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Industry 4.0 and Marketing: Understanding the Challenges and Capitalizing on Opportunities

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ABSTRACT

The emergence of Industry 4.0 has profoundly transformed the marketing landscape, ushering in unprecedented challenges and opportunities. This study undertakes a comprehensive examination of the Industry 4.0 marketing paradigm, investigating the transformative impact of emerging technologies on marketing strategies, consumer behavior, and organizational performance. The main objective of this study is to investigate the challenges marketers face in adapting to the Industry 4.0 marketing landscape. Others are to identify the opportunities afforded by Industry 4.0 technologies including artificial intelligence, blockchain, and the Internet of Things (IoT) and to develop a framework for navigating the Industry 4.0 marketing landscape. A mixed-methods approach is employed, integrating qualitative and quantitative data collection and analysis methods. The study draws on a comprehensive review of existing literature, supplemented by primary data collected through surveys and interviews with marketing professionals. This research aims to contribute meaningfully to the existing body of knowledge on Industry 4.0 and marketing, providing actionable insights for marketers, policymakers, and business leaders seeking to navigate the complexities of the Industry 4.0 marketing landscape. The study's findings are expected to inform the development of effective marketing strategies, enhance organizational performance, and drive business growth in the Industry 4.0 era to stay ahead of the competition.

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Introduction

The advent of Industry 4.0 has revolutionized the marketing landscape, bringing about unprecedented challenges and opportunities. The convergence of artificial intelligence (AI), automation, data analytics, and the Internet of Things (IoT) has transformed the way businesses interact with customers, design products, and deliver services. As we navigate this uncharted territory, marketers must adapt to the shifting dynamics of consumer behavior, technological advancements, and global connectivity [19,27,33].

Marketing in the Industry 4.0 era requires a fundamental shift in strategy, from traditional mass marketing to personalized, data-driven approaches. Companies must leverage emerging technologies to create seamless customer experiences across physical and digital channels. AI and machine learning are increasingly being used in marketing to analyze customer data, predict behavior, and optimize campaigns. IoT devices provide real-time customer data, enabling companies to respond promptly to customer needs and Big Data Analytics enables companies to process vast amounts of customer data, uncovering insights that inform marketing strategies. Virtual and augmented reality technologies are being used to create immersive customer experiences [16,17,22-23,28,34-35,40].

However, companies face challenges in implementing these emerging technologies, including data privacy concerns, talent acquisition, and organizational structure changes. In this era of digital transformation, marketers face challenges of the need for personalized customer experiences. However, Industry 4.0 also presents opportunities for marketers to leverage cutting-edge technologies, foster innovation, and create sustainable competitive advantages [24,29].

Digital Marketing Landscape Increased the use of digital channels, social media, and mobile devices while the emergence of new marketing technologies like AI, automation, and data analytics shift towards customer-centricity, personalization, and experiential marketing. Changes in segmentation, targeting, and positioning (STP) strategies Increased focus on content marketing, influencer marketing, and social media marketing. Emergence of new marketing metrics and performance indicators [9,10,12,13,32]

Statement of the Problem

The rapid evolution of 4.0 technologies such as Artificial Intelligence, Internet of Things and Data Analytics is transforming the marketing landscape, presenting both opportunities and challenges for marketers. Despite the potential benefits of enhanced customer insights, personalized experiences and increased efficiency, many marketers struggle to effectively navigate this new landscape facing challenges such as keeping pace with technological advancements and changing consumer behaviors, integrating industry 4.0 technologies into existing marketing strategies and processes, developing the necessary skills

and talent to leverage these technologies, balancing the benefit of data driven marketing with concerns around data privacy and security as well as measuring the effectiveness and return on investment of industry 4.0 driven marketing initiatives. [2,6,7].

As a result of the above, marketers need guidance on how to effectively navigate the marketing landscape of industry 4.0, capitalize on its opportunities and mitigate its challenges to drive business success

Objectives of the Study

The broad objective of this study is to investigate the impact of Industry 4.0 on marketing strategies, tactics, and operations.
Specific objectives are to:

- Investigate the impact of AI, blockchain, and IoT on the accuracy and timeliness of customer data for marketing strategies.
- Examine the effect of Industry 4.0 technologies on personalization of marketing efforts and customer satisfaction.
- Assess the influence of Industry 4.0 technologies on market share, customer engagement, loyalty, and competitiveness.

Research Questions

- Does the adoption of AI, blockchain, and IoT enable companies to gather more accurate and real-time customer data, leading to more effective marketing strategies?
- Can Industry 4.0 technologies enhance the personalization of marketing efforts, resulting in increased customer satisfaction?
- Do companies that adopt Industry 4.0 technologies experience a significant increase in market share, customer engagement, loyalty, and competitiveness?

Hypotheses

- The use of AI, blockchain, and IoT does not enable companies to gather more accurate and real-time customer data, leading to more effective marketing strategies.
- Industry 4.0 technologies do not enable companies to personalize their marketing efforts more effectively, leading to increased customer satisfaction
- Companies that adopt Industry 4.0 technologies do not experience a significant increase in market share, customer engagement, loyalty, and competitiveness

Conceptual Review

Overview of Industry 4.0 Era Technologies

Artificial Intelligence (AI)

Artificial Intelligence (AI) refers to the development of computer systems that can perform tasks that typically require human intelligence, such as learning, reasoning, problem-solving, perception and natural Language Processing. Despite continuing advances in computer processing speed and memory capacity, there are yet no programs that can match full human flexibility over wider domains or in tasks requiring much everyday knowledge. On the other hand, some programs have attained the performance levels of human experts and professionals in executing certain specific tasks so that artificial intelligence in this limited sense is found in applications as diverse as medical diagnosis, computer search engines, voice or hand writing recognition and chatbots [25,26].

