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Construction Industry Use of the Cloud: Case Studies, Advantages and Drawbacks

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Abstract

For a number of years, cloud computing technologies have revolutionized numerous industries. The construction industry is well-positioned to benefit from these technologies for operational and competitive advantages, but their widespread adoption follows a steep trend. As a result, the current contributions and use cases of cloud computing in construction practices are highlighted in this study. As a result, 92 peer-reviewed publications published between 2009 and 2019 were used in a systematic review. The fact that cloud computing is an innovation delivery enabler for other emerging technologies in the construction industry such as building information modelling, the internet of things, virtual reality, augmented reality, and big data analytics is a key highlight of the findings. As a result, the current and potential application areas of cloud computing in the construction industry are highlighted in this paper. In addition, the paper discusses ways to overcome obstacles that prevent the construction industry from adopting cloud computing more widely.

Keywords: Cloud computing • Emerging technologies • Construction industry • Future trends

Introduction

Due to the continuous generation of heterogeneous data as the project progresses, the construction industry is data intensive. Typically, the data from various project stages is stored in silos; individual desktops, laptops, smartphones, and so on; team server or desktop. As a result, data integration is necessary for the overall coordination of the project because a lack of access to a comprehensive view of the data frequently results in poor decisions that can delay the project and have an effect on its performance and profitabilit. Acquiring a high-end system with the capacity to store, process, and analyze data from its subcontractors is the conventional ICT solution. The deployment of on-site solutions necessitates a significant overhead—power, cooling, security, availability, updates—and a significant burden on operational costs. Because of the substantial initial investment required, commissioning on-site ICT infrastructure for all projects is impractical. In addition, in-house computing is usually more expensive to upgrade to meet a sudden increase in computing requirements because its capabilities are fixed. About 90% of the construction industry is made up of small and medium-sized businesses (SME). As a result, the industry cannot afford to make significant investments in the cutting-edge information and communication technology (ICT) infrastructure that is necessary to reap the benefits of the most recent digital innovations. As a result, the construction industry is one of the least digitalized. [1].

Description

Because the construction industry relies heavily on investments, it may be reluctant to experiment with new technology, resulting in a slow adoption rate. Cloud computing has a lot of potential for the construction industry, but it is not widely use. Utilizing a pay-as-you-go pricing model, cloud computing technology offers computing facilities that are both affordable and scalable. Consequently, the SME can benefit from cloud computing features. Cloud computing eliminates the cost of computing facilities' acquisition, installation, and upkeep, a significant obstacle to the construction industry's adoption of ICT. Researchers must inform construction practitioners about the potential benefits of cloud computing technology in order to assist the construction industry in adopting it. This study's research question was prompted by the need to fill this knowledge gap [1].

According to a review of the existing literature, no studies have examined the specific applications of cloud computing in the construction industry or predicted future trends. Despite the fact that efforts have been made to examine the current utilization of cloud computing in the construction industry, Zhang created a framework for comparing cloud computing applications based on BIM in order to assist ICT implementers in making informed adoption decisions. Wong and others in 2014, examined the existing literature on cloud-BIM, or the integration of cloud computing and BIM applications, with a focus on building life cycle management. Chong developed a decision-making model to assist practitioners in selecting the appropriate application for their use cases and conducted a study of the existing cloud computing applications in the built environment. Furthermore, Almaatouk came to the conclusion that data storage costs are reduced as a result of cloud computing's potential to enhance construction industry collaboration. Additionally, Bilal gave a more in-depth explanation of how cloud computing can be used in the construction industry by describing a number of the existing use cases. However, Wong et al. While the use of Building Information Modelling in the cloud was discussed in detail in, no concrete examples of how cloud computing can be applied to other emerging technologies were presented. As a result, these studies do not adequately address the requirements of practitioners seeking real-world guidance on cloud computing adoption. It should also be noted that this review only addresses cloud computing and its construction-related applications, which are distinct from point cloud technology. The term "point cloud" refers to a three-dimensional (3D) data set that is typically taken with light detection and ranging (LiDAR) sensors and is represented as X, Y, and Z points to represent the exterior surfaces of things like buildings. This study provides a comprehensive evaluation of the state of the art in cloud computing and highlights the current benefits of cloud computing application in construction in order to meet the expectations and needs of construction practitioners to be aware of, accept, and adopt cloud computing technologies. In addition, the study discusses the fundamental cloud computing technologies that set it apart from earlier distributed systems [2,3].

