IT Optimization with Cloud Computing: A SAP Cloud perspective for Education and Research

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***Abstract*:- This journal article discusses how IT optimization is achieved through Cloud Computing. The author unfolds examples of real-world organizations that implemented Cloud based solutions to demonstrate the practicality and advantages of Cloud adoption. The article also brings into limelight, for the first time, the compilation of case-studies from the education and research industry that implemented SAP Cloud solutions and how they were able to derive gains. The author further builds up the gathered information and proposes a step-by-step approach to continually optimize IT in the Cloud, to attain best Cloud performance and cost benefits.**

Keywords: CLOUD ADOPTION, SAP HANA ENTERPRISE CLOUD (HEC), ERP, SAP HANA, FIORI, IAAS, PAAS, SAAS, CASE STUDY, MAHWISH ANWAR, TECHVATIVE

INTRODUCTION

Cloud computing has wide-ranging features due to which it has stayed at the frontline of computing technology. One such benefit is of flexibility in terms of the scalability. Both virtual and physical resources are procured and released as the consumer requirement varies. Moreover, the services are available via the Internet which makes it possible for the Cloud consumer to access the services or resources via mobile devices, like smartphones, tablets, laptops, in addition to the desktop PCs (Zhang, Cheng, & Boutaba, 2010). Furthermore, reduced costs is one of the most weighty features of Cloud computing. The convenience of resource upsizing and downsizing enables Cloud consumers to evade the expenses of maintenance and data center facilities. David suggests to consider all costs holistically, cost of acquisition and operations, cost of the existing hardware and software, cost of the data center space, cost associated with the risks around leveraging a platform not fully owned by one consumer, hidden costs such as worth of getting an application to market faster through Cloud in competition with an on-premise solution. Amongst other benefits are getting a system that is available at all times, having multiple distributed backups and enhanced security (Linthicum, 2010). Thus, Cloud computing is an inexpensive, flexible, dependable and highly proficient technology, which is here to stay.

To see the power of Cloud computing in optimizing the IT infrastructure, Mahwish unfolds the examples of real-world organizations that implemented Cloud based solutions that demonstrate the practicality and advantages of Cloud adoption. Grounded on the above features of Cloud technology, it is evident that education and research sector can also leverage the power of Cloud capabilities, i.e. improving productivity and efficiency in managing the school or university, as well as, enhancing teaching and learning experiences. The author showcases, for the first time, the compilation of case-studies from the education and research industry that implemented SAP Cloud solutions and how they were able to drive IT optimization and other potential gains. Towards the end, the author shares a Cloud IT optimization approach that Cloud customers can take on to leverage the Cloud features optimally.

BACKGROUND

Cloud Computing has modified the way IT architectural solutions are put forward by means of virtualization. The National Institute of Standards and Technology (NIST) defined the computing model the means for enabling on-demand access to IT infrastructure; networks, storage, applications, and services (Anwar, 2013a). The top five Cloud vendors according to Forbes report of November 2017 are Microsoft, Amazon, IBM, Salesforce and SAP. SAP amongst all has the unrivaled incumbency within all of the world's leading firms as the seller of mission-critical business applications that run those companies. Moreover, SAP's partnerships with Amazon and Google foil its long-standing relationships with IBM and Microsoft, all of which give SAP clientele an amplified sense of self-confidence that SAP works best in heterogeneous environments (Evans, 2017).

Both small and large organizations benefit from moving their resources to the Cloud. It is a model that empowers small and medium businesses to access pooled IT resources that can be rapidly provisioned and freed with negligible administration effort or Cloud provider's involvement. This plug and play model has transformed the way organizations buy or manage computing resources. In this new model the Cloud vendor is responsible for provisioning the IT infrastructure; hardware and software; perform installations or upgrades; take backups; do data storage; and ensure security (Leavitt, 2009). As a result, the Cloud consumer can lower the IT asset outflows and operating costs, do away with the hassle of housing all IT equipment, yet enjoy latest/updated equipment with high availability and security, choice of computing power and bandwidth.