AI technologies include but not limited to Machine Learning (ML), Deep Learning (DL), Neural Networks (NN). Others are, Natural Language Processing (NLP) and Robotics and can be applied in Virtual Assistants (VA), Image Recognition (IR), Speech Recognition (SR), Predictive Analytics (PA) and Autonomous Vehicles (AV) [20,21,50]

Internet of Things (IoT)

The Internet of Things (IoT) refers to the network of physical devices, vehicles, buildings, and other items embedded with sensors, software, and connectivity, allowing them to collect and exchange data (Atzori et al., 2010). These devices have enhanced sensing, computing, and communication capabilities that allow them to communicate, sense, or interact with their internal state or external environment. Essential characteristics of IoT are Connectivity, Sensing, Actuation, and Intelligence. Till date, many marketing oriented organizations are striving to transform their digital initiatives which are changing the marketing landscape in many ways. An example is the automated cockpits which are becoming increasingly sophisticated and replacing traditional cockpits in airlines. The integration of the new generation of information technology and the industry has accelerated the process of industrial digitization, networking, and intelligence. IoT can be applied in Smart Homes, Industrial Automation, Healthcare and Transportation [42,46].

Data Analytics

Data Analytics is the process of examining data sets to draw conclusions and identify patterns, trends which in turn generate actionable insights that support informed decision making and correlations. The primary objective of data analytics is to address specific questions or challenges that are relevant to an organization to drive better business outcomes in today's business world and to gain a deeper understanding of consumers, optimize processes, generate new business opportunities [44].

It involves various techniques, tools, and methods to analyze and interpret data, including: 1. Descriptive Analytics (DA), 2. Predictive Analytics (PA), 3. Prescriptive Analytics (PrA), 4. Machine Learning (ML), 5. Data Mining (DM), 6. Business Intelligence (BI) (Negash & Gray, 2008). Data Analytics can be applied in the following areas of marketing in the industry 4.0 era vis-à-vis Customer Relationship Management (CRM), Supply Chain Optimization (SCO), Risk Management (RM), Healthcare Analytics and Marketing Analytics. From marketing campaigns and sales goals to research and development, a comprehensive data analytics program can benefit the entire organization

Cloud Computing

Cloud Computing is a model of delivering computing services over the internet, enabling on-demand access to a shared pool of resources, such as: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). Instead of buying, owning and maintaining physical data centers and servers, you can access technology services such as computing power, storage, and database on as needed basis from a cloud provider like Amazon Web Services. Organizations of every type, size, and industry are using the cloud for a wide variety of use cases such as data backups, disaster recovery, email, virtual desktops, software development and testing, big data analytics and customer facing web application which enables deployment of technology services in a matter of minutes and get fromk idea to implementation several orders of magnitude faster than before Cloud computing have so many benefits some of which are Cost savings, increased agility, scalability, reliability and Security.

Blockchain Technology

Blockchain technology is an advanced database mechanism

that allows transparent information sharing within a business network. A blockchain database stores data in blocks that are linked together in a chain. The data is chronologically consistent because you cannot delete or modify the chain without consensus from the network. As a result, you can use blockchain technology to create an unalterable or immutable ledger for tracking orders, payments, accounts, and other transactions. The system has built in mechanisms that prevent unauthorized transaction entries and create consistency in the shared view of these transactions. Blockchain technology is important to marketing practitioners because it avoids potential legal pitfalls by creating a decentralized, tamper proof systems to record transactions as a trusted third party has to supervise and validate transactions. Key features of blockchain technology include Decentralization, Immutable ledger, Consensus mechanisms, Cryptographic algorithms and Smart contracts. Blockchain technology can successfully be applied in the following areas [58]

1. Cryptocurrencies (e.g., Bitcoin, Ethereum) (Nakamoto, 2008), 2. Supply Chain Management, 3. Healthcare Record Management, 4. Voting Systems and Intellectual Property Protection

Cyber-Physical Systems (CPS)

Cyber-Physical Systems (CPS) integrates physical and computational components to create a new generation of engineered systems. It is a new generation of digital systems composed of computational and physical capabilities that engage with human like never before. It is designed to act like a network of multiple variables with both physical input and output rather than standalone technology. This type of concept is closely related to sensor networks such as robotics that function according to computational intelligence. CPS are characterized by Integration of physical and computational components, Real-time sensing and control, Networked communication and Autonomous decision-making.

CPS can be applied in Industrial automation, Smart grids , Transportation systems, Healthcare systems and Agriculture. However, CPS also present challenges such as Complexity, Security, dependability, and Reliability [45,49].

5G Networks

5G networks also known as the (Fifth Generation) networks represent a significant leap forward in wireless communication technology, promising faster data rates, lower latency, and greater connectivity. 5G Networks provides high-speed mobile internet, seamless Ultra-High Definition (UHD) for video streaming, connecting billions of devices, Real-time communication for emergency services and Telemedicine and remote health monitoring.

Key Features of 5G Networks includes

- Offer data rates up to 20 Gbps, significantly faster than 4G's 100 Mbps.
- Reduces latency to as low as 1 ms, enabling real-time applications.
- Supports a vast number of devices, making it ideal for IoT applications.
- Ensures ultra-reliable connections, critical for mission-critical applications.

