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The Potential of Cloud Computing Technology for Construction Collaboration

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Abstract: A major barrier to successful construction project delivery has been the fragmentation and poor relationships existing between players in the construction industry. This significant issue has exerted a negative influence on project objectives, especially those which are predetermined, such as time, specified budget and standard quality. Construction projects require intensive efforts and processes, which it is often a challenge to provide to parties within the construction industry, to access accurate information and efficient communications. The purpose of this paper is to investigate the construction collaboration tools along with concepts of context-aware computing and cloud computing. The findings in this research are based on a thorough review of the comprehensive literature on IT, computing and construction. Consequently, this study sets out to introduce and develop the concepts of potential innovative collaborative tools, such as Context-Aware Cloud Computing Information Systems (CACCIS), for facilitating the construction supply chain processes and networks by enhancing the opportunities for achieving better competitive advantages. Firstly, it is hoped that this study will lead to improved construction collaboration to enhance the competitive advantages and opportunities for the internationalisation and globalisation of the construction industry. Secondly, it presents an effective method to provide new insights into the process of integration and, most significantly, to improve the productivity, efficiency and effectiveness of the construction industry.

Introduction

Fragmented, complex and non-integrated environments are often found within the construction industry. A multidisciplinary team of stakeholders working collaboratively with various supply chain parties and project stakeholders must improve productivity, the effectiveness of construction management and the efficient utilisation of resources. Ultimately, the major purpose of this collaboration is to guarantee the success of construction projects in achieving their specific objectives which are mostly the pre-determined project time, allocated cost, quality and safety of the projects. Furthermore, construction is an information-intensive industry [1] and, as such, information delivery is the key to better management, effective decision-making, survival and success. Researchers have estimated that if this information could be managed effectively, then savings of up to 25% of the construction cost could be achieved [2]. Additionally, construction activities are widely dispersed and site locations are frequently changed [3] contributing to the fragmentation of the industry [4 and 5] and complicating the management of construction projects.

Firstly, this paper presents how construction collaboration technologies can assist the construction professional parties in managing construction projects more effectively. It also

demonstrates the enabling technologies of context-aware computing and cloud computing. The third part of this research illustrates the potential of Context-Aware Cloud Computing Information Systems (CACCIS) as a proposed collaboration tool. Finally, the conclusion develops ways to enhance the potential opportunities offered to the construction industry by collaborative technologies and tools.

Construction Collaboration Tools

Since the early 2000's, many researchers have sought to implement techniques, technologies and tools which reduce project duration and cost whilst improving quality, productivity, efficiency and effectiveness. Within the dynamic construction industry, clients, as a significant part of the construction supply chain, are requesting better value for money, higher-quality products, shorter construction periods and access to valid and up-to-date information at any time in the project life cycle [6]. As asserted by [7], collaboration in a project requires those involved to communicate and be aware of each other's activities. Moreover, collaboration requires successful and efficient sharing of knowledge, negotiation, coordination and management of activities [8]. On the other hand, the unstructured, dynamic and complicated nature of projects, their difficulties, threats and risks, are associated with the construction industry. Thus, in order to overcome the mobile and information-intensive nature of construction projects the use of creative and intelligent ways for collaboration will be necessary. Cloud computing is a significant potential tool to support the construction industry and its currently available collaboration tools such as desktops, internet networks, tablets, smartphones and laptops. Therefore, this research will propose the development of a context-aware construction collaboration tool (Application) for the implementation of cloud computing in the construction industry that could be utilized by the supply chain parties and project stakeholders. The next part of this research will present the concepts of context-aware computing and cloud computing.

Context-Aware Computing and Cloud Computing

Awareness of a user's context (such as their role, task, preferences, location, site conditions and etc.) in mobile construction applications will enhance the effectiveness of project delivery by providing information and services relevant to a particular context [9]. Therefore, context-awareness of users, which is a major element of the system proposed in this research, will be discussed in following parts of this research. This context-aware system could provide efficient and effective information, communication and services throughout the entire construction supply chain to enhance the success of construction projects.

Cloud computing is the technology that is being promoted by the IT industry as the next revolution that will influence how efficiently and effectively and useably the internet's networks, platforms, operating systems, applications, software, hardware and information systems operate. According to various definitions of cloud computing [10 and 11], to simplify the concept, this research has defined cloud computing as basically the sharing and utilization of applications and resources within a network environment to implement the business without any concerns regarding the ownership, maintenance and management of the network's resources, applications and services. The following part of this research will briefly discuss the proposed system of integrated, context-aware, cloud computing within the construction industry.

