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An Empirical Investigation of Drivers and Barriers of IoT-based Cloud Computing Deployment

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Abstract

The Internet of Things (IoT) and cloud computing have become increasingly intertwined in recent years. Cloud computing powered by the Internet of Things (IoT) is currently revolutionizing how we interact with technology by enabling seamless connectivity and real-time data analysis, empowering businesses to gain insightful information and make wise decisions while streamlining operations and fostering innovation. IoT-based cloud computing is presently being more widely used as more businesses see its potential. This study aims to experimentally investigate the factors that influence and impede the adoption of cloud computing based on the Internet of Things. We used survey data from 318 IT personnel from various businesses to apply SVM, Decision tree, and Random forest. SVM and decision trees have both shown the highest performance. The research demonstrates that a number of issues, such as compliance, latency, and reliance on internet access, might make adoption more difficult. When a system is dependent on internet access, inconsistent internet connectivity may result in problems including data loss and system unavailability. Data processing delays due to latency may result in slower reaction times and worse performance. Regulation and standard compliance are essential, and failure to comply may result in severe penalties and fines. All of these elements may result in a bad user experience and deter businesses from using IoT-based cloud solutions. The research also demonstrates that IoT-based cloud computing's scalability and real-time analysis are two essential qualities that significantly boost the uptake of this technology. The combination of real-time analysis and scalability makes it the perfect choice for companies and organizations wishing to fully use IoT technology. Real-time analysis helps organizations acquire important insights from the data produced by IoT devices. The most significant influences on IoT-based cloud migration are scalability and reliance on internet access. The compliance feature has the least influence on adoption, according to the Decision tree findings.

Introduction

As more organizations and people depend on the internet to store and access data and applications, cloud computing has grown in significance in the contemporary world. One of the main advantages of cloud computing is that users may access their data and apps from any location with an internet connection [1]. This feature is especially helpful for companies that need to provide their staff remote access to corporate data. Additionally, by eliminating the need for pricey hardware and infrastructure and enabling companies to just pay for the services they actually use, cloud computing may help them save money on IT expenses [2].

The ability for companies to scale their IT resources up or down as required, which is essential in today's fast-paced business climate, is another significant feature of cloud computing. As a result, organizations don't need to make substantial expenditures in new hardware to expand by adding additional storage, computing capacity, or other resources fast and inexpensively [3]. Businesses that face swings in demand may readily adapt their resources to suit shifting business demands because to this flexibility. Additionally, cloud computing allows businesses to experiment easily with new technologies and to create and deploy applications more quickly and effectively than ever before [4].

A fast-developing technology called the Internet of Things (IoT) has the power to completely alter how we live and work. IoT is fundamentally the process of connecting commonplace items to the internet so they can gather, transmit, and analyze data. Healthcare, agriculture, transportation, and logistics are just a few of the areas that this technology has already started to significantly affect [5]–[8]. By giving clinicians access to real-time data on a patient's health, IoT devices like wearables and smart medical equipment have the potential to enhance patient care in the healthcare sector. IoT devices in agriculture may be used to track crop development and soil quality, assisting farmers in increasing yields. IoT-enabled devices may be used in logistics and transportation to monitor the position of trucks and goods in real-time, enhancing the effectiveness of supply chains [9]–[12]. By integrating equipment that can detect fire, gas leaks, and other threats, IoT may also be used to enhance safety in homes, workplaces, and public spaces.

By enhancing the smartness and efficiency of our homes and towns, IoT also has the potential to enhance the quality of life for each person. For instance, controlling lighting, temperature, and other home systems using linked devices makes it simpler to regulate energy use. IoT-enabled devices may also be used to track traffic patterns and air quality in metropolitan areas, which will assist with better urban planning and pollution reduction [13]. IoT has the potential to significantly improve a variety of elements of our lives, making them more convenient and effective.

IoT-based cloud refers to the cloud computing with IoT technology, which allows the cloud and processing of data from IoT devices on distant servers [14], [15]. This makes it possible to quickly examine and utilize the enormous quantity of data produced by IoT devices to enhance many areas of our life. Sensors and other hardware that may gather and send data to the cloud are included in IoT-based cloud systems. Then, on distant servers, this data is processed and stored so that it may be examined and utilized to draw conclusions [16], [17]. The devices may be managed and controlled remotely via IoT-based cloud systems, allowing for centralized management and control of the devices.

