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Internet of Things in Financial Services

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ABSTRACT

The Internet of things (IoT) is an advanced technology that enables networks of connected devices (such as sensors, cameras, and smart gadgets) to collect real-time data, transfer it to the cloud for processing and analysis, and react to events in real time. IoT industry is developing rapidly and it provides people with a range of digital devices and sensors all around the world. It is evident that the IoT industry is booming, and there are many benefits for banking and financial services in adopting connected technologies. The Internet of things and financial services create a beneficial combination. IoT plays an important role in banking and finance, ensuring efficient data collection and processing. In this paper, we explore the applications of IoT in banking and finance.

KEYWORDS: *Internet of things, IoT, industrial Internet of things, IIoT, finance, banking, financial services*

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INTRODUCTION

The rapid advancement of technology has revolutionized our lives and business practices. Technology has not only made life easier for people; it has also turned the world to a global village where people are connected through the phone, laptops, and other machines that make communications and business transactions easier to carry out. The Internet is undoubtedly one of the most powerful inventions ever. Since its inception in the 1970s, the World Wide Web has continued to evolve, enabling us to work, study, play, buy, sell, and do so much more online. Two or more connected devices can exchange data through the Internet without the need for human intervention. This is known as the Internet of things (IoT) [1].

The Internet of things is among the emerging technologies that are widely embraced by most modern industries. What brings IoT into limelight is the surge of smartphones, wearable tech devices, automobiles, and smart homes with built-in sensors and the growing ability of financial institutions to anticipate customer. IoT expands the capability of the Internet beyond smartphones and computers to many other things, environment, and processes. IoT technology connects everyday objects (such as watches, phones, industrial equipment, and buildings) to the Internet, allowing them to connect with each other, conduct transactions, and share information. The Internet of things has emerged as a game-changer among transformative innovations. It is revolutionizing various sectors, and banking is no exception. IoT technology is widely used across the manufacturing, healthcare, agriculture, financial services, hospitality, and retail industries. It is revolutionizing financial services by enabling real-time data collection, automation, and enhanced security. IoT offers innovative services like context-aware payments and remote check deposits

OVERVIEW ON INTERNET OF THINGS

The concept of the Internet of things (IoT) has been around since the late 1990s, but it gained momentum in the 2000s with the rise of Internet-connected devices. The Internet began with some military computers in the Pentagon called Arpanet in 1969. It expanded throughout the 1980s as a set of four parallel military networks, each at a different security

level. The core technology which gives the Internet its particular characteristics is called Transmission Control Protocol/Internet Protocol (TCP/IP), which is essentially a set of rules for communication [2]. Figure 1 shows the symbol of IoT [3].

Internet of things (IoT) is a worldwide network that connects devices to the Internet and to each other using wireless technology. IoT is expanding rapidly and it has been estimated that 50 billion devices will be connected to the Internet by 2020. These include smart phones, tablets, desktop computers, autonomous vehicles, refrigerators, toasters, thermostats, cameras, alarm systems, home appliances, insulin pumps, industrial machines, intelligent wheelchairs, wireless sensors, mobile robots, etc. Figure 2 illustrates some applications of the Internet of things [4].

There are four main technologies that enable IoT [5]: (1) Radio-frequency identification (RFID) and near-field communication, (2) Optical tags and quick response codes: This is used for low cost tagging, (3) Bluetooth low energy (BLE), (4) Wireless sensor network: They are usually connected as wireless sensor networks to monitor physical properties in specific environments. Communications technologies in Internet of things are portrayed in Figure 3 [6].

IoT technology enables people and objects to interact with each other. It is employed in many areas such as smart transportation, smart cities, smart energy, emergency services, healthcare, data security, industrial control, logistics, retails, structural health, traffic congestion, manufacturing, and waste management. The Internet of things is extensively developed world-wide with a focus on civilian applications such as electric power distribution, intelligent transportation, healthcare, industrial control, precision agriculture, environmental monitoring, etc.

INDUSTRIAL INTERNET OF THINGS

The growth of the internet of things (IoT) is drastically making impact on home and industry. While the IoT affects among others transportation, healthcare, or smart homes, the Industrial Internet of Things (IIoT) refers in particular to industrial environments. IIoT is a new industrial ecosystem that combines intelligent and autonomous machines, advanced predictive analytics, and machine-human collaboration to improve productivity, efficiency and reliability. It is bringing about a world where smart, connected embedded systems and products operate as part of larger systems [7].