Along with hardware, software, and technology platforms, Cloud computing delivers additional benefits, including high availability and increase in business agility. The IT

expenses and responsibility generally associated with developing, acquiring, running, and maintaining in-house IT infrastructure are shifted to the Cloud vendor. Hence, Cloud computing facilitates establishments to lower IT capital expenditures, lower operating and maintenance costs, while focusing towards core business activities, turning Cloud computing into an IT-related approach for competitive gain (Armbrust et al., 2010). A growing percentage of on-premise spending is expected to be replaced by Cloud computing, see extrapolation in Figure 1.

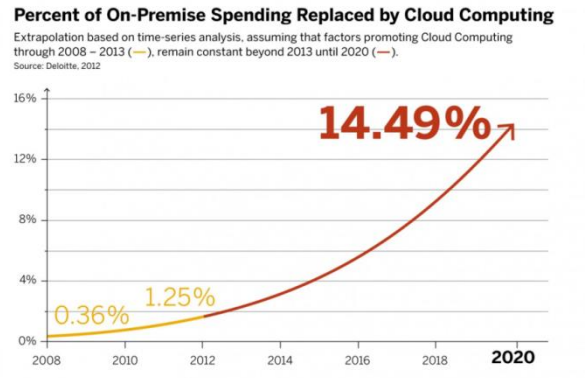

Figure 1: Percent of on-premise spending replaced by the Cloud

Cloud adoption is seen generally in different industries and education is not to be an exception. For higher education, Cloud is found to be valuable not only to stakeholders, administrators and educators, but also for the learners and researchers, who have their own technology-based devices, requirements, and desires to be taken into account (Sultan, 2010). The recent study that covered learning schools from 4 continents and 7 countries disclosed distinctive potentials regarding the use of Cloud for educational institutes (Hartmann, Braae, Pedersen, & Khalid, 2017). They concluded Cloud makes teaching and learning accessible to the countries and constituencies where distance learning proved challenging. This in-turn creates economic progression and can result in improving the living standard of people in the deprived areas of the world. Then it allows education of 21st century skills, such as processing terrestrial data using multiple cores via Internet or optimizing the rendering of heavy images using parallel computing through Cloud. Other noticeable feature is it boosts student collaboration, such as through virtual worlds or synchronous and engaging learning, which stimulates enthusiasm. The access to learning resources without any boundaries across time, space, and devices allows the teaching, learning, and alliance to happen anywhere and at any time. The institutes get unrestrained data storage and streamlined data management so loss of data or unapproachability are things of the past, hence, learners can maintain portfolios and track overall progress individually. The educational institutions also get away with maintenance, get extended hardware life, reduced licensing costs, and save on printing costs.

It is not wrong to say that in some cases Cloud infrastructure can expose the information, such as at the time of migrating virtual machines (Anwar, 2013b). While Cloud vendors provision data encryption, user name and password–level security, and primary identity management, one should be careful in hosting state secrets in the Clouds. Also, once the Cloud is commissioned, the control is divided between the Cloud provider and consumer, which arises the requisite of Service-level agreements (SLA). The SLA is a record of mutual understanding about services, primacies, accountabilities, assurances, and warrants between the Cloud provider and the Cloud user. Hence, SLAs must be paid the due significance and thoughtfulness by both parties.

Optimizing the IT infrastructure with Cloud computing in the light of real-world businesses

The IT infrastructure is the strategic base of an organization or an education institute. Having an IT frame that is fund consuming or hard to manage, will not assist the purpose well, that technology is there to serve in the first place. With Cloud Computing the IT infrastructure becomes more standardized, optimized, secured, controlled and better utilized, making the business more productive and focused towards core business needs.

In the beginning the main stimulus to adopt Cloud was financial. This was achieved by eradicating the up-front cost allowing organizations to begin small and add hardware and software assets as the requirement develops. The pricing models in Cloud scenario are flexible and predictable which gives the end users the time to plan well in advance. This pricing depends on type and level of service, the models include: per use, per subscription and per transaction. To take an example: at the infrastructure level, the suggested model is pay per use of the computing resources such as CPUs, storage and bandwidth. Consumers can procure the Cloud resources as and when required and let go when not needed, hence, attaining energy and computing resource conservation. According to (Lin, Fu, Zhu, & Dasmalchi, 2009) it is assessed that, Cloud brings decrease in cost of electricity that is used to run and/or cool PCs, servers, switches, backup drives, etc. and also cost reduction in network bandwidth, operations, software, and hardware.

