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Mathematical Analysis of Managerial Influences on Mobile Cloud Computing

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Abstract: Cloud computing's impact on mobile devices is a big problem in the IT industry. Tech advancements have not solved the problems of mobile devices' processing power, storage capacity, scalability, battery life, privacy and security, and pricing. But there are many options for getting around mobile limits when you combine cloud computing with mobile devices. Users may access the premium app on their mobile devices using this link. If we want to know how poor countries are using mobile cloud computing, we need to do more studies. This research not only presents a new theoretical framework for mobile cloud computing, but it also compares and contrasts its main pros and cons. A triangulation approach was used to acquire the data for the investigation. In the end, 312 qualitative surveys, 28 interviews, and 3 focus groups were used to obtain information. From beginning to end, the data processing operation made use of many tools, one of them being the NVivo application. Finally, a mathematical equation have been employed to represent the relations between factors.

Keywords: Mobile Cloud Computing, Quality assurance, Mathematical analysis, Artificial intelligence.

1 Introduction

Users may access and work with computers housed online rather than relying on local resources when they use web-based technologies such as cloud computing [1]. Virtual resources in the cloud provide almost infinite processing and storage capacity, catering to users' specific demands [2]. Removing or adding these resources is, hence, easy and cheap [3]. Users' payments are proportional to their use of these resources, and this scale is flexible enough to accommodate changes in demand [4]. Businesses and individuals may save a lot of money by using cloud computing instead of constructing expensive infrastructure from the ground up [5]. Cloud computing has the potential to imitate several fundamental technologies, including servers, virtual desktops, software, and data storage. Launching a virtual firm with minimal initial expense is possible thanks to cloud resources that can be instantly connected to the internet [6]. The introduction of revolutionary technologies by Apple in the 2000s caused a sea change in the music industry. One of Apple's first ventures into cloud computing was the iTunes music store [7]. Music, videos, and photos abound at this particular online store. Apple devices, such as iPhones, iPads, and iPods, may access data resources stored on Apple servers by uploading, downloading, or streaming. Costs have decreased substantially, and the only ones who will have to pay for use are the end users. Regardless, Apple makes a lot of money in this economic sector [8].

2 Ease of Use

2.1 Cloud Computing for Mobile Devices

When mobile and cloud computing come together, it opens up a world of possibilities for endless access to

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massive amounts of data [9]. Giant tech companies like Huawei, Apple, and Samsung have all assured customers that their devices are secure in the cloud, despite ongoing worries about data privacy and security. In the case of theft or misplacement, Apple customers, for instance, may trace their gadgets. Moreover, these gadgets are worthless without the iCloud login credentials. Furthermore, the capacity to impose internet limitations on any mobile device is provided by Samsung and Huawei using cloud computing technologies. Some of the most popular websites that rely on cloud computing include YouTube, Twitter, Facebook, Wikis, and Blogs [10]. Therefore, popular applications rely heavily on cloud computing. Through web-based servers, these apps may be accessible from any location at any time [11]. States that millions of people watch one billion videos on YouTube every single day. In a secure environment, Facebook transmits and stores an incredible amount of data—billions of gigabytes. To use these applications, the majority of consumers utilize their mobile devices.

2.2 Cloud Computing Model

To fulfill the needs of its cloud customers, cloud service providers provide a variety of cloud technology solutions. The deployment method and service model are the main ways in which cloud computing has been categorized by several specialists. Private, public, hybrid, and community clouds make up the four pillars of the cloud deployment paradigm [12]. One distinguishing feature of a private cloud is that its resources are owned by only one user [13]. Having said that, it's still the safest and most costly choice. Because it is mostly used inside a single organization, this technique has much greater expenditures compared to other cloud deployment strategies [14]. On the other hand, a public cloud approach allows several users to access a shared application repository. Although private cloud architecture is more costly, public cloud computing is less expensive but less secure. The hybrid cloud architecture is made by integrating parts of the public and private cloud architectures. Multiple community, private, and public cloud designs might be part of a comprehensive strategy [2]. The hybrid cloud approach sits between the two extremes of public and private cloud computing, with the former being more expensive than the latter. Hybrid clouds make use of private cloud technology [15]. The idea of a communal cloud is used to solve common problems by public libraries, schools, and businesses. Some members may choose to divide the cost in order to make the shared cloud cheaper. Customization of shared applications according to cloud users' demands is also possible with community cloud architecture [14]. In the cloud service paradigm, Infrastructure as a service, Platform as a service, and Application as a service are the three main components [16].

