In house labs (vs. Cloud Project Management?)

MS Project [1]

(20 marks - 20% weight)

Scope Statement – In-house IT labs (vs. Cloud PM?)

Date: March 3rd 2021 Prepared by Dr. Peter Busch

Scope statement [2]

Hosting of labs in 4 RPD

The Department of Computing at Macquarie University began the shift from E6A/9WW to 4 Research Park Drive (RPD) from September 2018 in two stages. Half the staff shifted in the second semester of 2018, while the remaining staff shifted in week 0 of semester 1 in 2019. The higher degree research (HDR) students shifted with their relevant supervisors at the same time.

As of March 2021, the Department of Computing occupies the 2nd and 3rd floors of 4 RPD. However, these two floors are occupied only by the staff and their HDRs - along with a couple of dedicated research only labs.[3]

Much work is taking place to bring the teaching labs from 9WW across to our new building in 4 RPD. Although the teaching labs will eventually occupy both the ground floor and first floor of 4 RPD, currently planning is taking place for the ground floor teaching labs only.

These teaching labs need to satisfy the undergraduate and coursework master's degree curriculum offered by the department. While many COMP1000 - 3000 and 6000 level units can use a general-purpose PC lab, there is a need for two specialized networking labs and two specialized games labs, for students studying those disciplines. Units relevant for the former include {COMP2250, 3100, 3250/6250, 7260, 8100, 8250, 8260, 8280}. Units relevant to the latter discipline include {COMP1150, 1160, 2150, 2160, 3150, 3151, 3170}.

To install our teaching labs, we anticipate:

Six (6) general purpose PC labs each with 25 desktop PCs. These labs all run the *windows* operating system.

Two (2) networking labs where: [4]

- each lab has 8 racks - called PODS. Each pod contains 2 routers, 2 switches, 1 wireless router and a patch panel.
- with student groups of 3-4 (ideally 3 per pod).

[1] Or other suitable PM software – up to you!

[2] This is largely true, but partly made up.

[3] For example an IoT lab on the third floor and soon some cyber labs and defence research labs on the second floor.

[4] This is *very* specialised material, so just do your best here – *you won't fail if you can't price everything accurately!*

- each lab will have access to a server rack that contains: 3 high end servers, firewall/intrusion detection device. Two (2) games labs each with 25 PCs. These labs operate specialized games software, such as *unity*.[4] [5]

PM (Project Management) in the cloud?

For almost three decades,[6] I have heard about this new paradigm - BYOD,[8] where we do not provide fixed labs instead students come to class with their own equipment and download wirelessly (or otherwise) what they require to conduct their learning. A more recent paradigm shift is the cloud whereby you IT outsource potentially whatever is not mission critical to the organisation.

Project success criteria:

Our goal is to complete this project within 8 months for no more than $?. The main goal is improve the lab experience for students by providing better machines and an improved study experience.

Basic assignment steps

a. You are the internal PM. *Consider your salary cost too*.

b. MQ Computing wants to establish the aforementioned ground floor 4 RPD teaching labs.

c. You as PM have some knowledge of the potential for PM in the cloud. [7] [10] Your superiors (the CIO etc.) also have some knowledge of the cloud and PM in the cloud is new, but they have heard of it.

d. MQ Computing has only an **8 month timeframe** to have their labs ready.

e. MQ Computing has 1 PM (you), 6 Science IT staff (3rd floor 9WW), 2 office staff to help with admin. [8]

f. You as PM can work out the budget **- there is no correct answer here!** What do you think it might cost over the 8 months?

- You have an idea of the number of machines you require and a broad understanding of some of the software you might want installed.
- You know the staff available to you and they are all *professional* (not academic) staff at MQ. Staff salaries for professional staff are here. [9]
- Let us assume a PM is a Higher Education Worker (HEW) level 9
- Your science IT staff are HEW 7
- Your office staff are HEW 5
- One way to work the payments out might be to work out an hourly rate of pay and multiple by the number of days per week and weeks per month your staff might be allocated to the lab.
- Please note - **there is no correct answer here**, just how well you explain yourself and why.
- You can be creative and *Google* some costings. Just state (write) in your assignment where you derived these.
- The more thorough/convincing/plausible your explanation is – the better.

[4] https://en.wikipedia.org/wiki/Unity_(game_engine)
[5] Look up the game engines and software you might care to see installed on these machines.
[6] Yes seriously! ;-) [8] Bring Your Own Device.
[7] https://www.cpaaustralia.com.au/~/media/corporate/allfiles/document/professional-resources/business/guide-to-cloudcomputing.pdf?la=en [10] Appendix 1.
[8] You are the PM - so you work out the costings of these staff. 'Google' what the salaries might be.
[9] https://staff.mq.edu.au/work/strategy-planning-and-governance/enterprise-agreement/professional-staff-enterprise-agreement-2018/schedule-1-full-time-annual-salaries

g. Consider, as with any workplace, the above staffing is only partially dedicated to achieving the end goal of lab establishment in 8 months. You decide what fraction of time is spent by staff on this initiative!

h. This project represents an *intra-organisational* view of PM.

- Having written the above – for the second question – can management gain some idea of the costs of hosting aspects of software (SaaS) or hardware (IaaS) in the cloud?

