analytics. Digital immigrants may be disadvantaged or left behind if they lack access to the newest technologies.

These drawbacks show how crucial it is to address concerns like data privacy, security, transparency, and moral technology use in order to make sure that the welfare and rights of consumers are not jeopardised by the development of analytics.

9. IMPLEMENTATION, AND IMPACT OF TECH -BUSINESS ANALYTICS ON EFFICIENCY OF QUATERNARY INDUSTRY SECTOR :

9.1 Implementation of Tech-Business in Quaternary Industry Sector:

Technology-business analytics has the potential to significantly boost the productivity of the Quaternary industry sector. Numerous tactics exist to increase productivity in this industry, a few of them are listed below:

Table 39: Implementation of Tech-Business in Quaternary Industry Sector

S.No.	Aspects	Description
1.	Streamlining operations	Companies that want to streamline their operations and find inefficiencies can benefit from tech-business analytics. Businesses may save time and money by automating some processes and getting rid of ones that are not essential.
2.	Optimizing resource allocation	Businesses that examine resource consumption data are able to allocate staff and equipment more efficiently. Companies may be able to lower expenses and increase total output as a result.
3.	Improving supply chain management	Tech-business analytics can assist companies in optimising their supply chains by offering information on inventory levels, demand trends, and supplier performance. Reducing lead times, cutting down on stock outs, and maximising inventory levels can all benefit companies.
4.	Enhancing customer experience	Businesses can better understand their customers' requirements, habits, and preferences by studying the data they collect from them. This will lead to happier and more loyal customers. This allows businesses to better tailor their goods and services to each customer's unique needs.
5.	Enabling data-driven decision-making	Real-time data can be obtained by organisations and used to inform decision-making through the usage of tech-business analytics. Better commercial results could be attained by businesses that respond to market movements with greater initiative and flexibility.

As a result, applying tech-business analytics can greatly boost the productivity of the Quaternary industry sector. Businesses can gain a competitive edge and increase profits by streamlining processes, optimising resource allocation, strengthening supply chain management, improving customer happiness, and supporting data-driven decision-making.

9.2 Impact of Tech-Business in Quaternary Industry Sector:

Tech-business analytics can significantly impact the Quaternary industry sector's efficacy in a number of ways.

Table 40: Impact of Tech-Business in Quaternary Industry Sector

S.No.	Aspects	Description
1.	Improved decision-making	Technology-driven business analytics can assist decision-makers in making more precise and knowledgeable decisions by utilising real-time data and insights from firms. More effectiveness and better outcomes could arise from this.
2.	Process optimization	By employing tech-business analytics to find inefficiencies in their operations and procedures, businesses can enhance and optimise their workflows. Lower expenses and more output could result from this.
3.	Enhanced resource allocation	Businesses can more effectively allocate resources like staff and equipment by examining data on resource usage. This could benefit firms by cutting expenses and increasing overall productivity.
4.	Improved supply chain management	Thanks to data on demand trends, inventory levels, and supplier performance, tech-business analytics can assist businesses in managing their supply chains more successfully. A few ways that firms might benefit from this are shorter lead times, fewer stock outs, and improved inventory management.
5.	Increased customer satisfaction	Businesses that collect customer data may choose to analyse it in order to obtain further understanding of the preferences, habits, and needs of their customers. As a result, there will be more satisfied

		and loyal customers. Consequently, enterprises can enhance their ability to customise their offerings to meet the specific needs of every client.

Consequently, tech-business analytics could have a big influence on the Quaternary industry's productivity. Businesses may increase their bottom line and obtain a competitive edge in the market by supporting improved decision-making, optimising processes, supporting resource allocation, improving supply chain management, and raising customer satisfaction.

10. ABCD ANALYSIS OF INTEGRATION OF BA WITH ICCT UT IN SERVICE INDUSTRY:

10.1 ABCD of Integrating Business Analytics with AI & Robotics in Quaternary Industry:

In the quaternary sector, which provides knowledge-based services including information technology, consulting, and education, integrating business analytics with AI and robotics has a number of benefits, drawbacks, and restrictions.

Table 41: ABCD of Integrating Business Analytics with AI & Robotics in Quaternary Industry

S. No.	Aspects	Description
Advantages:		
1	Enhanced Efficiency and Productivity	Greater productivity and quicker decision-making are possible due to AI and robotics' faster processing and analysis of huge datasets than humans.
2	Improved Accuracy	Artificial intelligence (AI) algorithms can reduce human error in data processing, producing more precise insights and plans of action.
3	Innovative Solutions	AI can find connections and patterns that people would overlook, which encourages creative solutions to challenging issues.
4	Cost Reduction	As regular jobs are automated by AI and robotics, labour costs and operating expenses can be decreased over time.
Benefits:		
1	Data-Driven Decision Making	Comprehensive data analysis can help businesses make better judgements.
2	Personalized Services	Customers' pleasure and loyalty can be increased by using AI to help provide customised services.
3	Competitive Advantage	By using robotics and AI to improve operations and find new ways to solve problems, businesses can obtain a competitive advantage.
4	Scalability	Businesses may scale their operations more efficiently with AI and robotics without needing to add as many human personnel as before.
Constraints:		
1	High Initial Investment	Robotics and AI integration might come at a high initial cost.
2	Technical Expertise Required	To operate and maintain these cutting-edge systems, businesses require qualified staff.
3	Data Privacy Concerns	Privacy and data security are issues that are brought up by the use of massive datasets.
4	Dependency on Technology	When human judgement is vital, an over-reliance on technology might become a limitation.
Disadvantages :		
1	Job Displacement	Workers may be displaced as a result of automation, particularly in laborious and repetitive jobs.
2	Complexity in Implementation	It can take a lot of effort and time to integrate these technologies into current systems.
3	Ethical Concerns	Biases in AI algorithms are just one of the ethical issues brought up by the application of robots and AI.