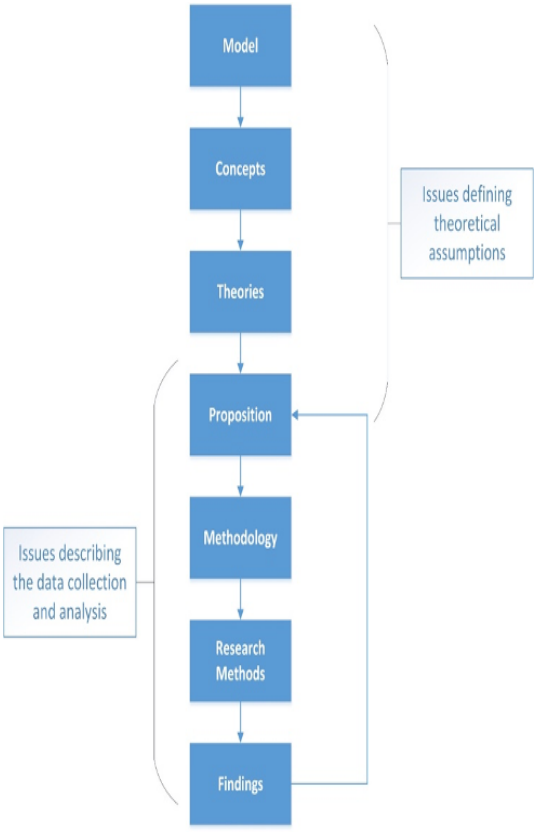

Fig. 1: A conceptual framework illustrating the research process, linking theoretical assumptions

3 Research Methodology

The paper that deals with the methodology of the study lays out the research premise, data gathering techniques, and analysis processes in great detail [17]. This research therefore used a triangulation technique, which included gathering and evaluating data from many sources. A total of 312 surveys, 28 interviews with semi-structured questions, and 3 focus groups were used as sources. To achieve this objective, we use Excel, NVivo, and Visio. The data originated from privately owned companies in Jordan. Data was collected and analyzed in a phased approach according to the procedure described in reference [18]. Prior to doing the literature review and data collection, the research laid out its intended course of action and provided arguments in support of the study's core concepts, theoretical foundations, conceptual basis in mobile cloud computing, and potential guiding theories. Having presented its findings, the research came to a close [19]. Condensing the data, presenting the facts, and drawing and validating results are the three main processes of qualitative data analysis, according to Miles and Huberman [20] (Fig. 1).

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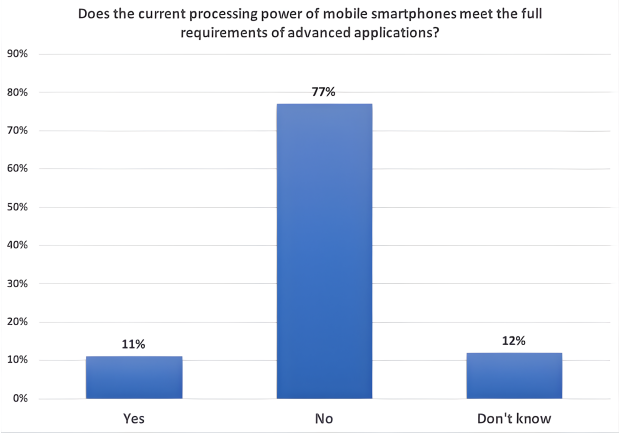

Fig. 2: Perception of Mobile Smartphone Processing Power for Advanced Applications