The Network Architecture are:

- Radio Access Network (RAN): 5G RAN consists of small cells, macro cells, and beam forming technology.
- Core Network: 5G core network uses software-defined networking (SDN) and network functions virtualization (NFV).
- Edge Computing: 5G edge computing enables data processing closer to the user
- Challenges and Limitations consist of Infrastructure Costs, Spectrum Allocation, Security Concerns and Health Concerns related to 5G radiations.

Augmented Reality

Augmented Reality (AR) is a technology that overlays digital information and images onto the real world, using a device's camera and display. AR emerged in 1968 when Van Sutherland developed the first AR headset after which AR research expanded with the development of virtual reality (VR) and mixed reality (MR) by mid 1990s. AR became the mainstream with the release of Pokémon Go and other mobile apps in 2010. The following represents the different types of AR:

- Marker-based AR: Uses physical markers to trigger digital content.
- Marker-less AR: Uses GPS, accelerometer, and gyroscope data to determine device location.
- Superimposition-based AR: Overlays digital information onto real-world objects.

AR can be Applied In

- ✓ **Education:** Interactive learning experiences (Basta, 2016)
- ✓ **Gaming:** Immersive experiences (Kim, 2017)
- ✓ **Healthcare:** Surgical training and patient education (Moro, 2017)
- ✓ **Retail:** Virtual try-on and product demonstrations (Poushneh, 2018)
- ✓ **Industrial:** Remote maintenance and repair (Shetty, 2020)

AR Technologies

- Displays: Smart glasses, head-mounted displays (HMDs), and mobile devices.
- Tracking: GPS, computer vision, and sensor fusion.
- Software: ARKit (Apple), ARCore (Google), and Unity.

The Benefits of AR are enhanced engagement and interaction, improved learning outcomes, Increased productivity and enhanced customer experience while challenges Technical limitations (e.g., processing power, battery life), Cost and accessibility, User experience and interface design, Privacy and security concerns

The Four-Phase Industrial Transformation

The four-phase industrial transformation simply means the four stages of industrial revolution and the activities that characterized the era starting from the first to the fourth.

Four-Phase Industrial Transformation Table

First Industrial Revolution (1760-1840)	Second Industrial Revolution (1870-1914	Third Industrial Revolution (1969-2000)	Fourth Industrial Revolution (2010-present)
Mechanization and steam power replace human labor	Electrification and gasoline-powered machines increase efficiency	Computing, internet, and digital technologies transform industries	Artificial intelligence, IoT, and big data integrate
Textiles, iron, and coal mining emerge as key industries	Steel, oil, and chemical industries drive growth	Software, electronics, and biotechnology emerge	Cloud computing, cybersecurity, and digital payments grow
Transportation revolutionized with railroads and canals	Telecommunications and railroads expand	Globalization and international trade increase	Renewable energy, sustainable materials, and eco-friendly technologies develop

Source: Authors Research Desk

Figure 1

State of Industry 4.0 Adoption in Marketing: Challenges and Opportunities Table

	Challenges	Opportunities
1	Data overload and complexity	Enhanced customer insightsand personalization
2	Need for new skills and talent	Increased efficiency and productivity
3	Balancing digital and physical channels	Newchannels andtouchpoints forcustomer engagement
4	Managing customer expectations and experiences	Improved product developmentand innovation
5	Ensuring data privacy and security	Competitive advantagethroughdata-driven marketing
6	Changing Consumer Behaviour	Virtualand Augmented Reality
7	Automated marketing processes and AI driven decision making	Real-time Marketing

Source: Authors Research Desk

Industry 4.0 Marketing Development Landscape Matrix

Short-Term Predictions (2023-2025)	Medium-Term Predictions (2025-2030)	Long-Term Predictions (2030-2040)
Increased adoption of AI-powered chatbots for customer service.	Widespread adoption of IoT sensors for supply chain optimization	Integration of artificial general intelligence (AGI) in marketing strategies.
Growth of e-commerce and digital payments.	Development of augmented reality (AR) and virtual reality (VR) marketing experiences.	Complete digitization of payment systems.
Rising importance of data analytics for personalized marketing.	Increased focus on cybersecurity and data protection.	Virtual and augmented reality-based shopping experiences.
Emergence of blockchain-based marketing solutions.	Emergence of blockchain-based marketing solutions.	Autonomous marketing systems using AI and machine learning.
Growing importance of sustainability and eco-friendly marketing practices	Growing importance of sustainability and eco-friendly marketing practices.	Merging of physical and digital marketing channels.

Source: Authors Research Desk

Case Studies and Best Practices

Nigerian Breweries Plc

Nigerian Breweries, a leading brewing company in Nigeria, has also adopted Industry 4.0 technologies to enhance its operations. It uses IoT sensors and AI-powered predictive maintenance to monitor equipment performance, reducing downtime and increasing overall efficiency. The company has automated its brewing process using Industry 4.0 technologies, ensuring consistent quality and reducing human error by 15%. In terms of supply chain management, Nigerian Breweries leverages Industry 4.0 technologies to optimize its supply chain, improving inventory management and logistics by 20%. Advanced analytics and AI-powered quality control systems ensure consistent product quality and detect anomalies in real-time by 25%

Nigerian Breweries' implementation of Industry 4.0 technologies demonstrates the potential for digital transformation in the Nigerian manufacturing sector. By addressing challenges and leveraging benefits, the company can continue to enhance its operations, drive innovation, and maintain its market leadership position.

