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# HARNESSING CLOUD OF THING AND FOG COMPUTING IN IRAQ: ADMINISTRATIVE INFORMATICS SUSTAINABILITY

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**Abstract**

*This article provides an overview of cloud computing and fog computing, as well as a discussion of the potential applications of these technologies in Iraq. The ability of cloud computing to provide scalable and adaptable computer resources on demand has led to a significant uptick in interest in this computing model all around the world. However, fog computing improves cloud computing by moving computation to devices that are positioned on the edge of a network. This research investigates the up-to-date applications of cloud computing and fog computing in Iraq, as well as the challenges that have been faced and the potential applications of these technologies in the future, particularly in terms of informatics and administrative issues. The use of questionnaires in research will be the topic of discussion in this study. This is made up of two different parts that work separately. In the first part of our survey, we ask respondents questions about their level of expertise with direct and indirect cloud on object and fog computing. The remaining aspects of the investigation are dissected in Part 2 of the study. These inquiries are in accordance with concerns regarding the complexity of the implementation process, the size and culture of an organization, practicability, compliance with legislation, compatibility with current systems, and support from the government. The final open-ended inquiry of the survey will assist us in compiling a wide variety of opinions on the types of cloud on object and fog computing services that are required by the Iraqi government.*

**Keywords :** Cloud of Thing, Fog Computing, Governmental support, Administrative Informatics Sustainability

## I. Introduction

Iraq is ripe with potential for cloud and fog computing, which, depending on their uses and sustainability levels, might be very useful to many different industries and marketplaces. Fog computing (FC) circumvents the limitations of centralized cloud infrastructures by bringing processing closer to edge devices, whereas cloud computing offers a cost-effective and scalable alternative for handling massive amounts of data. One inexpensive way to manage enormous data sets is with cloud computing. In the context of the IoT, which enables data gathering, analysis, and processing to boost efficiency and production, both concepts are crucial [IX], [X], [VIII], [V].

Iraq encounters obstacles such as low internet adoption, obsolete infrastructure, and a general lack of knowledge due to the nascent state of cloud computing in the nation. The good news is that global cloud service companies and programs like the National Cloud Computing Strategy are working together to find solutions to these problems. When it comes to data storage and analytics, government agency collaboration, and business operation efficacy, cloud computing might be a game-changer in Iraq. Moreover, Iraq has the potential to gain significant advantages from fog computing, particularly in sectors where the ability to analyze data instantaneously is of utmost importance. Hence, the intelligent management of parking, real-time monitoring of traffic, and identification of accidents might yield significant advantages for the country's transportation system. The healthcare industry stands to benefit greatly from fog computing, which could pave the way for effective resource utilization, real-time data analysis to detect outbreaks, and remote patient monitoring. By empowering farmers to make informed decisions about irrigation, fertilization, and pest management, fog computing could transform precision farming techniques in the agricultural business [XI], [III].

Cloud of Thing (CoT) and fog computing (FC) have tremendous untapped potential in Iraq, opening up a world of possibilities for greener, more creative applications in many different industries. Opportunities for economic growth and social progress will present themselves as the country keeps adopting these technologies.

## II. Method

For the purpose of carrying out the mandatory survey in Iraq, our group utilised its sizable personal contact network, in addition to certain online communities and dependable social connections. Due to the fact that 120 Iraqi citizens have adequate knowledge of cloud of thing and fog computing, they were requested to fill out a questionnaire. The survey received responses from just one hundred persons total. In spite of the fact that follow-up emails and texts were sent out to encourage participation, only about 88% of people replied to the survey. This level of reaction, on the other hand, was satisfactory, and it did offer some helpful suggestions. The study's overarching goal is to paint a detailed picture of the conditions under which fog and cloud computing might flourish in Iraq. The booklet summarizes the expectations of Iraqi community members regarding cloud and fog computing. For every survey question, one hundred people fill out the form. We can see the specifics of each inquiry from the responses given, which provide light on their character. Data analysis has been

carried out using both the survey results and IBM's Statistical Package for the Social Sciences, version 25 (SPSS 25). Here are some conclusions drawn from the survey results after collecting and summarising the data. The initial portion of the survey inquires about the respondent's function, department, organization size, and ministry in addition to their level of expertise with fog computing, direct and indirect cloud on objects, and computing in general. We also check their knowledge of cloud computing basics, including direct and indirect cloud on objects, as well as fog computing.