Also Cloud consumers need negligible support from the Cloud providers, they can themselves via the Internet develop, deploy and run applications. The controls are programmed and can be handled remotely; such as configuring, tuning, securing, uploading any content even running the applications. The Cloud management infrastructure takes care of the tasks of system administrator. To sum up the benefits of Cloud we can list the following; substantial reduction of upfront cost, improved utilization through sharing of physical assets, simplicity of resource management, fast implementation, elasticity of provisioning resources, convenience of programmability and management of distributed

applications, hardened security and controls, and flexible payment models.

A study conducted by Wharton School surveyed 364 executives from 20 industries of medium and large organizations. The study was divided in different phases; expectations, levels of Cloud adoption, Cloud impact and an outlook into the future. Of these 77% of the respondents that had extensive or complete Cloud adoptions, reported that Cloud was able to deliver most or all of their business requirements. The expectation of 68% of the respondents was that the Cloud will have a major impact on their company's performance within the next five years, and 85% expected that Cloud computing will completely renovate their business and industry (SAP, 2012).

The educational institutes are always ahead when it comes to software upgrades, or better IT hardware in order to fascinate learners and researchers, to stay abreast of technological developments and to ensure better, intuitive and engaging experience for educators and learners. Cloud has those capabilities, through which these ambitions can become a reality. Even in this perplexing economic climate, Cloud has empowered learning faculties to expand their educational services rather than to cut back (Zurita, Baloian, & Frez, 2014). The prospective of Cloud for efficiency gain, cost reduction and convenience for the educational industry is accepted by many educational institutes. The University of California (UC) at Berkeley, used Cloud in a course which required development and deployment of Software as a Service (SaaS) applications. The course was moved from in-house infrastructure to the Cloud as the course required temporary procurement of 200 servers. It was achieved in few minutes, and released as the activity got over (Armando, 2009).

Qatar in 2009 decided to move from an oil-based economy to knowledge-based economy. It is when Carnegie Mellon University along with IBM (International Business Machines) started the work on Cloud Computing Lab4 in the country. The research was the first step to bring Cloud computing to the middle-east. The study laid emphases on performance analysis of scientific workloads on the Cloud, and looked into approaches of Cloud adoption (Yuvaraj & Singh, 2013). Some applications that were explored were: Arabic search engine and oil and gas exploration.

Massachusetts Institute of Technology (MIT), since 157 years has been a pioneer in technological advancements. They are the creators of electronic spreadsheets and World Wide Web (WWW) consortium. In July 2015 they lifted and shifted the remaining non-SAP database onto SAP HANA database and migrated the on-premise SAP ERP 6.0 instance to SAP managed services with SAP HANA Enterprise Cloud. MIT's Senior Director of Emerging Solutions group, Eamon Kearns quotes; we have a Cloud-first strategy. Essentially, we want to get out of the business of running data centers that take up a lot of space and resources. Both are precious here, which is why we are actively moving that footprint off campus and freeing up those resources to work on high-value projects. (Murphy, 2016)

AlAlaa et al. in their exploratory study focused on Cloud computing adoption in Saudi Arabia, particularly in Higher Education (Tashkandi & Al-Jabri, 2015). Seham examined and evaluated the adoption of Cloud in Saudi hospitals in (Almubarak, 2017) and established that Saudis show positive attitude in embracing latest technological innovations.

Cloud computing provides higher education the mechanism of information delivery, enhances communication within the IT components and with users and improves collaboration between the handlers (Al-Ghatrifi, 2015). The author calls Cloud Computing, A key enabler for higher education in Sultanate of Oman.

Adopting Cloud for Higher Education and Research

Every institution is today a technology institution. The educational experience of today is more interactive, accessible and relevant, driven by technology enabled processes and people. No doubt, technology is the enabler for many universities around the world. It is an enabler for the educators. At an individual level, educators engage with the students in an interactive, instinctive and frictionless environment. They can develop understanding into individual student behaviors using the technology that supports latest learning and engagement models. At the group level, technology allows real-time, geographically distributed engagement through the supported Learning Environment of the school.