4	Resistance to Change	Employee and management resistance may arise from ignorance or a fear of the unknown.

Consequently, there are limitations and drawbacks associated with cost, complexity, and ethical issues, even while the quaternary industry's integration of business analytics with AI and robotics offers tremendous advantages and benefits in terms of efficiency, accuracy, and creativity. To make an informed decision about implementing these technologies, businesses must carefully consider these considerations.

10.2 ABCD of Integrating Business Analytics with Blockchain in Quaternary Industry:

A distinct set of benefits, limitations, and drawbacks can be experienced when integrating blockchain technology with business analytics in the quaternary sector, which includes knowledge-oriented services like IT, consulting, and education.

Table 42: ABCD of Integrating Business Analytics with Blockchain in Quaternary Industry

S. No.	Aspects	Description
Advantages:		
1	Enhanced Security	Higher degrees of data security are ensured by the decentralised and tamper-evident nature of blockchain, which is essential for sensitive business analytics.
2	Increased Transparency	Blockchain's immutable ledger feature offers unrivalled transparency in data exchanges and transactional processes.
3	Improved Traceability	By enabling exact tracking of data and transactions, blockchain enhances corporate operations' accountability.
4	Reduced Fraud	A major factor in lowering the likelihood of fraud in corporate operations is the intrinsic security features of blockchain.
Benefits:		
1	Trust in Data Integrity	Increased trust in the integrity and accuracy of the data utilised for analytics can be given to stakeholders..
2	Streamlined Processes	Businesses may operate more efficiently by automating and streamlining a variety of business processes with blockchain.
3	Better Compliance Management	Regulation compliance is aided by the immutable record-keeping, particularly in industries with strict data rules.
4	Enhanced Collaboration	Blockchain creates a single source of truth that makes it easier for many entities to collaborate.
Constraints:		
1	Scalability Issues	Transaction speeds can be impacted by scalability issues with blockchain networks, particularly ones with strong security.
2	Technical Complexity	Blockchain implementation involves a high level of technical knowledge and proficiency, which can be prohibitive for certain businesses.
3	Integration Challenges	It can be difficult and resource-intensive to integrate blockchain with the current IT infrastructure and business analytics tools.
4	Energy Consumption	Environmental concerns are brought up by the energy-intensive nature of several blockchain technologies, such as Proof of Work.
Disadvantages:		
1	High Initial Costs	Installing a blockchain infrastructure can be costly, particularly for small and medium-sized businesses.
2	Regulatory Uncertainty	Businesses may find it difficult to negotiate the quickly changing regulatory environment surrounding blockchain.
3	Limited Expertise Available	Implementation may be hampered by the small number of highly qualified individuals who understand blockchain technology.

4	Resistance to Adoption	The integration process can be slowed down or impeded by organisational inertia and opposition to implementing new technology.

Thus, there are a number of benefits, such as increased security and transparency, to combining business analytics with blockchain in the pharmaceutical sector. However, there are drawbacks as well, including scalability problems and large upfront expenses. To fully reap the rewards of blockchain technology in augmenting their business analytics capabilities, organisations must carefully weigh these aspects against their willingness to embrace new technologies.

10.3 ABCD of Integrating Business Analytics with Cloud Computing in Quaternary Industry:

In the quaternary sector—which encompasses knowledge-based services including information technology, education, research, and consulting—integrating business analytics with cloud computing offers a unique mix of benefits, drawbacks, and limits.

Table 43: ABCD of Integrating Business Analytics with Cloud Computing in Quaternary Industry

S. No.	Aspects	Description
Advantages:		
1	Scalability and Flexibility	With the enormous flexibility that cloud computing offers, organisations can simply scale their analytics operations up or down dependent on their needs.
2	Cost Efficiency	lessens the requirement for a sizable initial capital investment in hardware and infrastructure because cloud services usually have a pay-as-you-go business model.
3	Accessibility	Telecommuting and remote work are made easier by the accessibility of data and analytics tools.
4	Rapid Deployment	The time-to-insight can be accelerated by using cloud platforms, which facilitate the quick configuration and deployment of analytics tools and apps.
Benefits:		
1	Enhanced Collaboration	Cloud-based analytics tools and shared data facilitate productive collaboration among geographically dispersed teams.
2	Real-Time Data Processing	Large data sets can be handled by cloud computing, enabling real-time analytics and data processing..
3	Data Backup and Recovery	For the purpose of protecting data and maintaining business continuity, cloud services frequently incorporate data backup and recovery.
4	Latest Technologies	To guarantee that companies have access to the newest analytics tools and technology, cloud providers upgrade their services on a regular basis.
Constraints:		
1	Data Security and Privacy Concerns	Cloud providers often enhance their services to ensure businesses have access to the newest analytical tools and technologies.
2	Dependence on Internet Connectivity	A steady and quick internet connection is necessary for cloud services, which might be a drawback in places with spotty connectivity.
3	Vendor Lock-in	Cloud services rely on a fast and reliable internet connection, which could be problematic in areas with inconsistent coverage.
4	Compliance and Legal Issues	Handling the legal and regulatory ramifications of cloud data storage, particularly across nations, can be challenging.
Disadvantages :		
1	Ongoing Operational Costs	Monthly membership prices can add up over time, even with modest beginning costs.

