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EVALUATING AND IMPLEMENTING GATEWAY TO CONNECT EDGE, INTERNET OF THINGS, AND CLOUD RESOURCES IN DISTRIBUTED COMPUTING ENVIRONMENTS

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Abstract
The Internet of Everything (IoE) is moving quickly forward, making it possible for more smart devices to connect to the Internet and creating huge amounts of data. This has led to problems with traditional cloud computing models, such as overloaded transmission capacity, slow response times, bad security, and bad protection. Traditional cloud computing can't meet all of the information-handling needs of today's advanced society, so innovations in edge computing have come about. It is another way to look at computing for making estimates at the edge of the organisation. In contrast to cloud computing, it puts more emphasis on being close to the customer and the information source. At the edge of the organisation, it is light and easy to use for nearby information storage and handling with a small scope.Because our current base of remote businesses and Internet of Things (IoT) applications is so well virtualized, existing information evaluation and dynamic cycles are done by a single framework. There is a good chance that these current techniques will have more prompts and gives that correspond to organisational elements, which will slow down the organization's response time and cause more traffic and downtime. Another point of view, called edge computing (EC), says that the organisation should get ready for the development of new applications and administrations to avoid these problems and get the most out of its assets. Due to the EC's integration, there is no longer a need for a common framework.

Keywords: Edge Computing, IoT, Quality of Service, Cloud Computing, Distributed Computing environment.

1. INTRODUCTION

The emerging paradigm for computing is edge computing (EC). A variety of applications that is mission-critical. EC a niche in the technological world as a result of due to its outstanding performance in offering real-time data analysis, cheap operating costs, better scalability, lower latency, and the Quality of service (QoS). Due to its incredible processing capabilities, EC will transform several areas include social networks, e-commerce, healthcare, education, and transportation. According By 2020, there will likely be more than 20 billion networked or connected IoT devices, according to study results from (Gartner, 2015).

Additionally, according to estimates by McKinsey Global Institute, the overall economic impact of IoT and by 2025, EC devices will be worth $11 trillion (Mckinsey, 2015). In On-demand services with EC have suffered in recent years. A market dominated by giants like Amazon (Echo Dot) Apple (Smart watch), Google (Nest) (Ken Cassar, 2016), GE (Predix), Cisco (IOx, 2016), and Itron (Riva, 2014) and numerous others, all competing to be the next major computing revolution at the cutting edge of technological advancement.

The decentralised architecture of EC places data processing at the frontier network's edge. Networks to reach self-sufficient conclusions. Therefore, before connecting to the cloud, the EC applications will carry out operations locally, like reducing the problems with network overhead as well as privacy and security concerns. Additionally, EC can connect readily with other wireless networks Such as vehicular and mobile ad hoc networks (VANETs), intelligent Internet of Things (IoT) and transport systems (ITSs) In order to reduce network-related and computational difficulties. When combined with these network programmes, EC, render judgments very rapidly, avoiding any life-related pauses preserving events.

For instance, in the healthcare industry, EC-enabled ambulance services come standard with prediction algorithms that are self-sufficient and independent of the cloud. End devices for transportation-related applications like smartphones and on-board devices, Systems with EC can foresee time-critical events fast.

2. EDGE COMPUTING

Technology that allows computation close to data sources at the network's edge is known as "Edge Computing." It works with both downstream and upstream data on behalf of cloud and IoT services (Bajic, Cosic, Katalinic, Moraca, & Lazarevic, 2019). Devices for computing or networking situated between cloud data centres and The term "edge devices" refers to information sources. For instance, a cell phone might be placed. Alternatively, a cloudlet or mDC could be utilised to separate a mobile device from the cloud and body sensors by way of the cloud (Sunil Sharma, 2021).

Edge has the capacity to offer a variety of benefits in practical applications. Scientists have demonstrates the benefits of offloading computer tasks for wearable assistance systems that are cognitive techniques that use cloudlets speed up response times by 80 to 200 milliseconds while using less energy 30 to 40% less consumption. Cloud's edge computing technology enhances response. 95% less time and energy is used for evaluated applications (Sunil Sharma, 2021).The Architecture of Edge Computing shown in Figure 1.