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Virtualization

Virtualization provides a logical abstraction level that run application, operating systems, or system services in a logically distinct system environment that is independent of the physical computer systems. Computer resources (processors, memory and I/O devices) virtualization allows multiple operating systems and software stacks on a single physical computer platform. The hypervisor, a software layer, which is the virtual machine monitor (VMM) mediate access between each guest operating system presented as a virtual machine (VM) and the physical hardware. The most notable VMMs are VMware, Xen and KVM. Workload management in a virtualised environment involves isolation, consolidation and migration. Workload isolation ensures computer programmes are fully confined inside a VM, such that software failure in a VM does not affect other VMs; thus, improving the security and reliability. Consolidation allows heterogeneous workloads onto a single physical platform to overcome software and hardware incompatibilities, and enables several systems to run concurrently. Workload migration is responsible for application mobility to achieve hardware maintenance, load balancing and disaster recovery [4].

Quality of service (QoS)

Service provisioning in the cloud is governed by Service Level Agreements (SLAs), which is a contract specifying commitment to deliver cloud services by a provider to a cloud user. SLA includes compensation to users; thus, SLA serves as warranty to cloud users. SLA signed between the customer and the service providers include non-functional requirements of the service specified as Quality of Service (QoS). QoS parameters include CPU time, network bandwidth, storage capacity; provider's profit; deadline, budget, penalty ratio, size of input file from customer and request length. Garg classified QoS requirements into quantifiable QoS attributes such as Accountability, Agility, Assurance of Service, Cost, Performance, Security, Privacy, and Usability and non-quantifiable QoS attributes such as Service Response Time, Sustainability, Suitability, Accuracy, Transparency, Interoperability, Availability, Reliability and Stability. Cloud service performances are measured using QoS parameters. Khazaei employed the Markov chain to model the performance of a cloud computing centre using the response time. Ding presented a guaranteed QoS-aware resource matching algorithm for cloud computing systems. Also, Heidari and Buyya presented an algorithm which considers service level agreement (SLA) requirements and quality of service (QoS) for provisioning appropriate combination of resources in order to minimize the monetary cost of the operation [5-7].

Discussion

Finally, cloud adoption also has huge significant impact on efficiency within organisational operations. For instance, the use of cloud computing helps to reduce the number of in-house servers thus reducing energy consumed by individual servers. Data centres are specially designed with sophisticated cooling systems and are designed to be efficient than in-house servers. This combination results in high energy saving systems. Similarly, online monitoring of construction and online collaboration using cloud computing as well as other emerging technologies greatly reduces the commuting of construction workers thus reducing carbon emission as well carbon footprint. The use of cloud computing in construction also eliminates the need for papers in the stages of construction e.g. design, tendering, procurement, etc. This in turn saves a lot of energy required for creating papers as well as energy required to discard waste papers. As such, with cloud computing adoption resulting in reduced operational cost, reduced IT spending as well as maintenance cost, the impact on RoI for the construction industry will be greatly enhanced. Thus, cloud computing adoption by Construction Company is a great move towards a green society [8-10].

Conclusion

The study looked at how much cloud computing has been used in construction over the past ten years and how it has affected the construction industry. A review of relevant, up-to-date, robust, and trustworthy SCOPUS, Science Direct, and Google Scholar publications has been conducted. This is the first study of its kind to look at the construction industry from before cloud computing was invented to now. The study gave an overview of cloud computing, including the technologies that have helped cloud-native services develop. This study looked at the previous research and found that cloud computing in construction is a hot topic of study.

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Conflict of Interest

None.

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