Assignment Algorithm

1. Implement the above project scope (basic assignment steps) into *MS Project* (or appropriate PM software). *You are free to modify the WBSs as you see appropriate* (**15 marks**). Please answer the following: -

- How long will your project take?
- How did you calculate this? (explain)
- Provide the critical path (e.g. figure 1 below) for your implementation.
- You may use the network diagram feature in MS Project (or equivalent) and modify/comment to illustrate your point, rather than redrawing from scratch.
- Provide a discussion of your approach – how did you arrive at your costings, timeframes, how staff were allocated and so on?
- *Hint: higher grades tend to refer to sources of information* [10]

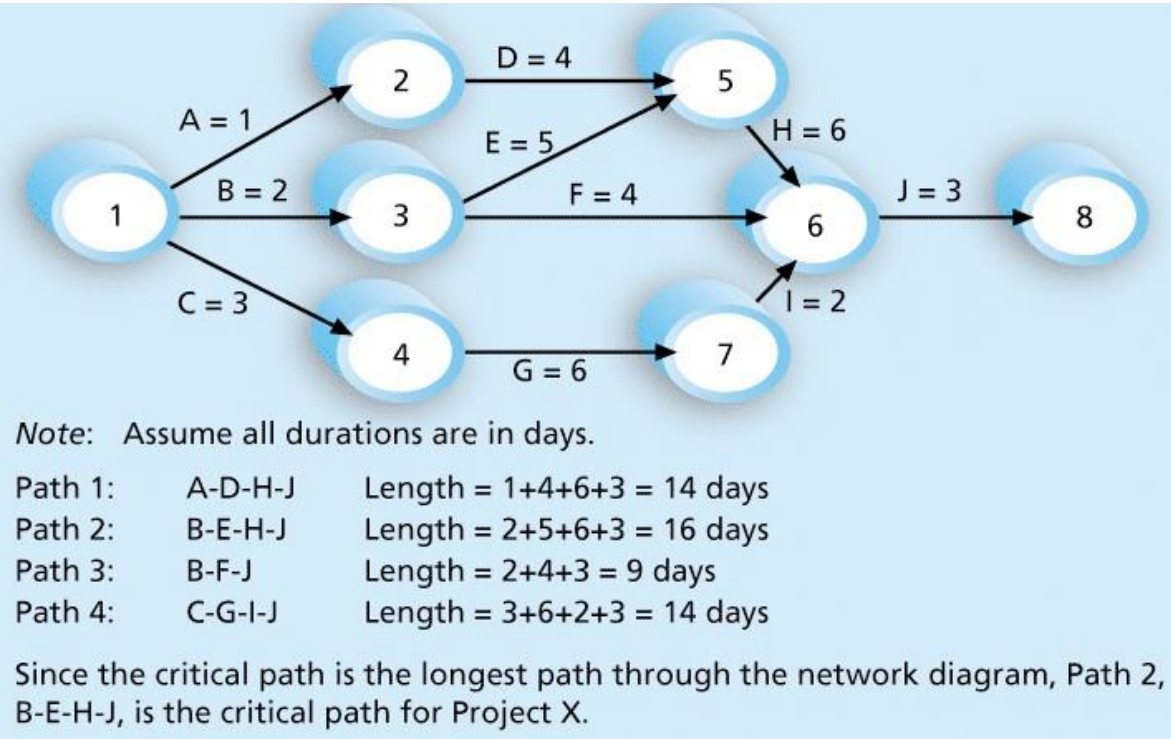

Figure 1: Determining the critical path for project X (source: Schwalbe, 2018 p. 260).

[10] See assignment 1 – appendix 1.

2. What do you foresee as potential cloud options? [11] Are there aspects of the above able to be implemented in the cloud – what are some of the potential options? Perhaps no cloud options exist and you choose to argue that way? What about BYOD – is this paradigm helpful? [12] Again, note footnote 13 below! **(5 marks).**

Deliverables – soft copy only

One pdf file containing your MS project (or equivalent) solutions (question 1), which includes:

a. **WBS charts**, including

   i. Gantt chart
   ii. Network diagram
   iii. Resource graphs etc.

b. The answers to your 'algorithm' - questions 1 and 2 above.

Submission

Place your **soft copy** (1 file) in the appropriate folder on iLearn.

Marking Rubric

You will note higher grades bring in examples more widely from the literature. Higher grades show greater initiative in costings, providing explanation for why staff cost what they did, reasons for time durations on tasks and so on. The critical path will be well explained, showing good understanding of what is taking place.

	Developing (Borderline Pass-Fail)	**Functional** (Pass)	**Proficient** (Credit)	**Advanced** (Distinction to HD)
Comprehending the underlying scenario	An understanding that organisations have PM strengths, expressed through basic statements articulating how some organisations may be better because of PM.	Some indication literature exists providing wider examples of CM, staffing etc. in organisations.	Recourse to the literature, illustrating similar organisation profiles with regard to CM and PM, staffing etc. and how these factors relate to the material under study.	A comprehensive study of the literature providing deeper examples of similar CM and how PM has strengthened them.
PM software	Limited use of PM software showing some understanding of the tool.	Competent use of PM software showing understanding of the software, perhaps making some basic mistakes.	Good understanding of the software, using tool appropriately without any significant mistakes.	Excellent understanding of the PM software, using tool appropriately at an expert level.

[11] Appendix 1 below.
[12] Bring your own device.

PM modelling	Limited understanding of PM modelling, some obvious mistakes.	Competent understanding of PM modelling, some trivial mistakes still in evidence, but generally an understanding of what is taking place and why.	Good grasp of PM modelling bringing in other examples of PM modelling from the literature explaining how this has improved project scenarios.	Excellent grasp of PM modelling, also drawing on the literature widely to exemplify in the case of further examples how PM modelling has aided other organisations as well.