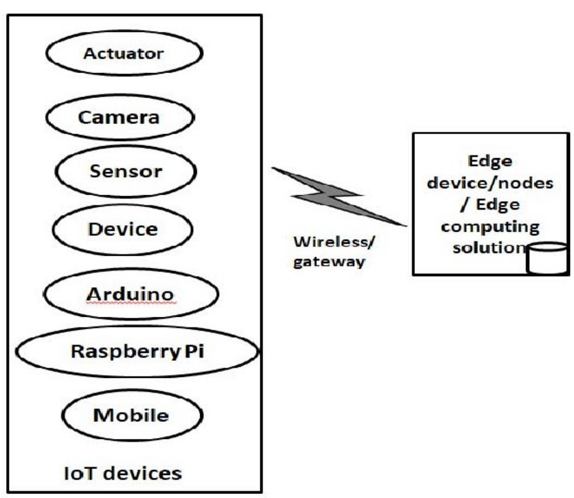

Figure 1: IoT Edge architecture

Source: (Naveen, 2019)

2.1.Edge Computing Benefits

Putting the processing power close to the data source has several disadvantages. Advantages over the more established cloud-based computing model.

- **Decreased latency and response time:** Researchers have finished using Facial Recognition by running it at the edge rather than in the cloud the system was able to recognise faces with a response time that was lowered from 169 to 900 milliseconds able to recognise the face between 169 and 900 ms quicker than a cloud system.
- **Decreased energy needs:** To transmit the computational tasks for wearable technology, researchers used cloudlets. Specifically, the Response time was cut in half to 220 milliseconds. Additionally, the energy usage was noted to be while employing edge, the reduction is 30–40%.
- **higher data security:** It is challenging to use edge computing since the data is only distributed to the devices or the nearest node attack every device in an effort to obtain the data.
- **Better performance of the app:** Apps like Facebook, Instagram, and the pictures app provide superior results because the data is handled at the edge. Customer service to the users. Users get less lag time and easier app navigation as a result. The uploading of photographs and videos is currently on-going.
- **Decreased operating costs:** Edge assists in lowering the cost of data traffic as well as the need for cloud data storage. This aids in cost savings. Nevertheless, connectivity problems won't be too troublesome because the Technology is autonomous.
- **Limitless scalability:** In contrast to cloud computing, edge computing gives users the choice to grow their IoT network as needed. Reference to the user's storage is not absolutely necessary.

2.2.Integration of Edge Computing and Cloud Computing

To boost cloud computing's efficiency, edge computing was introduced. With the aid of Performance of cloud computing can be improved by edge computing in the following ways:

- **Slowed reaction time:** Data is processed/ prepared as soon as it is produced at the source. At the edge, which reduces response time and hence speeds up processing efficiency and a decrease in network stress (Dahiya, 2021).
- **Why Popularizing IoT:** Cloud computing cannot handle enormous amounts of data on its own. Edge Computing aids in circumventing this restriction, enabling an increasing number of devices to a part of the IoT.
- Instead of uploading massive amounts of data, data producers and consumers should work together. It may be uploaded to the network's cloud since it would need a lot of bandwidth edge.

Table: 1 Comparison between Cloud Computing and Edge Computing

Area of Comparison	Edge Computing	Cloud Computing
Storage	Micro data storage	Big data Storage

It is possible to process data.	There isn't much data.	Getting ready for big data
Power to do computations	It doesn't do as much.	It is stronger.
Time to react	Reaction is faster	Response time is slower.
Data Safety	Safe	Not safe,
Annual cost	It doesn't cost as much.	It costs more.

Regarding the Cloud, the information storage and processing techniques are equivalent. Technologies for computing and edge computing. The variations between these methods depend on the place where data is stored and processed as well as the reaction time, as illustrated in Figure 1. Due to these variations and difficulties, various computer technologies provide opportunities for others, and the opposite. Consequently, this contrasts the promise and difficulties of cloud computing with Edge computing uses different key variables selected in accordance with the supplied data analytics needs (Dustdar, 2016) in Table 1.