The industrial Internet of things (IIoT) refers to the application of the Internet of things (IoT) across several industries such as manufacturing, logistics, oil and gas, transportation, energy/utilities, chemical, aviation and other industrial sectors. A typical industrial Internet of things is shown in Figure 4 [8].

IIoT is often used in the context of Industry 4.0, the Industrial Internet and related initiatives across the globe. Industry 4.0 describes a new industrial revolution with a focus on automation, innovation, data, cyber-physical systems, processes, and people [9]. With Industry 4.0, the fourth industrial revolution is set on merging automation and information domains into the industrial Internet of things, services, and people. The communication infrastructure of Industry 4.0 allows devices to be accessible in barrier-free manner in the industrial Internet of things, without sacrificing the integrity of safety and security [10].

IOT IN FINANCE

IoT connects different tools, devices, and software that finance companies use. The technology collects and processes the data to help the finance team make better decisions on risk analysis, investments, insurance amounts, and more. It automates the core finance processes that boost productivity. It enables financial organizations to deliver better services to their customers. Banks can use it to offer their customers additional services and update them with the necessary information.

The Internet of things is rapidly accelerating digital transformation in banking and financial services with its ability to connect devices, collect real-time data, and automate processes. It is believed to be a major force in streamlining processes and enabling the analysis of real-time data in financial services. IoT is transforming the finance and banking industries by improving operational efficiency and creating new customer experiences. The IoT is not just an emerging technology that could be the future but is also a crucial part of financial institutions' swift progress toward complete digital change. It allows customers to make payments from any location and can be a robust security instrument. Hence providing a secure method of processing and encrypting the information used to make payments is crucial. IoT drives new innovations in the finance industry by empowering organizations to harvest more data, improve operational efficiency, and provide better customer service. Figure 5 shows the symbol of IoT in finance [11].

APPLICATIONS OF IOT IN FINANCE

Applications such as smart commercial real estate building management systems and auto-insurance telematics clearly show how IoT has improved processes. Application opportunities of IoT are as

limitless as human imagination. Top applications of IoT in financial services are illustrated in Figure 6 [12]. Common applications include the following [12-16]:

- *Banking:* The banking industry is constantly under pressure to stay ahead in the changing tech landscape in the financial sector. Banks from all over the world are trying to use IoT capabilities in their industry to get more customers involved. IoT in banking refers to a network of connected devices that collect data for banking services. It is poised to transform the financial industry. Banks can collect and review vast amounts of information in real-time when they connect devices and systems to the Internet. This data is used to detect fraudulent and unusual behavior patterns and, ultimately, help stop criminal activity. With IoT, banks will move towards digitalization more quickly to boost their market share in the future. Figure 7 shows a representation of smart banking [3]. IoT is creating various changes in the banking industry by improving security, offering personalized services, automating processes, and many more. IoT applications in banking improve the customer experience within banking by providing specific services customized to the individual's habits and preferences. The banking of things (BoT) performs banking services through the Internet of things. It is infrastructure that harnesses information from devices to offer more and better financial services to people and businesses. Many banks require minimum fees just to start depositing funds and charge extra to close an account, use an ATM, or be inactive. Figure 8 shows the use of ATM [17].
- *Accounting:* Finance and accounting processes involve the collaboration of different departments for the efficient collection of information. Instead of manually collaborating, companies can automate the whole process. IoT-enabled communication of the clients' payment systems and the CPAs' software ensures quick and secure data exchange and facilitates the automation of routine bookkeeping processes such as data entry, reconciliation, invoicing, etc. With IoT in accounting, all transactions can be tracked in real-time and sent to the accounting department. Using IoT, accountants can easily track the audit trails of all the employees or business units, whether they make a purchase or receive money in real-time.
- *Auditing:* Auditing is essential for banks in today's banking environment. Accounting and auditing are crucial to identify any irregularities in the finance processes and uncover fraud. Auditing in banks is usually a time-consuming and labor-intensive task. Yet, with the integration of IoT, this process can be significantly streamlined. IoT devices automate data gathering, reducing human errors, and making auditing faster. Most banks have adopted technology like IoT to enhance their auditing procedures. By installing branch sensors and connected devices, they can gather numerous data points to spot warning signs and avoid fraud.
- *Trade Finance:* For banks involved in trade financing, IoT ensures the visibility of physical flows they are financing and enables decision-making based on real-time information. IoT-generated data helps the banks better assess the risks throughout the trade life cycle. The data collected via monitoring the movements of goods with IoT sensors helps enhance the visibility and security of the assets and facilitates prompt recognition of those assets on the balance sheets of clients.
- *Insurance:* IoT is set to revolutionize the insurance sector, particularly in auto and health insurance. "Usage-based insurance" or "pay as you live" policies will become more prevalent. Insurers will use IoT device data, like fitness trackers and vehicle telematics, to customize premiums according to actual risk data. IoT devices monitor the state of insured objects and alert the insurers of any abnormalities so that they can intervene and take proper measures to reduce risks. Insurers also leverage IoT-generated data to take on a preventive approach and predict incidents. A more specific case of the above is usage-based insurance that is being actively adopted by auto insurance providers across the globe. IoT devices monitor the condition of insured items and alert insurers about any issue or deformity so that they can take immediate action to reduce the risk. Data generated with the help of IoT enables insurers to take protective measures and forecast what might happen in the future.
- *Fraud Detection:* Banks and financial institutions are prime targets of hackers. With the rise in digital transactions, fraud detection and prevention have become critical in the banking industry. Financial companies invest heavily in IoT to improve security and prevent potential fraud. The data gathered from various scenarios are analyzed to devise a risk mitigation strategy that secures each customer account. IoT also prevents fraud by detecting unusual behavior in

