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CLOUD COMPUTING FROM SMES PERSPECTIVE: A SURVEY-BASED INVESTIGATION

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ABSTRACT

Cloud computing has the potential to play a major role in addressing inefficiencies and make a fundamental contribution to the growth and competitiveness of enterprises mainly for SMEs. By adopting cloud computing services SMEs will be able to obtain the latest technology, without the need for upfront cost. This paper explores the perception of cloud computing from an SME stance. Motivations, requirements, and concerns surrounding the adoption of cloud computing are discussed. A survey of 300 SMEs conducted in the UK shows an interest in exploiting cloud services. However, SMEs have shown concerns with regards to security and vendor lock-in. These concerns could have influenced the speed of cloud computing adoption. The findings are expected to assist SMEs in their adoption of cloud computing services; they may also inform service providers with respect to end-users' concerns.

Keywords: Cloud computing, Cloud computing migration, Cloud computing services, SMEs

INTRODUCTION

The rapid evolvement in the contemporary business market has made competition to be at the highest level, thereby resulting products and skills to become obsolete [1]. Small and Medium enterprises (SMEs) usually have less advantages in such a competition due to their limited resources. This has restricted SMEs from accessing new technologies of IT services. SMEs play a vital role for economies by offering large amount of employments [2]. To survive, SMEs need to find and implement new strategic ideas at an even faster pace to gain a competitive advantage over their rivals within the global market. "The need to quickly respond to business demands is imperative in this new age. Waiting six to eight weeks for a new server deployment is unacceptable."[3]. A new strategy should enable SMEs to incorporate new technologies, reduce costs, develop process innovation, and enhance speed of implementation. A developed IT infrastructure can remove some of the barriers to global competition and allow SMEs to be more efficient, competitive and also provide a degree of flexibility.

Cloud Computing has the potential to play a major role in addressing inefficiencies and make a fundamental contribution to the growth and competitiveness of organisations mainly for SMEs. Cloud computing offers a new pathway to business agility and supports a faster time to market by offering ready-to-consume cloud enabled resources such as IT infrastructure as a service, software platforms, and business applications. These services can all be accessed on-demand and provide support to new business requirement far faster than acquiring, installing, configuring and operating IT resources in house [4].

Much of research on cloud computing has concentrated on two broad issues: i) business agility and ii) catalysts for more innovation. However, difficulties still exist in deciding on the approach for implementing cloud computing services for SMEs. To assist SMEs to adopt cloud computing services, this study aims to answer the research question: "How do SMEs perceive 'Cloud Computing'?" (i.e. their requirements and concerns). This paper, discusses the outcome of a survey conducted with 300 SMEs in the United Kingdom (refer to section 3 for full analysis of survey). The study has found that SMEs are highly interested in cloud computing due to the reduction in cost, flexibility and scalability of IT resources that the cloud offer. The study also shows that SMEs have concerns about security and vender lock-in with respect to the adoption of cloud computing.

The paper is organized as follows. Section 2 presents the concept of cloud computing in a wider context. Section 3 presents a survey that explored the views of SMEs in respect of cloud computing services. Section 4 provides discussion of SMEs migration to cloud computing. The conclusions drawn from the research and survey analysis are presented in Section 5.

BACKGROUND

The Concept of Cloud Computing

Cloud computing is an all-embracing and rapidly evolving concept; hence the understanding of cloud computing by SMEs can assist in their approaches for cloud computing services utilisation [5]. The cloud computing concept is based on a set of many pre-existing and well researched concepts such as distributed and grid computing, and virtualisation. Although, many of the concepts do not appear to be new, the real innovation of cloud computing lies in the way it provides computing services to customers [6]. The National Institute of Standards and Technology (NIST) has provided a broadly accepted definition of cloud computing that is "a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction" [7].

Organisations and enterprises are often being confronted by conflicting and exaggerated claims of how cloud computing dramatically transforms their industries. Therefore, it should be mentioned that the marketing hype and meagre analyses from many vendors, IT analysts, and users have an impact on the obscurity of the cloud capability and incumbent issues. Nevertheless according to the survey conducted in this paper, just over half of surveyed SMEs claimed to know what cloud computing is, as illustrated in Figure1, whereas 25.1% were not sure about its term. A survey conducted by ACCA [8] also paints a similar picture with just over 50% of respondents saying that SMEs have very limited or no understanding of cloud computing.