2	Performance Issues	Performance can suffer from latency problems, which are contingent on the cloud service provider and internet bandwidth.
3	Limited Customization	A drawback for some company requirements may be that many cloud services have little customisation choices.
4	Data Management Challenges	Organising and combining data from various cloud services and platforms can be difficult.

Thus, among other advantages, scalability, cost effectiveness, and improved collaboration are provided by combining business analytics with cloud computing in the quaternary sector. It does, however, come with limitations and drawbacks, including possible performance problems, reliance on internet connectivity, and data security difficulties. To select the best choice for their unique objectives and environment, businesses need to carefully analyse these considerations.

10.4 ABCD of Integrating Business Analytics with Cyber Security in Quaternary Industry:

Integrating business analytics with cybersecurity has several special advantages, disadvantages, and restrictions in the quaternary sector, which includes knowledge-based companies like IT, education, research, and consulting.

Table 44: ABCD of Integrating Business Analytics with Cyber Security in Quaternary Industry

S. No.	Aspects	Description
Advantages:		
1	Enhanced Threat Detection	Through the examination of data trends and anomalies, analytics can assist in identifying and forecasting possible cybersecurity risks.
2	Proactive Security Posture	By combining analytics, one may transition from reactive to predictive threat management, enabling a more proactive approach to security.
3	Improved Incident Response	By promptly determining the origin and type of a breach, analytics help reduce the reaction time to security issues.
4	Comprehensive Risk Management	It makes it possible for security concerns to be assessed and managed more thoroughly throughout the entire company.
Benefits:		
1	Data-Driven Decision Making	Based on data-driven insights, businesses may make well-informed decisions on their cybersecurity initiatives..
2	Cost Efficiency	Predictive analytics can reduce expenses associated with data breaches and system outages by preventing security breaches.
3	Regulatory Compliance	By keeping an eye on and reporting security incidents, analytics can support the upkeep of compliance with various data protection and privacy laws.
4	Strengthened Trust	Strong cybersecurity defences supported by data can raise stakeholder and customer trust.
Constraints:		
1	Complexity in Integration	It can need a lot of work and resources to integrate analytics platforms with cybersecurity tools.
2	Skill Gap	People with both cybersecurity and analytics expertise are in high demand, but they can be hard to come by.
3	Data Overload	The enormous volume of data created for cybersecurity reasons might be difficult to manage and analyse.
4	Constant Evolution	The ever-changing nature of cyber threats necessitates the regular updating and modification of analytics tactics.
Disadvantages :		
1	High Initial Investment	It can be costly, particularly for smaller businesses, to implement advanced analytics technologies for cybersecurity.

2	Privacy Concerns	Users' and workers' privacy concerns may increase as a result of the collection and analysis of massive volumes of data.
3	False Positives and Negatives	Threat detection systems run the danger of producing false positives or negatives, which could result in pointless actions or undetected threats.
4	Dependency on Technology	Undervaluing the value of human intuition and experience could result from an over-reliance on analytics in cybersecurity.

Therefore, there are several benefits to improving threat detection and risk management in the quaternary industry by merging business analytics and cybersecurity. But there are drawbacks as well, such as integration complexity and the requirement for specialised skills. To properly balance the technological and human components of cybersecurity, the drawbacks—such as large upfront expenditures and possible privacy issues—must also be carefully taken into account.

10.5 ABCD of Integrating Business Analytics with Internet of Things (IoT) in Quaternary Industry:

In the quaternary sector—which encompasses knowledge-intensive services like IT, research, education, and consulting—integrating business analytics with the Internet of Things (IoT) offers a distinct set of benefits, drawbacks, and limits.

Table 45: ABCD of Integrating Business Analytics with Internet of Things (IoT) in Quaternary Industry

S. No.	Aspects	Description
Advantages:		
1	Real-Time Data Collection	Real-time data is continuously streamed in from IoT devices, providing corporate analytics with the most recent insights.
2	Enhanced Decision Making	Making more educated, data-driven decisions is possible when IoT data and analytics are combined.
3	Improved Efficiency	Productivity and operational efficiency can be greatly increased by using IoT-based automation and monitoring.
4	Predictive Analytics	IoT analyses data trends to provide predictive maintenance and forecasting, assisting in proactive decision-making.
Benefits:		
1	Increased Operational Insights	Organisations acquire enhanced comprehension of their processes, client conduct, and industry patterns.
2	Cost Reduction	Considerable cost reductions can result from efficient operations and predictive maintenance.
3	Enhanced Customer Experience	IoT analytics can be used to better satisfy customers by customising goods and services to their tastes.
4	Innovation Opportunities	New business concepts and creative solutions may result from the abundance of data offered.
Constraints:		
1	Data Privacy and Security	It's difficult to maintain the security and privacy of all the data that IoT devices gather.
2	Integration Complexity	It might be difficult and resource-intensive to integrate IoT with current business analytics tools.
3	Data Overload	It can be quite challenging to adequately manage the massive amount of data produced by Internet of Things devices.
4	Dependency on Network Connectivity	The dependence of IoT devices on network access can be problematic in places with inadequate connectivity.
Disadvantages :		
1	High Initial Investment	IoT technology implementation and analytics integration might come at a high cost.

2	Technical Expertise Required	IoT system management and upkeep demand a high degree of technical proficiency.
3	Potential for Technical Issues	Problems with connectivity, device malfunctions, or inaccurate data can affect how effective IoT analytics are.
4	Scalability Challenges	It can be difficult to scale Internet of Things solutions while preserving security and performance.

Therefore, combining IoT and business analytics in the quaternary sector has several benefits, such as better decision-making and real-time data collecting, but it also has drawbacks, such as integration difficulty and data protection issues. The pros are more operational insights and chances for innovation; the drawbacks are a large initial outlay and possible technological problems. When contemplating this integration, businesses need to balance these aspects against their objectives, available resources, and ability to handle sophisticated, data-intensive technologies. To efficiently leverage IoT and analytics while avoiding related risks and constraints, striking this balance is essential.