The deployment of smart homes, whereby the home's gadgets, such as thermostats, lights, and security systems, are linked to the internet and can be managed and monitored remotely using a cloud-based platform, is one example of IoT-based cloud computing. Another example is in the industrial sector, where IoT-enabled sensors may be used to track the operation of equipment and send the information to the cloud for analysis and equipment optimization [18]. IoT-based cloud refers to the fusion of IoT technology with cloud computing, which allows the storage, processing, and analysis of data produced by IoT devices on distant servers in the cloud. Due to this connection, people and organizations may make greater use of the data produced by IoT devices and enhance many areas of their personal and professional life.

Hypotheses development

The ability of the system to handle an increasing volume of devices and data is known as scalability, and it is a crucial component of IoT-based cloud computing. The adoption of an IoT system by businesses may be significantly impacted by its scalability. Because scalability makes it simple for businesses to integrate additional devices and data into the system, it may have an influence on the adoption of IoT-based cloud computing. This is crucial for businesses wishing to increase their IoT deployment since it enables them to do so without having to spend money on extra hardware or infrastructure. This is especially helpful for businesses wishing to use IoT in a cost-efficient way.

Scalability, which enables businesses to manage enormous volumes of data, may also have an influence on the adoption of IoT-based cloud computing. The volume of data produced grows along with the number of devices. Scalability enables companies to manage and analyze this data effectively, which is important for decision-making and taking action. Additionally, since scalability makes it simple for businesses to manage their IoT devices, it may have an influence on how widely IoT-based cloud computing is adopted. Scalability enables businesses to simply add, delete, and upgrade devices as necessary. For businesses searching for a flexible and effective way to manage their IoT devices, this is crucial.

Scalability, which enables businesses to quickly modify their IoT system to suit changing demands, may have an influence on how widely IoT-based cloud computing is adopted. IoT needs may alter as enterprises expand and develop. Scalability enables businesses to quickly modify their IoT system to match these shifting needs, which may be crucial for businesses trying to maintain their position as market leaders. Scalability is a crucial component of IoT-based cloud computing and may significantly influence how widely used by businesses [19], [20]. Organizations can simply handle massive volumes of data, manage devices, add devices, and change the system to suit their changing requirements. Scalability should be taken into account by businesses when implementing IoT-based cloud computing, as it may be crucial for the success and expansion of an IoT deployment.

The above discussion has led to the following hypothesis:

Hypothesis 1:
Scalability impacts the decision to deploy IoT based cloud computing

An increasingly popular option for data processing and storage is cloud computing powered by the Internet of Things (IoT). It is nonetheless reliant on internet access, which may provide a challenge in places with subpar connectivity. The performance and usability of IoT systems may be significantly impacted by this reliance on internet access.

IoT devices must be linked to the internet in order to send data to the cloud. This implies that in order for the devices to transfer data, they must have a dependable internet connection. Data loss or transmission delays may result from a faulty or unstable connection. IoT systems that depend on real-time data to make choices and execute actions may find this to be an issue.

The system being dependent on internet access might also cause delay, which is a problem. The time lag between when data is transferred from an IoT device and when it is retrieved by the cloud is known as latency. Many things, including network congestion and the distance between the device and the cloud, might contribute to this delay. Time-sensitive applications, as those used in manufacturing or transportation, might have problems with latency.

The reliance on internet connection may potentially put the system at risk for security breaches. Because IoT devices and the cloud need internet connectivity in order to function, they are susceptible to hacking and data breaches. IoT systems that handle sensitive data, such as private information or financial transactions, should be especially concerned about this. To guard against these threats, it is crucial to ensure the security of IoT devices and the cloud.

Although IoT-based cloud computing is an effective method for processing and storing data, it is reliant on internet access. This reliance might result in performance and functionality problems as well as security vulnerabilities. The dependability and security of the internet connection must be ensured by businesses and organizations that rely on IoT technologies. This involves adopting secure methods for data transport and having redundant connections.

The above discussion has led to the following hypothesis:

Hypothesis 2:
Dependence on internet connectivity impacts the decision to deploy IoT based cloud computing

Latency in IoT based cloud computing can negatively affect its adoption by organizations in several ways. Latency refers to the delay between the time data is transmitted from an IoT device to the cloud and the time it is received and processed by the cloud. This delay can be caused by various factors such as network congestion, distance between the device and the cloud, and the amount of data being transmitted.

Latency can negatively affect the adoption of IoT based cloud computing by impacting the performance of the system. For example, in time-sensitive applications such as manufacturing or transportation, high latency can cause delays in decision-making and actions, which can negatively impact the efficiency and productivity of the organization. This can discourage organizations from using IoT based cloud computing, as they may prefer to use alternative solutions that offer lower latency.