The contemporary rise in failures of higher education institutes is not a glitch. The traditional on-campus four-year university business model has been defied to the point of extermination. Real-time and projecting insights into all areas of the institution – from the organizational data and systems that run them to the teachers, students and stakeholders who use them – is indispensable to achieve better-quality management and forecasting of the entire educational enterprise. The atomic student insight and its linking to student success are as imperative as are insights into the corporate side of an association.

Educational institutions like other businesses have workforce (faculty and staff) and consumers (students), demanding sponsors and patrons, asset-intense campuses, and suppliers they rely on for products and services. These four dimensions, irrespective of what type of company or industry an organization is in, totally require substantial resources to manage. With Cloud digitalization the learning society can resolve the pressing necessity to adapt and progress with the fast shifting business and user requirements. With Cloud digitization it becomes probable to have gears for better student engagements and learning models, streamlined operations, data analytics for current management insight and forecasts, flexible staffing models and virtual support. The phenomenon not only allows near-

infinite resource availability, but also allows streamlining economics and the course management.

The graphic (Figure 2) below shows simplified structure of the main users of IT services in a typical university setting using the Cloud computing services; software as a service (SAAS) and infrastructure as a service (IAAS). For example, the students, researchers and faculty can access email accounts, learning management system, university portal services via SAAS. Or the researchers may require special software and hardware to run experiments that are likely to involve a great deal of processing and computation, which they can do so by accessing the IAAS service. For both models, users can access the resources online. The administration and faculty can get in depth analytics and insights on how to align efforts to improve the teaching and learning cycle.

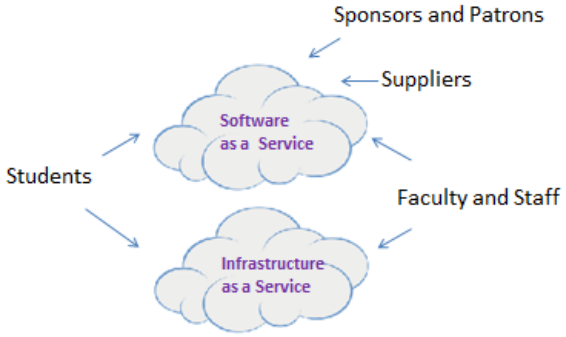

Figure 2. Simplified Cloud service setup for an educational institute

Major Cloud providers such as SAP, Google and IBM are promoting the Cloud computing as tools for research. Google and IBM in 2007 commenced an initiative intended to develop computer science students' understanding of parallel computing to prepare them for large-scale distributed computing models. (Chang & Wills, 2012) published a case-study on the University of Greenwich in which they shared university's strategic plan behind choosing SAP Cloud over Oracle for enterprise education and to better learner satisfaction in school, such as by using simulations of business processes.

Adaptability of SAP for Cloud based IT landscape

SAP Cloud has over 110 million subscribers distributed over 41 state-of-the-art data centers around the world. SAP's portfolio over Cloud includes Cloud apps (SaaS), Cloud platform (PaaS), and on-demand infrastructure (IaaS) with hardened security and 3 hosting models; public, private and hybrid. Let us assume Company A belonging to any industry plans to adopt SAP Cloud. Figure 3 illustrates the starting point for Company A for Cloud adoption.

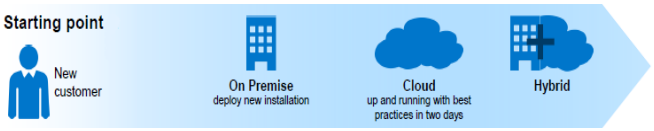

Figure 3. SAP Cloud deployment options for Company A

The Cloud can be public or private. The public Cloud services will be delivered to Company A over a network that's open for public usage. Public Clouds offer efficiency and affordability, and are often multi-tenant. The Private Cloud is also an option for Company A where its services are maintained on a private network protected by a firewall. It can be built within Company A's data center or at the data center of some other vendor. Private Clouds offer the most security and control. The Hybrid Cloud is a composition of two or more Clouds (public or private), often from multiple providers. Hybrid Clouds offer variety to Company A to pick and choose business aspects for the hybrid landscape.