10.6 ABCD of Integrating Business Analytics with 3D Printing in Quaternary Industry:

Within the quaternary sector, which includes knowledge-intensive activities such as IT, education, research, and consulting, integrating business analytics with 3D printing offers a range of benefits, drawbacks, and limits.

Table 46: ABCD of Integrating Business Analytics with 3D Printing in Quaternary Industry

S. No.	Aspects	Description
Advantages:		
1	Customization and Personalization	Analytics may be used to find patterns and consumer preferences, which makes it possible to use 3D printing to customise products more successfully.
2	Enhanced Product Development	With 3D printing, firms can quickly prototype and improve items by studying market and consumer data.
3	Supply Chain Optimization	Parts may be produced on-demand with 3D printing, which lowers inventory and transportation costs, and analytics can identify opportunities for efficiency gains.
4	Resource Optimization	Waste can be reduced in 3D printing operations by using analytics to determine the most effective methods to use resources and materials.
Benefits:		
1	Faster Time-to-Market	The entire product development cycle—from design to production—is accelerated when analytics and 3D printing are combined.
2	Cost Reduction	Lowers the price of tooling and storage—two expenses related to conventional production methods.
3	Data-Driven Manufacturing	Makes production processes more flexible and responsive to consumer needs and analytics-identified patterns.
4	Innovation Opportunities	Creates new opportunities for product design and manufacturing process innovation.
Constraints:		
1	Integration Complexity	It might be technically difficult to integrate business analytics software with 3D printing technology.
2	Data Management	In 3D printing, efficiently organising and analysing the enormous volume of data can be challenging.
3	Limited Materials and Applications	The kinds of objects that can be manufactured and the materials that may be used are limited by 3D printing technology.
4	Skill Gap	Needs certain knowledge in order to combine and apply 3D printing with analytics in an efficient manner.
Disadvantages :		

1	High Initial Investment	Technologies for 3D printing and analytics integration can be expensive.
2	Quality and Durability Concerns	When comparing products made with 3D printing to those made using conventional methods, there may be differences in terms of quality and longevity.
3	Dependence on Technology	An over-reliance on technology might put you at risk, especially in the event of cyberattacks or other technological difficulties.
4	Intellectual Property Challenges	Illegal reproduction or theft of intellectual property are risks that are increased when digital product designs are shared.

For this reason, the quaternary industry can profit from the integration of business analytics and 3D printing in addition to quicker time-to-market and innovation potential. These benefits include improved product development and supply chain optimization. On the other hand, it also presents drawbacks including significant initial investment and difficulties with intellectual property, as well as integration complexity and skill shortages. If businesses want to take full advantage of this integration's potential ethically and successfully, they must use careful thought and strategic planning. Organizations may develop a more inventive, efficient, and adaptable production environment by tackling these issues and utilizing the advantages of both technologies.

10.7 ABCD of Integrating Business Analytics with Mobile Communication in Quaternary Industry

In the knowledge-intensive quaternary sector—which includes IT, research, education, and consulting—integrating corporate analytics with mobile communication presents a number of benefits, drawbacks, and restrictions.

Table 47: ABCD of Integrating Business Analytics with Mobile Communication in Quaternary Industry

S. No.	Aspects	Description
Advantages:		
1	Increased Accessibility	The flexibility and responsiveness that come with mobile communication are increased since it makes analytics tools and data accessible from anywhere.
2	Real-Time Data Collection and Analysis	Real-time data collection and transmission from mobile devices can give decision-makers the most recent information available.
3	Enhanced Customer Engagement	To improve their marketing and customer service tactics, businesses can leverage mobile analytics to gain insight into the behaviour and preferences of their customers.
4	Operational Efficiency	Faster information flow and communication are made possible via mobile communication, which raises total operational efficiency.
Benefits:		
1	Improved Decision Making	Decisions may be made more quickly and intelligently when data and analytics are instantly accessible through mobile devices.
2	Increased Productivity	Because they can access analytics tools while on the go, employees are more productive and flexible.
3	Better Customer Insights	Mobile analytics offer insightful information about consumer preferences, interactions, and feedback.
4	Cost-Effective Solutions	There is usually less need for costly infrastructure when using mobile solutions instead of traditional ones.
Constraints:		
1	Data Security and Privacy	Data security and privacy breaches are major hazards associated with mobile devices.

2	Dependence on Internet Connectivity	High-speed, reliable internet connectivity is essential for mobile analytics.
3	Limited Data Processing Capabilities	When it comes to processing big amounts of data, mobile devices might not be as capable as traditional computing platforms.
4	Compatibility Issues	It can be difficult to guarantee that analytics tools work with various mobile platforms and gadgets.
Disadvantages :		
1	Risk of Data Overload	Data accessibility made simple might result in information overload, which makes it challenging to draw actionable conclusions.
2	Increased Vulnerability to Cyber Threats	Cyber threats such as phishing and hacking can more easily target mobile devices.
3	Potential for Distraction	An excessive dependence on mobile devices for analytics may result in decreased in-person interactions and distractions.
4	Maintenance and Update Requirements	To make sure they operate efficiently and securely, mobile platforms need to receive regular upgrades and maintenance.

Better decision-making and consumer insights are thus brought about by combining business analytics and mobile communication in the quaternary sector. Other benefits include enhanced accessibility and real-time data analysis. But there are drawbacks as well, such as the possibility of data overload and heightened susceptibility to cyberattacks, along with limitations including data security issues and restricted data processing power. For mobile communication to be both convenient and flexible while maintaining the strength and security of analytics procedures, organizations need to carefully weigh these factors.