Additionally, latency can also negatively affect the adoption of IoT based cloud computing by introducing security risks into the system. If data is transmitted over a long period of time, it can be vulnerable to hacking and data breaches. This can be particularly concerning for organizations that handle sensitive data, such as personal information or financial transactions. Ensuring the security of IoT devices and the cloud is essential to protect against these risks. Another aspect is that latency can also negatively affect the adoption of IoT based cloud computing by increasing the cost of the system. If an organization needs to invest in additional equipment or services to reduce latency, this can increase the overall cost of the system, which can discourage organizations from using IoT based cloud computing.

The latency can also negatively affect the adoption of IoT based cloud computing by diminishing the user experience. In applications such as smart home or building automation, where the users expect a responsive system, high latency can make the system feel slow and unresponsive, which can lead to user dissatisfaction and ultimately discourage organizations from using IoT based cloud computing. Latency in IoT based cloud computing can negatively affect its adoption by organizations in several ways. It can impact the performance of the system, introduce security risks, increase the cost of the system and diminish user experience.

As a consequence, we recommend the following hypothesis:

Hypothesis 3:
Latency impacts the decision to deploy IoT based cloud computing

Compliance refers to the adherence to regulatory standards and industry best practices in IoT based cloud computing. Compliance issues can have a significant impact on the adoption of IoT based cloud computing by organizations, as non-compliance can lead to costly fines and penalties. One of the main ways that compliance issues can impact the adoption of IoT based cloud computing is by introducing additional costs for organizations. Organizations must ensure that their IoT devices and cloud infrastructure comply with regulatory standards and industry best practices. This can include investing in additional hardware, software, and personnel to ensure compliance. This can be a significant cost for organizations, particularly small and medium-sized enterprises (SMEs) that may not have the resources to invest in compliance.

Compliance issues can also impact the adoption of IoT based cloud computing by introducing additional risks for organizations. Non-compliance can lead to costly fines and penalties, and can also lead to reputational damage. Organizations may also be at risk of legal action if they are found to be non-compliant. This can be a significant risk for organizations, particularly those that handle sensitive data, such as personal information or financial transactions. Another way compliance issues can impact the adoption of IoT based cloud computing is by slowing down the deployment and adoption of IoT. Organizations need to invest time and resources to ensure compliance, which can delay the deployment and adoption of IoT systems. This can be particularly problematic for organizations that are looking to implement IoT in a timely manner to stay competitive in their industry.

Compliance issues can also impact the adoption of IoT based cloud computing by creating confusion and uncertainty for organizations. As regulatory standards and industry best practices are constantly evolving, it can be difficult for organizations to keep up with the changes. This can lead to confusion and uncertainty, which can make it difficult for organizations to make informed decisions about their IoT deployment.

In conclusion, compliance issues can have a significant impact on the adoption of IoT based cloud computing by organizations. Compliance issues can introduce additional costs, risks, slow down the deployment, and create confusion and uncertainty. Organizations should consider compliance issues when adopting IoT based cloud computing, as non-compliance can lead to costly fines and penalties. Organizations should invest in resources and expertise to understand the compliance requirements and ensure compliance in their IoT deployment. It's important for organizations to stay informed and up to date with the regulatory standards and industry best practices and to have a compliance strategy in place to ensure their IoT systems are compliant.

As a result, we recommend the following hypothesis:

Hypothesis 4:
Compliance issue impacts the decision to deploy IoT based cloud computing

Real-time analysis is one of the key benefits of IoT based cloud computing, as it allows organizations to analyze data from IoT devices in real-time, which can be critical for decision making and actions. The ability to analyze data in real-time can have a significant impact on the adoption of IoT based cloud computing by organizations.

Real-time analysis can impact the adoption of IoT based cloud computing by allowing organizations to make quick and informed decisions. With real-time analysis, organizations can analyze data from IoT devices as soon as it is generated, which allows them to make decisions and take actions in a timely manner. This can be critical for organizations that operate in fast-paced industries, such as manufacturing or transportation, where real-time data is needed to optimize operations and improve efficiency.

Real-time analysis can also impact the adoption of IoT based cloud computing by allowing organizations to improve their products and services. With real-time analysis, organizations can use data from IoT devices to identify patterns and trends, which can help them to improve their products and services. This can be particularly beneficial for organizations that are looking to innovate and stay competitive in their industry. Another way real-time analysis can impact the adoption of IoT based cloud computing is by allowing organizations to improve their customer engagement. With real-time analysis, organizations can use data from IoT devices to gain insights into customer behavior, which can help them to improve customer engagement and retention. This can be particularly beneficial for organizations that operate in customer-centric industries, such as retail or healthcare.