3.1 Implementing the Experimental Protocol

The purpose of doing pilot research is to see whether a plan for direct observation, interviews, and questionnaires is feasible, and to identify early on any potential problems with data collection techniques, such as recording issues. The viability of efficiently executing the schedule is another objective of the pilot research. To further verify the whole dataset's validity and reliability, pilot studies are highly recommended [21]. A pilot study was carried out to ensure that the collected real data was accurate and consistent, and to reduce the likelihood of any research errors. It was also useful for arranging data collection for the people who would be the focus of subsequent research. The initiative was a collaborative effort between a researcher and a professor of management information systems. In addition to conducting three rounds of unstructured interviews, they collaborated on the development of the study's survey, focus group, and interview questions. Five more people were asked for their comments by the researcher. After the pilot research revealed several gaps in the data gathering process, the interview and survey questions were fine-tuned. The interviews and their corresponding interview dates were recorded using a code scheme that ran from Pn1 (the first interviewee) to Pn28 (the final interviewee, the twenty-second in total). During data processing, these codes will be used to expedite the search for matching explanations provided by the questioned participants. As previously mentioned, three focus groups were been conducted to further investigate the elements influencing the adoption of mobile cloud computing. Processing speed, mobile capacity, battery life, security and privacy, and cost are some of the variables that might impact mobile cloud computing technologies, according to this research.

3.2 Processing Capacity

The lack of processing power in mobile devices is a big downside, according to the qualitative study. A mobile device's processing power pales in comparison to that of a server, workgroup, edge computer, or supercomputer. An authority in the subject and an associate professor in the IT department has said that mobile service providers inflate the level of complexity and processing capacity that their customers' devices really possess. The preinstalled software on the majority of smartphones is more than enough to do the task. Conversely, state-of-the-art applications such as MATLAB and 3D rendering software will become completely inoperable. We have the user's input, which is "(Pn3)". If you want to see what proportion of people believed mobile devices could accomplish their jobs well, look at Figures 2 and 3. Only 12% of those who took the survey had any doubts about their response, while 77% kept acting inappropriately. Thanks to advancements in cloud computing, mobile devices may tap into almost limitless processing power. To do this, data is sent to remote computers in the cloud, processed, and then the results are retrieved. One example is the use of cloud computing by smartphones and other mobile devices, which allows them to access enormous processing resources to augment their limited capabilities.

Finding techniques to extend the battery life of mobile devices, such as smartphones, is a significant task. The efficiency and lifespan of batteries have been enhanced by several advancements. Contrarily, keeping the program running might cause a 45 percent surge in the battery's power usage. Due to the limited storage capacity of individual mobile devices, mobile cloud computing has emerged as the only viable option for extending app functionality beyond the mobile platform, hence extending the life of the devices' batteries. Utilizing mobile cloud computing for remote processing is one approach to optimizing the use of energy resources allocated to remote applications. A potential 41% reduction in mobile device battery usage is possible with the capacity to create 3D photos in less than 30 minutes. The fact that 46% of those who took the survey said they wouldn't be happy unless their smart gadgets could last longer than 72 hours is just one of many interesting things that came out of this survey. A smartphone's battery life, under ideal circumstances, is limited to 48 hours when utilized as intended. Finding techniques to extend the battery life of mobile devices, such as smartphones, is a significant task. The efficiency and lifespan of batteries have been enhanced by several advancements. Contrarily, keeping the program running might cause a 45 percent surge in the battery's power usage. Due to the limited storage capacity of individual mobile devices, mobile cloud computing has emerged as the only viable option for extending app functionality beyond the mobile platform, hence extending the life of the devices'

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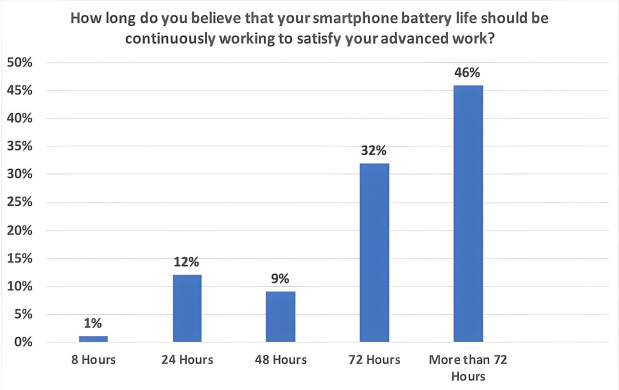