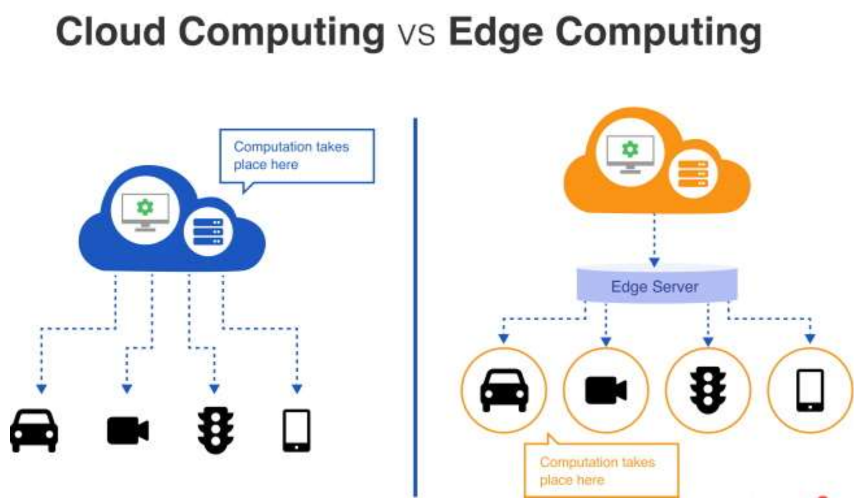

Figure 1: Edge and cloud computing structures contrast

Source: **(Jackson-Barnes, 2022)**

3. INTERNET OF THINGS AND CLOUD COMPUTING

The IoT is a contemporary strategy where borders are removed. The boundaries between the physical and digital worlds are gradually removed by gradually converting every mechanical equipment to a smart alternative prepared to offer intelligent services. Everything in the Smart devices, sensors, and other IoT components all has unique identities. They form the communication network when combined, and will become objects that participate actively (S. M. Babu, 2015). These things incorporate anything other than just commonly used technological equipment. Such as meals, clothing, supplies, components, and subassemblies; luxuries and commodities, landmarks and monuments, and a variety of commercial and cultural practises (B. B. P. Rao). Additionally, these Requests can be made by objects, and they can also change their states. Thus, Every IoT device can be traced, counted, and monitored, which reduces cost, loss, and waste greatly (J. Zhou et al., 2013).

Both the IoT and cloud computing are expanding quickly Services, and each has its own distinctive qualities. For instance On the other hand, the IoT strategy is centred on smart devices that converse with one another in a dynamic, global network infrastructure. The possibility of omnipresent computing is enabled. The IoT typically consists of widely dispersed devices. With a meagre processing and storage capacity. These tools encounter problems with performance, dependability, and privacy, safety and (A. Botta, 2016). In contrast, cloud computing includes a vast network with limitless storage. Capacities and processing strength. Additionally, it offers an environment that is adaptable and stable and permits changing data combining data from numerous sources (J. Zhou et al., 2013). The use of clouds has majority of the IoT problems were only partially fixed. In fact, IoT and Two comparatively difficult technologies are cloud and mobile.

Table 2: Pros and Cons of Edge and IoT

	Advantages	**Disadvantages**
Edge Clouding	• Low Latency • Real Time Availability • Real- Time Data Transmission • Bring Company and Customer together • Productivity Increase	• Limited Redundancy • Potential Loss • Longer Outage time • Higher Risk
IoT	• Reduces the amount of human labour • Reduces effort and time. • Beneficial for personal security and safety	• rising privacy issues • higher rates of unemployment • extremely reliant on the internet

3.1.Types of Cloud Service

The article lists and discusses three different kinds of cloud services.