real-time. IoT coupled with AI-powered analytics helps identify fraud and hacker attacks by collecting and analyzing user account data. Accounts can then be secured through biometrics to ease payments with additional security. It helps improve the safeguarding process of data and build customer trust. IoT also prevents fraud by detecting unusual behavior in real-time.

- *Smart Contracts:* IoT can also integrate well with other novel technologies such as smart contracts. IoT devices can function well with smart contracts. Smart contracts are self-executing terms of agreement deployed on a blockchain. Running on pre-programmed terms and conditions, smart contracts are self-executable blockchain applications. They govern transactions without the intervention of humans. The use of smart contracts in banking and financial institutions enables them to streamline processes. The contract will be processed only on a condition-based principle. Therefore, it allows the automation of processes.
- *Invisible Payments:* This is also known as wearable payments. Paired with wearables, the impact of the IoT on the banking industry will grow impressively. The combination of sensors and software facilitates the development of invisible payments and other main financial procedures using wearables like smartwatches, voice-recognition devices, special RFID sensors in Uber cars and restaurants to make automated payment without taking the phone out. Several world-leading financial institutions plan to make wearables the main payment device within a couple of years. Smart refrigerators and other home appliances also allow users to make payments for food delivery, as an example.
- *Asset Monitoring*: The Internet of things allows banks to keep an eye on their own equipment, assess the assets of a branch's uses and improve the quality of decision-making. Banks and financial institutions use IoT-enabled devices to monitor their equipment. They ensure the assets at a branch are used optimally to improve its efficiency and reduce operational overheads. Banks can better control their customers' assets and monitor them remotely using IoT technology. IoT can record the performance of digital assets and offer information necessary to reduce operating costs and downtime of the branch.

BENEFITS

IoT for financial services comes with multifold benefits. It has the potential to transform traditional banking by allowing users to access their funds from anywhere at any time. It is helping financial institutions keep up with customer expectations and stay ahead of their competitors. Financial services have become more accessible and customized for bank clients. Other benefits include the following [12]:

- *Customer-centricity*: Excellent customer support is key to growing your business by building lasting relations with your customers. This holds true in all industries. IoT can address the ever-growing needs of modern consumers. Making their lives easier, the technology allows customers to check accounts, make payments, and avail banking facilities without visiting a branch or an ATM. Customer service in banking is becoming more personalized and proactive due to IoT. For example, alerting customers when an unexpectedly high amount of money is spent on a transaction is possible because of IoT. Inside the bank branch, the data can be used to notify customers about their wait time or redirect them to a free counter. By keeping track of customer needs at different times of the year, banks can proactively send them personalized offers and reminders.
- *Intelligent Automation*: Automation in banking has become a reality thanks to IoT. By connecting devices and exchanging real-time data, IoT automates various banking operations. IoT-powered systems can automatically perform certain operations: process requests, open bank accounts, disable credit cards, etc., thus minimizing human intervention and, as a consequence, human errors. IoT is a win-win situation for both banks and customers as IoT bridges gaps in client services while automation is easing employee workload. Automated processes, like smart ATMs and connected security systems, reduce the need for manual intervention and enhance service reliability. IoT-powered systems excel in executing specific operations automatically, from handling requests to initiating new bank accounts and even deactivating credit cards.
- *Enhanced Security:* Security is considered a top priority in every financial institution. Hackers still find it easier to steal by phishing than trying to break into a bank using IoT. Since IoT is the whole network of devices and various software, the risk of hacking is increasing exponentially. The IoT offers advanced security solutions that protect financial institutions and their customers from cyber threats and fraud. IoT can make banking safer and protect customer information.

With devices like smartphones and smartwatches, biometric authentication adds an extra layer of security to transactions and account access. IoT is a driver of cybersecurity: wearable devices enable user authentication via fingerprints, retinal scan, and face ID when customers make payments via mobile apps. Biometric authentication techniques that IoT enables, like fingerprint recognition, have brought about a brand new age of secure identity verification.

- *Efficiency:* IoT can optimize various banking operations, resulting in time and cost savings. Banks can use smart devices to automate tasks, track assets, and monitor infrastructure. With IoT, predictive maintenance keeps banking hardware like ATMs and servers operating efficiently. It results in reducing downtime and service disruption.
- *Decision-making:* IoT systems allow financial institutions to derive valuable insights from physical banking environments. It allows data to be collected from different sources, aiding in making better decisions. Many business decisions including investment decisions are based on in-depth data analytics, business pattern analysis, and market research. Such data-based decision-making provides obvious company benefits. Businesses can use IoT devices to collect and analyze clients' data to gain valuable insights into their needs and ensure faster decision-making.
- *More Inclusive:* The ability to offer affordable and accessible financial services to underserved populations has been a significant hurdle for decades. IoT makes financial services accessible to people who do not have an existing infrastructure. While online banking still relies on existing accounts and physical locations, many IoT technologies operate independently. For example, mobile money is entirely digital and has no ties to existing financial infrastructure. Instead, it relies on network providers and operates independently. As a result, people gain a lot more flexibility with their banking and spending habits. IoT promotes inclusion through personalization.

Some of these benefits are shown in Figure 9 [18].

CHALLENGES

Although IoT provides numerous benefits for finance industry, it can also pose some challenges. There is no uniform standard of performance and maintenance of IoT devices. Sharing IoT data securely is another challenge as banks do not have the resources to share information across borders. A lot of people find it difficult understanding what IoT technologies are all about because they are quite complex to use. Other challenges include the following [16]:

- *Privacy:* One of the primary concerns with IoT is data privacy and security. As IoT devices share sensitive personal and financial information, protecting this information is essential. A security breach can result in financial losses and a loss of customer trust. Thus, banks must use strong encryption methods and secure data transmission protocols.
- *Complexity:* The longer and bigger system is, the higher the probability of any failures in the system. The implementation of IoT in finance involves integrating various devices, platforms, and systems. This process results in extra complexity to the existing banking infrastructure. It can pose challenges like system compatibility, management, and maintenance.
- *Legacy System:* Implementing IoT in finance requires integration with diverse platforms and devices. This adds difficulty to the current banking infrastructure and can create integration, management, and upkeep challenges. Banks require technical knowledge and resources to manage and maintain these intricate IoT devices to succeed.
- *Regulatory Requirements*: Regulations have a high impact and play a critical role in shaping the market, as they establish essential guidelines and standards for space activities. A number of regulators have noted the need to think about security by design in IoT devices recently. The banking sector is very controlled and has strict privacy, data protection, and security requirements. IoT applications must comply with regulations like GDPR, which impose stringent data handling and privacy regulations. Compliance becomes more difficult because IoT devices can increase the amount of data gathering and processing.
- *Lack of Standards:* There are no common standards for maintaining IoT equipment. IoT hardware equipment are of different types; they are built by different types of manufacturers and require different maintenance approach. It is this lack of a common standard that can lead to failure in the functionality of IoT devices. It seems to be impossible for today to resolve this issue. The matter is that all hardware used in IoT can be manufactured by different suppliers and they cannot have one common maintenance standard. The lack of common standards can be the reason for failures in the functionality of IoT devices.