**Table 1: Data collected from survey takers regarding their responses to questions about direct advantages**

| What are the immediate advantages CoT and FC that could convince your organization to implement them? | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | MB | CoT and FC disaster recovery | Security benefits of CoT and FC | LS | A | SU | V | SC | CS |
| | 86 | 80 | 50 | 90 | 66 | 83 | 59 | 75 | 70 |

**Table 2: Responses to questions about indirect advantages recorded by survey takers**

| Why might your organization be interested in CoT and FC if not for the direct benefits they provide? | | | | | | |
|---|---|---|---|---|---|---|
| Faster job completion is possible with the help of CoT and FC services, which allow customers to do things like automatically configure new computers, networks, and storage space in a matter of minutes. | Improve the work's effectiveness and efficiency. | CoT and FC capabilities boost staff morale and output. | Your staff may be efficient and productive thanks CoT and FC services, as well as the accessibility of your online databases at any time and from any location. | Having the option to work from home or at odd hours boosts morale because workers don't have to conform to traditional office hours. | Facilitating a decrease in commuting times | The adoption of remote work methods inside the organization has resulted in an increase in employee loyalty. |
| 90 | 89 | 80 | 77 | 90 | 95 | 68 |

To gain a better understanding of the current situation of cloud-on-item and fog computing usage in Iraq, we used exploratory research to ask a number of Iraqi persons who are experts or knowledgeable about the topic for their comments. When asked about the direct and indirect benefits they would reap from adopting the cloud of things and fog computing. Direct advantages include mobility (MB), CoT and FC disaster recovery, Security benefits of CoT and FC, limitless storage (LS), automation (A), software updates (SU), virtualization(V), scalability(SC), and cost-saving (CS). The vast majority of respondents highlighted the importance of doing so in order to save time, money, and other resources while simultaneously strengthening the link between the government and its constituents. Direct and indirect benefit item selection rates are detailed in Tables 1 and 2, respectively.

On these likert scales, a score of 1 means it is not significant at all, a score of 2 means it is not important at all, a score of 3 means it is neutral, a score of 4 means it is important, and a score of 5 means it is as important as it can be [III], [VII]. Conversely, the "I don't know" option has become a symbol of ignorance. In Tables 3–8, we can see the statistical results of the questionnaire's Likert scale ratings for criteria including complexity, organization size, culture, regulatory compatibility, and government support. There are the questions from each issue and their corresponding means and standard deviations. When asked about additional difficulties associated with a cloud of things and fog computing's technical, organizational, and environmental characteristics, respondents' answers showed vastly different priorities based on TOE, DOI, and Loccovo [III], [IV].

**Table 3: Respondents' recorded responses to questions measuring complexity**

| What are your primary considerations regarding the Complexity matter? | Mean | Std. deviation |
|---|---|---|
| It can be difficult to reconfigure your applications to satisfy the requirements of the new host. | 3.76 | 1.251 |
| The transition to CoT and FC will add complexities to the overall administration of IT resources. | 3.79 | 1.244 |
| At the outset of adoption, we may need a third party to administer CoT and FC systems. | 3.73 | 1.243 |
| The difficulty of maintaining and updating operating systems, applications, and underlying hardware in CoT and FC setting. | 3.84 | 1.231 |
| It is challenging to find personnel with the necessary expertise to manage CoT and FC systems. | 3.64 | 1.274 |
| **Mean Sum** | **3.75** | **1.249** |

**Table 4: Documented responses from survey takers regarding items pertaining to company size**

| How, in your opinion, does the scale of an organization affect the adoption of CoT and FC? | Mean | Std. deviation |
|---|---|---|
| Large organizations are better equipped to employ CoT and FC services due to their ample financial, technical, and human resources. | 4.17 | 1.118 |
| Large organizations have greater resource flexibility, allowing them to experiment with new innovations. | 3.91 | 1.121 |
| There may not be a tendency for large organizations with a large number of employees located in numerous locations to adopt the cloud of things and fog computing. | 3.53 | 1.304 |
| Small and medium-sized businesses may benefit more from CoT and FC because they need not invest in infrastructure and applications. | 3.63 | 1.358 |
| **Mean Sum** | **3.81** | **1.225** |