Dangote Cement Plc

Dangote Cement, a leading cement manufacturer in Africa, has implemented Industry 4.0 technologies to enhance efficiency, productivity, and innovation. Dangote Cement uses AI-powered predictive maintenance to optimize equipment performance and reduce downtime and IoT sensors to monitor production lines, tracking parameters like temperature, pressure, and flow rates with Robotics Process Automation (RPA) to streamlines repetitive tasks, such as data entry and inventory management.

Dangote Cement leverages cloud-based solutions for data storage, analytics, and collaboration. Advanced data analytics inform business decisions, optimize supply chains, and predict customer behavior. The result is that, Automation and RPA reduced manual errors and enhanced productivity by 20%. AI-powered quality control systems detect anomalies, ensuring consistent product quality, Data analytics inform product development, meeting evolving customer needs. Predictive maintenance and optimized supply chains minimize waste and reduce expenses by 12%. Dangote Cement's Industry 4.0 implementation demonstrates its commitment to innovation and efficiency. By addressing challenges and expanding technology adoption, Dangote Cement will continue to enhance its operations, drive growth, and maintain its competitive edge in the African cement market.

Nigerian Bottling Company (NBC) Plc

Nigerian Bottling Company, a leading beverage manufacturer, has embraced Industry 4.0 to enhance efficiency, productivity, and innovation. NBC has automated its production lines using IoT sensors, machine learning algorithms, and data analytics to optimize production, reduce downtime, and improve product quality. It utilizes predictive maintenance techniques, enabled by machine learning and IoT, to forecast equipment failures, reducing maintenance costs and increasing overall equipment effectiveness. NBC has implemented blockchain technology to enhance supply chain transparency, traceability, and security, ensuring the authenticity and quality of raw materials. AI-powered quality control systems inspect products in real-time, detecting defects and anomalies, and enabling prompt corrective actions and leverages data analytics and business intelligence tools to analyze sales trends, consumer behavior, and market insights, informing strategic decisions and driving business growth.

NBC has implemented robust cyber security measures to protect its Industry 4.0 infrastructure from potential threats and data breaches while making huge invests in employee training and development programs, equipping workers with the skills needed to effectively work with Industry 4.0 technologies.

NBC collaborates with technology providers, startups, and research institutions to stay updated on the latest Industry 4.0 advancements and innovations. Nigerian Bottling Company has enhanced its operational efficiency, product quality, and innovation capabilities, positioning itself for continued success in the competitive beverage manufacturing industry.

Unilever Nigeria Plc

Unilever Nigeria PLC, a leading Fast Moving Consumer Goods (FMCG) company, has embraced Industry 4.0 technologies to enhance operational efficiency, productivity, and innovation. Unilever Nigeria uses AI-powered predictive maintenance to optimize equipment performance and reduce downtime. It uses IoT sensors to monitor production lines, tracking parameters like temperature, pressure, and flow rates while Robotics Process Automation (RPA) streamlines repetitive tasks, such as data entry and inventory management. Unilever Nigeria leverages cloud-based solutions for data storage, analytics, and collaboration while Big Data Analytics inform business decisions, optimize supply chains, and predict consumer behavior. Digital Twinning: Virtual replicas of production lines enable simulation, testing, and optimization 3D printing for prototype development, reducing product development cycles.

Cutix Nigeria Ltd

Cutix Nigeria, a leading manufacturer of electrical and lighting products, has embraced Industry 4.0 technologies to enhance efficiency, productivity, and innovation. Cutix Nigeria has adopted smart manufacturing techniques, utilizing sensors, machines, and data analytics to optimize production processes. The company has implemented automation technologies, such as robotic assembly lines, to improve efficiency and reduce manual labor. Cutix Nigeria has integrated IoT sensors and devices to monitor and control production processes, enabling real-time data analysis and decision-making. The company leverages AI and ML algorithms to predict maintenance needs, detect anomalies, and optimize production workflows. Cutix Nigeria utilizes data analytics tools to gain insights into production processes, customer behavior, and market trends. The company has implemented digital twinning, creating virtual replicas of physical products and processes to simulate and optimize production. Cutix Nigeria prioritizes cyber-security, implementing robust measures to protect against data breaches and cyber threats. The company invests in employee training and up-skilling programs to ensure workers are equipped to work effectively with Industry 4.0 technologies. Cutix Nigeria uses Industry 4.0 technologies to optimize supply chain management, improving inventory control, logistics, and delivery times. The company encourages innovation and R&D, leveraging Industry 4.0 technologies to develop new products and solutions.

By embracing Industry 4.0 technologies, Cutix Nigeria has achieved significant improvements in efficiency, productivity, and innovation, positioning itself as a leader in Nigeria's manufacturing sector.

First Bank of Nigeria Plc

First Bank of Nigeria deploys its chatbot, "FirstMobile", to provide customer support and transactional services. AI-powered predictive analytics help identify potential loan defaulters, detect fraudulent transactions, and optimize credit risk management while AI-driven virtual assistants aid in customer onboarding, account opening, and product recommendations.

First Bank utilizes blockchain technology to secure transactions, ensure data integrity, and prevent fraud. Blockchain-based supply chain finance solutions facilitate secure and efficient trade finance operations. While Self-executing smart contracts automate business processes, reducing manual errors and increasing efficiency.

IoT sensors monitor and control branch infrastructure, optimizing energy consumption and security. IoT-enabled ATMs detect and report issues, reducing downtime and improving customer experience. First Bank's wearable banking solution allows customers to make transactions using smart watches.