A recent study conducted by Craig shows that there is an increase of 14% of SMEs in understanding cloud computing [9]. The increase of cloud computing understanding is expected to accelerate the cloud adoption by SMEs. Industry research giants including Gartner, Forrester and other industry research analysts predicted that a substantial number of the world's top enterprises would have migrated their IT needs to the cloud offerings by 2011 [10] Furthermore, IBM predicted that cloud computing migration will be more than double by 2014[11].

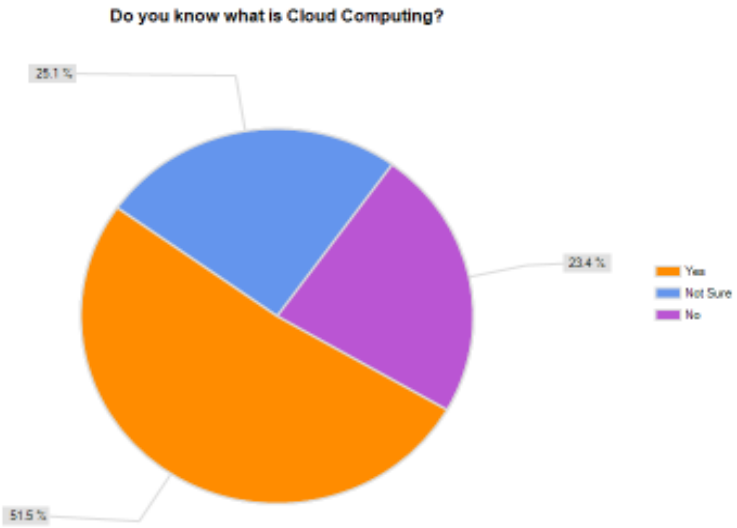

Figure 1: SMEs understanding of what Cloud Computing

Cloud Computing Architecture

Cloud computing architecture relies on virtualisation techniques that create multiple virtual IT environments. These techniques leverage the efficiency and flexibility of cloud computing services. Virtualisation plays also a vital role in cloud computing by providing the capability to isolate physical server failures or slow server responses, from users services through migration to virtual machine.

The cloud is composed of five essential characteristics; four deployment models that are represented as layers in the cloud technology stack: ranging from the cloud infrastructure (Infrastructure as a Service or IaaS); cloud application platform (Platform as a Service or PaaS); and cloud application (Software as a Service or SaaS) [4]. Figure 2 shows such a structure.

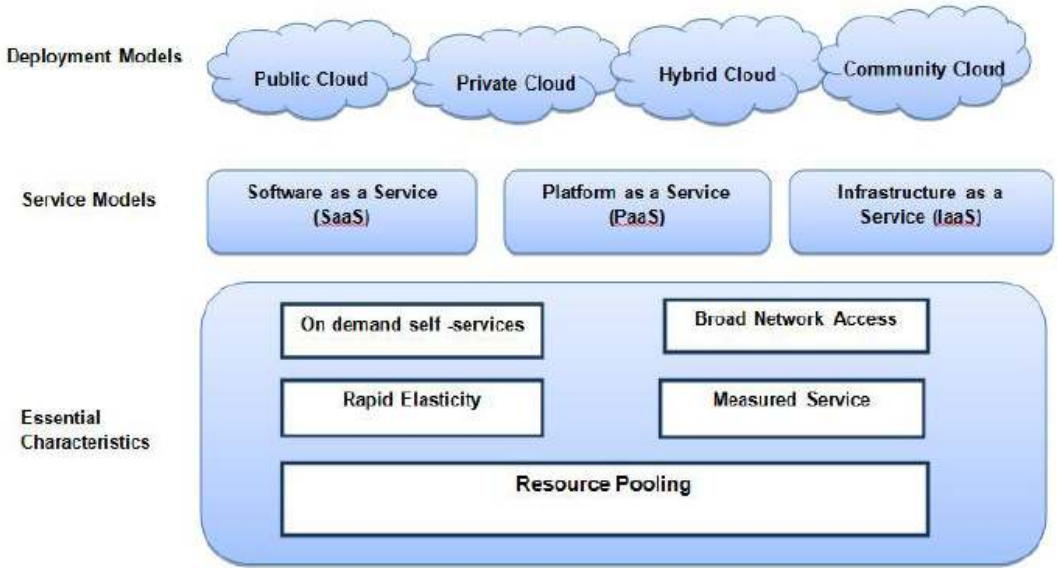

Figure 2: Cloud Computing Models (Adapted from NIST [12])

The cloud offers several deployment models - management, cost, and security of these clouds depend on the choice of the organisation in either opting to buy and operate its own cloud or to obtain cloud services from a third-party. Due to the clouds' elastic and usage-based pricing model, hosted cloud-based applications from a third-party (i.e. public clouds) probably offer the most attractive solutions to SMEs. Public cloud service offerings will allow new and smaller organisations to benefit from enterprise level services, security and products, at a reduced cost [13]. Moreover common services such as e-mail and other office-based application suites commonly consumed by small companies equally can be obtained from major vendors like Google, which uses its private cloud to provide these services to regular outside users. From this simple example, it can be seen that using a pay-as-you-go utility cloud computing models are beneficial for many SMEs.