**Table 5: Survey takers' recorded responses to questions measuring cultural sentiments**

| What do you think of your organization's cultural outlooks? | Mean | Std. deviation |
|---|---|---|
| Because CoT and FC involve new methods of utilizing, storing, and sharing data and applications, the prevalent beliefs and attitudes in an organization may prevent them from being adopted. | 3.88 | 1.331 |
| The organization is very supportive of changes | 3.09 | 1.314 |
| The majority of individuals in this organization are encouraged to offer suggestions for enhancement. | 3.31 | 1.282 |
| Organizational culture, including norms, perspectives, and structures, can be restructured to make better use of emerging technologies. | 3.48 | 1.224 |
| Whether or not a business decides to implement CoT and FC technologies can be influenced by factors such as its location. Businesses in more stable or central locations may be more hesitant to make the switch. | 3.91 | 1.12 |
| **Mean Sum** | **3.53** | **1.254** |

**Table 6: Documented responses from survey takers regarding regulatory issues**

| What checks and balances should be in place before moving data or applications to CoT and FC infrastructure? | Mean | Std. deviation |
|---|---|---|
| **In the event of non-compliance with said criteria, the relevant laws and regulations** | 4.24 | 1.036 |
| **Policies, rules, and laws that govern the organization's use of CoT and FC (how are they being deployed?, for what tasks?). to what end?)** | 4.29 | 0.912 |
| **Compliance with applicable information security and privacy standards to guarantee the safety and legality of data processing** | 4.32 | 0.93 |
| **When it comes to meeting the requirements of law, regulation, and business, how secure are service provider data centers?** | 4.29 | 0.92 |
| **Is there a law requiring us to refrain from sharing this information with anyone outside of our company?** | 3.83 | 1.231 |
| **Is there a Service Level Agreement (SLA) for the services you receive from your cloud of things and fog computing provider? Does it boast an extremely high uptime guarantee, say between 99.9% and 99.999%?** | 4.32 | 1.223 |
| **Mean Sum** | **4.22** | **1.042** |

**Table 7: Questionnaire Respondents' Recorded Responses Regarding Compatibility**

| Is there anything specific that has you worried about the compatibility problem? | Mean | Std. deviation |
|---|---|---|
| Is it known if or not any current software or hardware is CoT and FC compatible? | 4.31 | 1.023 |
| Is it possible to switch to a newer version that works with CoT and FC, or to replace outdated software with one that does? | 4.14 | 0.987 |
| How long (in days, weeks, or months) might it take to adapt our infrastructure and software to work with CoT and FC? | 3.85 | 1.095 |
| If we decide to switch CoT and FC service providers, will our data be incompatible with theirs? | 4.29 | 1.026 |
| If our current beliefs, methods, and requirements can be accommodated by CoT and FC. | 3.82 | 1.175 |
| **Mean Sum** | **4.08** | **1.061** |

**Table 8: Data collected from survey takers regarding government assistance difficulties**

| Regarding government assistance, what are your primary concerns? | Mean | Std. deviation |
|---|---|---|
| Will the prevalent implementation of CoT and FC be aided by government laws and regulations? | 4.21 | 0.913 |
| When it comes to CoT and FC, will the government fund the important training programs and research to ensure that the relevant skills are acquired? | 4.24 | 0.983 |
| To what extent will the government support non-profits in overwhelming their budget constraints? | 4.13 | 1.021 |
| If the government is ready to simplify the adoption of CoT and FC by reducing the number of meetings and permits required, then these technologies can be truly launched. | 4.13 | 1.077 |
| If the government establishes stringent data storage and privacy rules to safeguard information for businesses, how effective will these measures be? | 4.24 | 1.076 |
| Do you need support from the government to implement CoT and FC at your company? | 3.48 | 1.372 |
| **Mean Sum** | **4.07** | **1.074** |

The reliability of the field study is demonstrated by Cronbach's Alpha. With a Cronbach's alpha ranging from 0.504 to 0.84, the questionnaire is a reliable tool that the Iraqi government can utilize with assurance. Based on the criteria laid out by George and Mallery (2003), an acceptable Cronbach's Alpha value is 0.7, a doubtful value is 0.6, a poor value is 0.5, and an unacceptable low value is less than 0.5 [I], [IV]. It also explains how field studies employ ordinal scales to determine median importance ratings, as shown in Table 9.

