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Automating and Expanding Businesses in the 21st Century through Internet of Things (IoT) or Blockchain Technology

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Abstract

This article explores the transformative potential of Internet of Things (IoT) and blockchain technology in automating and expanding business operations in the 21st century. The study examines their individual and combined impacts on automating processes, improving security, and fostering new business models. Data for this study were collected through both primary and secondary sources. The authors reviewed materials from various books, web pages, and journals, and conducted a survey using a questionnaire distributed via Google Forms. The survey sample comprised 248 respondents, including business owners and executives, IT managers, industry experts, government officers, researchers, technology vendors, and other related personnel within the Nigerian business context. Simple percentage and descriptive statistics, including mean and standard deviation, were used to analyze the data. Responses with a mean value of 3 and above were considered significant. Findings indicate that implementing IoT and blockchain technologies significantly impacts supply chain management, customer service, product development, operational efficiency, financial transactions, contract management, and data security. Major recommendations for businesses considering these technologies include conducting need assessments, developing clear strategies, investing in workforce education and training, ensuring robust security measures, collaborating with vendors and experts, monitoring and evaluating performance, and focusing on interoperability and integration. This study offers valuable insights for businesses seeking to leverage IoT and blockchain to navigate and thrive in the evolving technological landscape.

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Introduction

Businesses in the 21st century are looking for more creative ways to improve their operational efficiency, security, and scalability in the ever-changing digital landscape. The Internet of Things (IoT) and blockchain technology are two of the most revolutionary innovations causing this shift. IoT makes real-time data collecting, monitoring, and automation across a range of sectors possible by connecting a massive network of devices. Blockchain (BC) technology, on the other hand, provides a decentralized, unchangeable ledger system that guarantees data security, integrity, and openness. The combination of blockchain technology and the Internet of Things offers enterprises previously unheard-of possibilities for growth and automation as they work to remain responsive to consumer needs and competitive [1]. The way of life for the majority of people will be greatly impacted by the integration of IoT in various fields, and things will improve. The public's changing lifestyles will also lead to the emergence of new business models. To bring this to pass, we will need to put in place strong, dependable, and highly secure structures that will act as a worldwide platform for international cooperation. It is necessary to implement a specific set of ideas, practices, and standards in order to create IoT-enabled infrastructures that enable seamless, highly efficient configuration and monitoring. With the exponential rise in the number of devices in this decade (which is around fivefold, close to 75 billion!) there is a pressing need Canny framework with generous self-setup, self-observing, and self-recuperating properties are required to deal with the huge and quickly developing number of gadgets. Advancement is being made in a significant number of these territories; this position paper will along these lines concentrate on an issue that has not gotten enough consideration yet, however is urgent for structure and conveying IoT applications in modern or endeavor settings on a more extensive scale: The possible usage IoT in business operations mindful of IoT [2].

Blockchain, also known as Distributed Ledger Technology, is a distributed database collectively maintained by various nodes in a decentralized network [1]. Each data block is determined through mining operations conducted by millions of computers, dispersed globally, and stored in a decentralized global ledger using advanced encryption [2]. When a transaction occurs, miners, based on their immense computational power, create a block encompassing all previous transactions approximately every 10 minutes [3]. The technology enables key participating nodes in an information system to utilize various encryption methods for potential coherence of data blocks, each containing all transaction information for a specific time effectively. From an auditing perspective, BC can reduce audit costs, minimize financial risks, reduce human errors, lower audit costs, and expedite data processing, presenting a new form of accounting [4]. BC has undergone three developmental stages: BC 1.0 as a digital currency, BC 2.0 with smart contracts, and BC 3.0 as a decentralized system.

This research article aims to explore the potential of these technologies in transforming business operations, examining their individual and combined impacts on automating processes, improving security, and fostering new business models. By analyzing case studies and current implementations, this study seeks to provide a comprehensive understanding of how IoT and blockchain can synergistically enhance business capabilities and drive innovation in today's digital economy.