- *Higher Unemployment*: IoT helps automate working processes that required human brain before, and it means that some employees would simply lose their work positions, especially if these are young and not so skilled workers yet. Banks and other financial institutions will have to cut more jobs with the advent of IoT technologies in the financial industry.

CONCLUSION

Internet of things (IoT) is a technological trend that describes a network of objects enabled with electronics, sensors, software, and connectivity allowing them to be interconnected via Internet. It allows buildings, cars, watches to become "smart." It has not only changed our daily lives but has also shaped various industries. IoT has enormous potential to transform society and businesses in a connected, digital world. Although IoT is just starting entering in FinTech, it is expected that the IoT will play a very important role in banking strategies. To stay competitive, a business must build the right IoT product that meets your requirements.

The future of IoT promises to transform the banking industry. As technology advances, the future of banking and financial services will also be centered around AI and IoT. The future trends of IoT promise to be exciting, with advances in edge technology, connectivity to 5G, AI integration, blockchain security, sustainability, and improved data analytics. More information about Internet of things in the finance industry can be found in the books in [19-21] and a related journal: *IEEE Internet of Things Journal.*

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Figure 1 The symbol of IoT [3].

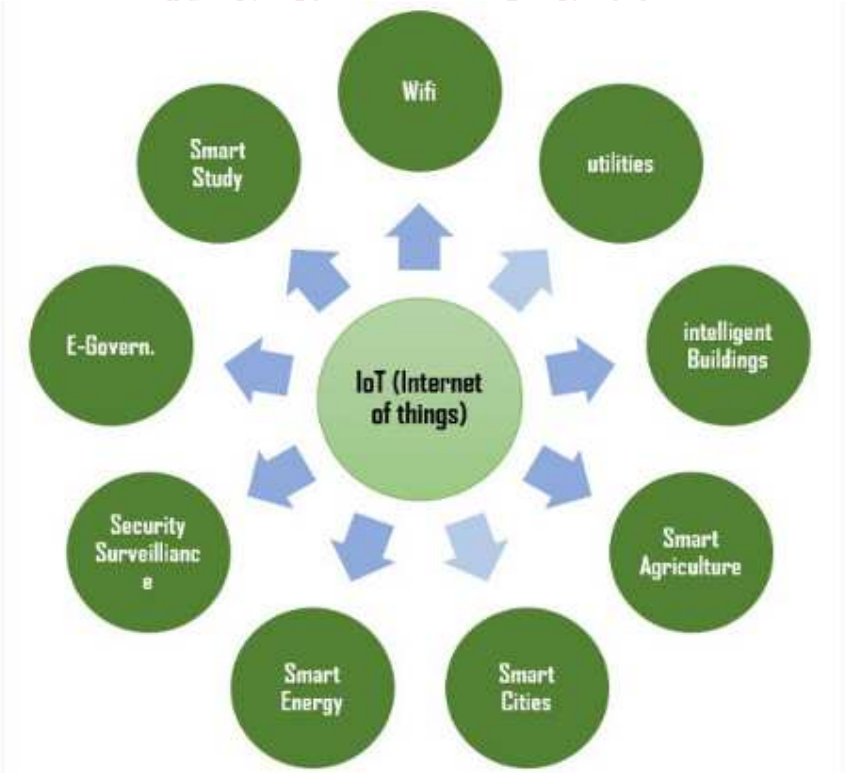

Figure 2 Applications of Internet of things [4].