**Table 9: Percentage of field studies that demonstrate reliability and average ordinal scale**

| Variable | Average | Cronbach's Alpha | Mean ordinal scale percentage |
|---|---|---|---|
| **Complexity** | **3.75** | 0.81 | 68.75 |
| **Organization Size** | **3.81** | 0.504 | 70.25 |
| **Cultural attitudes** | **3.53** | 0.74 | 63.25 |
| **Regulatory** | **4.22** | 0.82 | 80.5 |
| **Compatibility** | **4.08** | 0.73 | 77 |
| **Government Support** | **4.07** | 0.84 | 76.75 |

## IV. Questionnaire Outcomes and Analysis

Only respondents with relevant expertise in cloud and fog computing were asked to fill out the survey. It was planned ahead of time to make sure the questions would be fair and uniform.

All of the participating organizations are hard at work creating their own cloud of things and fog computing prototypes in Iraq, with the goal of improving e-services and the Internet of Things (IoT). Customers know that the ways cloud computing and fog computing can help them save time, cut costs, and improve the quality of electronic services and the Internet of Things (IoT).

In accordance with items measuring cultural attitudes, questionnaire respondents provided the lowest average mean value (M = 3.53; SD = 1.254). This is a result of the two lowest mean values for inquiry sub-branches "The organization is very supportive of changes" and "The majority of individuals in this organization are encouraged to offer suggestions for enhancement" with mean magnitudes of 3.09 and 3.31, respectively, which reduce the average total mean of the cultural attitudes section.

The participants' near-important level Likert-scale responses to the questions on government assistance and compatibility suggest a hopeful outlook. With a standard deviation of 1.061 and 1.074, respectively, both had mean values of 4.08 and 4.07, respectively.

The selected survey has a high degree of dependability and positive results, according to Cronbach's alpha, which has a range of 0.504 to 0.84. This range indicates that the survey's reliability is strong. Within Iraqi government agencies, this survey might pave the way for future research and development into cloud and fog computing. You might use this survey as a guide.

On top of that, we have collected expert opinions and suggestions, which will help us implement cloud computing on things and fog computing technologies and make great strides forward. Some survey takers think that Iraq needs to look into the obstacles preventing the growth of the CoT and FC environment and work to break them. The results of the survey made it possible to track down and get information from these people. An assortment of challenges must be overcome; they include issues of a political nature, individuals employed in the field of information and communication technology (ICT), access to power, and the internet. Furthermore, a small percentage of poll takers believe that Iraqi government agencies may benefit from official gateways of cloud-on-item and fog computing technologies. Among the thoughts voiced by those who took part in the research was this. Quite a few respondents to the survey expressed views similar to this one. In the future, these gateways should be able to facilitate a wide range of projects and studies pertaining to changes in the utilization of internet services and enhancements in performance. Future government plans to promote electronic transactions and attract investors in Iraq will rely heavily on this gateway, which is why it is so important. Attracting foreign capital is the primary motivation for achieving these objectives. The goals here are to boost investment in Iraq and foster more usage of digital commerce and the Internet of Things.

Some experts' opinions and ideas from an applied survey indicate that cloud computing and fog computing-based e-governance in Iraq is strategic and offers numerous advantages to an organization. These thoughts and recommendations were submitted as a component of a practical survey. A decrease in data dispersion, more affordable resources, better security management, more scalability, and more accountability are all advantages. Thus, it is of the highest importance that Iraq build an electronic administration, even though the country did not have a particularly rough start in this area. This is in sharp contrast to the present state of the technology behind cloud and fog computing, which are presently on ground level.

Microstrip antennas and filters play a major role in fog computing, IoTs and cloud computing. Some of these include industrial sensors, smart home gadgets, and autonomous cars. The opening of wireless communication is made possible by their ability to allow interconnected devices that can transfer data and information wirelessly. With the gradual increase in the number of connected devices, services and applications from cloud and fog computing based on microstrip filters and antennas will be useful [XIII], [VI], [II], [XII], [XIV].