This research article aims to explore the transformative potential of Internet of Things (IoT) and Blockchain technology in automating and expanding businesses in the 21st century. The specific objectives of the study are:

1. Analyze the Impact of IoT on Business Automation
2. Assess the Role of Blockchain in Business Expansion
3. Compare and Contrast IoT and Blockchain Technologies
4. Forecast Future Trends and Opportunities

II. The Characteristics of Blockchain Technology and How They Affect Business Automation and Growth

Blockchain provides a special way to store data encoded with bitcoin. The data layer, network layer, consensus layer, incentive layer, contract layer, and application layer make up this particular data structure [5]. A significant amount of transaction data can be saved in this structure. At the moment, blockchain technology mainly offers the following functions; Decentralization and distribution, Traceability Throughout the Entire Process and Resistance to Manipulation, openness and transparency, smart contracts.

Blockchain offers special benefits for enhancing connectivity and data reliability. It has the potential to improve the caliber of business accounting data if it is applied in accounting successfully [6]. Such areas in accounting include; Account processing section, account settlement section, part of accounting information disclosure [7]. Blockchain serves eight primary functions in the financial domain [8]: Identity verification and account balances, transferable value, value storage, value loans, exchange value, financial provision and investment, value assurance and risk management, accounting and auditing. Blockchain has the potential to transform business operations, simplifying financial transactions and accelerating processes. Cross-border collaboration can become much more straightforward, and blockchain's innovative poles are emerging globally, reshaping commerce and transactions. Initial Coin Offerings (ICOs) and Security Token Offerings (STOs) can completely alter the landscape of risk-bearing capital. Blockchain supports and promotes: Entrepreneurship-Friendly Environment, Community of Partners and Customers, Robust Investment Space, Risk Management, Fair Regulatory Environment and Stakeholder Protection.

Blockchain is revolutionizing the financial industry by enabling rapid transactions, asset transfers, safe and transparent asset management, and auditing. It has the ability to completely transform a number of corporate processes and establish blockchain as a key element of the future. Blockchain has the potential to bank the unbanked worldwide because it allows users to join a decentralized, secure network that is run without the need for middlemen.

III. Iot and Its Impacts in Business

The internet transformed communication and helped people who were separated by distance communicate with each other. However, by enabling device connectivity to the internet, the development of the IoT altered the functions of gadgets. Imagine being able to set alarms with your voice and having your alarm clock connected to the internet. One of the biggest concerns in the tech world at the moment is the effect of IoT on the business sector. As of now, there are more than 14 billion connected IoT devices worldwide. By 2030, the total number of connected IoT devices may reach 26 billion. Expenses on IoT solutions in 2020 reached almost $750 billion, and the expenses in 2022 reached the $1 trillion mark. Experts have drawn forecasts about global IoT spending reaching $1.1 trillion in 2023. Some of the biggest uses of IoT have been identified in the field of consumer media devices, connected vehicles, and payment terminals [9]. The answers to “What does IoT mean for businesses?” would point to the different ways in which IoT revolutionizes businesses. A clear overview of the transformative influence of IoT on different aspects of business operations could help you understand the responses. Figure 1 shows some of the notable ways in which IoT has influenced business practices.

Figure 1. Ways in which IoT has influenced business

The Internet's evolution can be divided into five distinct eras: the Internet of documents, which includes electronic libraries and document-based webpages; the Internet of commerce, which includes websites for stock trading, e-banking, and e-commerce; the Internet of applications, or Web 2.0; the Internet of people, or social networks; and the Internet of Things, or connected devices [10]. Internet of Things has been described in a number of ways in scientific publications [11]. As described by [12], [13], [14], [15], [16], [17], [18], and others, it has been characterized as a network, an ecosystem, a paradigm, a concept, and a global network infrastructure.

The Internet of Things (IoT) has its own set of technologies that facilitate object connectivity, data retrieval, and application-to-application communication [19]. The Internet of Things is fast growing in number. 8.4 billion Internet-connected devices were in use in 2017, according to estimates from industry analytics firm Gartner [20]. These items include industrial machinery, transportation systems, wearable technology like fitness trackers and smartwatches, and mobile devices like smartphones and tablet PCs. Furthermore, the Internet of Things has a significant impact on both the economy and the Internet. According to some estimates, there will be up to 100 billion IoT-connected devices and a global economic impact of over 10 trillion euros by 2025 [10].