Lastly, real-time analysis can also impact the adoption of IoT based cloud computing by allowing organizations to optimize their operations. With real-time analysis, organizations can use data from IoT devices to identify inefficiencies and bottlenecks in their operations, which can help them to optimize their operations and improve their bottom line. This can be particularly beneficial for organizations that are looking to reduce costs and increase profitability. Real-time analysis is one of the key benefits of IoT based cloud computing, and can have a significant impact on the adoption of IoT based cloud computing by organizations. Real-time analysis allows organizations to make quick and informed decisions, improve products and services, improve customer engagement, and optimize operations. Organizations should consider the benefits of real-time analysis when adopting IoT based cloud computing, as it can be critical for the success and growth of their IoT deployment.

As a result, we recommend the following hypothesis:

Hypothesis 5:
Real-time analysis option impacts the decision to deploy IoT based cloud computing

Methods

We test the hypotheses of table 1 using SVM, Decision tree, and Random forest. Support Vector Machine (SVM) is a supervised learning algorithm used for classification and regression tasks . The algorithm creates a boundary or a hyperplane that separates the data points into different classes. The boundary is chosen in such a way that it maximizes the margin, or the distance between the boundary and the closest data points from each class. SVM is particularly useful when the data has a clear boundary between classes, and when the data is not linearly separable.

A Decision Tree is a type of algorithm used for both classification and regression tasks. It is a tree-like model of decisions and their possible consequences, including chance event outcomes, resource costs, and utility. Decision Tree is a tree-based algorithm where an internal node represents feature (or attribute), the branch represents a decision rule, and each leaf node represents the outcome. It recursively splits the data based on the feature that results in the highest information gain until the data is homogeneous. Random Forest is an ensemble machine learning method for classification and regression. It is a collection of decision trees where each tree is trained on a random subset of the data. The final prediction is made by averaging the predictions of all the trees in the forest. Random Forest is considered to be a robust and accurate algorithm, as it reduces overfitting by averaging the predictions of multiple decision trees. It also allows for the importance of features to be determined, which can be useful in feature selection and feature engineering.

Table 1. Drivers and barriers with rationales for research hypotheses

	Drivers/barriers	**Rationale**
Hypothesis 1	Scalability	Cloud computing allows for the easy scaling of IoT systems as more devices and data are added.
Hypothesis 2	*Dependence on internet connectivity*	*IoT devices and the cloud need to be connected to the internet in order to work, which can be a problem in areas with poor connectivity.*
Hypothesis 3	Latency	Processing and transmitting data to the cloud can introduce latency, which can be an issue for time-sensitive applications.
Hypothesis 4	Compliance	IoT devices and cloud infrastructure may have to comply with regulatory standards, which can be complex and costly.
Hypothesis 5	Real-time analysis	Data from IoT devices can be analyzed in real-time, allowing for quick decision making and actions.

Results

Figure 1. and Table 1. Show confusion matrices and classification reports for SVM, Decision tree, and Random forest. It can be seen that SVM has performed best followed by decision tree. Table 3 and figure 2 shows the importance of features and impacts (coefficient signs). It can be seen that according to Decision tree, and Random forest algorithms, scalability and dependence on internet connectivity have strongest impacts on IoT based cloud adoption. According to the Decision tree results, the compliance feature ahs the least impacts on adoption.

One way to increase the positive impact of scalability in IoT based cloud on adoption by organizations is to focus on security. Ensuring that the cloud infrastructure and connected devices are secure can give organizations the confidence they need to adopt and scale IoT solutions. This can be achieved through measures such as encryption, authentication, and regular security audits. Another way to increase adoption is to make the process of scaling IoT solutions as simple and streamlined as possible. This can be achieved by providing organizations with easy-to-use tools and interfaces that allow them to quickly and easily scale their IoT deployments. Additionally, providing organizations with clear and detailed documentation can help them understand the scalability options available to them and make informed decisions about how to best scale their solutions.

Another important factor to consider when increasing the positive impact of scalability in IoT based cloud on adoption by organizations is to minimize downtime. This can be achieved through a combination of redundancy, load balancing, and failover mechanisms. By ensuring that IoT solutions are highly available and resilient, organizations can minimize the risk of downtime and increase the likelihood of adoption.

To increase adoption, it is also important to ensure that the IoT based cloud solution can be easily integrated with the existing IT infrastructure of the organization. This can be achieved by providing organizations with APIs and SDKs that allow them to easily connect their existing systems and applications to the IoT based cloud solution. Additionally, providing organizations with pre-built connectors for popular platforms and technologies can also help to facilitate integration. Lastly, providing organizations with flexibility and customization options is also key to increasing adoption of IoT based cloud solutions. This can be achieved by providing organizations with the ability to configure and customize their IoT deployments to meet their specific needs. Additionally, providing organizations with the ability to easily switch between different scalability options as their needs change, can also help increase adoption.