With the deployment model, Company A also considers which SAP Cloud service to choose; SAAS, PAAS or IAAS. Table 1 below compares each. The selection of service depends on few factors, which include; the need, affordability, availability of resources, simplicity and elasticity.

Table 1. Cloud services available to Company A

Software as a service	Platform as a service	Infrastructure as a service
It is way of delivering applications over the Internet. Customers can access SaaS applications right from a Web browser, which means there is no hardware or software to buy, install, maintain, or update.	It provides a Cloud platform and tools to help developers build and deploy Cloud applications. Users access PaaS from a Web browser, so there is no need to purchase and maintain the underlying hardware and software. With PaaS, developers can pick and choose the features they want on a subscription basis.	It lets companies "rent" computing resources such as servers, networks, storage, and operating systems on a pay-per-use basis. IaaS providers host the infrastructure and handle tasks like system maintenance and backups – so customers don't have to buy hardware or employ in-house experts to manage it.

SAP Cloud case studies for Higher Education and Research

SAP wants to provide access to leaning, to enable student success and to facilitate research discovery. Their success in teaching is apparent in their 7000 universities of research, customers across 6 continents, including 93 of the world's top 100 universities. Universities and students are under the forefront of technology and want solutions to help them drive education and efficiency. SAP Cloud based solutions offer the ability to quickly deploy and adapt technology in response to changing needs. These solutions

can be deployed at low cost and low risk while ensuring flexibility, scalability and integration across organization. It is empowering education beyond physical boundaries through mobile applications, e-learning technologies and research collaboration endowing universities to evaluate and share real-time results, take decisions and collaborate. Academia has to look at the restricted finances and extreme rivalry. As a result they must draw all available and suitable information to progress learner performance and preserve best students and best talent. To make sense of all the data SAP has analytics functionality embedded in the software allowing detailed coordination of information to manage cost and improve research and innovation. A compilation of case studies that implemented SAP Cloud is presented below and summarized in Table 2.

Table 2. Summary of case studies of educational institutes using SAP Cloud services

Institute	SAP Solutions	Benefits	Users
La Trobe University, Australia	SAP S/4 HANA finance on SAP HANA Enterprise Cloud	• Enhanced user experience • Simplified processes with no latency • Increased data reliability	3000 employees
Schola Europaea, Office of the Secretary-General of the European Schools, Europe	SAP Simple Finance on SAP HANA Enterprise Cloud.	• No resource costs • Significant improvement in accountability • Better cost control and compliance using selfservice • procurement • Real-time accounting processes and instant insight into core financials • Reduction in data footprint	25000 students, 4000 employees
Technical University of Munich, Germany	Innovative education services based on SAP S/4HANA Cloud SAP Fiori	• Equipped students with the latest tools and skills to drive the Internet of Things and digital transformation in the business world	9846 employees
TED University, Turkey	SAP ERP SAP Student Lifecycle Management 20 SAP Fiori Apps	• Provided students and faculty access to academic and administrative tasks through any mobile device • Simplified the user experience, resulting in increased productivity, user adoption, and satisfaction • Reduced training requirement	250 employees
Kadir Has University, Turkey	SAP Fiori apps	• Faster completion of academic and administrative tasks • Access to applications from any mobile device • Greater user satisfaction	450 employees

CASE STUDIES

La Trobe University, Melbourne, Australia:

La Trobe University has over 40000 enrolled students and staff, and has 7 campuses across Australia. The university is a beacon of education and research in Australia. Their aim was to reduce the workload on staff and educators and to automate the reporting and data accumulation. La Trobe is the first university in Australia to adopt SAP solutions. With SAP HANA Cloud technology La Trobe University was able to gather all and any data and present it in a logical way.

After having firm base, they deployed SAP HANA Enterprise Cloud university-wide to allow real-time information sharing and reduce risks. Also, SAP S/4 HANA finance solution was implemented to streamline financial processes and get real-time consolidated analytics (Connolly, 2015).