10.8 ABCD of Integrating Business Analytics with Information Storage Technology in Quaternary Industry:

There are several benefits, drawbacks, and restrictions associated with integrating business analytics with information storage technology in the quaternary industry, which encompasses industries such as information technology, education, research, and consulting.

Table 48: ABCD of Integrating Business Analytics with Information Storage Technology in Quaternary Industry

S. No.	Aspects	Description
Advantages:		
1	Enhanced Data Storage Capacity	Efficient data management is made possible by advanced storage solutions, which can manage the massive amounts of data produced by business analytics.
2	Improved Data Retrieval and Processing	The effectiveness and speed of analytics are improved by quicker and more efficient data retrieval procedures.
3	Data Redundancy and Reliability	Redundancy is a feature of modern storage technology that guarantees data is not lost and is consistently available for analytics.
4	Scalability	Technologies for storage can be expanded to accommodate expanding data requirements, enabling the development of corporate analytics capabilities.
Benefits:		
1	Data-Driven Decision Making	Data-driven decision making is strengthened by effective and safe data storage.

2	Cost Efficiency	Data management and analytics operations can be made more affordable by using efficient storage.
3	Enhanced Data Security	Sophisticated storage options frequently come with strong security measures to guard against unwanted access to private analytics data.
4	Improved Business Continuity	When there are hardware malfunctions or other disruptions, businesses may still run efficiently thanks to reliable data storage.
Constraints:		
1	High Initial Investment	Large-scale analytics may need the implementation of modern storage solutions, which might come with hefty upfront expenditures.
2	Complexity in Management and Maintenance	Resources and specialised skills are needed to manage complex storage technologies.
3	Integration Challenges	Modern analytics solutions might be difficult and time-consuming to integrate with new storage technologies.
4	Rapid Technological Changes	It might be difficult to keep up with the times and maximise investments due to the rapid improvements in storage technologies.
Disadvantages :		
1	Potential for Data Silos	Effective data analysis might be hampered by the formation of data silos caused by improper integration of storage systems.
2	Dependence on Technology	Relying too heavily on technology for analytics and sales might make businesses more vulnerable to technological failures or breaches.
3	Privacy and Compliance Issues	Maintaining a large amount of data, especially confidential data, might raise issues with privacy and compliance.
4	Resource Intensive	It can require a lot of resources to manage, update, and maintain storage systems over time.

As a result, there are several benefits for the quaternary industry from combining business analytics with information storage technologies, including better data management and more effective decision-making. However, it also has drawbacks including the potential for data silos and privacy concerns, coupled with limitations like large initial investments and management complexity. In order to guarantee that their storage solutions meet their analytics requirements and are in line with their overall strategic goals, businesses must give careful consideration to these elements.

10.9 ABCD of Integrating Business Analytics with Ubiquitous Education Technology in Quaternary Industry

The quaternary industry, which encompasses fields like IT, research, and consultancy, allows for the integration of corporate analytics with ubiquitous education technology. This integration has its own set of benefits, drawbacks, and restrictions.

Table 49: ABCD of Integrating Business Analytics with Ubiquitous Education Technology in Quaternary Industry

S. No.	Aspects	Description
Advantages:		
1	Personalized Learning Experiences	The learning process can be improved by using analytics to assist customise educational content to each student's needs and learning style.
2	Improved Educational Outcomes	Better educational outcomes and more effective teaching methods can result from data-driven insights.

3	Enhanced Engagement and Motivation	Analytics can identify what engages students most, leading to more interactive and motivating learning environments.
4	Efficient Resource Allocation	By analysing which areas require more attention and resources, institutions can optimize their expenditures.
Benefits:		
1	Data-Driven Decision Making	Institutions can make informed decisions about curriculum development, teaching methods, and resource allocation based on data insights.
2	Scalability and Accessibility	Ubiquitous technology allows for scaling educational offerings to a wider audience, including remote learners.
3	Continuous Improvement	Ongoing data collection and analysis lead to continuous improvements in teaching methods and learning materials.
4	Increased Student Success	Early identification of at-risk students through analytics enables prompt support and intervention.
Constraints:		
1	Data Privacy and Security	Privacy and security are major concerns when it comes to gathering and preserving educational data.
2	Technology Integration	It might be difficult and resource-intensive to integrate analytics tools into the current platforms for educational technology.
3	Dependence on Technology	Reliance on technology too much can result in less in-person contact and conventional teaching approaches.
4	Digital Divide	It's possible that some students do not have equitable access to the technology required for a completely integrated learning environment.
Disadvantages :		
1	High Initial Costs	Advanced analytics and pervasive technologies can be costly to implement and maintain.
2	Complexity of Data Analysis	Having the right knowledge and tools is essential for properly evaluating and understanding educational data.
3	Potential Overload of Information	One could perhaps have analysis paralysis due to being overtaken by the amount of data.
4	Resistance to Change	Instead of embracing new technologies and methods, educators and institutions may choose to stick with tried-and-true teaching strategies.

As such, there are benefits such as tailored learning and enhanced academic results by combining corporate analytics with widely used education technology in the quaternary sector, but there are drawbacks as well, like worries about data privacy and the difficulty of integrating new technologies. Costs are significant and there may be reluctance to change, but advantages include data-driven decision making and improved accessibility. To properly implement this integration and realise its full potential in improving educational procedures and outcomes, meticulous planning and consideration of technology and human elements are necessary.