Note this is a Turnitin assignment, meaning the software will detect if you have copied and pasted inappropriately (i.e. not used "…" quote marks where you have simply copied and pasted someone else's work).

Late submission of individual work will incur a 10% penalty for every 24 hours, or part thereof, it is late. So within 24 hours, the maximum mark that can be obtained is 90% of the full grade for that assessment task; between 24 and 48 hours, the maximum mark that can be obtained is 80% of the full grade; and so on.

If you require an extension, please do so via **ask.mq**.

Appendix 1

Oza, B., Busch, P., (2020) "Cloud Project Management" *International Business Information Management Conference (36th IBIMA)* 4-5th November Granada, Spain 13 pages.

Cloud Project Management

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Abstract

Effective and efficient project management is essential at all times to ensure projects meet goals, within given constraints. This paper seeks to determine how cloud computing can enhance project management with respect to the ten project management bodies of knowledge (PMBOK). Results show there are various cloud project management tools available, having the potential to perform better than traditional project management tools in all areas of the PMBOK. A qualitative analysis performed on relevant literature by discovered the overall concept of cloud project management is generally positive. Observations from this research and analysis resulted in some recommendations which may help ensure successful project management using cloud computing.

Keywords

Cloud Computing, Project Management, Qualitative Analysis.

Introduction

Technology is constantly advancing and providing new ways to make our personal and professional lives more efficient. The "cloud" is one such component of this rapidly evolving technology (Arora & Parashar, 2013). In its simplest form, the cloud can be described as storing your memory and CPU (Central Processing Unit) power elsewhere i.e. in the "cloud", but taking their advantage on your machines. Cloud use can range from personal use, such as Google Docs to make your documents, to professional use such as running virtual machines on your clients. Project management (PM) is a critical component of any organization's success, even when dealing with complex problems such as pandemics (Ruan *et al*., 2019), and it has been found good project management leads to successful projects (Schwalbe, 2018). PM also needs to keep adapting to technological changes in order to provide effective solutions, which are vital to a project or organization's performance. In this instance, change refers to cloud computing. This paper examines the integration of cloud computing and project

management and how the cloud can help in project management, vindicating the arguments by performing qualitative analysis.

Cloud computing

Cloud computing is believed to be the 'silver bullet' of IT in the 21st century, but it is also a complex subject (Bredenkamp, 2012). On-demand computing resources are available because of cloud computing, including computing power and data storage without having to perform management on a daily basis. Cloud computing has led to "portable" data centres made available to internet users. Broadly, clouds can be divided into four types – the private cloud for a single organization, the public cloud for the general public, the hybrid cloud and the community cloud (Verma & Sharma, 2019). Cloud computing providers usually offer their services in three categories – Infrastructure as a Service (IaaS) (Preimesberger, 2015), Platform as a Service (PaaS) (Hurwitz, 2012) and Software as a Service (SaaS) (Pocatilu *et al*., 2010). Other categories include Mobile Backend as a Service (MBaaS) (Monroe, 2013), Serverless Computing (Miller, 2015), Function as a Service (FaaS) (Avram, 2016), Content as a Service (CaaS) (Doglio, 2012), Data as a Service (DaaS) (Olson, 2010), Desktop as a Service (Rouse *et al*., 2013), Integration Platform as a Service (IPaaS) (Thoo *et al*., 2011), Network as a Service (NaaS) (Frank, 2011), Security as a Service (SECaaS) (Olavsrud, 2017) and Business Process Management as a Service (BPMaaS) (Barnawi *et al*., 2015). Customers can choose their preferred service based on what they desire. Dropbox, Google Drive, Salesforce, etc. are some of the famous cloud applications. As a lot of terms were introduced above, below are three figures classifying these terms, making these concepts easier to understand (figures 1, 2 and 3). These types and categories, as well as Dropbox, are discussed after the figures, beginning with the Private Cloud.