The most important benefits that are achieved by IoT applications are monitoring and consequently immediate decision making for efficient management [18]. The IoT can be useful for the human resource department as well. With the help of data from the employees received via wearables, the human resource department could set up a promisingly positive work culture, as now it is possible that the productivity of the employees, the communication and behaviours could be assessed [21]. Additionally, there would be faster and more effective communication as well as much easier idea sharing. This is how the Internet of Things will enhance worker productivity and provide a better working environment for workers. With the use of IoT technology, employee well-being may also be tracked and evaluated. Employee health is monitored via wearable technology, and if unfavorable information is found, appropriate action can be taken. A digital work culture is fostered by the Internet of Things [22].

IV. Research Questions

The summarized research questions are listed below:

1. How familiar are you with IoT and Blockchain technologies, and has your business adopted these solutions?
2. What benefits and challenges has your business experienced in implementing IoT and/or Blockchain technologies?

3. How do you perceive the future impact of IoT and Blockchain on business automation, and do you plan to expand their use in the coming years?

V. Materials and Methods

The data used for this study were collected through both primary and secondary sources. The researchers having reviewed materials from different books, web pages, and journals related to this work and also carried out a survey, coupled with the result of the questionnaire was capable to draw inference.

A questionnaire was distributed via "Google Forms" from the 23rd of May, 2024 to 7th of June, 2024, titled; "A Questionnaire on Automating and Expanding Businesses in the 21st Century Through IoT or Blockchain Technology" and the sample comprised 248 respondents. Google Forms was used because it's an efficient tool that can be easily accessed by anyone for free. It is an assessment tool that can reduce cost, increase efficiency and reduce one's workload [23].

The target population for the respondents were individuals and entities directly involved in the adoption, implementation, and impact assessment of IoT and blockchain technologies within the Nigerian business context. The target population include: Business Owners and Executives, IT managers and Technology officers, Industry experts and consultants, Government officers, Researchers and academics, technology vendors and service providers and other related personnel. To ensure a representative and comprehensive understanding of the research topic, Stratified Random Sampling technique was employed. By targeting a well-defined population and employing stratified random sampling, this research work gathers comprehensive and representative data to understand the role of IoT and blockchain technologies in automating and expanding businesses in Nigeria.

The questionnaire contained six (6) sections. Section A (Demographics) which contains details like; Gender, Age and Industry. Section B (Business Information), which contained 3 questions – size of business, role in company and longevity of business. Section C (Awareness and adoption of IoT and Blockchain). Section D (Impacts/Benefits and challenges of using Blockchain and IoT in Business automation), Section E (Future prospects), and Section F (General Opinion). Simple percentage and descriptive statistics were used to analyze the data. For the descriptive statistics, standard deviation and mean were used. Responses with a mean value of 3 and above were considered as significant, while those with less than 3 were insignificant.

The study area

The study area for this research included business owners and executives, IT managers, industry experts, government officers, researchers, technology vendors, and other related personnel within the Nigerian business context.

Study Population

The population in this study was made up of 248 respondents including business owners and executives, IT managers, industry experts, government officers, researchers, technology vendors, and other related personnel within the Nigerian business context.

Study Design

Action research design methodology was adopted in this study. In this study design you first seek proper and basic understanding of what is on ground. Once the basic understanding is gained, a new interventional strategy is adopted, and a cyclic process repeats, continuing until a sufficient understanding of the problem is fairly achieved. It further moves through several interventions and evaluations to arrive at the targeted solution. The rational for adopting the action study design is the fact that action search studies often have direct and obvious relevance to practice. Action search design focuses on pragmatic and solution-driven research rather than testing theories

Data collection Methods

Data for this study were collected through both primary and secondary sources. Materials from various books, web pages, and journals were reviewed, survey were conducted using questionnaire distributed via Google Forms. The use of questionnaire ensures confirmation and completeness of data as well as increase confidence in the credibility of our findings.

Stratified random sampling was employed to ensure a representative and comprehensive understanding of the research topic.