Architectural System of Context-Aware Cloud Computing

Context-awareness of users and cloud computing are the technologies that use the internet and central remote servers to receive and deliver data and applications.

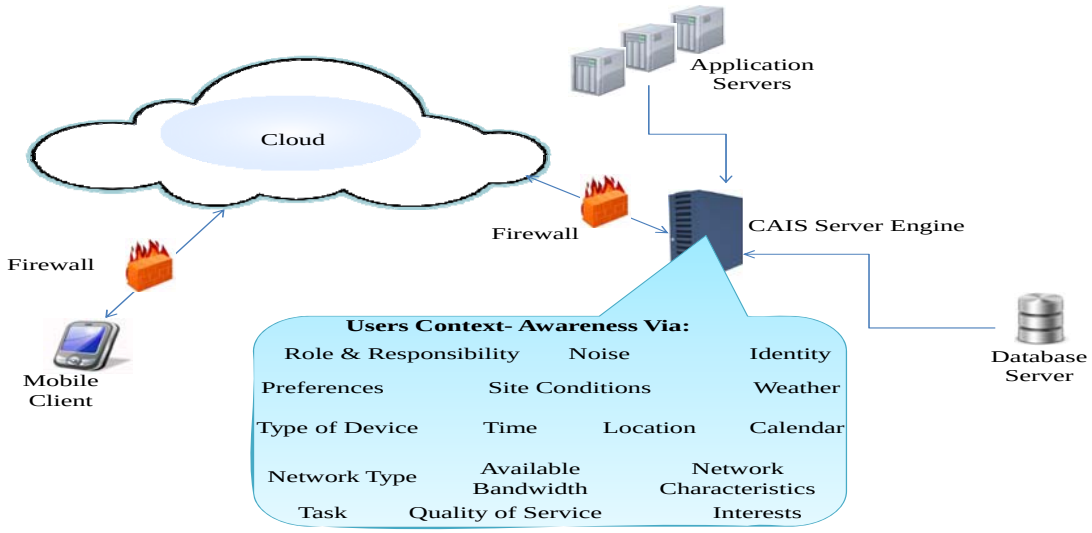

Figure 1: Context-Aware Cloud Computing Information System (CACCIS) Architecture

Figure 1 shows that all the data will be received by application servers and database servers which, in turn, will be sending the information to the Context-Aware Information System server engine (CAIS server engine) to process the information. The CAIS server engine will then send back the relevant information to the users based on selected contexts. Basically, the CACCIS architecture consists of four main components:

(1) The Mobile Client: A mobile device (smart phones and mobile computers) which is able to transmit data and information to the CAIS server engine through the cloud. Also, the client will receive the information from the cloud;

(2) The Firewall: In this system, two firewalls have been proposed: the first between the CAIS server engine and cloud and the second between the cloud and the mobile client. It should be noted that these firewalls are for the security of the data and information which will be transmitted and received by the devices;

(3) CAIS Server Engine: The data which is received from application servers, database servers and mobile clients will be processed by the CAIS server engine. In this phase, many features of the users based on the context defined, such as location, roles and responsibility, identity, preferences, calendar, noise, type of network, time, weather, site conditions, available bandwidth, interests, network type, task, activity, quality of services and network characteristics (user context-awareness) will be selected;

(4) The Cloud Server: All the user information which is generated through the CAIS server engine will be transferred through the cloud with authorization through the firewall. Furthermore, this information will then be manipulated and disseminated to the mobile client through the cloud. There are three categories of cloud computing: Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS).

Having context-aware applications (such as the location and activity context) allows the application to provide information and services that are relevant to the parties involved in the construction project. The last part of this research will set out a brief overview of the significant points within this research, as discussed above, and present conclusions.

Summary

Overall, this paper has proposed an intelligent collaborative tool through the implementation of cloud computing. This research demonstrates that there is a potential for context-aware computing which could be integrated with cloud computing in order to ensure the effective delivery of a reliable information system. This will enhance the collaboration of the construction project stakeholders. Moreover, the integration of context-awareness and cloud

computing, through context-aware, cloud-based, web services within the construction industry, will offer considerable opportunities for enhancing the effective and appropriate information flow along with access to context-specific data, information and services.

The study presented in this paper is a part of on-going research which will eventually attempt to further enhance the practices and implementation of cloud computing as one of the innovative construction collaboration tools.

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