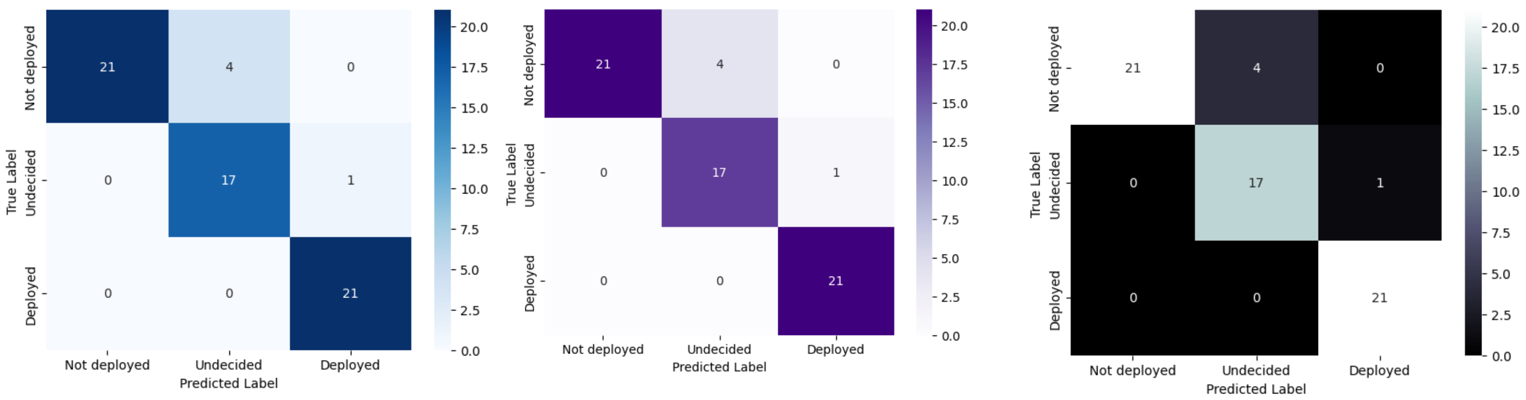
Table 3 show that Dependence on internet connectivity can negatively affect the adoption of IoT based cloud computing. Dependence on internet connectivity can negatively impact the adoption of IoT based cloud computing by organizations. However, there are several ways to mitigate this negative impact. Organizations can invest in multiple internet connections, such as cellular and Wi-Fi, to ensure that they have a reliable internet connection at all times. This can help to ensure that IoT devices can transmit data to the cloud, even if one connection is lost or becomes unreliable.

Another way to mitigate the negative impact of dependence on internet connectivity is by using secure protocols for data transmission. Organizations can use encryption and other security measures to protect data transmission over the internet, which can help to ensure that data is not intercepted or tampered with. This can be particularly important for organizations that handle sensitive data, such as personal information or financial transactions.

Organizations can use edge computing to mitigate the negative impact of dependence on internet connectivity. Edge computing allows for data processing and analysis to be performed at the edge of the network, closer to the IoT devices. This can help to reduce the amount of data that needs to be transmitted over the internet, which can help to reduce latency and improve the reliability of the connection. LPWANs are designed to support low-power IoT devices and can provide wide coverage with low-power consumption. This can be beneficial for organizations that operate in remote areas or that have devices that need to operate on batteries for long periods.

Figure 1. confusion matrices for SVM, Decision tree, and Random forest

Support vector machine **Decision tree** **Random forest**



According to the table 3, latency in IoT based cloud computing can negatively impact the adoption of IoT based cloud computing by organizations. Organizations can use networks such as 5G or wired networks that are designed to reduce latency, which can help to ensure that data is transmitted and received in a timely manner. This can be particularly beneficial for organizations that operate in time-sensitive industries, such as manufacturing or transportation.

Another way to mitigate the negative impact of latency is by optimizing data transmission. Organizations can use techniques such as data compression and data aggregation to reduce the amount of data that needs to be transmitted, which can help to reduce latency. Additionally, organizations can also implement protocols such as MQTT that are designed to reduce the overhead of data transmission, which can also help to reduce latency.

Another way to mitigate the negative impact of latency is by implementing edge computing. Edge computing allows for data processing and analysis to be performed at the edge of the network, closer to the IoT devices. This can help to reduce the amount of data that needs to be transmitted over the internet, which can help to reduce latency and improve the reliability of the connection.