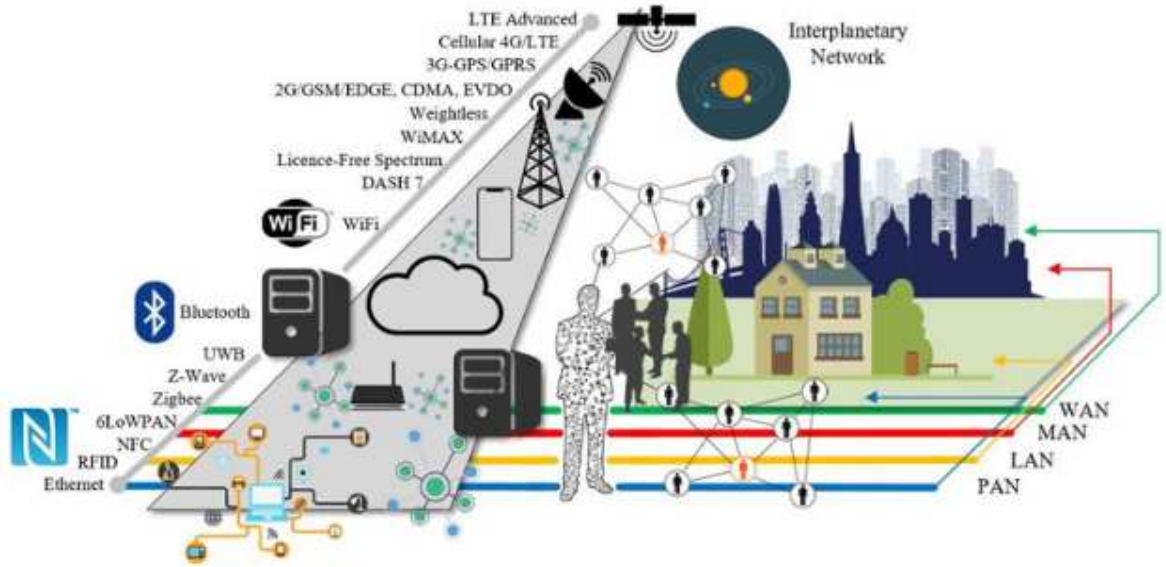

Figure 3 Communications technologies in Internet of things [6].

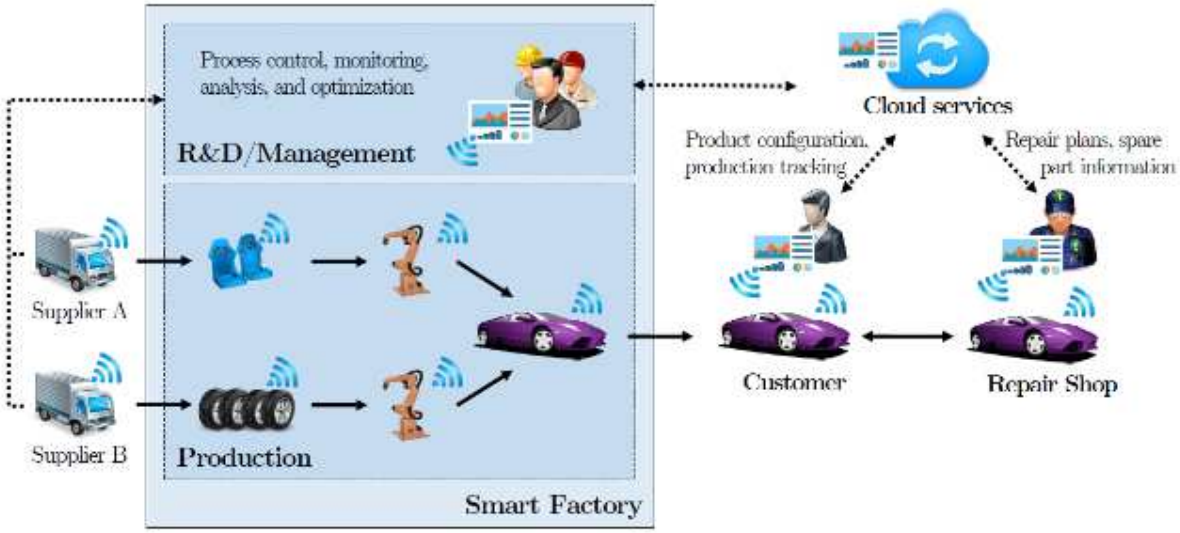

Figure 4 A typical industrial Internet of things [8].

Figure 5 Symbol of IoT in finance [11].