Data analysis

Simple percentage and descriptive statistics, including mean and standard deviation, were used to analyze the data. Responses with a mean value of 3 and above were considered significant

VI. Results

The results from the responses are represented in figures and tables, showing their percentages, mean and standard deviation values. Total number of respondents (n) is 248.

Gender, Age and Industry of Respondents

The gender, age and industry the respondents currently work is depicted using pie chart in figures 2a, 2b and 2c. The pie chart was created using the free online tool “metachart[dot]com”.

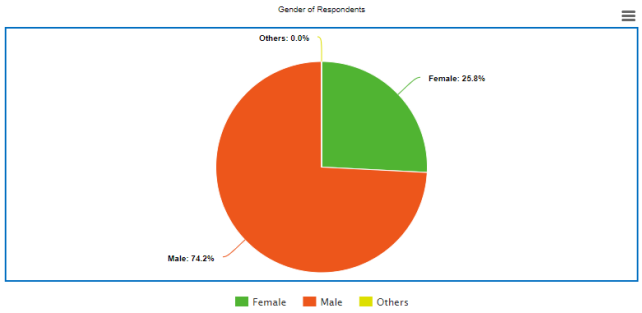

Figure 2a. Respondents’ Cadres

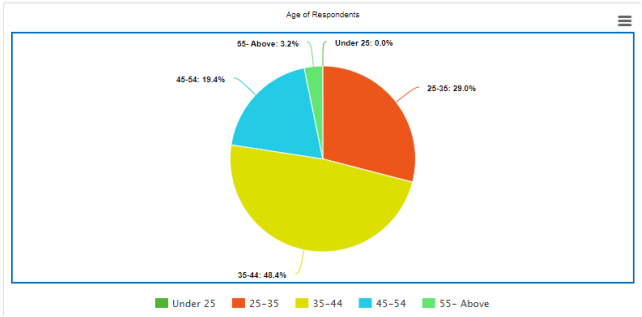

Figure 2b. Age distribution of Respondents

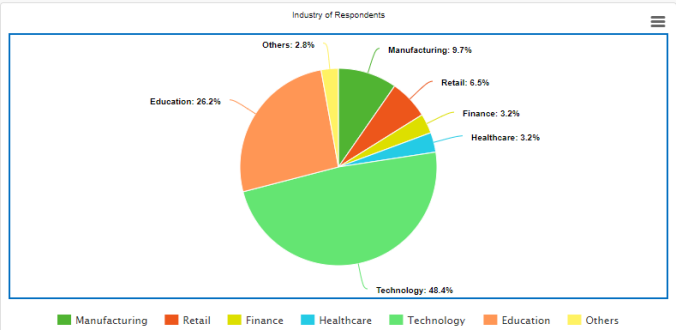

Figure 2c. Respondents’ Industry

Figure 2a shows that 25.8% (64) of the respondents are female, while 74.2% (184) are Male and none are “other” gender. In figure 2b, we find out that 0% of the respondents are under 25 years, about

29% (72) of the respondents are from the ages of 25 to 34, 48.4% (120) are 35 to 44 years, 19.4% (48) of the respondents are 45 to 55 years and only 8 of the respondents (3.2%) are above 55 years old.

However, in figure 2c, we discovered that only about 3.2% of the respondents are in Health Care and Finance Industries each. 9.7% (24) are in manufacturing, 6.5% (16) are in retail, 48.4% (120) are in Technology, 26.2% (65) are in Education and just 2.8% (7) are in other industries not listed above.

Business Information

Figures 3a, 3b and 3c show percentage of size of business, role in company and length (number of years) of business operation of respondents respectively.