## V. Conclusion

The study outcomes highlight the need for applying CoT and FC in Iraq by ecologically friendly means. These technologies should be developed and deployed in an environmentally conscious, energy-efficient manner while taking into consideration the aspects of carbon offsetting as well as responsible supply chain management. The investigation establishes that education, partnerships, and constant quality improvement are essential to surmount challenges in the successful application of cloud and fog computing technologies within Iraq. If Iraq overcomes these challenges with sustainable solutions, it can speed up its digital transformation and improve global competitiveness.

## VI. Recommendation

1. Collaborating with renewable energy suppliers: Iraq might extend partnerships with renewable energy suppliers that would deliver clean sources of electricity for cloud and fog computing structures, which eventually will help them to reduce the negative effects caused by these technologies.

2. Realization of the principles in the Regenerative Economy Cloud and fog computing programs that are run based on circular economy practices increase resource efficiency by increasing equipment lifetime, improving recycling and reuse activities, as well minimizing waste generation. This approach can minimize the volume of waste created.

3. Funding research and development in ecologically friendly technology. Research and development investments in green cloud and fog computing may lead to energy-efficient hardware, ecologically friendly data centers, as well as environmentally sound software outcomes.

4. Public Awareness Campaigns: A very efficient way to promote a culture of sustainability and responsible use of technology is by conducting public awareness campaigns where information about the social and environmental benefits that come along with cloud computing is given.

5. Enacting localization and sovereignty policies can enhance data privacy by protecting information through security within Iraq's borders and under the authority of Iraq. This goal can be achieved by putting in place policies that encourage data localization and sovereignty.

6. Establishing holistic plans for disaster recovery and business continuity in cloud as well as fog computing architecture helps to ensure the sustainability of these systems over time, even under potential interruptions or disasters.

7. To promote the ethical and responsible use of these technologies while adhering to recommended procedures, it is necessary to create industry standards and certification programs for green cloud computing.

8. A possible approach to encourage the general adoption of eco-friendly technology may be given in incentive opportunities—tax holidays or subsidies, for instance –to embrace a sustainable model through cloud and fog technologies.

9. Collaborations between businesses and governments: An enabling environment for technological development and diffusion can be created through facilitating cooperation among academic institutions, commercial firms, and government. This will encourage innovation in the area by leading to environment-friendly cloud and fog computing technology development.

10. The carbon footprint of the cloud and fog computing infrastructure can be significantly reduced by investing in environmentally friendly data centers that run on renewable energy sources.

11. Energy-Efficient Cooling Systems The adoption of data centers that are powered by energy-efficient cooling systems will help reduce power consumption and increase the environmental impact of cloud as well as fog computing.

12. Carbon Offsetting: To support Iraq in meeting its sustainability goals, one approach is to embrace carbon offsetting initiatives that aim at countering the undesirable environmental impacts brought by cloud and fog computing.

13. In terms of countering the environmental and social impact associated with cloud and fog computing, one approach builds on sustainable business practices in the entire supply chain.

14. Green Procurement Rules: Another strategy for making the market for environmentally-friendly IT products better is through setting standards on green procurement to consider cloud and fog computing solutions which are eco-friendly.

15. The application of fog and cloud computing in projects should include a full environmental impact assessment to unveil threats and opportunities for minimizing the negative effects on nature.

16. Collaborating with international organizations: Building a network of global organizations as well as sustainable technology projects, one can gain the knowledge needed, the financial funds, and optimal strategies for embracing green cloud and fog computing solutions.

17. Educating and Trained Programs In order to improve the level of skills and ability in this field, creation of educational programs for IT professionals and decision leaders with sustainable cloud fog computing strategies must be established.

18. Monitoring and Record-keeping.

19. Encouraging Data Center Green Certification: To evidence their sustainable practices, data centers can aim at getting green certifications like LEED or BREEAM.

20. Fostering a Culture of Continuous Advancement and Novel Concepts: The focus on a culture that values continuous innovation can be one of the methods to promote sustainable cloud and fog computing practices. This might develop technology and, at the same time improve environmental conditions.

**Conflict of Interest:**

The authors declare that there was no conflict of interest regarding this paper.

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