10.10 ABCD of Integrating Business Analytics with Virtual and Augmented Reality Technology in Quaternary Industry:

The quaternary industry, which encompasses knowledge-intensive services like IT, education, research, and consulting, presents a unique mix of benefits, drawbacks, and limits when it comes to integrating business analytics with Virtual Reality (VR) and Augmented Reality (AR) technologies.

Table 50: ABCD of Integrating Business Analytics with Virtual and Augmented Reality Technology in Quaternary Industry

S. No.	Aspects	Description
Advantages:		
1	Immersive Data Visualization	Complex data sets can be visualised in novel ways with VR and AR, increasing their comprehensibility and engagement potential.

2	Enhanced Training and Simulation	These technological advancements provide training with lifelike simulations, enabling risk-free, immersive learning environments.
3	Improved Customer Engagement	Customers' engagement and comprehension of goods and services can be improved by using VR and AR to create distinctive, interactive experiences.
4	Innovative Product Development	Virtual prototypes can be created with them, eliminating the need for actual models and facilitating testing and improvement.
Benefits:		
1	Data-Driven Insights	The experiences and simulations are made more relevant and effective by integrating them with corporate analytics, which guarantees that they are based on actual facts.
2	Cost Reduction	Significant cost reductions can result from removing the requirement for physical models or in-person training.
3	Increased Accessibility	No matter where someone is in the world, AR and VR can open up access to sophisticated data and training for a larger audience.
4	Competitive Advantage	Through creative customer experiences and data presentation techniques, businesses utilising these technologies can obtain a competitive edge.
Constraints:		
1	High Initial Investment	Creating and integrating VR and AR applications with analytics can be expensive.
2	Technical Expertise	It may be difficult to find, requiring specific expertise in both data analytics and VR/AR development.
3	Hardware Dependencies	In order to utilise VR and AR effectively, advanced gear is frequently needed, which can be costly and requires frequent updates.
4	Integration Complexity	These technologies can be difficult and time-consuming to integrate seamlessly with current analytics tools.
Disadvantages :		
1	User Experience Challenges	Challenges related to motion sickness in virtual reality or ergonomics in augmented reality may impact user adoption and efficacy.
2	Limited Reach	Some end users might not have access to the gear required to take full advantage of VR/AR solutions.
3	Data Privacy Concerns	Privacy concerns may arise when data is collected and used in VR/AR environments.
4	Technological Obsolescence	Rapid technological progress can quickly make current VR/AR solutions obsolete.

For this reason, the quaternary industry can benefit from merging business analytics with VR and AR to get data-driven insights and lower costs, as well as immersive data visualisation and improved training. Constraints like high upfront costs and the need for technical know-how are also prevalent, and there are drawbacks like difficulties with user experience and the risk of technology obsolescence. When combining VR and AR technologies with business data, businesses must carefully evaluate these factors.

10.11 ABCD of Integrating Business Analytics with Quantum Computing Technology in Quaternary Industry:

In the quaternary industry, which includes knowledge-intensive services like IT, education, research, and consulting, integrating business analytics with quantum computing technology offers certain benefits, drawbacks, and limits.

Table 51: ABCD of Integrating Business Analytics with Quantum Computing Technology in Quaternary Industry

S. No.	Aspects	Description
Advantages:		
1	Exceptional Processing Speed	Data analysis is greatly accelerated by quantum computing's ability to process complicated data sets far more quickly than with traditional computers.
2	Advanced Data Modelling	Because of its ability to handle intricate variables and relationships, it enables more accurate and advanced data modelling.
3	Enhanced Optimization	Compared to conventional techniques, quantum algorithms can optimise logistics and operations more effectively.
4	Breakthroughs in Problem Solving	Issues that conventional computers are presently unable to handle may be resolved by quantum computing.
Benefits:		
1	Improved Decision Making	Improved business decisions are a result of faster and more precise data analysis.
2	Innovative Solutions	Research and development opportunities can be expanded through the use of quantum computing to enable creative solutions to data-driven problems.
3	Competitive Advantage	Analytics companies that use quantum computing early on can greatly outperform their rivals.
4	Efficiency in Resource Allocation	Cost savings and more effective resource allocation are possible outcomes of improved data processing skills.
Constraints:		
1	Technical Complexity	The topic of quantum computing is extremely complicated and calls for certain training and experience.
2	Limited Accessibility	At the moment, quantum computing is mostly the purview of specialised research and is not generally available.
3	Integration Challenges	It can be quite difficult to integrate quantum computing with current analytics systems and infrastructure.
4	Data Security Concerns	New difficulties in data encryption and security are brought forth by quantum computing.
Disadvantages :		
1	High Initial Costs	Significant financial resources are needed for the creation and application of quantum computing systems.
2	Scalability Issues	It is currently exceedingly difficult to scale quantum computing solutions for real-world, commercial applications.
3	Rapid Obsolescence	Current quantum solutions may soon become outdated due to the rapid advancements in quantum technology.
4	Uncertain Timeline for Practical Implementation	It's still unclear when quantum computing will be economically feasible for commercial analytics.

Therefore, the quaternary industry can benefit greatly from integrating business analytics with quantum computing due to its exceptional processing speed and sophisticated data modelling. However, there are drawbacks as well, such as limited accessibility and technical complexity, as well as high initial costs and scalability issues. As quantum computing develops, quaternary businesses will need to take these factors into account and get ready for the revolutionary effects this technology may have on data analytics and decision-making processes.