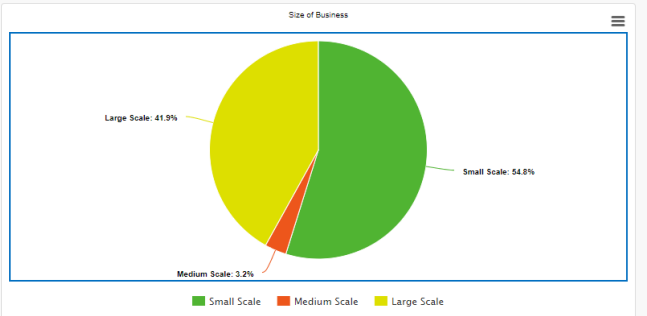

Figure 3a. Size of respondents' business

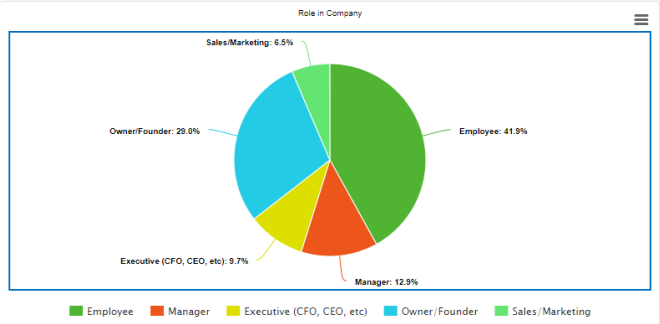

Figure 3b. Role of respondents in Company

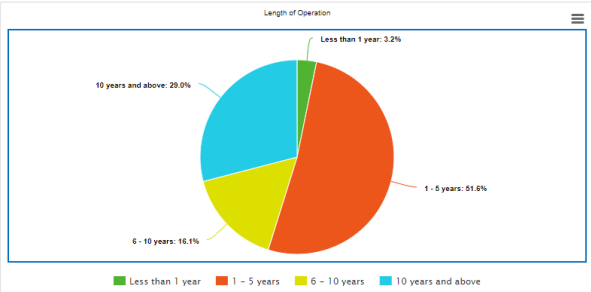

Figure 3c. Length of operation of business

Figure 3a shows that 54.8% of the respondents work in a small-scale business, 3.2% of the respondents in a medium scale business and 41.9% of the respondents work in Large scale business.

Also, from figure 3b, we find out that 41.9% of the respondents are employees in the place of business, 12.9% are managers, 9.7% are Executives

(CEO, CFO, etc), 29% are the owners/founders of the business, while 6.5% are in sales/marketing. From figure 3c, we discovered that only 3.2% of the respondents have spent less than a year in their place of business, 51.6% have spent 1 to 5 years, 16.1% have spent 6 to 10 years and 29% have spent over 10 years.

Awareness and Adoption of IoT and Blockchain

The familiarity of IoT and Blockchain Technologies of the respondents and whether their businesses have adopted these technologies before were depicted using multiple bar charts in figures 4a and 4b. Multiple bar charts were created using the free online tool "metachart[dot]com."

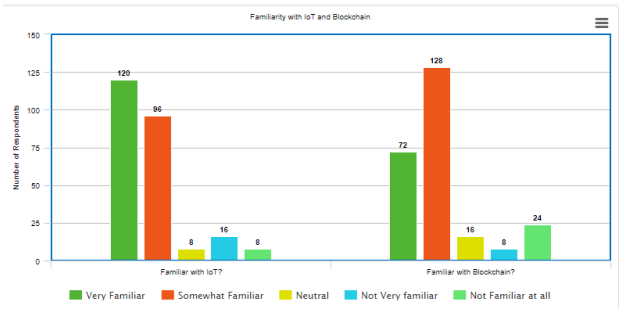

Figure 4a. Respondents' familiarity with Blockchain and IoT

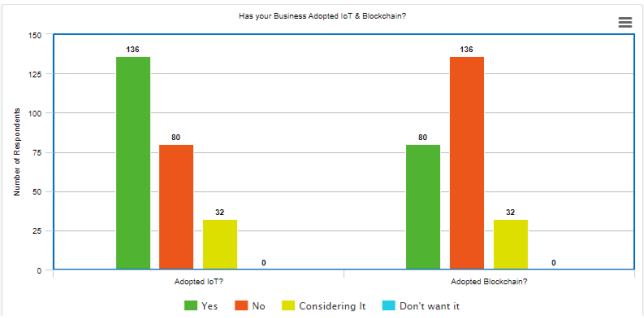

Figure 4b. Number of businesses that have adopted IoT and Blockchain

From figure 4a, we discovered that 48.4% (120) and 29%(72) of the respondents are very familiar with IoT and Blockchain technologies respectively, 38.7% (96) and 51.6%(128) of the respondents revealed that they're somewhat familiar with these technologies respectively. However, 3.2% (8) and 9.7% (24) of the respondents know nothing about IoT and Blockchain technologies respectively. Figure 4b reveals that, 54.8% (136) and 32.3% (80) of the respondents have adopted these respective technologies in their businesses. On the flip side, 32.3% (80) and 54.8% (136) of the respondents have not adopted IoT and Blockchain in their businesses respectively. 12.9% (32) of all respondents are considering adopting it.