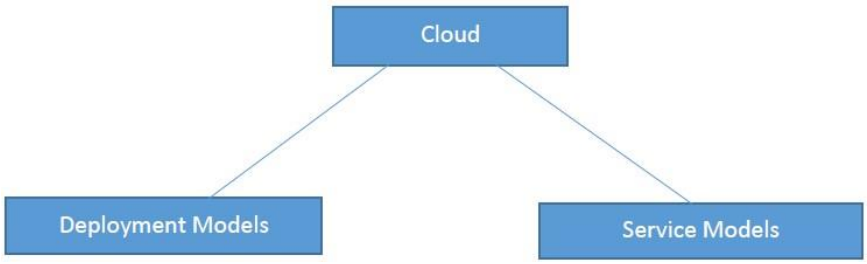

Figure 1 Cloud Classification

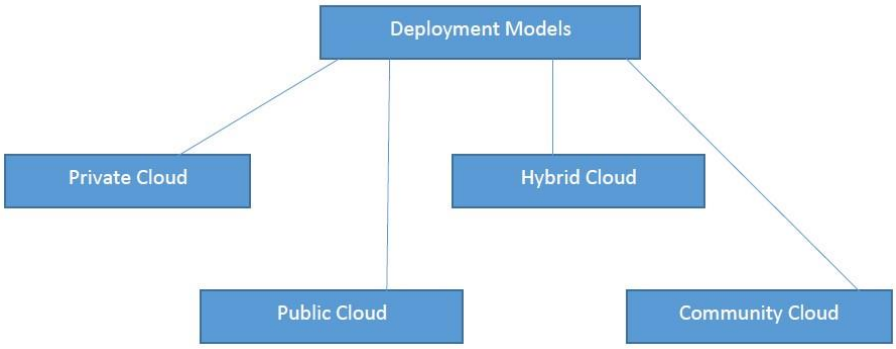

Figure 2 Deployment models

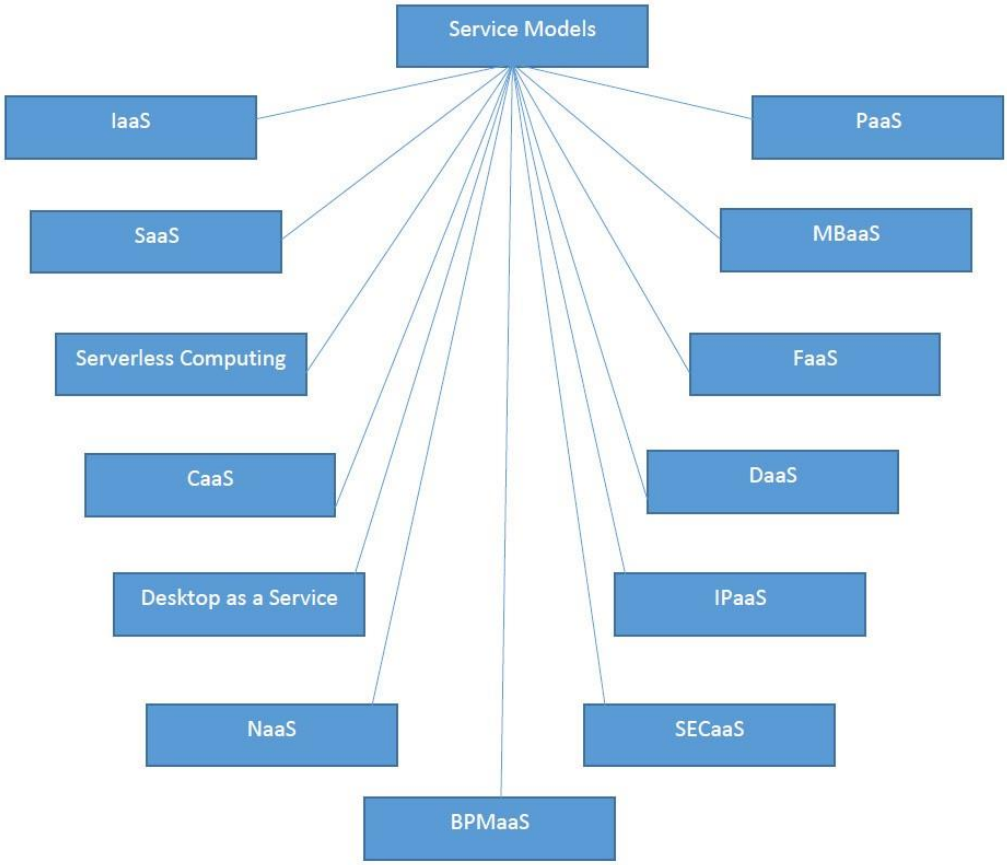

Figure 3 Service Models

Deployment models

A *private cloud* involves a secure and distinct cloud based environment created exclusively for the specified client. It is explicitly built for providing services within an organization to maintain privacy and security (Verma & Sharma, 2019). Examples of a private cloud include Microsoft's Azure and Amazon's AWS cloud. A private cloud removes the need to have on premise hardware or data centres for the client organization. *Public Cloud* can be defined as cloud services offered by companies over the public internet, thus making it available to any interested user (Verma & Sharma, 2019); this can be free or paid, depending on provider and user requirements. Examples include Google Drive and Microsoft's OneDrive. The paid versions can be set-up in such a way the customer pays only for what they use; this can be based on CPU cycles used, amount of storage required, bandwidth consumed and so forth. Using a combination of private and public cloud is known as the *Hybrid Cloud* (Verma & Sharma, 2019). The driver to use this type of cloud is the combination of privacy and availability for multi-tenancy. Examples of hybrid cloud are the US Microsoft Hybrid Cloud (Cybercon.com), IBM Cloud App Development (Bluemix.net) and so on. *Community cloud* allows sharing and management of information by a number of related organizations (Verma & Sharma, 2019). Community Cloud is operated by a community of organizations which share common concerns such as storage and security. Some examples of community clouds include Salesforce and QTS Data Centres.

Service models

With regard to service models, *Infrastructure as a Service (IaaS)* refers to online services providing high level Application Program Interfaces (APIs). Typically, a hypervisor - a virtual machine monitor, runs the virtual machines as guests. One of the most common hypervisors is VMware's ESXi; others include Microsoft's Hyper-V, Citrix's Xen, KVM, etc. Some of them are open source such as the Kernel-based Virtual Machine (KVM), whereas most are proprietary such as ESXi or Hyper-V, to name but a few. IaaS is used frequently nowadays, for example a company called GoGrid manages cloud and dedicated hosting for more than 15,000 customers claiming to deploy more than 600,000 virtual machines for those customers using IaaS (Preimesberger, 2015). *Platform as a Service (PaaS)* provides a platform to users for running, developing, and managing applications without building and maintaining infrastructure which would otherwise be required. PaaS can be delivered as a public cloud with the customer controlling software development with minimal configuration as a private service behind a firewall, or as a software deployed on public IaaS (Hurwitz, 2012). *Software as a Service (SaaS)* is a subscription-based and centrally hosted cloud computing service for software licensing and delivery. For example, SaaS Customer Relationship Management (CRM) is used by many large enterprises across the world instead of on-premise systems, for managing sales opportunities and actions of sales personnel (Chen *et al.*, 2018). Salesforce is one of the successful organizations in the field

of CRM. They focus on areas of marketing automation, analytics and application development, along with ways to improve customer service. *Mobile Backend as a Service (MBaaS)* - also known as "Backend as a Service" (BaaS) (Monroe, 2013), enables application developers to link their applications to backend cloud storage and APIs exposed by backend applications. MBaaS also provides useful features such as integration with social networking services and user management.