Cloud Computing Applications and Services

Cloud computing offers its services in three deployment models: (IaaS), (PaaS), and (SaaS). IaaS is a set of IT equipments that are owned, managed, and maintained by a cloud provider and then used by a cloud customer in a pay-as-you go manner. IaaS services include storage, where virtualised storage is delivered on demand which allows customers to pay only for the amount they use. IaaS also provides other services such as backup and recovery, Content Distribution Network (CDN), service management and platform hosting.

PaaS provides infrastructure and middleware without the need to manage the underlying resources (hardware and software), allowing cloud costumers to create and control their applications through the cloud. These services include databases, deployment, development applications integration, and administration tools. An example of the PaaS services is Google Cloud SQL, which allows developers to create and control their databases without requiring the installation of any software for database management, maintenance, and administration.

SaaS allows cloud customers to access applications and their associated data without the complexity of buying and installing in-house applications. SaaS is the most popular cloud deployment; it includes a wide range of applications. In terms of business, SaaS can cover accounting applications, sales, collaboration, management information systems (MIS), customer relationship management (CRM), enterprise resource planning (ERP), billing, and human resource management (HRM). Sales Force is a common example of SaaS that provides innovative and easy to access CRM tools to cloud customers.

A study conducted by Chalef [15] showed that there are 10 cloud-based applications that provide SMEs a competitive edge. For human recourses, cloud-based applications such as Resumator and Paychex can enable SMEs to perform different processes and managing hiring workflow. Moreover, cloud-based applications such as SugarCRM and Pardot have the ability to provide SMEs easy to use and flexible CRM application that can improve business processes and customer needs. Google Docs and Carbonite are also valuable cloud-based applications that can enhance SMEs' collaboration and backup services.

CLOUD COMPUTING FROM SMES PERSPECTIVE (THE SURVEY)

The survey attempted to explore SMEs' requirements and their concerns in respect of cloud computing services. The study started by investigating the driving factors that encouraged SMEs to migrate to cloud computing services and then explored the strategies adopted by SMEs for could utilisation. For example, were the SMEs planning to use the cloud for their current business activities, new business operations, or did they not have plans to use the cloud? The survey also explored the applications that were most likely to be outsourced from SMEs' point of view. Moreover, the study reflects the current issues hindering cloud computing adoption which were raised by the participants in the survey.

The methodology employed was based on a quantitative online survey questionnaire approach. The target population consisted of SMEs situated within the United Kingdom. Participants varied between IT decision-makers and managers within their respective business enterprise. Participants were from organisations of different sizes and from diverse industry sectors. Over 300 UK SMEs were invited to participate. A total of 169 questionnaire responses were received. This gives a satisfactory response rate of 56 per cent for this kind of studies where response rates below 15 per cent become questionable [14]. Table 1 provides a socio-demographic profile of the organisations and participates in the survey. The sample was slightly dominated by SMEs sized between 51 and 250.

Table 1: Socio-Demographic Profile of Participant Organisation

Organisation Size	Percentage
1 – 24	20.5%
25 – 50	19.3%
51 – 250	41.0%
More than 250	19.3%
Total:	100%
Organisation Sector	**Percentage**
Manufacturing and industrial market	15.6%
Financial services	3.0%
Public sector & healthcare	11.6%
Business sector	22.3%
ICT services	15.0%
Trading sector	7.8%
Other	24.7%
Total:	100%

The Motivations of SMEs to Migrate to Cloud-based Services

In order to observe which of the cloud advantages mostly motivate SMEs to adopt cloud-based services, the survey explored "what were the reasons behind using cloud computing". Figure 3 shows the analysis of the motivations that the SMEs provided.