Question: What benefit(s) has your business experienced using IoT and/or Blockchain technologies?

Table 1: *Standard Deviation (SD) and Mean Score (X) of respondents' business benefits from using IoT and Blockchain technologies (n=248).*

IoT			Blockchain		
Benefits	**X**	**SD**	**Benefits**	**X**	**SD**
Improved Efficiency	4.25	1.01	Enhanced Security	3.14	1.12

Cost Savings	3.01	1.54	Improved Transparency	3.16	1.32
Better Data Collection & Analysis	3.98	1.14	Faster Transactions	3.89	1.08
Enhanced Customer Experience	2.12	1.48	Reduced Cost	2.87	1.45
Increased Automation	3.58	1.42	Better Traceability	2.98	1.85

Table 1 shows that Improved Efficiency is the major benefit of IoT on businesses with a mean score of 4.25 and SD of 1.01. Better Data collection and analysis, cost savings and Increased automation are also significant importance of IoT in business. Faster transaction is revealed as the major benefit of integration Blockchain to businesses with X = 3.89 and SD = 1.08. Other significant importance are; Enhanced security, and improved transparency.

Question: What challenges have you faced in implementing IoT and Blockchain technology?

Table 2: *Standard Deviation (SD) and Mean Score (X) of respondents' business challenges using IoT and Blockchain technologies (n=248).*

IoT			Blockchain		
Challenges	**X**	**SD**	**Challenges**	**X**	**SD**
High Initial Cost	4.12	1.23	Regulatory Issues	3.01	1.31
Technical Complexity	3.12	1.42	Technical Complexity	3.42	1.07
Security Concern	1.42	1.17	High Energy Consumption	1.45	0.88
Lack of skilled workforce	3.23	1.32	Limited Scalability	1.22	1.32
Integration with Existing System	2.19	0.89	Integration with Existing Systems	2.22	1.23

Table 2 reveals that high initial cost has a mean rating of 4.12, Technical complexity has 3.12, Lack of skilled workforce has 3.23, which are all higher than the accepted significant score of 3, indicating that the respondents agreed that these are the major challenges faced when implementing IoT technology in businesses. Regulatory issues and technical complexity are the only challenges face for blockchain implementation with significant mean scores.

Question: Do you plan to expand the use of IoT and Blockchain in your business in the next 2 to 5 years?

Figure 5 shows the number of respondents that wish to or not to expand the use of these technologies in their businesses in the next two to five years.

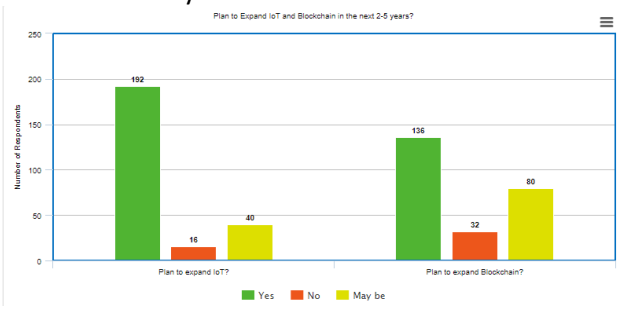

Figure 5. Number of respondents that wish to/not to expand the use of IoT and Blockchain in their businesses in the next 2 to 5 years

From figure 5, we find out that 77.4% (192) of the respondents are planning to expand the use of IoT in their businesses in the next two to five years, while 54.8% (136) of the respondents wish to do so with blockchain. 6.5% and 13% of the respondents do not wish to expand in IoT and Blockchain respectively. While, 16.1% and 32.3% of the respondents may do so with IoT and Blockchain respectively.

Question: What areas do you see as the most promising for IoT and Blockchain Application in your business?