Other models include *Serverless Computing* - a cloud computing category in which the provider runs the server, dynamically allocating machine resources; this is unique as pricing is actually based on resources consumed by the application, rather than pre-purchasing units of capacity (Miller, 2015). Serverless computing has the potential to be cheaper than purchasing or renting servers (Jamieson, 2017). *Function as a Service (FaaS)* provides a platform on which customers can run, develop and manage application functions without the need to build and maintain infrastructure. Thus, it is similar to PaaS, however FaaS does not require any constantly running server process, thus differentiating itself with the former (Avram, 2016). AWS Lambda is one of the earliest FaaS offerings by a major provider (Eyk *et al*., 2017). *Content as a Service (CaaS)* otherwise known as "Managed Content as a Service" (MCaaS), is where the provider is responsible for delivering content to the customer via licensed internet services under a subscription model. This is an on-demand service. The primary benefit of this service is that the client has the ability to centralize content, as well as make it easily manageable (Doglio, 2020). *Data as a Service (DaaS)* accesses the provider's data product and is used by the client on demand (Olson, 2010), that is to say beyond geographical and organizational borders. As this service is focused on data with access being controlled via data services, quality is improved due to a single point of updates by the provider. *Desktop as a Service* refers to the concept of remote desktop virtualization and virtual desktop infrastructures, or VDIs. In essence, desktop virtualization involves a logical operating system or a virtual operating system isolated from the client used to access it (Rouse *et al*., 2013). Desktop as a service tends to be used amongst public cloud providers. *Integration Platform as a Service (IPaaS)* addresses data, processes and application integration (Thoo *et al*., 2011) and can also be described as a suite of cloud services enabling customers to govern, develop, and execute integration flows between different applications. Such an integration is critical to the needs of certain businesses.

Other approaches use *Network as a Service (NaaS)* for network transport connection; this service is often combined with mainstream services such as IaaS, PaaS and SaaS (Frank, 2011). NaaS considers computing resources and networking as a single point for optimizing resource allocations. At times NaaS can involve a virtual network service as well. *Security as a Service (SECaaS)* sees a provider integrate their security services into an infrastructure accomplished on a subscription basis. In fact SECaaS is more cost effective when compared to running one's own security services when taking total ownership cost in to account (Olavsrud, 2017). Additionally, SECaaS negates the need for on-premise hardware (Furfaro *et al*., 2014). *Business Process Management/Monitoring as a Service (BPMaaS)* is a runtime business process compliance monitoring framework incorporating a broad range of high level compliance patterns for abstracting the specification of relevant constraints (Barnawi *et al.,* 2015). End users benefit from the friendly interface provided by BPMaaS to monitor their business. One application of these service models is *Dropbox*, a popular American cloud service company allowing users to host files (Li *et al*., 2013). Dropbox has computer applications for most mainstream operating systems such as Microsoft Windows, Linux computers, Apple macOS, iOS and Android. Dropbox offers cheap storage and thus has the potential to generate high amounts of internet traffic (Drago *et al*., 2012).

On-demand resources, along with portable data centers, are very helpful for today's organizations, making cloud computing critical for the IT industry (Bredenkamp, 2012). The four types of cloud computing discussed earlier were the Private, Public, Hybrid and the Community Cloud. We also divided the cloud into different categories (Pocatilu *et al*., 2010). The three major categories discussed were Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS). Some seldom used categories were also reviewed, namely Mobile Backend as a Service (MBaaS) (Monroe, 2013), Serverless Computing (Miller, 2015) Function as a Service (FaaS) (Avram, 2016), Content as a Service (CaaS), Data as a Service (DaaS), Desktop as a Service, Integration Platform as a Service (IPaaS), Network as a Service (NaaS), Security as a Service (SECaaS) and Business Process Management as a Service (BPMaaS). A particularly well-known application called Dropbox was also discussed. Let us now turn our attention to the topic of project management with a cloud focus.

Cloud Project Management

Project Management has existed in a formal western sense of the term since the Manhattan project, producing the world's first atomic weapons (Schwalbe, 2018). The goal of project management is to achieve all project goals within given constraints. Traditionally this has been accomplished manually or via on-premise systems (Preimesberger, 2019). However, most projects require the management of numerous documents and related work, which can be made easier by implementing cloud based solutions (Baird, 2015). Cloud is a relatively new concept, and thus its integration with project management is an even newer concept. As a result SaaS is the only area of cloud computing where considerable literature exists for discussion of the integration of cloud and project management; which is what the following section explores. Following this discussion, specific tools related to cloud project management are introduced, such as BaseCamp, Zoho Projects, etc. Finally, coverage with regard to PMBOK is undertaken.