As shown in Figure 3, cost reduction (45.5%) and mobility and convenience in accessing applications (44.9%) are seen by SMEs to be the key motivations behind adopting cloud computing services. This shows that SMEs are aware of the advantages of cloud computing services and its importance for business agility. In agreement with this finding, a recent study conducted by Craig [9] concluded that cost reduction is still the top priority for SMEs. The ability for cloud users gaining convenient access from anywhere and anytime were also found to be main factors for adopting cloud computing services. This indicates that SMEs are interested in access to applications and data from anywhere, on-demand, through cloud computing. Therefore, the cloud is remarkably an ideal IT solution for businesses whose employees require on-demand remote access to tools and data.

SMEs find ubiquity and flexibility of cloud computing interesting too (38.9%). This indicates the need for innovative solutions that would enable SMEs to gain competitive advantage over their rivals. Increasing computing capacity and providing greater IT efficiency were also found to be important reasons for using cloud computing services (32.9%) and (31.7%) respectively. Green IT, reliable access, backup, disaster recovery, maximising asset utilisation, and adding redundancy to network infrastructure were also reasons of adopting the cloud but they appear to be less important motivations to use the cloud from SMEs point of view.

SMEs Strategies for Cloud Services Utilisation

The cloud concept offer many options to start-ups and SMEs to decide how to utilise cloud computing services. Start-ups may decide to launch all their applications on the cloud, while more established firms might decide on moving existing software assets gradually to the cloud environment. Moreover some cloud-based services do interoperate with on-premise software so instead of spending more on renting and/or buying new software licenses, rather benefits can be reaped from applications that interoperate with vendor platforms. To explore SMEs plans for utilising cloud computing services, this study raised the question" what do you intended to use cloud computing services for". Figure 4 shows the analysis of SMEs plans.