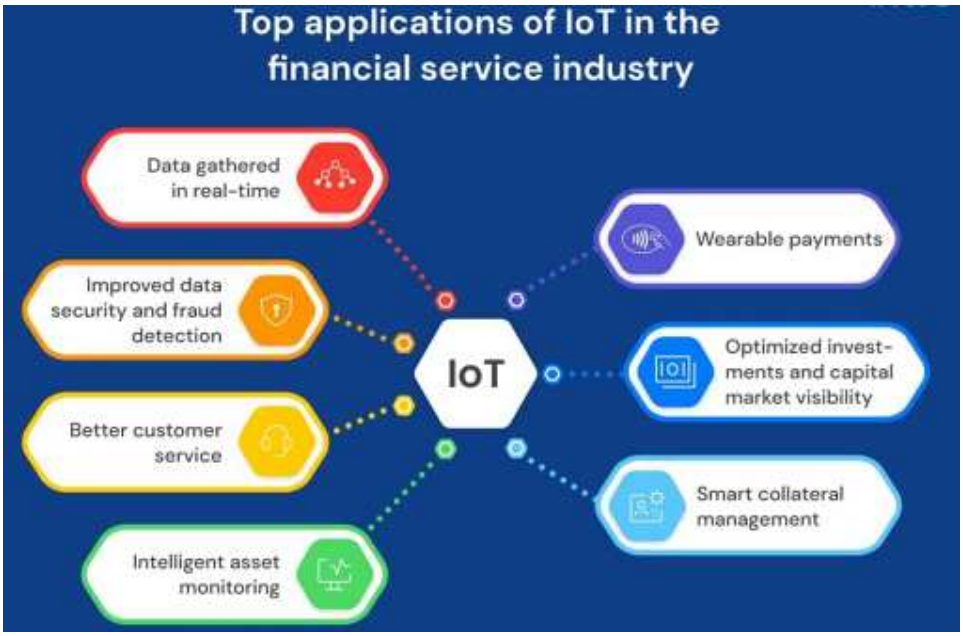

Figure 6 Top applications of IoT in financial services [12].

Figure 7 A representation of smart banking [3].

Figure 8 Use of ATM [17].

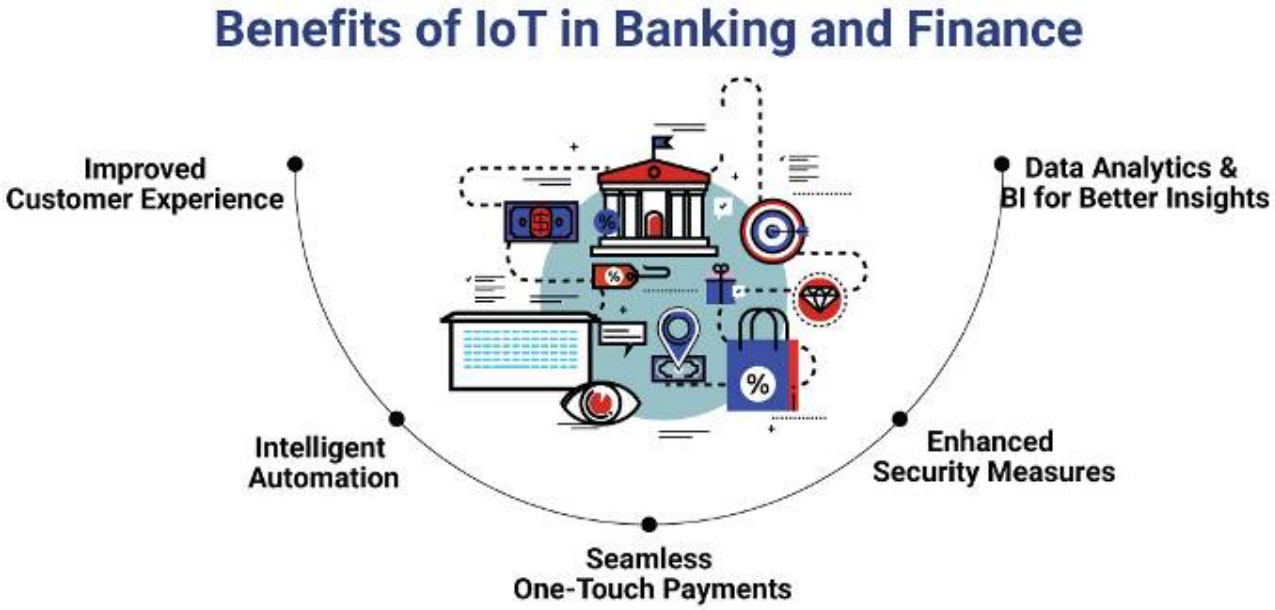

Figure 9 Some of the benefits of IoT in banking and finance [18].