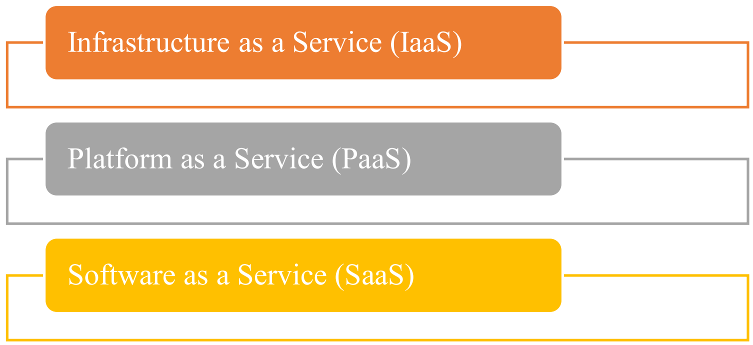

Figure 2: Types of Cloud Service

- **Infrastructure as a Service (IaaS):** An Organization's infrastructure provides services like storage, hardware, data servers, and networking components utilised in outside organisations.
- **Platform as a Service (PaaS):** It creates a setting where rentable or provided as an integrated service computing using a network connection.
- **Software as a Service (SaaS):** obtaining exclusive and priceless resources software that is made available online. Services as a Service consumer use an application that the provider hosts in its data centre. Uses a conventional web browser to access it, and its updates are applied without consumer input automatically.

3.2.Cloud Models

The following lists and discusses three cloud models.

- **Private Cloud:** In this category of cloud computing, IT services are made available over a private IT infrastructure for a single organization's exclusive use. The resources located on an organization's premises are used to manage a private cloud.
- **Public clouds:** A computing service architecture known as "public cloud" is utilised to offer storage and computing capabilities to everyone via the Internet.
- **Hybrid clouds:** Hybrid clouds combine private and public cloud architectures to offer cloud computing solutions. To accommodate a company's distinct and specialised requirements, the internal IT infrastructure offers a hybrid cloud solution along with other goods and services.

A public cloud is created over the Internet for consumers who have paid for the service to access. A private cloud, on the other hand, is created within a business's own Internet domain. As a result, only the corporation's and its partners' clients have access to it. Both the public and private clouds are utilised in a hybrid cloud. To create a hybrid cloud, for instance, a private cloud is combined with computing power from a public cloud.

4. LITERATURE REVIEW

4.1.Edge Computing for IoT

Compared to edge computing, cloud computing has lower performance. Due to its centralised structure in terms of processing, storage, Security issues brought on by the clouds' separation from IoT Along the path to the, users, and the potential for data theft skies (D. Liu, 2019).

IoT edge devices address issues related to the cloud architecture centralization; by bringing cloud local device computing, Internet of Things, and edge computing can handle data more quickly, and real-world applications instances where a quick response is necessary for a large number of these applications (W. Z. Khan, 2019).

4.2.IoT Analytics and Edge Computing

In 2018, (Pan, 2018) investigated the primary justification for edge computing, along with the modern initiatives, important technology, and research besides the usual IoT themes, there are more subjects in this applications that would gain from having a modern cloud. In a more particular manner, it is suggested create an IoT edge computing platform that is handled to assist in the dynamic deployment of virtualized distributed analytics containers.

On the other hand, (Alrowaily, 2018) sought to Review the ideas, characteristics, security, and IoT-enabled edge computing applications' security features in the data-driven world of today.

The identical year, Yu et al. in another review-based work (2018) did a thorough study to examine how edge IoT networks could benefit from computing. Similar to this, Premsankar and colleagues 2018 backed the notion of utilising edge computing for growing use of new IoT applications programmes that are interactive and use sensor streams. Finally, the final piece worth highlighting in this succinct review (He, 2018) article is one of the significant ones examined IoT security concerns.

(Abujubbeh, 2019) Concentrated on the thorough evaluation of the viability of using smart metres to improve power quality and dependability monitoring. An overview of smart metres, routing algorithms, and wireless communication technologies is given in the enhanced metre infrastructure as enabling technologies (AMI). Another study (S. Pawar and B. F. Momin, 2017) offers a succinct summary of Tools and technology used in smart power data analytics for metres.