First Bank leverages big data analytics to gain insights into customer behavior, preferences, and needs and uses Cloud-based infrastructure to enhance scalability, flexibility, and disaster recovery capabilities. Advanced cybersecurity measures protect customer data and prevent cyber threats.

First Bank of Nigeria's implementation of Industry 4.0 technologies demonstrates its commitment to innovation and customer satisfaction. While challenges exist, the benefits of enhanced customer experience, improved efficiency, and increased security make the adoption of these technologies a strategic imperative for the bank's future success.

Innoson Vehicle Manufacturing (IVM)

Innoson Vehicle manufacturing, a Nigerian automaker, has implemented Industry 4.0 technologies to enhance efficiency, productivity, and innovation. IVM uses AI-powered predictive maintenance to optimize equipment performance and reduce downtime. IoT sensors monitor production lines, tracking parameters like temperature, pressure, and flow rates. It uses Robotics Process Automation (RPA) to streamlines repetitive tasks, such as data entry and inventory management and cloud-based solutions for data storage, analytics, and collaboration. IVM uses advanced data analytics to inform business decisions, optimize supply chains by 15%, and predict customer behavior.

IVM's Industry 4.0 implementation demonstrates its commitment to innovation, efficiency and expanding technology adoption, IVM will continue to enhance its operations, drive growth, and maintain its competitive edge in the African automotive market to remain ahead of the competition.

Theoretical Foundations

Digital Transformation Framework by Gartner et al.

Digital Transformation Framework is a structured approach to guide organizations in their digital transformation journey, ensuring alignment with business objectives and effective integration of digital technologies. Popular Digital Transformation Frameworks are Gartner's Digital Transformation Framework which focuses on business model transformation, customer experience, and operational efficiency, MIT Center for Information Systems Research (CISR) Digital Transformation Framework which emphasizes digital transformation as a journey, focusing on customer engagement, operational efficiency, and business model innovation, World Economic Forum (WEF) Digital Transformation Framework which concentrates on four pillars: customer-centricity, operational efficiency, innovation, and societal impact and Boston Consulting Group (BCG) Digital Transformation Framework of 2018 which focuses on six building blocks: strategy, organization, technology, data, people, and culture [8].

The key components of this framework are Strategy, Organization, Technology, Data, People and Culture to foster a digital-first mindset whereas the benefits are enhanced customer experience, improved operational efficiency, and increased innovation. Others are better decision-making and competitive advantage while challenges are resistance to change, lack of digital skills, data management and security, Integration with existing systems and measuring success.

Dynamic Capabilities Theory (DCT) by David Teece et al.

Dynamic Capabilities Theory is a strategic management framework that explains how organizations adapt, innovate, and evolve to sustain competitive advantage in rapidly changing environments. The key concepts of this theory is the ability of an organization to integrate, reconfigure, and renew its resources and capabilities to respond to changing market conditions unlike Resource-Based View (RBV) and Evolutionary theory which focuses on the internal resources and capabilities of an organization and emphasizes the role of organizational learning and adaptation respectively. Dynamic capabilities theory can be applied in Strategic management, Innovation management, Entrepreneurship Development and Organizational Change and development. Criticisms and Limitations of this theory are that, it lacks of clear definitions and measurements, Overemphasis on internal resources and capabilities and insufficient attention to external factors [54].

Resource Based View (RBV) Theory by Barney (1991)

The Resource-Based View (RBV) theory is a strategic management framework that emphasizes the importance of internal resources and capabilities in achieving sustainable competitive advantage. Proposed that firms with valuable, rare, inimitable, and non-substitutable (VRIN) resources are more likely to achieve sustainable competitive advantage. According to the VRIN Criteria, valuable resources must provide value to the firm, Rare Resources must be unique or scarce, Inimitable resources must be difficult to replicate and Non-Substitutable resources must have no substitutes. The Implication of this is that Internal Analysis focus on internal resources and capabilities, Competitive Advantage is achieved through unique resources and capabilities whereas Sustainability is difficult to replicate resources ensuring long-term advantage [3,4,5].

The major criticism is the overemphasis on Internal Resources which ignores external factors and the difficulty in Identifying VRIN Resources i.e. challenges in determining resource value.

This study will be anchored on Dynamic Capabilities Theory (DCT) because of its relevance to Industry 4.0 as the theory DCT is particularly suited for studying organizations' adaptation to rapid technological changes which is a hallmark of Industry 4.0. It also focuses on capabilities by emphasizing the development and deployment of dynamic capabilities to address changing market conditions, aligning with the study's focus on marketing landscape navigation [14,15,53].

DCT also provides a framework for understanding how organizations can leverage digital technologies to transform their marketing capabilities and emphasis on the importance of innovation in responding to changing market conditions, which is considered a critical aspect of navigating Industry 4.0 [52,59].

By anchoring the study on Dynamic Capabilities Theory, a robust framework for exploring the challenges and opportunities in navigating the marketing landscape of Industry 4.0. Era would have been established.

Methodology

Research Design

- Mixed-methods approach: Combine qualitative and quantitative methods to provide a comprehensive understanding.
- Exploratory and descriptive research: Explore the current state of marketing in Industry 4.0 in Nigeria.