Fig. 3: Desired Smartphone Battery Life for Advanced Work

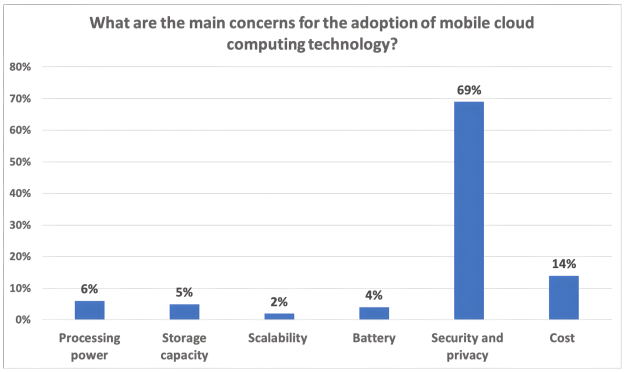

Fig. 4: Main Concerns Regarding Mobile Cloud Computing Adoption

batteries. Utilizing mobile cloud computing for remote processing is one approach to optimizing the use of energy resources allocated to remote applications. A potential 41% reduction in mobile device battery usage is possible with the capacity to create 3D photos in less than 30 minutes. Among the many noteworthy findings from this poll is the fact that 46% of respondents said they couldn't be satisfied until their smart devices had a battery life of more than 72 hours. In ideal conditions, a smartphone battery can only last up to 48 hours on a single charge when used as intended. The findings of the survey's battery life question are shown in Figure 3.

3.3 Security and Privacy

The poll also revealed that mobile devices, such as smartphones, had limited storage space. One of the several advantages of cloud computing is the availability and simplicity of online cloud storage. Apple and Microsoft are only two of several cloud service companies that provide free, restricted storage to its consumers [22]. Utilizing mobile cloud technology, you may access sufficient storage for a usage-based fee, which can be paid monthly or annually. It was the opinion of a number of survey takers that purchasing cloud-based data storage servers was more economical than purchasing actual hardware. As an additional advantage, customers get limitless access to their data [23]. According to a computer science professor at an engineering school, today's smartphones are more than enough for everyday activities like taking photos and posting them online [24]. Equally impressive are their video recording capabilities, which can reach resolutions of up to about 1080p. The computer expert thinks these features are more than enough for everyday use. However, even with terabytes of storage capacity, these devices still can't handle complicated software. Something that catches the eye and draws notice Curiously, most respondents believe that current smartphones do not meet the basic storage demands of most apps. An overwhelming 89A high-priced device will have plenty of storage space, like 512 GB. Due to its capacity being less than one terabyte, this storage is insufficient for a three-dimensional rendering process that lasts an hour, resulting in an excessively lengthy period (Pn20). Cloud service providers must be able to adapt to changes in demand in order to provide flexible scalability in data processing and storage. The data processing or storage capacity's scalability may be adjusted. A price structure that was previously unavailable to mobile cloud users is now within reach thanks to the integration of these capabilities with mobile devices. This price structure can be useful for customers who utilize cloud services on the go. Cloud computing solutions with a "pay as you go" approach might affect the total cost of adoption, either increasing it or decreasing it. With mobile cloud computing, customers may independently modify their resource, virtual node, and server consumption. Along with the financial advantages, scalability is one of the key features of cloud computing. As mentioned by Pn27, the scalability of mobile cloud computing will undoubtedly save the time and money needed to acquire additional physical resources. Plus, there are no extra costs for mobile cloud clients to make full advantage of upgraded RAM, graphics cards, and CPUs. In case a reduction in resources is necessary, it also gives mobile cloud users the opportunity to do so.

3.4 Cost

Respondents to the survey overwhelmingly agreed that a cost-benefit analysis is a crucial component of cloud computing. When it comes to meeting the demands of sophisticated processing, this approach works wonders with mobile cloud technology. One must have it in order to use cloud computing. Most respondents that employ a pay-per-use pricing model said that cloud computing

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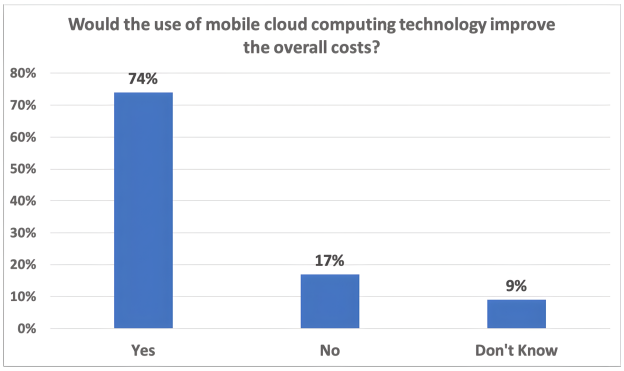