Likewise, (G. D. L. T. Parra, 2019) concentrated on a SG and industrial Internet of Things security tool (IIoT) Deep packet inspection is a term. Deep packet inspection is investigated together with existing models and suggestions. The major priority is security risks and weaknesses in SG systems built on the IoT.

In (G. Bedi, 2018), systems are explored. Value and significance of IoT in an electrical power network, issues, suggestions, consequences on the environment, the economy, and society as a whole. The study of electrical power systems.

(M. B. Mollah, 2020) Seeks to provide an exhaustive survey on the use of block chain in Singapore has shown some significant security issues that block chain can address. There are numerous books addressing Security concerns in the SG by block chain space include given, along with significant issues for future research directions for using block chain to address smart grid security challenges are also highlighted. 'e framework for the anticipated possibilities of SG communication and capabilities are shown in Tang, B., Chen, Z., Hefferman, G., Wei, T., He, H., Yang, Q (2015) . Study results and solutions in which the deployment of 5G expands the usefulness of smart It surveys grids. The value of key management Sharma, P.K., Park, J.H. (2018) highlights the system (KMS) for the security of advanced metering infrastructure (AMI) in the smart grid. The survey highlights all the significant security issues of SMGA MI. Initially, the SG installation framework, the key traits of AMIs, as well as their link SG and AMI are discussed. Major characteristics of AMI are investigated, and security vulnerabilities and problems are addressed; lastly, the difficulties and potential solutions for KMS are summarised in AMI.

4.3.Statement of the Problem

"Methods for Distributed Computing Environments to integrate the Edge, and Internet of Things"

4.4.Objective of the study

- To overview the Edge and IOT Cloud Computing.
- Provide appropriate cloud computing services (software as a service, Internet as a service, and platform as a service).
- To provide an appropriate cloud computing model.

5. PROPOSED METHOD

This section describes the methodology that was used to direct the current investigation. Its responsibilities include coming up with a test plan, a philosophy for developing instruments to use during the test, a timeline for conducting the test, a means of collecting data, and a strategy.

5.1. **The Study Design:** The primary data from the review was through expressive overview of promoting exploration and execution of business association.

5.2. **The Sample Design:** The sample Design was 100 IT Employees.

5.2.1. **Population:** IT Employees of the different Organisation.

5.2.2. **Sample size: 1**00 IT Employees were required for the examination.

5.2.3. **Sampling Technique:** The random sampling method has been applied. The randomization of test results is taken into consideration by the random sampling technique, which means that each example has a similar possibility of being chosen to represent the entire population. It is seen as one of the most notable and direct data grouping procedures in research fields (probability and experiences, math, etc.). It thinks about reasonable data combination, which permits studies to reach honest outcome.

5.3.**Variables of the study**: security, privacy, performance, and reliability

5.4. **Tools for Data Collection:** The data was gathered via the study instrument of choice, the Questionnaire. Since there was not enough time to do a quantitative study, the qualitative exploratory approach was suitable. This limitation on the size of the sample made it hard to generalise the findings. A questionnaire was used to compile the data. We analysed the data using SPSS 25.0.

5.5. **Tools for Data Analysis**

5.5.1. **Descriptive Statistics:** Describing or summarizing features from a group of data with a descriptive stat is called descriptive statistics. The process of using and analysing these stats is called descriptive statistics.

5.5.2. **Correlation:** Connection or dependence in measures refers to any observable relationship—whether causal or not—between two stochastic components or bivariate data. But broadly speaking, "association" may show any kind of relationship, in estimations it conventionally implies how much two or three elements are sprightly related.