Data Collection Methods

Qualitative:

- In-depth interviews (IDIs) with marketing professionals and industry experts (n=20-30)
- Focus Group Discussions (FGDs) with marketing teams and stakeholders (n=3-5)
- Case studies of Nigerian companies navigating Industry 4.0 marketing challenges

Quantitative:

- Online survey of marketing professionals and business owners in Nigeria (n=200-300)
- Secondary data analysis: Review existing literature, reports, and industry data on Industry 4.0 marketing in Nigeria

Data Analysis Methods

Qualitative

- Thematic analysis: Identify patterns and themes from IDIs, FGDs, and case studies
- Content analysis: Analyze Industry 4.0 marketing strategies and initiatives in Nigeria

Quantitative

- Descriptive statistics: Summarize survey data using means, frequencies, and percentages
- Inferential statistics: Conduct regression analysis to identify relationships between variables

Research Instruments

- Interview guide for IDIs
- FGD protocol
- Survey questionnaire
- Case study protocol

Sampling Strategy

- Purposive sampling: Select marketing professionals, industry experts, and companies actively engaged in Industry 4.0 marketing
- Snowball sampling: Ask participants to recommend additional respondents

Sample Size

- Qualitative: 20-30 IDIs, 3-5 FGDs, 5-10 case studies
- Quantitative: 200-300 survey respondents

Data Validation and Reliability:

- Pilot testing: Pre-test survey questionnaire and interview guide
- Data triangulation: Use multiple data sources to validate findings
- Member checking: Verify findings with participants

Result

A total of 250 questionnaires were retrieved (qualitative and quantitative inclusive), representing a 83.3% return rate from the 300 distributed instruments. This satisfactory response rate ensures that the collected data accurately reflects the opinions and experiences of the sampled population.

Assumption Analysis

The assumptions to be satisfied for techniques employed in this study are normality, homoscedasticity and no multicollinearity. Anderson-Darling (AD) statistic was employed to test for the normality, White test and Breusch-Pagan test techniques were employed for homoscedasticity while Variance Inflation Factors (VIF) and Condition Index (CI) techniques were used for multicollinearity.

Homoscedasticity Test

The White test and Breusch-Pagan test techniques of detecting homoscedasticity were examined as displayed in Table 1.

H0: Residuals are distributed with equal variance (i.e., homoscedasticity)

H1: Residuals are distributed with unequal variance (i.e., heteroscedasticity)

Table 1: Heteroscedasticity Test for Survey Data

White test				
Statistic	**p.value**	**Parameter**	**Method**	**Alternative**
1.238	0.924	6	White's Test	Greater
Studentized Breusch-Pagan test				
data: model				
BP = 0.312.167, df = 3, p-value = 0.964				

Both tests have a p-value greater than a significance level of 0.05, therefore we cannot reject the null hypothesis that the variance of the residuals is constant and infer that homoscedasticity is indeed present.

Multicollinearity Test

Ascertaining if the predictor indicators employed in this study was correlated implied multicollinearity testing. Hence; the Variance Inflation Factors (VIF) and Condition Index (CI) techniques of detecting multicollinearity were examined.

Table 2: Variance Inflation Factors (VIF)

Collinearity Statistics	
Variables	**VIF**
AI	1.0324
Blockchain	1.1132
IoT	1.0217

Since each of the VIF values for the predictor variables in the model are between 1 and 10, multicollinearity is not a problem in the model. 6.875

Table 3: Eigenvalues and Condition Index

Variables	Eigenvalue	Condition Index
AI	0.165	6.011
Blockchain	0.068	10.539
IoT	0.024	14.008
CI=2.622		

Since CI = 2.622 < 10, there is no significant multicollinearity. Thus, the two statistics employed in this study confirmed that the predictor indicators are not correlated. Hence, it was a good result for employing significance testing via multiple regression technique.

Normality of Errors Assumption for Linear Regression

The hypotheses of the Anderson-Darling test are as follows:

H0: Errors are normally distributed

H1: Errors are not normally distributed

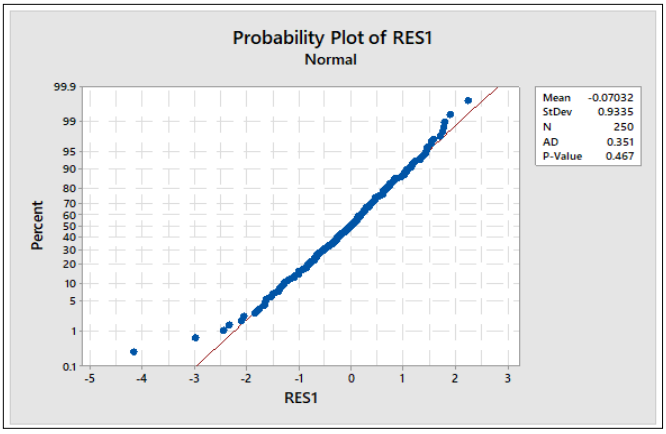

Figure 2: Normal Probability Plot of Residual for Simple Linear Regression

Source: Minitab

Since the p-value (0.467) is greater than 0.05 from Fig. 1, the null hypothesis is not rejected. This implies that the assumption of normality distributed errors is satisfied.

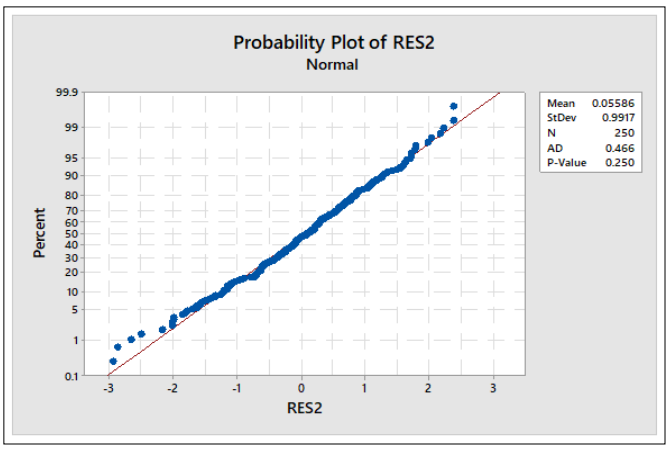

Figure 3: Normal Probability Plot of Residual for Multiple Linear Regression

Source: Minitab

Since the p-value (0.250) is greater than 0.05 from Figure 2, the null hypothesis is not rejected. This implies that the assumption of normality distributed errors is satisfied.