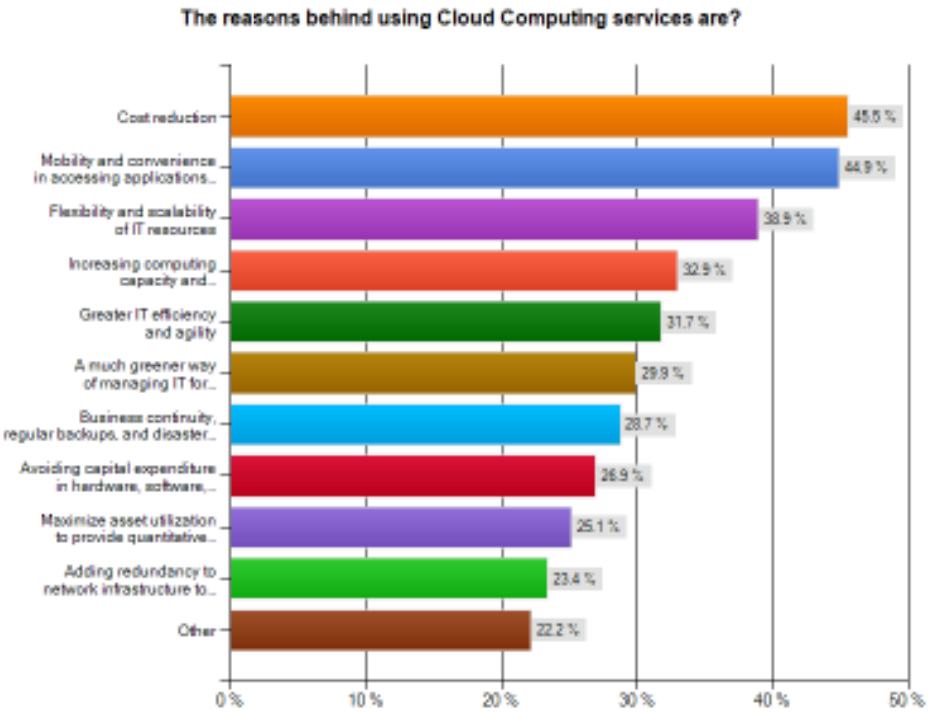

Figure 3: Drivers for Cloud Computing Adoption by UK SMEs

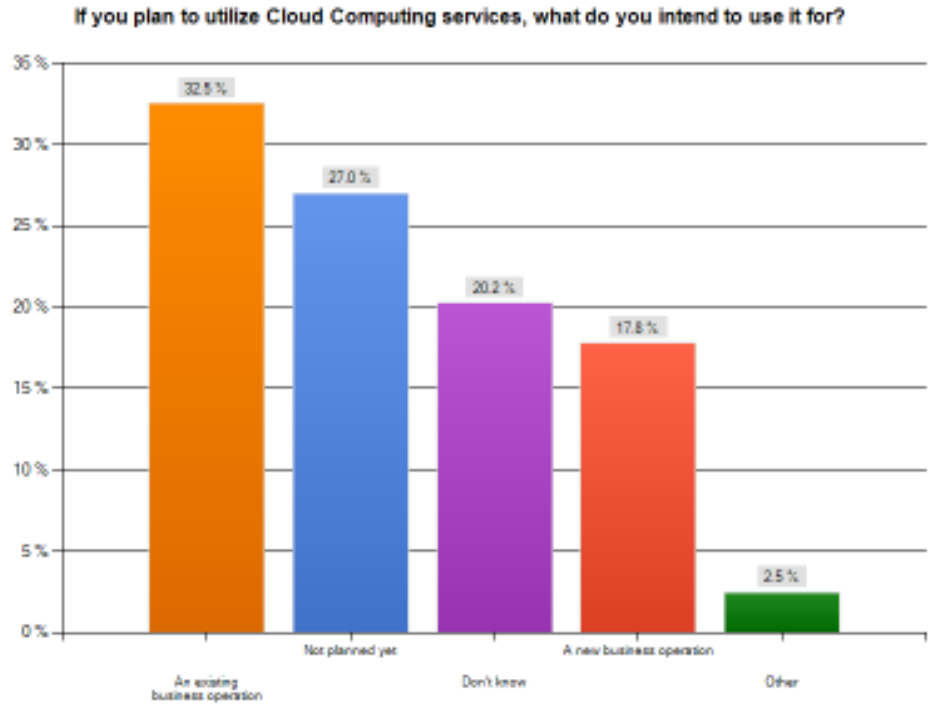

Figure 4: SMEs plan to use Cloud Computing service for their business operations

Figure 4 indicates that as many as 32.5 % of SMEs plan to use cloud-based services for their current business operations. This signifies a high interest amongst SMEs to find efficient solutions that develop their business operations. It also shows that SMEs are aware that cloud services have the ability to interoperate with on-premise systems. On the other hand, the study suggests that cloud computing should be pitched to consumers in a clear and lucid style seeing as SMEs 27 % of respondents in the survey have indicated that they have no plan in place to use cloud computing services yet. Furthermore, 20.2% of the surveyed SMEs don't know if they would use cloud computing services.

Some SMEs (17.8 %) plan to use cloud computing services for new business operations. This indicates that SMEs are aware of the importance of business agility and they find cloud computing as a strategy that enables to develop innovative business operations. These strategies could contribute to the growth in dynamic and evolving business environments and allow SMEs to gain competitive advantage within the global market.

Services Most Likely to Be Exploited

In order to meet SMEs demands, the study has additionally tried to find out the type of IT services and applications that SMEs are interested to exploit or most likely to be outsourced from SMEs point view. Figure 5 illustrates the analysis of requirements for these IT services and applications.

Figure 5 shows that SMEs draw on the following cloud-based service offerings: hosting services (55.4%), backup services and hosted emails (41.4 %) and data storage (40.1%) respectively. This signifies that SMEs show high interest in reducing their IT infrastructures by having access to these services on-demand and operated in support of a new business requirement instead of fixed-in house IT equipments. These services usually require not only costly IT equipments but also appropriate management. Therefore, outsourcing these services would allow SMEs to cut cost, improve flexibility, and also to focus on innovations and creation of their business values. SMEs have also shown interest in outsourcing booking systems seeing as 22.9%. These applications would improve SMEs relationships with customers.