6. DATA ANALYSIS

6.1. Descriptive Statistics

Table: 3. Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
	Statistic	Statistic	Statistic	Statistic	Statistic
Reliability	100	1.40	5.80	3.5693	.87523
Security	100	1.60	5.60	3.4525	.71536
Privacy	100	1.00	5.80	3.6235	.72286
Performance	100	1.40	5.00	3.6221	.65937
Valid N (listwise)	100				

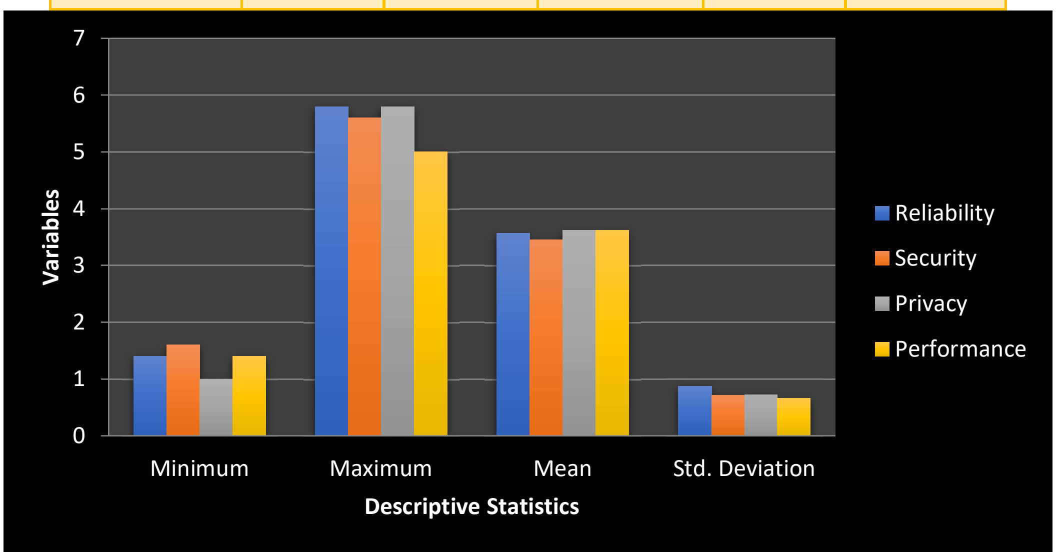

Figure 3: Graphical Presentation of Descriptive Statistics

Table 3 demonstrates that for our investigation, the variations in Reliability, security, Privacy, and performance are statistically significant. Privacy has a greater mean value than other variables.

6.2. Non-parametric Correlations

Table: 4. Spearmen Correlation

Correlations						
			Cost	Security	Functionality	Performance
Spearman's rho	Reliability	Correlation Coefficient	1.000	.165*	.071	.195
		Sig. (2-tailed)	.	.045	.321	.092
		N	200	200	200	200

	Security	Correlation Coefficient	.165*	1.000	.086	.040
		Sig. (2-tailed)	.045	.	.226	.571
		N	200	200	200	200
	Privacy	Correlation Coefficient	.071	.086	1.000	.071
		Sig. (2-tailed)	.321	.226	.	.318
		N	200	200	200	200
	Performance	Correlation Coefficient	.195	.040	.071	1.000
		Sig. (2-tailed)	.092	.571	.318	.
		N	200	200	200	200
*. Correlation is significant at the 0.05 level (2-tailed).						

Reliability and performance (r=.195), Reliability and security (r=.165), and Privacy and performance (r=.071) only have a weak link, see Table 4 above. Given the foregoing, the main goal of our investigation is to suggest an appropriate edge computing environment and a range of services for e-Government by taking the necessities into consideration (Reliability, security, Privacy and performance).

We gathered information to get the respondents' thoughts on a few issues pertaining to community cloud computing ecosystem characteristics.

Table: 5. Survey on some of the factors of community cloud

	Agree	**Neutral**	**Disagree**
When it comes to appropriate edge computing, you believe that Reliability is essential.	50%	20%	30%
Safety is a crucial factor in the development of edge computing	45%	30%	25%
Performance raises efficiency and reduces the volume of data transferred to the main server for archival purposes.	60%	25%	15%
Privacy reduces latency, increases security, uses less bandwidth, and decreases costs.	55%	35%	10%