Thus, having satisfied these parametric assumptions, it was necessary to employ the parametric statistical techniques in the analysis of research questions and hypotheses in this study.

Analysis of Research Questions and Hypotheses

To address Research Question 1 and Hypothesis 1, multiple Pearson correlation and multiple regression analysis were utilized, as the data met the multicollinearity assumption. In contrast, simple Pearson correlation and simple regression analysis were employed for Research Questions 2-3 and Hypotheses 2-3, respectively, since the error terms satisfied the normality assumption.

Research Question One

Does the adoption of AI, blockchain, and IoT enable companies to gather more accurate and real-time customer data, leading to more effective marketing strategies?

Table 4: Multiple Correlation Coefficient Summary for Research Question One

Independent Variables	n	$\overline{X}$	SD	R
AI	250	9.872	3.016	
Blockchain	250	10.142	3.007	0.821
IoT	250	9.172	3.182	
Very High Extent				

Source: IBM SPSS Software

Table 4 shows the result obtained in respect of research question one. The result reveals that the multiple correlation coefficient value is 0.821, which is very high. This implies that the adoption of AI, blockchain, and IoT, to a very high extent enable companies to gather more accurate and real-time customer data, leading to more effective marketing strategies.

Hypothesis One

The use of AI, blockchain, and IoT does not enable companies to gather more accurate and real-time customer data, leading to more effective marketing strategies.

Table 5: Results Summary of Hypothesis One via Multiple Linear Regression

	Coefficient	Standard Error	t-value	p-value
AI	0.25	0.05	4.23	< 0.001
Blockchain	0.18	0.04	3.56	< 0.001
IoT	0.22	0.05	4.01	< 0.001

Source: IBM SPSS Software

The results in Table 5 indicate that the use of AI, blockchain, and IoT has a significant positive impact on marketing strategy effectiveness ($p < 0.001$). Therefore, we reject the null hypothesis (H0) and conclude that the use of these technologies significantly enables companies to gather more accurate and real-time customer data, leading to more effective marketing strategies.

Research Question Two

Can Industry 4.0 technologies enhance the personalization of marketing efforts, resulting in increased customer satisfaction?

Table 6: Pearson Correlation Summary for Research Question Two

Variables	n	$\overline{X}$	SD	R
Industry 4.0 technology adoption	250	9.762	3.534	0.864
Customer Satisfaction	250	9.286	3.233	
Very High Extent				

Source: IBM SPSS Software

Table 6 shows the result obtained in respect of research question two. The result reveals that the Pearson correlation coefficient is 0.864, which is very high. This implies that industry 4.0 technologies, to a very high extent enhance the personalization of marketing efforts, resulting in increased customer satisfaction.

Hypothesis Two
Industry 4.0 technologies do not enable companies to personalize their marketing efforts more effectively, leading to increased customer satisfaction

Table 7: Results Summary of Hypothesis Two via Simple Linear Regression

	Coefficient	Standard Error	t-value	p-value
Industry 4.0 technology adoption	0.25	0.05	4.23	< 0.001
R-squared = 0.65				

Source: IBM SPSS Software

The results in Table 7 indicate that Industry 4.0 technology adoption has a significant positive impact on customer satisfaction ($p < 0.001$). Therefore, we reject the null hypothesis (H0) and conclude that industry 4.0 technologies significantly enable companies to personalize their marketing efforts more effectively, leading to increased customer satisfaction.

Research Question Three
Do companies that adopt Industry 4.0 technologies experience a significant increase in market share, customer engagement, loyalty, and competitiveness?

Table 8: Canonical Correlation Coefficients Summary for Research Question Three

Canonical Variate	N	Canonical Correlation (ρ)
1	250	0.851
2	250	0.562
3	250	0.443
4	250	0.414

Source: R-Studio Software

The canonical correlation coefficients (ρ) indicate the strength of the relationship between the Industry 4.0 technologies adoption and the dependent variables. The first canonical variate shows a strong positive correlation ($\rho = 0.851$) between Industry 4.0 technologies adoption and the dependent variables, indicating that companies that adopt Industry 4.0 technologies tend to experience significant increases in market share, customer engagement, loyalty, and competitiveness. The second, third and fourth canonical variates show moderate positive correlations ($\rho = 0.562$, 0.443 and $\rho = 0.414$), indicating additional relationships between Industry 4.0 technologies adoption and specific dependent variables. Generally, the canonical correlation analysis suggests that companies that adopt Industry 4.0 technologies tend to experience significant increases in market share, customer engagement, loyalty, and competitiveness.