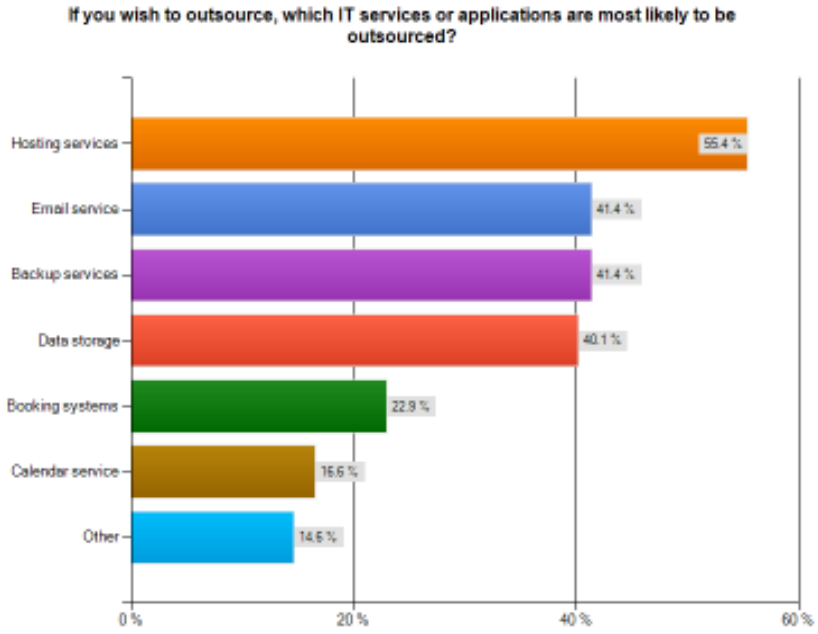

Figure 5: Hosting services are the most likely IT services to be outsourced

Concerns of Adopting Cloud Computing

In order to determine which issues mostly affect the adoption of cloud computing, the study further explored SMEs' concerns of cloud-based services. Figure 6 illustrates issues raised by participants hindering the cloud computing adoption rate. Security and vender lock-in were raised by SMEs as their major concerns.

Moreover, SMEs have also shown concern of other aspects regarding the adoption of cloud computing. These concerns were not found as significant as security and vender lock-in; therefore they are not included in this discussion.

Figure 6 shows that 54.6% (the second largest percentage response to any question asked in the research) of the surveyed SMEs indicated data protection and privacy as the number one reason for not considering cloud-based IT as a service. In contrast to the traditional provision of onsite IT resources, the multi-tenant nature of cloud computing usually raises the question in respect of privacy, confidentiality and data integrity. Cloud computing presents its own set of security issues coupled with the risk and threats inherent in traditional IT computing. The fact that consumers can tap into cloud services using Web browsers, shows the benefits of mobility and convenience on the one hand, but on the other, it has raised issues concerning data privacy and security.

About half of the surveyed SMEs considered vender lock-in as a major concern for adopting cloud computing. Cloud computing users are concerned about losing control of their data that could be locked-in by a cloud provider. Although the cloud providers implement up-to-time and a secure IT infrastructure; consumers continue suffering from the loss of control and lack of trust problems [16]. To further substantiate on this matter in agreement with StarUK [17], "for many people, the issue is one of control: many IT managers believe that if something is not under their direct oversight, then they cannot know if it is secure until it has been compromised: which is sometimes the hallmark of a put upon, reactive, service-based culture".