Table 3: *Standard Deviation (SD) and Mean Score (X) of most promising areas of the application IoT and Blockchain technologies in respondents' businesses (n=248).*

IoT			Blockchain		
Areas of Application	**X**	**SD**	**Areas of Application**	**X**	**SD**
Supply Chain Management	3.01	1.32	Supply Chain Management	3.01	1.13
Customer Service	3.03	1.24	Financial Transaction	3.28	1.17
Product Development	3.23	1.12	Data Security	4.23	1.09
Operational Efficiency	4.23	1.01	Contract Management	3.12	1.23
Marketing	2.82	0.92	Customer trust & Transparency	2.89	1.45

With X = 4.23, table 3 shows that Operational Efficiency is the most promising arear of application of IoT in business for the respondents and other significant arears are; product development, customer service and supply chain management in that order. While, Data Security appears to be the most promising arear of the application of Blockchain in businesses by the respondents with X = 4.23. Other significant areas include; financial transaction, contract management and supply chain management.

Question: How do you perceive the overall impact of IoT and Blockchain technologies on business automation and expansion?

Figure 6 shows how respondents perceive the overall impact of IoT and Blockchain technologies on business automation and expansion.

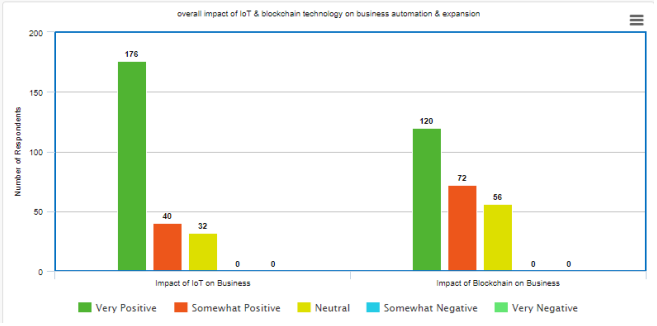

Figure 6. Number of respondents on the overall impact of IoT and Blockchain on business automation and expansion.

From figure 6, 71% and 48.4% of the respondents assert that IoT and Blockchain have a very positive impact on business automation and expansion respectively. 16.1% and 29% agree that these respective technologies have a somewhat positive impact and others are neutral about it. This depicts that IoT and Blockchain generally have positive impacts on these technologies.

Question: Do you believe that IoT and blockchain technologies can work together to provide greater benefits for businesses?

Figure 7 shows how respondents agree if IoT and Blockchain technologies can work together to provide greater benefits for businesses.

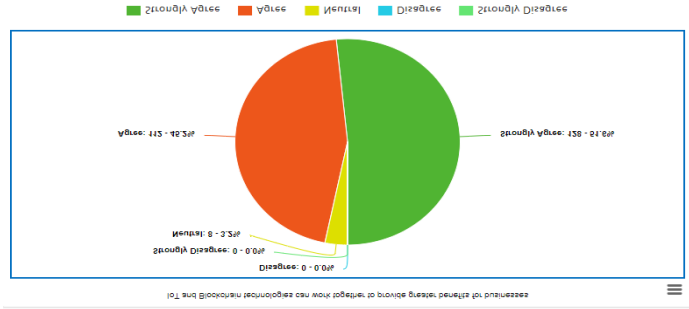

Figure 7. How respondents agree whether IoT and Blockchain can work together to provide greater benefits for businesses

From figure 7, we discovered that a total of 96.8% of the respondents agree that IoT and Blockchain technologies can work together to provide greater benefits for businesses, while only 3.2% are neutral and none of the respondents disagree. This depicts that indeed, both technologies can work together for greater benefits of businesses.

Question: What recommendations would you provide to businesses considering implementing IoT and/or blockchain technologies?