European Schools:

They provide nursery, primary and secondary education through their 14 schools that are situated in 7 countries. They were using an IT system that was 20 years old and not compatible with what their required. Their aim was to reduce logistics and administrative effort by adopting Cloud based solution, to get consolidated and transparent insights and to align and secure accounting and financial

processes. Their natural inclination was towards SAP, since 2 other integrators failed to offer the current solution and due to SAP's stable IT platform. The European School's moved to SAP HANA Enterprise Cloud, thereby reducing staff workload, costs and unneeded data footprint. They got insight into core financials and the power of real-time accounting via simple SAP Finance (SAP, 2015).

Technical University of Munich, Germany:

Technische Universität München, is one of the leading technical universities of the world and at the top when it comes to the field of Informatics. Their objective is to stay close to the industry and harness the latest trends and technological advancements so that its learners stay topnotch. To achieve that they shifted from SAP ERP on-premise to SAP Suite for HANA in the Cloud, and acquired features, such as intuitive student experiences, real-time information retrieval and capabilities of Big Data and analytics (SAP, 2016).

TED University and Kadir Has University, Turkey:

Both the universities were struggling with similar challenge, i.e. their students, teachers and staff were spending a lot of time on simple administrative tasks on their SAP software. They both installed around 20 SAP Fiori apps and got an intuitive, user-centric, and simple interface, resulting in increased productivity and user satisfaction (SAP, 2017a) (SAP, 2017b).

IT OPTIMIZATION APPROACH

To potentially improve Cloud operations and manage costs, it is essential for the Cloud customer to follow a systematic approach from the beginning and then continually optimize the IT setting. The reason for which is that the Cloud deployments breed progressively and need to be tied to the scope regularly to avoid cost sprawls or bill shocks. The researcher shares an iterative approach to achieve Cloud optimization, as presented in Figure 4.

Phase 1: Planning. In this phase, it is recommended to identify requirements, pinpoint specifically what needs to be migrated and why, and also devise ways to monitor the usage of computing resources. These measures would support in keeping performance and costs optimized in later phases. Some examples of output for this phase are: list of applications/services to move, workload duration (days or unlimited) and resources per job, server capacity, cost budgets for line of business/projects, key performance indicators (KPIs) to track current usage and costs and ways to forecast usage and cost.

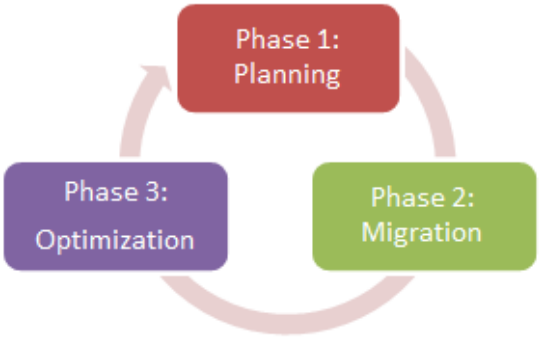

Figure 4. Approach for IT optimization in Cloud

Phase 2: Migration. Often tools assist in migration; however, standardizing the processes, data, and work flows is essential to avoid misuse. The policies, guidelines and best practices should be made use of to harden security and to manage resources optimally.

Phase 3: Optimization. IT optimization is an ongoing process in Cloud computing. To have both cost and performance value-added for the organization, the following examples should be looked into. Examples: rid unattached volumes, eliminate unused object storage, remove abundant instances, spread CPU load, size servers carefully, check memory and load average, check firewall, update security patches, automate operations as scripts where possible, assess usage of CPUs, memory etc., keep track of cost and performance KPIs, add new resources only when absolutely necessary, use procured resources optimally.

CONCLUSION

The paper presented real-world examples of Cloud implementations and SAP Cloud case-studies for higher education and research to demonstrate the practicality and advantages of Cloud adoption in both sectors. Having the Cloud implementation doesn't necessarily mean that IT optimization is achieved and will stay that way; it just means we should guard this success by performing continuous optimization to get the most Cloud benefits. The impact of it defiantly appears in performance, innovation and cost control of Cloud customers. The author articulated a simple approach for IT optimization in the Cloud. As part of the future work, it would be logical to conduct a case-study on an institution using the above approach.

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