Organizations can mitigate the negative impact of latency in IoT based cloud computing by implementing several strategies. Using low-latency networks, optimizing data transmission, implementing edge computing and using cloud platforms that are designed to minimize latency are effective ways to reduce latency and improve the performance of IoT systems. Additionally, organizations should also consider the location of their IoT devices and the infrastructure available in that area before deploying IoT based cloud computing to reduce latency. Regular monitoring and testing of the network and data transmission can also help organizations to identify and address any latency issues in a timely manner. Overall, organizations should consider the potential challenges associated with latency when adopting IoT based cloud computing and take steps to mitigate.

Table 2. Classification reports

Support vector machine

	precision	recall	f1-score	support
0	0.95	0.79	0.86	24
1	0.72	0.93	0.81	14
2	1.00	1.00	1.00	26
accuracy			0.91	64
macro avg	0.89	0.91	0.89	64
weighted avg	0.92	0.91	0.91	64

Decision tree

	precision	recall	f1-score	support
0	0.90	0.79	0.84	24
1	0.53	0.57	0.55	14
2	0.86	0.92	0.89	26
accuracy			0.80	64
macro avg	0.77	0.76	0.76	64
weighted avg	0.80	0.80	0.80	64

Random forest

	precision	recall	f1-score	support
0	0.76	0.67	0.71	24
1	0.35	0.50	0.41	14
2	0.83	0.73	0.78	26
accuracy			0.66	64
macro avg	0.65	0.63	0.63	64
weighted avg	0.70	0.66	0.67	64

Table 3. Feature importance and impacts

Features	Random forest	Impacts	Decision tree
scalability	0.2125	Positive	0.128125
RTanalysis	0.15	Positive	0.053125
dependence	0.175	Negative	0.128125
latency	0.159375	Negative	0.075
compliance	0.1453125	Negative	0.0046875

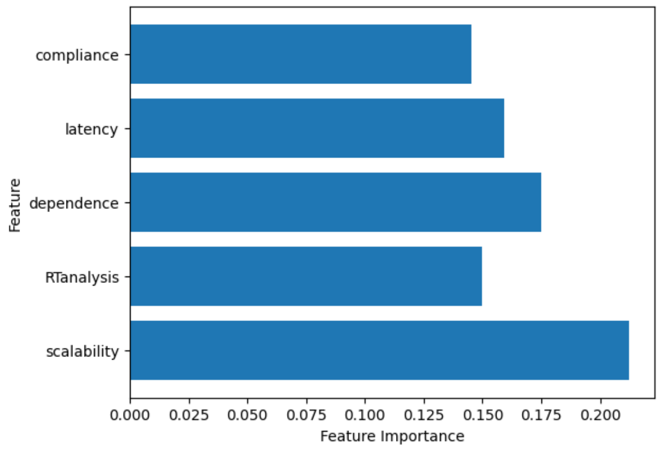
According to table 3, Compliance issues can negatively impact the adoption of IoT based cloud computing by organizations. However, there are several ways to mitigate this negative impact. Organization can mitigate the negative impact of compliance issues by staying informed about regulatory standards and industry best practices. Organizations should keep up-to-date with the latest regulations and standards related to IoT and cloud computing, and ensure that their IoT devices and cloud infrastructure comply with these regulations and standards. This can help to ensure that the organization is not at risk of fines or penalties, and can also help to protect sensitive data.

Organizations should implement security measures such as encryption, access controls, and incident response plans to ensure that data is protected and that the organization is prepared to respond to security incidents. This can help to ensure that the organization is compliant with regulations and industry best practices related to data protection and security. Organizations can also use cloud platforms that are designed to comply with regulations and industry best practices. Some cloud platforms are specifically designed for IoT and have features such as data encryption, data governance, and data compliance that can help organizations to comply with regulations and industry best practices.

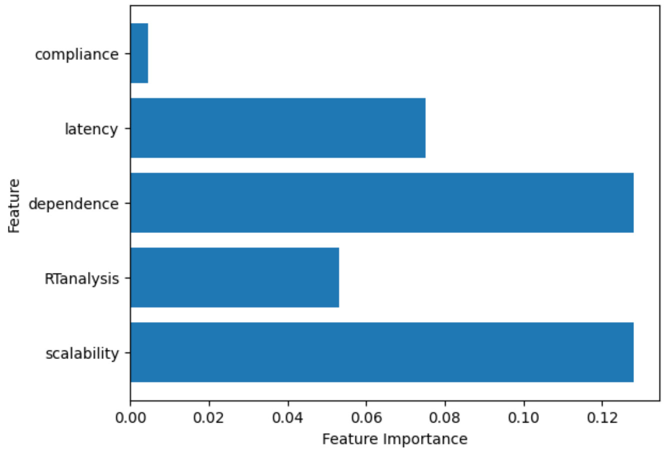
Organizations should have a clear strategy in place for ensuring compliance, which includes identifying regulatory and industry requirements, assessing the organization's compliance posture, and implementing controls and procedures to address any identified gaps. This can help organizations to understand their compliance status, identify areas of improvement, and develop a plan to achieve compliance. Staying informed about regulatory standards and industry best practices, implementing security measures, using cloud platforms that are designed to comply with regulations, and implementing a compliance strategy are effective ways to ensure compliance and protect sensitive data. Organizations should also regularly assess their compliance posture and make necessary updates to their systems and procedures to ensure compliance. Overall, organizations should consider the potential challenges associated with compliance when adopting IoT based cloud computing and take steps to mitigate these challenges to ensure a successful IoT deployment.