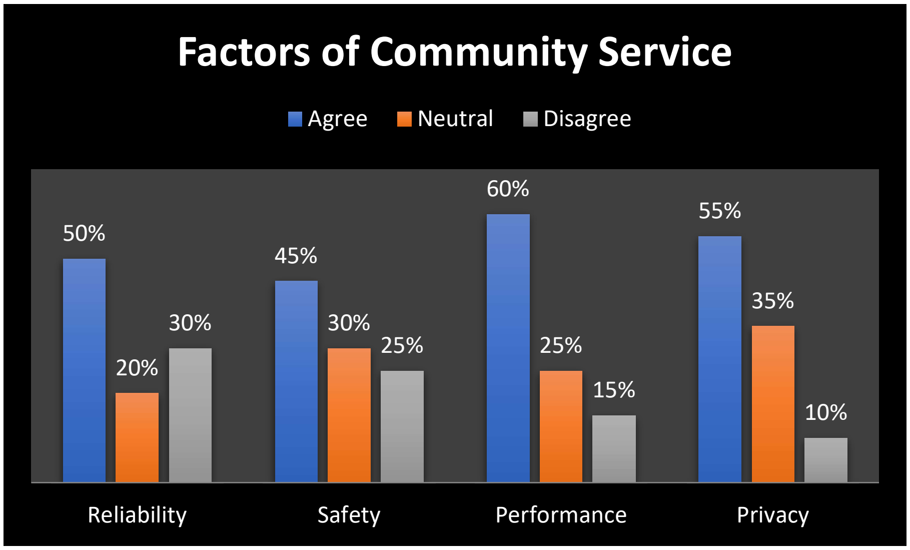

Figure: 3. Survey result of some of the factors of community cloud

In e-Government, three different cloud setups can be used. On a public cloud environment, data and services are available to everyone and a variety of various types of clients, and the data are stored in an external system. Due to concerns over security and privacy, the use of the public cloud in government is therefore not entirely appropriate. As a result, we decided to offer the edge computing cloud, or ECC, to the general public. To deliver a secure data association and block access to enable the sharing of use and IT resources between the venture area and a public cloud, we specifically used an overall business hatchery that was established between the public authority and the business area (G2B) and that supports IT projects.

The applications and data can be safely stored and only accessed by the authorised clients of an organisation or association thanks to the private cloud. Therefore, the private cloud can be used to deliver a higher level of security and protection for internal e-Government data that must be accessed by e-Government officials.

However, our concept used the local area cloud to ensure that government agencies could work together successfully. In our approach, more than 60 government entities can share the infrastructure and services, such as storage, servers, organising services, and data, and access applications that are protected by a high level of security thanks to the presence of a strong government network between them.

7. RESULT AND DISCUSSION

Without a doubt, edge computing is a crucial component of the IoT. Edge computing reduces inactivity, uses less data transfer capacity, improves security, and saves money. The goal of edge computing is to increase viability and analyse how much data is sent away from the main server for capacity. The concept of edge computing allows for a greater degree of computing knowledge and capacity limit at the edge of an organization's own structure. One of the top ten innovation trends in the foundation and tasks field, edge computing is focused on ongoing applications that call for extremely fast reaction times. Edge computing can therefore provide a solution to the growing security risk seen in cloud computing. The next step in our research is to employ cutting-edge computing technology.

8. CONCLUSION

Integration of IoT and cloud computing is a precursor to the next major Internet advancement. The IoT Cloud refers to the new class of applications that result from this combination. This research study examines the various facets of cloud computing, the Internet of Things, and the advantages of developing a synergistic strategy. In addition, it goes into detail about how to include edge computing to reduce the security-related difficulties involved with combining cloud computing with the Internet of Things for a variety of applications. IoT in the cloud is creating new opportunities for commerce and study. We anticipated that this combination will present a brand-new paradigm for the coexistence of numerous networks and a platform for open user services in the future. The IoT is evolving into a more pervasive computing service that demands enormous amounts of data storage and processing power. The integration of the Cloud into the IoT is highly helpful in terms of overcoming these obstacles because the IoT has limited processing power and storage capacity, as well as significant issues like security, privacy, performance, and dependability.

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