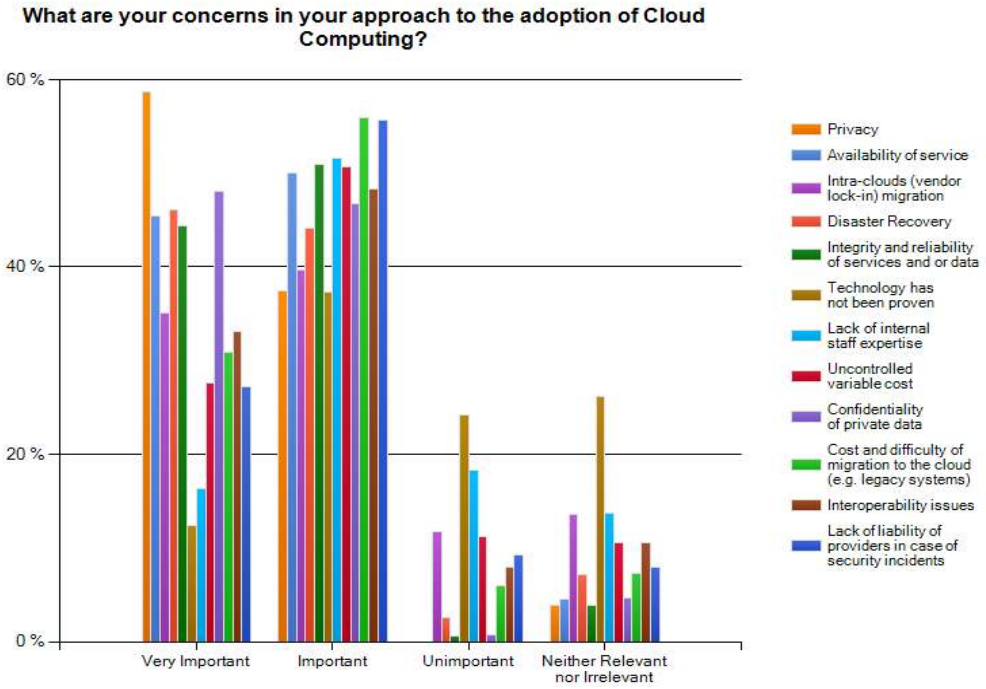

Figure 6: Barriers to Cloud Computing Adoption of SMEs in UK

DISCUSSION OF SMES MIGRATION TO CLOUD COMPUTING

With the current economic downturn, business agility has become essential for enhancing commercial success. In order for SMEs to survive their businesses, it is significantly important to decrease time-to-market. Adopting cloud computing within an overall IT strategy, can provide a real competitive advantage, improve business performance and control the cost of IT resources for SMEs [18]. Further, a recent research report found that giving a third party control over the IT infrastructure of a company can help reduce capital expenditure whilst maximizing asset utilisation to provide a quantitative

Return on Investment (RoI) and thereby eliminating costs associated with in-house provision of the equipment required for building up the infrastructure [19]. Cloud computing can Also provide the IT resources required for a scalable business, without demanding the IT budget of a large enterprise to put these systems in place. In addition to its capabilities, the cloud also comes with high speed of implementation and a smooth upgrade pathway.

With the increase of competitiveness in the contemporary business market, it is also vital for organisations to build connection infrastructures that are; fast enough to deliver real-time business processes and flexible enough to continuously evolve in response to dynamic business conditions. The cloud can automate organisations' IT resources which allow them to adapt to changing demands of their business needs. Could computing customers also can conveniently access to business applications on the move, meaning staffs can work flexibly from anywhere. cloud computing can enable SMEs to focus on innovation and creation of business values, thereby enhancing staff productivity without requiring updating software, and other IT equipments. Further, by effectively utilising the current communication technology capabilities, SMEs can compete with anyone, anytime, anywhere, and of any size by using the cloud platform to deliver innovative services quickly [13]. The potential benefits of cloud computing have raised the IT expectations of SMEs beyond measure. These advantages were seen by SMEs as key reasons for migration to cloud computing (refer to the survey section 3.1). However, SMEs should ensure how well Service Level Agreements (SLA) meet their business requirements and guarantee the security. The cost calculation in RoI and other factors such as the price of the cloud service offerings, SLAs, compliances, and licensing issues, are vital in migrating to the cloud and should be considered when implementing a cloud strategy for an organisation.

Achieving the potential benefits of cloud computing requires each feature of the cloud platform to support the key design principles of the cloud model – either: SaaS, PaaS or IaaS. Migration to the cloud environment requires more emphasis on business design where cloud service will interface with business systems. Therefore, the success of cloud computing is mainly based on the efficient implementation of the architecture.

With cloud-based computing, applications run on centralised virtual servers managed by the cloud provider thereby eliminating the need for expensive equipments to be at company's site which could be capital intensive for SMEs. The range of cloud-based services now offered by vendors is growing simultaneously with the emergence of varying cloud service providers. SMEs can find cloud-based model of possibly everything from General-purpose applications such as office, email, and collaboration technologies to sales management and accounting software [20]. Therefore, Along with the utilisation strategy, it is important to perceive which applications SMEs desire to exploit the cloud for. Despite its offerings and ease of deployment, cloud computing requires careful consideration by SMEs in areas such as strategic advice to enable them to decide when and what computing resources will be most efficient option to outsource [8].

Despite the enormous advantages that the cloud can offer, cloud computing adoption has been at a slower rate from what had been expected [21]. Security and vender lock-in were raised by SMEs as major concerns of migration to cloud computing (refer to the survey section 3.4). These concerns have caused a major hindrance to cloud computing being adopted by SMEs.

The fact that before data can get into the cloud, it has to progress outside a company's firewall via an access network, that makes data vulnerable to attacks. For example, the most common way of accessing the cloud is through a web browser. Therefore, cloud services may share much vulnerability as any website, such as SQL injection or cross-site scripting (XSS) [22]. The cloud also relies on virtual machines (hypervisors), which mean any compromises in the set up of the software used could cause unauthorised access to sensitive data. Additionally, cloud computing providers have multiple data centres at different geographical locations in order to optimally serve consumers' needs around the world. In most cloud service scenarios, consumers have no idea of where there data is stored. Therefore, legal and regulatory issues arise which require careful considerations because the physical location of data centres determines the set of laws that can govern the management of data.