Figure 2. Feature importance

Random forest



Decision tree



Real-time analysis is one of the key benefits of IoT based cloud computing, and organizations can take several steps to increase the positive impact of real-time analysis on their IoT deployment. To increase the positive impact of real-time analysis is by investing in the right infrastructure. Organizations should invest in the hardware, software, and network infrastructure needed to support real-time data processing and analysis. This can include investing in powerful servers, high-speed networks, and real-time data processing software. Organizations can use machine learning and AI to analyze and make predictions from the real-time data generated by IoT devices. This can help organizations to identify patterns, trends, and insights that can be used to make better decisions and take actions. Additionally, organizations can also increase the positive impact of real-time analysis by creating a data-driven culture. Organizations should encourage the use of real-time data across the entire organization and make it easily accessible to all employees. This can help to ensure that real-time data is being used to inform decision-making and actions throughout the organization.

Organizations can use real-time data to identify inefficiencies and bottlenecks in their operations, which can help them to optimize their operations and improve their bottom line. This can be particularly beneficial for organizations that are looking to reduce costs and increase profitability. Thus, organizations can increase the positive impact of real-time analysis in IoT based cloud computing by investing in the right infrastructure, leveraging machine learning and AI technologies, creating a data-driven culture, and using real-time data for process optimization. By taking these steps, organizations can increase the value of real-time data, and improve decision-making and actions throughout the organization. Overall, organizations should consider the benefits of real-time analysis when adopting IoT based cloud computing, as it can be critical for the success and growth of their IoT deployment.

Conclusion

Businesses Dependence on internet connectivity can have a significant negative impact on the adoption of IoT based cloud computing. Many organizations rely on internet connectivity to access and utilize cloud-based IoT solutions, and if the internet connectivity is unreliable or unavailable, it can hinder the ability of organizations to effectively utilize these solutions. This can lead to issues such as data loss, system downtime, and decreased productivity. Latency, or the delay in the transfer of data, can also have a negative impact on the adoption of IoT based cloud computing. Latency can cause delays in the processing of data, resulting in slower response times and decreased performance. This can be particularly problematic for applications that require real-time data processing, such as those used in industrial automation and control systems. Compliance is another important factor that can have a negative impact on the adoption of IoT based cloud computing. Organizations may be hesitant to adopt IoT based cloud solutions if they are concerned about compliance with regulations and standards such as the General Data Protection Regulation (GDPR) and the Health Insurance Portability and Accountability Act (HIPAA). Organizations must ensure that the IoT based cloud solutions they adopt comply with relevant regulations and standards, otherwise it can lead to significant penalties and fines. The combination of these three factors, dependence on internet connectivity, latency, and compliance, can lead to a poor user experience, which can be detrimental to the adoption of IoT based cloud computing. Organizations may be hesitant to adopt IoT based cloud solutions if they are concerned about the reliability and performance of the solutions, or if they are worried about the potential legal and financial risks associated with compliance. In order to overcome these challenges, organizations must work closely with their IoT vendors to ensure that the solutions they adopt are reliable, compliant, and meet their specific needs. Scalability is a key feature of IoT-based cloud computing that has a significant positive impact on the adoption of this technology. Scalability allows for the seamless integration of new devices and sensors into the network, without the need for extensive reconfiguration or additional infrastructure. This makes it easy for businesses and organizations to expand their IoT deployments as needed, without incurring significant costs or disruptions to their operations. Another impact of IoT-based cloud computing is the ability to perform real-time analysis of data. With the vast amount of data generated by IoT devices, it is essential to have the ability to quickly and efficiently process and analyze it in order to gain valuable insights and make informed decisions. Cloud-based platforms and services provide the necessary computing power and storage capacity to handle large volumes of data, allowing for near-instant analysis and actionable insights.

References

[1] V. C. Patil, K. A. Al-Gaadi, D. P. Biradar, and M. Rangaswamy, "Internet of things (Iot) and cloud computing for agriculture: An overview," *Proceedings of agro-informatics and precision agriculture (AIPA 2012), India*, pp. 292–296, 2012.