11. TO COMPARE TBA IN QUATERNARY SECTOR WITH RESPECT TO PRIMARY INDUSTRY SECTOR, SECONDARY INDUSTRY SECTOR AND TERTIARY INDUSTRY SECTOR:

11.1 To compare tech-business analytics in Quaternary Sector with respect to Primary Industry Sector and Secondary Industry Sector:

Understanding each sector's features as well as the function of technology and analytics within it is necessary in order to compare tech-business analytics in the Quaternary Sector to the Primary and Secondary Industry Sectors.

Table 52: To compare tech-business analytics in Quaternary Sector with respect to Primary Industry Sector and Secondary Industry Sector

S.No.	Type of Sector	Characteristics	Technology and Analytics
	Primary Industry Sector	Natural resources are the source of raw materials that are directly extracted and produced in this industry. Fishing, mining, forestry, and agriculture are a few examples.	Traditionally, technology and analytics have been employed in primary industries to increase productivity in tasks including resource management, yield optimization, crop monitoring, and mineral exploration. Still, compared to other industries, analytics tends to be less sophisticated.
	Secondary Industry Sector	In this industry, manufacturing techniques are used to convert raw materials into completed commodities. The food processing, textile, electronics, and automobile industries are a few examples.	Technology and analytics are essential to secondary industries because they help with supply chain management, quality assurance, product customization, and manufacturing process optimization. Predictive maintenance, demand forecasting, and production optimization are examples of advanced analytics that are frequently used to increase productivity and cut costs.
Comparisons			
1.	Sophistication of Analytics	Every industry uses analytics, but because knowledge-based services are prevalent and there is a wealth of data available, the Quaternary Sector typically uses more advanced methods.	
2.	Focus on Innovation	Although primary and secondary sectors may employ analytics more for optimization and efficiency advantages, the Quaternary Sector places a greater emphasis on innovation and research and development, using analytics to drive product development and process improvements.	
3.	Data Availability and Utilization	While data availability may be more restricted or fragmented in primary and secondary sectors, the Quaternary Sector benefits from massive amounts of digital data that enable broad use of analytics.	
4.	Economic Impact	Every sector has a part in the economy, but because the Quaternary Sector is responsible for innovation, productivity increases, and knowledge creation, its influence is frequently more noticeable.	

Thus, the Quaternary Sector has a strong reliance on advanced analytics to support innovation, knowledge development, and value-added services, even though technology and analytics are essential to many industries.

11.2 To compare tech-business analytics in Quaternary Sector with respect to Primary Industry Sector and Tertiary Industry Sector:

The purpose of this analysis is to compare tech-business analytics in the Quaternary Sector to the Primary and Tertiary Industry Sectors by looking at the functions of technology and analytics in each sector:

Table 53: To compare tech-business analytics in Quaternary Sector with respect to Primary Industry Sector and Tertiary Industry Sector.

S.No.	Type of Sector	Characteristics	Technology and Analytics
1.	Primary Industry Sector	Natural resources are the source of raw materials that are directly extracted and produced in this industry. Fishing, mining, forestry, and agriculture are a few examples.	Analytics and technology are being used more and more in the primary sector to streamline operations including sustainable resource management, precision agriculture, crop monitoring, and mineral prospecting. Yet, given the nature of operations and the accessibility of data, the degree of analytics sophistication may be somewhat lower than in the Quaternary Sector.
2.	Tertiary Industry Sector	Service delivery to customers and businesses is a part of this industry. The retail, healthcare, hotel, financial, and educational sectors are a few such.	For the tertiary sector to improve customer experience, boost operational efficiency, and personalize services, technology and analytics are critical. Sentiment analysis, recommendation systems, fraud detection, demand forecasting, consumer segmentation, and risk management are all aided by analytics. Analytics may not be as sophisticated or specialized as they are in the Quaternary Sector, while being more common in the Tertiary Sector.
Comparisons			
1.	Focus on Data-Driven Decision Making	In order to generate insights and spur innovation, the Quaternary Sector mostly depends on data-driven decision-making employing sophisticated analytics. In primary and tertiary industries, analytics are also employed, but they might not play as much of a role in decision-making.	
2.	Innovation and Knowledge Creation	With analytics driving R&D, product development, and service innovation, the Quaternary Sector places a strong emphasis on innovation and knowledge production. All sectors have innovation, but because of its nature, the Quaternary Sector may have more of it.	

3.	Customer-Centric Analytics	With an emphasis on topics like personalization and customer relationship management, the Tertiary Sector prioritizes customer-centric analytics to improve customer experience and satisfaction. Analytics in the Quaternary Sector often focuses on innovation and larger market trends, though it may also include consumer analysis.
4.	Economic Impact	The Quaternary Sector plays a significant role in promoting innovation, technological improvement, and knowledge creation, which in turn leads to economic growth and competitiveness. Despite the fact that other sectors contribute to the economy, its influence may be greater.

Hence, while technology and analytics are important in every industry, the Quaternary Sector is notable for heavily depending on advanced analytics for knowledge creation, innovation, and value-added services, while the Primary and Tertiary sectors use analytics primarily for optimization and customer-centric improvements.

11.3 To compare tech-business analytics in Quaternary Sector with respect to Secondary Industry Sector and Tertiary Industry Sector:

It is important to comprehend the functions of technology and analytics in each sector when comparing tech-business analytics in the Quaternary, Secondary, and Tertiary Industry Sectors.