Fig. 5: Perceived Cost Benefits of Mobile Cloud Computing

might help them save money [25]. The rapid ascent to prominence of mobile cloud computing may be attributed, in large part, to this particular characteristic [26]. A number of experts in the industry, however, agree that determining the return on investment (ROI) is a necessary first step before committing to cloud computing. Prior to using mobile cloud computing, it is essential to calculate the return on investment (ROI), which is the whole cost of processing and storage over time. According to a well-known cloud computing specialist, this is a crucial factor to think about. Compared to buying a storage device instead of leasing one from a service like iCloud, the recurring expenses of cloud computing are much greater, despite the fact that there is almost no upfront investment. This is because a higher bandwidth capacity is required for data retrieval and storage in the cloud. This user has entered the text "(Pn13)". Another responder said that storing data on the cloud may be a cost-effective solution when dealing with big quantities of capacity, such as terabytes. But, if you want to use this product often, it may not be the ideal choice. A mobile phone or smartphone might be transformed into a data access point with the use of big data. The current user's text is "(Pn18)". The survey results are shown in figure (4), as viewed by the participants. A majority of 74% believe that mobile cloud computing can reduce overall expenditures, while a minority of 17% say that mobile cloud technology isn't beneficial for saving money. However, 9% of respondents either didn't know the response or were unable to come up with one.

3.5 A suggested model for the factors influencing the uptake of mobile cloud computing

The author suggests using mobile cloud computing, as seen in figure 6 below. This proposal is supported by the findings of this research (8). The website also has a

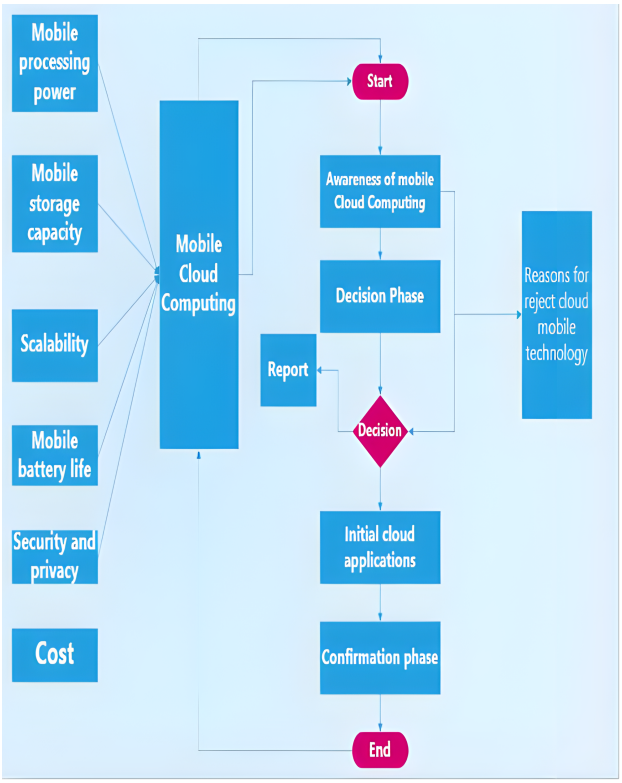

Fig. 6: A proposed framework for the deployment of mobile cloud computing adoption in this study

sequence diagram on the right side that outlines the likely stages of adopting mobile cloud technologies. It was critical to fully understand the concept of mobile cloud computing and its benefits and drawbacks before putting it into practice. One way to make this information more accessible would be to look at the study's criteria and how they influence the adoption of mobile cloud computing. It is also necessary to reevaluate the adoption procedure's initial requirement [27]. The second part focuses on the first decision made while adopting mobile cloud applications. For the most part, this choice was preceded by testing out a free version of a sophisticated application. One of the results might be acceptance, while another could be a positive or negative rejection. You have the opportunity to refine your approach and give it another go if you get a positive refusal. In this case, a report outlining the reasons for the denial would be necessary [28]. A negative choice, on the other hand, means that moving forward with mobile cloud adoption will not be happening. After the request is approved, we will proceed to the first confirmation step and install any required cloud applications for mobile devices. Eventually, mobile cloud computing will aim to enhance the user experience in every way possible, including software updates, maintenance procedures, and maintenance itself [29].