Hypothesis Three
Companies that adopt Industry 4.0 technologies do not experience a significant increase in market share, customer engagement, loyalty, and competitiveness

Table 9: Results Summary of Hypothesis Three via MANOVA

Dependent Variable	F-value	p-value
Market share	12.15	< 0.001
Customer engagement	10.56	< 0.001
Loyalty	9.21	< 0.001
Competitiveness	11.43	< 0.001

Source: R-Studio Software

The results in Table 9 indicate that companies that adopt Industry 4.0 technologies experience a significant increase in market share, customer engagement, loyalty, and competitiveness ($p < 0.001$). Therefore, we reject the null hypothesis (H0) and conclude that industry 4.0 technology adoption has a positive and significant impact on these business outcomes.

Summary of Key Findings
- The top challenges faced by marketers in adapting to Industry 4.0 were lack of skills and training, limited budget for innovation, and difficulty in integrating new technologies.
- The use of AI, block-chain, and IoT has a significant positive impact on marketing strategy effectiveness.
- Industry 4.0 technologies significantly enable companies to personalize their marketing efforts more effectively, leading to increased customer satisfaction.
- Companies that adopt Industry 4.0 technologies experience a significant increase in market share, customer engagement, loyalty, and competitiveness.

Discussion of Findings
The result of research question one reveals that the multiple correlation coefficient value is 0.821, which is very high. This implies that the adoption of AI, blockchain, and IoT, to a very high extent enable companies to gather more accurate and real-time customer data, leading to more effective marketing strategies, while the result of hypothesis one reveals that the use of these technologies significantly enables companies to gather more accurate and real-time customer data, leading to more effective marketing strategies. The results of this study are consistent with that of whose study found that the adoption of artificial intelligence in marketing led to improved customer data analysis and more effective marketing strategieswhose result revealed that the implementation of Industry 4.0 technologies resulted in enhanced customer engagement and competitiveness; Sarpong and Maclean (2020), whose study demonstrated that the use of blockchain in marketing led to increased transparency and accountability in customer data management; and whose result found that the integration of IoT, AI, and blockchain in marketing resulted in improved customer satisfaction and loyalty [30,36,42,48].

The result of research question two reveals that the Pearson correlation coefficient is 0.864, which is very high, which implies that industry 4.0 technologies, to a very high extent enhance the personalization of marketing efforts, resulting in increased customer satisfaction, whereas the result of hypothesis two reveals that industry 4.0 technologies significantly enable companies to personalize their marketing efforts more effectively, leading to increased customer satisfaction. The results of this study are consistent with that of whose study found that the adoption of Industry 4.0 technologies led to enhanced personalization of marketing efforts and increased customer satisfaction; whose result revealed that the use of artificial intelligence in marketing resulted in more effective personalization and customer satisfaction;

whose study demonstrated that the implementation of IoT and blockchain in marketing led to increased personalization and customer satisfaction; and) whose result found that the integration of Industry 4.0 technologies in marketing resulted in improved customer satisfaction and loyalty [31,51].

The result of research question three reveals that the canonical correlation coefficients (ρ) indicate the strength of the relationship between the Industry 4.0 technologies adoption and the dependent variables. The first canonical variate shows a strong positive correlation ($\rho = 0.851$) between Industry 4.0 technologies adoption and the dependent variables, indicating that companies that adopt Industry 4.0 technologies tend to experience significant increases in market share, customer engagement, loyalty, and competitiveness. The second, third and fourth canonical variates show moderate positive correlations ($\rho = 0.562$, 0.443 and $\rho = 0.414$), indicating additional relationships between Industry 4.0 technologies adoption and specific dependent variables. Generally, the canonical correlation analysis suggests that companies that adopt Industry 4.0 technologies tend to experience significant increases in market share, customer engagement, loyalty, and competitiveness. On the other hand, the result of hypothesis three reveals that industry 4.0 technology adoption has a positive and significant impact on these business outcomes. The results of this study are consistent with that of whose study found that the adoption of Industry 4.0 technologies led to significant increases in market share, customer engagement, loyalty, and competitiveness; whose result revealed that the use of digital technologies in marketing resulted in improved business outcomes; Sahin et al. (2019), whose study demonstrated that the implementation of IoT and blockchain in marketing led to increased competitiveness and market share; and whose result found that the integration of Industry 4.0 technologies in marketing resulted in improved customer satisfaction, loyalty, and business competitiveness [1,39,47,56].

Conclusion

The study's findings highlight the significance of Industry 4.0 technologies in transforming marketing strategies and practices. Marketers are adapting to the changing dynamics of Industry 4.0 by adopting new technologies and changing their marketing strategies. However, they face challenges such as lack of skills and training, limited budget for innovation, and difficulty in integrating new technologies. The study's results demonstrate the importance of embracing Industry 4.0 technologies to enhance marketing strategy effectiveness, customer satisfaction, and business outcomes. [11,18,37,43]

Implications for Marketing Professionals and Organizations

- Marketing professionals need to develop skills in emerging technologies such as AI, blockchain, and IoT to remain relevant in the Industry 4.0 era.
- Organizations should invest in training and development programs to enhance the skills of their marketing professionals.
- Marketing strategies should focus on personalization, customer experience, and omnichannel engagement to meet the changing expectations of customers.
- Organizations should allocate sufficient budget for innovation and experimentation with new technologies to stay ahead of the competition.

Future Research Directions

- Investigating the impact of Industry 4.0 technologies on specific marketing functions such as advertising, branding, and public relations.
- Examining the role of emerging technologies such as augmented reality, virtual reality, and 5G in marketing.
- Studying the challenges and opportunities of implementing Industry 4.0 technologies in small and medium-sized enterprises (SMEs).
- Exploring the ethical implications of Industry 4.0 technologies on marketing practices and consumer data privacy [43,55,57,60].

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Declarations of Interest

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