This question is a textual response question. Respondents were asked to type in their answers and top 10 most common responses were taken. See them in no particular order below:

1. For the implementation IoT and/or blockchain technologies, it is important business owners consider the infrastructure involved. The physical layer includes IoT devices, the network and computing resources used to process the data.
2. Prioritize security in the design and implementation of IoT and blockchain solutions to protect sensitive data and prevent unauthorized access.
3. Evaluate the specific needs and pain points of your business to determine where IoT or blockchain technologies can provide the most value.
4. Define clear objectives and goals for implementing IoT or blockchain technologies.
5. Ensure that your team is knowledgeable about IoT and blockchain technologies through workshops, training programs, and certifications.
6. Begin with small-scale pilot projects to test the feasibility and effectiveness of IoT or blockchain solutions in your business context.
7. Partner with reputable technology vendors and consultants who have experience in implementing IoT and blockchain technologies.
8. Choose IoT and blockchain solutions that can easily integrate with your existing systems and platforms.
9. Establish key performance indicators (KPIs) to measure the success and impact of IoT and blockchain implementations.
10. Select IoT and blockchain solutions that can scale with your business as it grows.

VII. DISCUSSION OF FINDINGS

The study shows that improved efficiency, better data collection and analysis, increased automation, and cost savings are the significant benefits of integrating IoT in business automation, while – faster transaction, improved transparency and enhanced security are significant benefits to integrating blockchain into one's business. These findings tally with [24], [25], who opined that, "in more recent years, the adoption of digital solutions in businesses has been both fashionable and appealing due to their potential benefits and the role they play in the digital world. The authors

discovered that, although cost savings is one of the significant benefits, the initial cost of implementing and integrating these technologies into one's business can be on the high side, hence agreeing with [26] who opined that in order to understand how they can benefit from blockchain, firms need an accurate estimation of their economic outcomes, and a careful assessment of the implications for the whole supply chain network.

Another finding of this study shows that technical complexity and lack of skilled workforce are significant challenges businesses face implementing the IoT and blockchain technologies into their business. Regulatory risk is also a challenge in implementation of blockchain into businesses. This result is consistent with Woodsides et al., [27]'s research where they opined that "Blockchain-related programs have no specific regulatory requirements. Additionally, different operational conditions, different actors, and cross-border activity permits can create regulatory obstacles for blockchain adoption." Even though there are potential risks involved in integrating IoT and Blockchain into one's business, the use of these technologies and other internet facilities offers the potential for increased visibility and more efficient communications for businesses [28].

It was also discovered that supply chain management, customer service, product development, operational efficiency, financial transaction, contract management and data security and significant application arears of IoT and Blockchain in business automation. This is consistent with [29] who opined that, "Blockchain technology enables trustless networking, because the parties can make transactions even though they do not trust each other; therefore, their applications can considerably increase the chances for firms to create an efficient and effective supply chain network." Also, with the fusion of Internet of Things in businesses, it will have a huge impact on the livelihood of the general masses and they will change for the better. This will also facilitate the lifestyle changes of the public, and bring forth emergence of new business models [30].

This study revealed that IoT and blockchain have positive impact on business automation and expansion. It was also revealed that IoT and blockchain technologies can work together to provide greater benefits for businesses due to their complementary strengths in enhancing security, efficiency, and transparency. IoT devices generate vast amounts of real-time data essential for automating processes and improving operational efficiency, but they often face challenges related to data integrity and security. Blockchain technology addresses these challenges by providing a decentralized, tamper-proof ledger that ensures the immutability and trustworthiness of data. This synergy enables businesses to secure IoT-generated data, automate transactions through smart contracts, and maintain transparent and auditable records. Together, IoT and blockchain can streamline supply chains, enhance regulatory compliance, reduce costs by eliminating intermediaries, and foster new business models, ultimately driving innovation and growth in the 21st century.

VIII. Conclusion

This work focused on finding the major benefits of automating and expanding businesses in the 21st Century through IoT or Blockchain Technologies, identifying the challenges of implementing them and finding out how these technologies can work hand in gloves to achieve one's business goals. The significant importance of implementing these technologies are – supply chain management, customer service, product development, operational efficiency, financial transaction, contract management and data security. Challenges one can encounter are huge initial cost, technical complexity and lack of skilled workforce. Major recommendations for businesses considering implementing IoT and/or blockchain include need assessment, developing a clear strategy, investing in education and training of workforce, ensuring robust security measures, collaborating with vendors and experts, monitoring and evaluating performance, focusing on interoperability and integration.

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