Table 54: To compare tech-business analytics in Quaternary Sector with respect to Secondary Industry Sector and Tertiary Industry Sector

S.No.	Type of Sector	Characteristics	Technology and Analytics
1.	Secondary Industry Sector	In this industry, manufacturing techniques are used to convert raw materials into completed commodities. The food processing, textile, electronics, and automobile industries are a few examples.	In secondary industry, supply chain management, quality control, manufacturing process optimization, and product customization all depend on technology and analytics. Increased productivity and lower costs are frequently achieved by utilizing advanced analytics approaches including demand forecasting, production optimization, and predictive maintenance.
2.	Tertiary Industry Sector	Service delivery to customers and businesses is a part of this industry. The retail, healthcare, hotel, financial, and educational sectors are a few such.	Technology and analytics are crucial in the tertiary sector for enhancing customer satisfaction, operational effectiveness, and personalized service. Customer segmentation, sentiment analysis, recommendation engines, fraud detection, and risk management are all aided by analytics. Although analytics are common in the tertiary sector, they might not be as sophisticated or specialized as they are in the quaternary sector.
Comparisons			

1.	Innovation and Knowledge Creation	The Quaternary Sector has a strong emphasis on innovation and knowledge generation, using advanced analytics to propel R&D, service innovation, and product development. Innovation is present in the secondary and tertiary sectors as well, but because it is knowledge-intensive, it might be more noticeable and disruptive in the quaternary sector.
2.	Market Analysis and Strategy	In the Quaternary Sector, tech-business analytics frequently include in-depth market research and strategic planning grounded in data-driven insights. Although the secondary industry may also utilize analytics for market analysis, its main priorities are frequently supply chain optimization and operational efficiency. In a similar vein, analytics are used in the tertiary sector for customer-centric strategies as opposed to more extensive market study.
3.	Data Complexity and Utilization	Utilizing cutting-edge analytics approaches, the Quaternary Sector works with intricate datasets to derive useful insights. All industries use data analytics, but the Quaternary Sector's focus on knowledge and innovation frequently necessitates managing a wider variety of unstructured data types.
4.	Economic Impact	Because of its role in promoting innovation, technological advancement, and knowledge creation—all of which contribute to economic growth and competitiveness—the Quaternary Sector may have a greater overall economic impact. All sectors, however, provide distinct contributions to economic growth; the tertiary sector places more emphasis on service delivery, while the secondary sector is primarily concerned with manufacturing production.

Hence, all sectors heavily rely on technology and analytics, but the quaternary sector is notable for heavily depending on advanced analytics for innovation, knowledge creation, and value-added services, while the secondary and tertiary sectors prioritize analytics for customer-centric strategies, operational efficiency, and market analysis.

12. POSTULATES & SUGGESTIONS:

To optimise benefits and minimise drawbacks, the following hypotheses and recommendations can be outlined with regard to tech-business analytics in the quaternary industry sector, which includes knowledge-based services like information technology, consulting, research, and education:

(1) Data as a Key Asset: Data is a vital resource in the quaternary industry. Customer satisfaction, efficiency, and creativity may all be fuelled by efficient data management and analysis.

(2) Consumer-Centric Approach: Analytics should be applied to provide individualised services and goods, improving the customer experience.

(3) Ethical Use of Data: Consumer data gathering, analysis, and utilisation must all prioritise ethical issues.

(4) Technology as an Enabler: While analytics and technology might help make decisions more intelligently, they shouldn't take the place of human contact and judgement.

(5) Continuous Innovation: The industry is highly innovative and depends largely on analytics to spot trends and possibilities.

(6) Security and Privacy: Considering the growing dangers of data breaches and cyberattacks, protecting customer data need to be a primary responsibility.

(7) Enhance Transparency: To earn customers' trust, businesses should be open and honest about how they gather, utilise, and safeguard customer information.

(8) Invest in Data Security: To safeguard sensitive data, significant investments must be made in cybersecurity measures.

(9) Address Bias and Accuracy: To guarantee fairness and accuracy in data analytics, develop strategies to recognise and reduce biases.

(10) Foster Digital Literacy: Reduce the digital divide by teaching staff and customers how to use digital tools and data.
(11) Personalization with Boundaries: For personalisation, use data analytics, but be mindful of consumer privacy and steer clear of invasive tactics.
(12) Encourage Consumer Feedback: Seek out and consider customer feedback on a regular basis to enhance offerings.
(13) Ethical AI Use: Establish moral standards for AI and machine learning applications to promote technology responsibility.
(14) Promote Collaborative Innovation: Encourage cooperation to promote innovation between research organisations, educational institutions, and IT enterprises.
(15) Adapt to Changing Consumer Needs: Continue to be adaptable and aware of changing market trends and customer preferences.
(16) Regulatory Compliance: Remain informed about and abide by all applicable privacy and data protection regulations.
Businesses in the quaternary sector can profitably use tech-business analytics while upholding ethical standards and preserving customer confidence by following these postulates and putting these recommendations into practice. Instead of sacrificing moral principles or human values, the goal should be to develop a balanced strategy that uses technology to improve service offerings.

13. CONCLUSION:

Tech-business analytics has significant potential benefits for the Quaternary industrial sector, which comprises knowledge-based businesses such as finance, consulting, and IT services. Businesses may learn a great deal about their operations, customers, and markets by utilising cutting-edge technologies like machine learning and artificial intelligence. Now that they have facts to go on, they can make decisions and work together more effectively. Supply chain management, resource allocation optimisation, operational simplification, and customer experience improvement are all possible with the use of tech-business analytics. Businesses may find new avenues for expansion and innovation with the use of tech-business analytics. Nevertheless, there are a few limitations and drawbacks related to tech-business analytics, such as the requirement for highly skilled staff, the intricacy of data analysis, and ethical conundrums with data security and privacy. All in all, the Quaternary industry sector stands to gain a great deal from the application of tech-business analytics; however, as with any project, careful consideration of the advantages, limitations, and risks must be made before moving forward. Businesses in this industry are able to minimise risks and problems while optimising the advantages of tech-business analytics.

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