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Once the groundwork is laid for deploying mobile cloud computing, using the knowledge acquired from this study. An assessment and validation procedures were carried out by three businesses to determine the framework's feasibility. None of the persons engaged in this procedure were involved in the project's inception [30], [31].

4 Mathematical equations to represent the relations between factors in this study

For creating a framework that models the relationships between managerial determinants, MCC adoption, and Quality Assurance outcomes. There is a structured set of equations and variables as follows:
Variables
Define key variables:

- –M: Managerial Determinants Index (composite score of leadership, literacy, cost analysis, etc.).
- –T: Technological Readiness (capabilities and infrastructure to implement MCC).
- –U: MCC Utilization Rate (extent of mobile cloud computing adoption).
- –Q: Quality Assurance Efficiency (measured improvement in QA due to MCC).
- –R: Return on Investment (financial or performance gain from MCC adoption).

β_1,β_2,β_3: Weights or coefficients representing the impact of factors. ε: Error term (unexplained variability).

a)Managerial Determinants Impact on MCC Utilization

$$U = \beta_1 M + \beta_2 T + \varepsilon_1 \tag{1}$$

This equation quantifies how managerial determinants (MM) and technological readiness (TT) drive the utilization of MCC.

b)MCC Utilization and Quality Assurance Efficiency

$$Q = \beta_3 U + \varepsilon_2 \tag{2}$$

This equation models the direct relationship between MCC utilization (UU) and improvements in quality assurance (QQ).

c)Comprehensive Model for QA Efficiency Combine the two equations:

$$Q = \beta_3(\beta_1 M + \beta_2 T + \varepsilon_1) + \varepsilon_2 \tag{3}$$

Simplified:

$$Q = \beta_3\beta_1 M + \beta_3\beta_2 T + (\beta_3\varepsilon_1 + \varepsilon_2) \tag{4}$$

d)Dynamic QA Efficiency Model
The improvement in QA efficiency (QQ) is modeled as a dynamic system influenced by MCC utilization and managerial interventions:

$$\frac{dQ}{dt} = \kappa_1 U(t) - \kappa_2 Q(t) + \kappa_3 Z(t) \tag{5}$$

Where: κ_1,κ_2, κ_3: Rate coefficients for MCC influence, QA decay, and external improvements.

e)Optimization of ROI with Constraints

$$\mathbf{R} = \int_0^T [\lambda_1 Q(t) - \lambda_2 C(t)]\, dt \tag{6}$$

f)Feedback System for Managerial Determinants
Managerial determinants (M(t)M(t)) are themselves influenced by organizational feedback loops:

$$\frac{dM}{dt} = \rho_1 Q(t) - \rho_2 M(t) + \rho_3 Y(t) \tag{7}$$

Where:

- –$\rho_1\rho_1$: Feedback effect of QA success on managerial performance.
- –ρ_2 ρ_2: Deterioration rate of managerial efficiency over time.
- –$\rho_3 Y(t)\rho_3 Y(t)$: Impact of external training or consulting on managerial determinants.

5 Conclusion

This kind of study bolsters the case for mobile cloud computing. There were a lot of different methods used to collect data, including focus groups, interviews, questionnaires, and direct observation. Results showed that mobile cloud computing is significantly impacted by many different factors. Concerning smartphones, mobile cloud computing, cloud computing generally, and mobile devices specifically, several aspects need to be considered. Considerations such as processing power, storage capacity, battery life, scalability, privacy benefits, security measures, and financial incentives are among these variables. The study found that there are much more advantages to employing mobile cloud technologies than disadvantages. Without a doubt, the benefits outweigh the drawbacks. Still, mobile cloud computing could be the way to go for complex application software when it comes to satisfying end users. Consequently, it seems that there may not be a significant benefit to using mobile cloud technology for a few basic applications.

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