Cloud computing comprises of different deployment models nevertheless each service comes with its own security issues. Thus, to guarantee the security of corporate data in the cloud is difficult, if not impossible [23]. In Infrastructure as a Service (IaaS) model, for example, the security responsibility of the underlying infrastructure and abstraction layers belong to the cloud service provider, while the remainder of the stack is the consumer's responsibility. Organisations, before moving applications outside their corporate firewalls, should be aware of the data intrusion risks associated with such an environment.

IaaS cloud models are prone to attacks like XML Signature Element Wrapping [24] – this is a well-known attack on protocols using XML Signature such as SOAP (that stands for Simple Object Access Protocol) messages. These protocols are used to provide authentication for messaging through the web. With Platform as a Service

(PaaS) model, the security of the platform used for development is the service provider's responsibility, but the security of the applications developed is the responsibility of the consumers. Concerns about cloud service integrity and binding issues with PaaS' cloud models should be given further consideration. PaaS models are prone to cloud malware injection attacks and metadata spoofing attack as described by Jensen [25].

In Software-as-a-Service (SaaS) model, the service provider is responsible for, not only providing physical and environmental security capabilities, but also addresses the security control on the infrastructure, applications and data. According to a Forrester research, security concerns are the most commonly cited reason why enterprises are not interested in SaaS [26]. A major concern of SaaS is unauthorised access due to data being transferred to a remote server thought the internet. This might allow adversaries to obtain passwords, inspect data, and modify or damage the data. This would be more harmful in case of unauthorised access to sensitive information such as payments details and information on human resources. Denial of service attacks and network failure present the availability concern of SaaS.

The lack of standards in cloud computing also rise interoperability and manageability issues inside and between cloud providers, with possible economic impacts. Interoperability is concerned with the migration and integration of applications and data between different vendor's clouds. Whereas standardisation, strives to support applications by different service vendors to interoperate with one another, exchange traffic, and cooperatively interact with data as well as protocols for joint coordination and control [27].

In the absence of standardisation, SMEs willing to outsource and combine the range of services from different cloud providers to achieve maximum efficiency, will experience difficulty when trying to get their in-house (legacy) systems to interact with the cloud providers system. Likewise, the lack of standardization may also bring disadvantages, when migration, integration, or exchanges of resources are required. The main negative aspect is the necessity of factoring applications to comply with other cloud Application Programming Interfaces (APIs), which can possibly lead to higher costs, delays and risks, thus opposing agility, efficiency, and low costs [28]. In the aforementioned, reconfiguration of systems and applications to achieve interoperability are time consuming and thus, require a considerable amount of expertise, which could be challenging for SMEs. Further, interoperability and portability will give rise to standard reusability, which in turn will lead to faster cloud deployment [29].

Therefore, SMEs considering cloud-based services should be aware of the associated risks and vulnerabilities before adopting them for critical applications or sensitive information. SMEs might be interested in migrating gradually by starting from some of the non-core business/mission-critical applications to the cloud environment. But a common challenge associated with many cloud migration projects is on how effectively the migration risks are identified.

CONCLUSION

In this paper, the cloud computing concept, architecture, and services have been briefly discussed. A survey of 300 SMEs in the UK results that SMEs are highly interested in cloud computing that enables them to reduce costs, improve flexibility and scalability. These benefits are seen by SMEs as key driving reasons to adopt cloud computing services. However, the rapid increase in corporate data, placed in the cloud, has raised issues concerning security, vendor lock-in, and complications with data privacy and data protection. Consequently, this resulted in the slow growth of cloud computing adoption.

As a result, In order to convince more SMEs to adopt cloud computing, these issues need to be addressed. The privacy challenge for cloud-based software architects, demands the design of a service in a way that security risks is reduced, whilst ensuring legal compliance. In other words, safety of data should be placed at the front and centre in the design process of any cloud service. Cloud providers should implement regulatory compliances that cover operational and security areas that users may have concerns about. Theses compliances would improve the security by having cloud vendors and customers to be securely certified. It would also reduce the concerns of interoperability and portability. Cloud vendors should provide details of their security police to include risk management, access control, network security, physical security, and backup and system recovery. They should also provide details of how customers' systems would be segregated from others in a multi-tenant environment. However, often cloud providers tend not to reveal more details about their systems and data centres, claiming doing so would compromise their security.

Still, cloud computing is a winsome venture for SMEs but it certainly takes a good business sense and steps in order to fully reap its benefits. Organisations should learn to rationalise their business needs and priorities, their business applications, and their on-premise data, and then consolidate their infrastructure accordingly.

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