PM with SaaS

SaaS project management can specifically refer to delivering project management software on demand, in an environment where cloud computing is in place. As every business requires the ability to manage projects effectively, SaaS is an appropriate delivery model for project management software. SaaS project management applications consist of comprehensive tools for managing projects throughout their lifecycle, such as bug trackers and tickets, change management tools, online chats, virtual conference rooms, cost and budget trackers, dashboards, contact management tools, reporting tools, templates, collaboration tools, audit tools, scheduling tools, resource management tools and so on. Companies such as Gehry Technologies (Post, 2012), Autodesk (Maher, 2009) and Newforma (Joyce, 2012) have been developing such SaaS tools. Using SaaS project management service adds significant advantages. In fact Arnold (2009) suggests using Google Sites (an example of SaaS) for management after the project is completed. He describes Google Sites as a collaborative tool with a very good trouble ticketing system. Some other tools described are Zoho Projects and BaseCamp. In contrast to on-premise project management tools, SaaS PM tools are a popular alternative, as on premise tools lack the ability to serve remote clients effectively (Chen *et al.*, 2018); such PM Tools also remove all barriers to team collaboration as people can simply connect to the internet and start working, regardless of their location (Arnold, 2009). Another collaboration benefit is the use of a central repository to track and synchronize projects, unlike on-premise systems. Some examples of such centralized repositories are GitHub, BitBucket etc.

SaaS PM Tools also have an advantage over traditional tools regarding costs; this is due to SaaS applications running in the cloud, as this in turn helps SaaS vendors distribute maintenance costs over time, making prices affordable for their clients. Tiered pricing structures also help in lowering costs for clients (Abaffy, 2013). SaaS vendors also handle upgrade works and costs, lessening the workload of clients. Such benefits are more applicable to start-ups as they usually lack funding for onpremise systems. One major advantage is also the high scalability of SaaS tools; this can be as simple as subscribing to more services and power from the respective vendor. Finally, SaaS tools demand little training since they only require people are comfortable using internet as most complex jobs are the vendor's responsibility (Chen *et al.*, 2018). In recent times, Customer Relationship Management (CRM) has become a widely studied concept. CRM is related to SaaS as it traditionally uses SaaS to function (Chen *et al.*, 2018). Large enterprises across the world use SaaS CRMs instead of on-premise systems to manage their sales departments. The driver for this behaviour are the low costs of SaaS, such as zero investment in machinery and equipment. Companies such as Salesforce rely on their CRM business for generating revenue (Arnold, 2009). Let us next examine some examples.

BaseCamp provides core project management and collaboration features. Third party applications are available to extend their features, such as introducing time tracking, accounting and charts to the core BaseCamp application (Arnold, 2009). Useful components of BaseCamp are the messaging and whiteboard features which help in collecting ideas from large groups of people. One can post and reply to messages via email from BaseCamp. Messaging threads are also available. *Zoho* [www.zoho.com] consists of a full suite of inexpensive and high quality business applications and can be considered a one stop shop for any business (Arnold, 2009). Basic features such as time tracking and progress charts have been incorporated in Zoho, which takes a more traditional approach in project management when compared to BaseCamp (Arnold, 2009). The popular *Google Sites* is originally a tool called JotSpot that Google acquired many years ago (Arnold, 2009). Google Sites is an array of applications such as Docs, Spreadsheets, Presentation, Calendar etc., effectively comprising all routinely used applications. Other useful tools include ticketing systems and file storage (Google Drive). One major advantage of Google Sites is that it makes project documentation easy due to the abovementioned features. Microsoft's Azure is another major cloud product (Sawyer, 2011), although typically used by larger organizations. Having explored cloud options, let us turn our attention to the management of projects in the cloud space.

Cloud vs. Traditional PM and the PMBOK

According to the Project Management Institute [pmi.org], there are 10 bodies of knowledge with respect to project management (Huda & Maliki, 2019): Project Integration, Scope, Time, Cost, Quality, Human Resource, Communication, Risk, Procurement and Stakeholder Management. Dillon & Scanlon (2011) comprehensively described how the cloud can contribute to making PM easier compared to traditional PM. As the cloud allows integration at a centralized place easily and this data can be seamlessly shared, along the lines of GitHub, integration and stakeholder management can benefit from this strategy.

Cloud tools such as BaseCamp can quickly determine if the scope of project is feasible or not by utilizing its third party applications; this can help in the case of scope management. Tracking tools such as Atlassian's Jira can help with time management (McDuling, 2019). In the cloud, live changes of anything including costs, can quickly be circulated among the team members as described earlier, helping with cost management. Using tools such as Zoho projects and BaseCamp, strict quality management can be enforced and improved with tools such as audit manager and document manager. Tools such as Workday also consist of additional features (Preimesberger, 2019) helping with timesheet submissions, vacation requests and performance reviews, clearly decreasing the workload of the human resources (HR) department. Tools such as Google Sites enable rapid communication thus improving communication management. The third party application - BaseCamp (Arnold, 2009) can also have features providing information about operation inefficiencies, thus improving risk management. These tools (Preimesberger, 2019) also allow for total oversight and control of service spending, improving procurement

management. The aforementioned arguments indicate the cloud helps improve traditional on-premise project management (Dillon & Scanlon, 2011) in each of the ten areas of the PMBOK. Table 1 summarizes the above.

Cloud project management is a new but useful concept helping businesses thrive. Compared to traditional approaches to project management, cloud project management can be particularly helpful. SaaS is so far the only cloud service which project management has adopted. SaaS project management offers a range of benefits such as low costs, tension free clients, centralized repositories, CRM software and so on. BaseCamp, Zoho Projects, and Google Sites are a few examples of specific tools related to cloud project management. The cloud - particularly SaaS, improves every area of the PMBOK in different ways (Dillon & Scanlon, 2011).