[2] A. Elgelany and W. G. Alghabban, "Cloud computing: Empirical studies in higher education a literature review," *International Journal of Advanced Computer Science and Applications*, vol. 8, no. 10, 2017.

[3] L. M. Kaufman, "Data Security in the World of Cloud Computing," *IEEE Secur. Priv.*, vol. 7, no. 4, pp. 61–64, Jul. 2009.

[4] N. Jayapandian, S. Pavithra, and B. Revathi, "Effective usage of online cloud computing in different scenario of education sector," in *2017 International Conference on Innovations in Information, Embedded and Communication Systems (ICIIECS)*, 2017, pp. 1–4.

[5] I. Lee and K. Lee, "The Internet of Things (IoT): Applications, investments, and challenges for enterprises," *Bus. Horiz.*, vol. 58, no. 4, pp. 431–440, Jul. 2015.

[6] S. Li, L. D. Xu, and S. Zhao, “The internet of things: a survey,” *Inf. Syst. Front.*, 2015.
[7] D. Bandyopadhyay and J. Sen, “Internet of things: Applications and challenges in technology and standardization,” *Wireless personal communications*, 2011.
[8] J. Gubbi, R. Buyya, S. Marusic, and M. Palaniswami, “Internet of Things (IoT): A vision, architectural elements, and future directions,” *Future Gener. Comput. Syst.*, vol. 29, no. 7, pp. 1645–1660, Sep. 2013.
[9] A. Whitmore, A. Agarwal, and L. Da Xu, “The Internet of Things—A survey of topics and trends,” *Inf. Syst. Front.*, vol. 17, no. 2, pp. 261–274, Apr. 2015.
[10] L. Atzori, A. Iera, and G. Morabito, “The Internet of Things: A survey,” *Computer Networks*, vol. 54, no. 15, pp. 2787–2805, Oct. 2010.
[11] A. Al-Fuqaha, M. Guizani, M. Mohammadi, M. Aledhari, and M. Ayyash, “Internet of Things: A Survey on Enabling Technologies, Protocols, and Applications,” *IEEE Communications Surveys & Tutorials*, vol. 17, no. 4, pp. 2347–2376, Fourthquarter 2015.
[12] R. Khan, S. U. Khan, R. Zaheer, and S. Khan, “Future Internet: The Internet of Things Architecture, Possible Applications and Key Challenges,” in *2012 10th International Conference on Frontiers of Information Technology*, 2012, pp. 257–260.
[13] J. A. Stankovic, “Research Directions for the Internet of Things,” *IEEE Internet of Things Journal*, vol. 1, no. 1, pp. 3–9, Feb. 2014.
[14] R. Hasan, M. M. Hossain, and R. Khan, “Aura: An IoT Based Cloud Infrastructure for Localized Mobile Computation Outsourcing,” in *2015 3rd IEEE International Conference on Mobile Cloud Computing, Services, and Engineering*, 2015, pp. 183–188.
[15] H. Cai, B. Xu, L. Jiang, and A. V. Vasilakos, “IoT-Based Big Data Storage Systems in Cloud Computing: Perspectives and Challenges,” *IEEE Internet of Things Journal*, vol. 4, no. 1, pp. 75–87, Feb. 2017.
[16] S. Sareen, S. K. Sood, and S. K. Gupta, “IoT-based cloud framework to control Ebola virus outbreak,” *J. Ambient Intell. Humaniz. Comput.*, vol. 9, no. 3, pp. 459–476, 2018.
[17] P. K. Gupta, B. T. Maharaj, and R. Malekian, “A novel and secure IoT based cloud centric architecture to perform predictive analysis of users activities in sustainable health centres,” *Multimed. Tools Appl.*, vol. 76, no. 18, pp. 18489–18512, Sep. 2017.
[18] A. Sajid, H. Abbas, and K. Saleem, “Cloud-Assisted IoT-Based SCADA Systems Security: A Review of the State of the Art and Future Challenges,” *IEEE Access*, vol. 4, pp. 1375–1384, 2016.
[19] F. Al-Turjman, Y. K. Ever, E. Ever, H. X. Nguyen, and D. B. David, “Seamless Key Agreement Framework for Mobile-Sink in IoT Based Cloud-Centric Secured Public Safety Sensor Networks,” *IEEE Access*, vol. 5, pp. 24617–24631, 2017.
[20] S. Tyagi, A. Agarwal, and P. Maheshwari, “A conceptual framework for IoT-based healthcare system using cloud computing,” in *2016 6th International Conference - Cloud System and Big Data Engineering (Confluence)*, 2016, pp. 503–507.