Table 1: Project management bodies of knowledge (PMBOK) vs. cloud offerings

PMBOK	What makes cloud PM better than traditional PM?
Integration	Ability for centralized data (Arnold, 2009) integrating everything into one place.
Scope	Advanced tools like BaseCamp consisting of fully functional scoping tools (Arnold, 2009).
Time	Tracking tools such as Jira, ensure time is managed wisely (McDuling, 2019).
Cost	Live changes to costs provided instantaneously to all stakeholders (Chen *et al*., 2018).
Quality	Zoho delivers audit and document management tools improving quality management (Arnold, 2009).
HR	Workday consisting of timesheet submission and vacation request features, ensuring easier HR management (Preimesberger, 2019).
Communications	Google Sites enable quick communication among participants making communication management easier and quicker (Arnold, 2009).
Risk	BaseCamp provides information about operational inefficiencies thus improving risk management (Arnold, 2009).
Procurement	BaseCamp allows for total oversight and spending control (Preimesberger, 2019).
Stakeholder	Ability for centralized data (Arnold, 2009) means stakeholders access data easily.

With the cloud (especially SaaS) expected to keep expanding, cloud project management can only grow further (Farb, 2011). We wanted to do more than just establish the boundaries of project management and cloud computing, and sought to undertake some qualitative analysis of the literature around this topic to see if we could uncover hidden concepts overlapping the two areas. We turn our attention to this exploration of concepts next.

Qualitative Analysis of themes

Qualitative analysis is the analysis of qualitative data such as text from journal articles. NVivo is an example of qualitative analysis software (Lam & Busch, 2019), able to provide useful insights into any topic, provided you feed it with enough raw data. Forty articles (included in the reference list), from 2009 to 2020, were loaded into a new NVivo hermeneutic unit. The papers were gathered from 40 library databases such as Academic Search Premier, ACM Digital Library, Advanced Technologies & Aerospace Database, AIS Electronic Library, Computer Index Australasia, Elsevier, ENGINE, IEEE, O'Reilly, Scopus, Springer and Wiley. The keywords used to find these papers were "cloud computing" AND "project management". Some papers were also obtained from Google Scholar using the keyword "cloud project management". Autocoding was performed at the sentence level looking for themes. In auto-coding, NVivo automatically recognizes themes and topics or concepts present in the given files. The output of this operation appears in various forms – tree maps, bar graphs and so on. The following section shows those reports generated by NVivo auto-coding and their discussion. Figure 4 shows a tree map generated from NVivo auto-coding. Bigger tiles indicate higher dominance of that topic in the literature gathered.

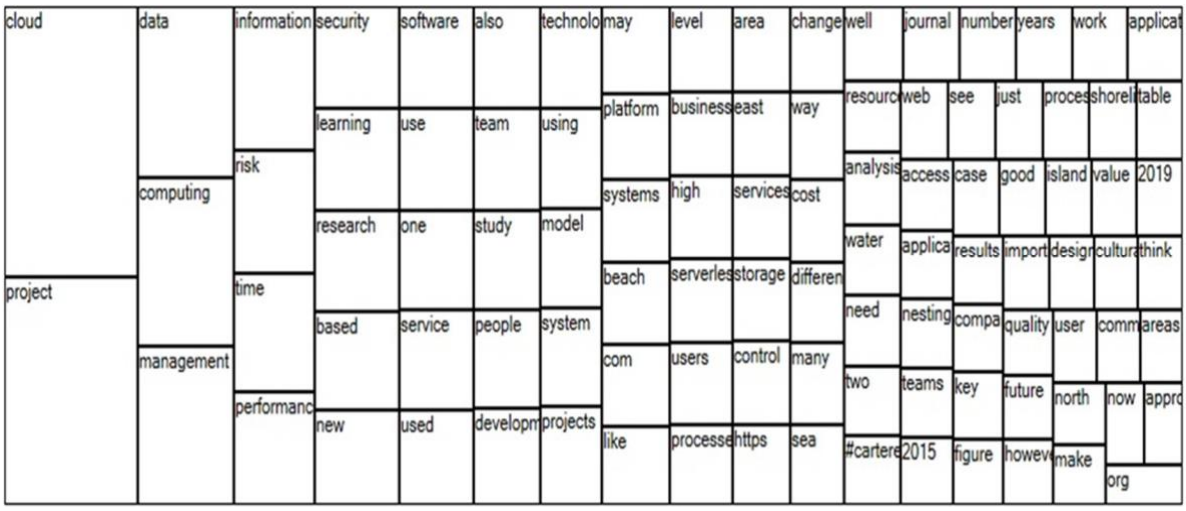

Figure 4: illustrating themes from auto-coding cloud vs. project management.

Nodes and Sentiment Analysis

Sentiment analysis was also conducted in Nvivo where sentiment represents a critical way of undertaking qualitative analysis illustrating the tone of an article or a topic. NVivo can generate themes or nodes from all provided documents by auto-coding keywords. Eighteen themes or nodes were auto-generated and after merging some terms e.g. merging cloud and computing, project and management etc., 14 final themes were determined. A sentiment analysis was then conducted resulting in figures 5, 6 and 7. Each major box in figure 5 corresponds to a particular theme. Inside those are four boxes corresponding to different sentiments about that theme: neutral, mixed, positive and negative. Clearly the neutral majority demonstrates the neutrality of all themes, but also fails to offer more insight. For a deeper analysis, figure 6 illustrating a bar graph is shown; this figure shows bars of each themes, separated into four different colours for very negative, moderately negative, moderately positive and very positive sentiments. It is clear the green - "moderately positive" category dominates. This result is vindicated by figure 7, which shows the darkest shading in the same category. Both the graph and table also show exact auto-coding counts. To determine how the concept of cloud project management changed over the 2009 to 2020 time period, papers were equally divided into two categories: 2009-2014 and 2015-2020. Sixteen papers were from the 2009-2014 period and 24 from the 20152020 period as these were the numbers found from searching the library databases. Shown below in tabular form are both the reports starting with the 2009-2014 report (figures 8 and 9). These reports analyse sentiments provided in individual papers, and classify them into four different categories: Very Negative, Moderately Negative, Moderately Positive, and Very Positive. As an example, phrases like "cloud PM is the worst" would indicate a very negative sentiment, "cloud PM is bad" would be a moderately negative sentiment, "cloud PM is good" would be a moderately positive sentiment, and "cloud PM is the best" would be a very positive sentiment. Darker shading indicated a category's higher dominance for that article. Numbers shown in the figures are the count of how many times a sentiment was shown. In figure 7, sentiment was moderately positive as indicated by the darker shading. It is however difficult to determine overall sentiment in figure 8 due to mixed shadings. Hence, it is best to determine total count of each category for accurate analysis. The count was 127 for very negative, 324 for moderately negative, 419 for moderately positive and 166 for very positive. Now, it is clear a similar result of moderately positive was obtained for figure 9 as well. Therefore it can be said the attitude towards cloud project management has remained fairly consistent since 2009. The primary pattern noticed was the neutrality of the topic; even when it swayed towards negative or positive side, there still existed "moderate" sentiment. Whenever the topic was not neutral, the overall sentiment was found to be moderately positive. It must be noted the sample size was 40 documents, although these were gathered from a variety of sources. Also under the comparison reports section, the split of documents was not exactly the same, as there were 16-24 in favour of the 2015-2020 category. It was found that the overall outlook on the topic of project management in the cloud was moderately positive.

Discussion

One of the findings was that while many companies adopt SaaS PM, very few adopt PM with other cloud service models. One reason could be that SaaS is easier and quicker to setup then other mainstream services - i.e. IaaS and PaaS (Pocatilu et al., 2010). However, companies in the ICT industry such as VMware, Citrix and Nutanix for example, have certain very successful IaaS products such as hypervisors.

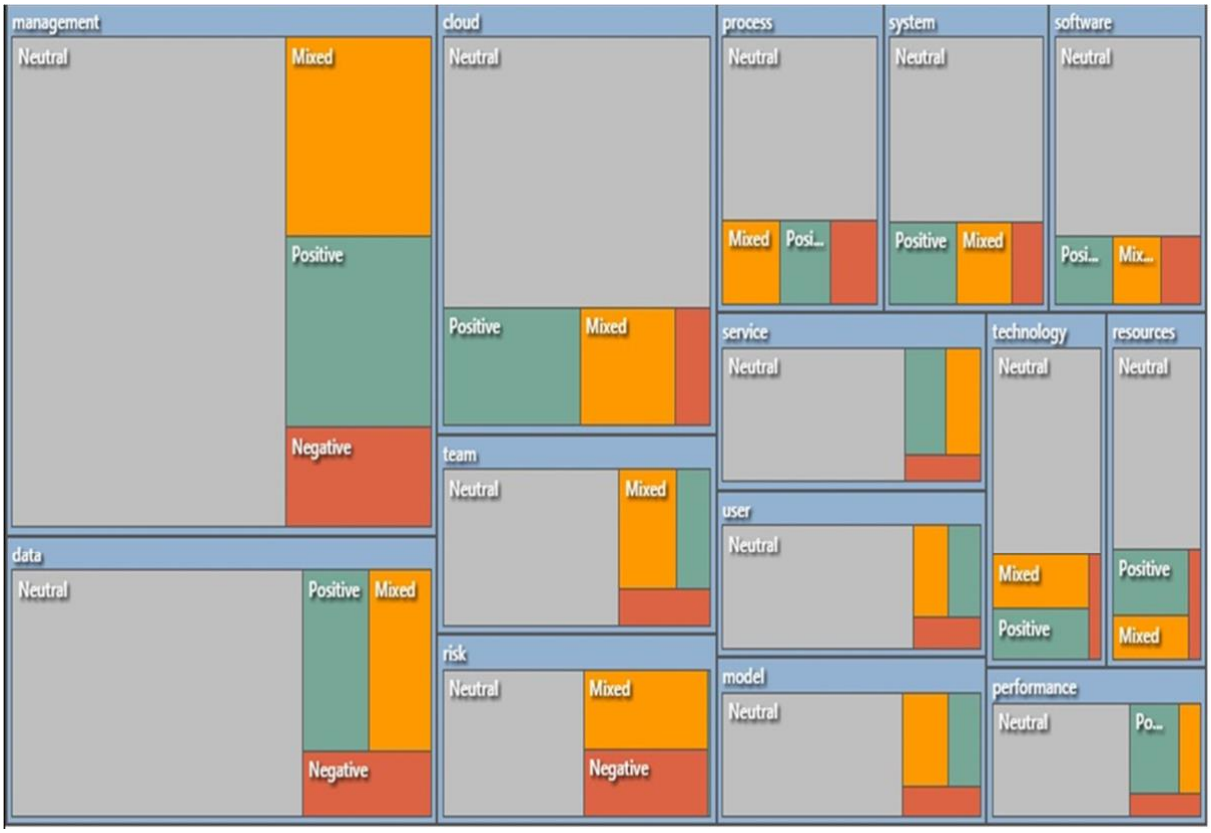

Figure 5 – Box Chart illustrating sentiment vs. themes

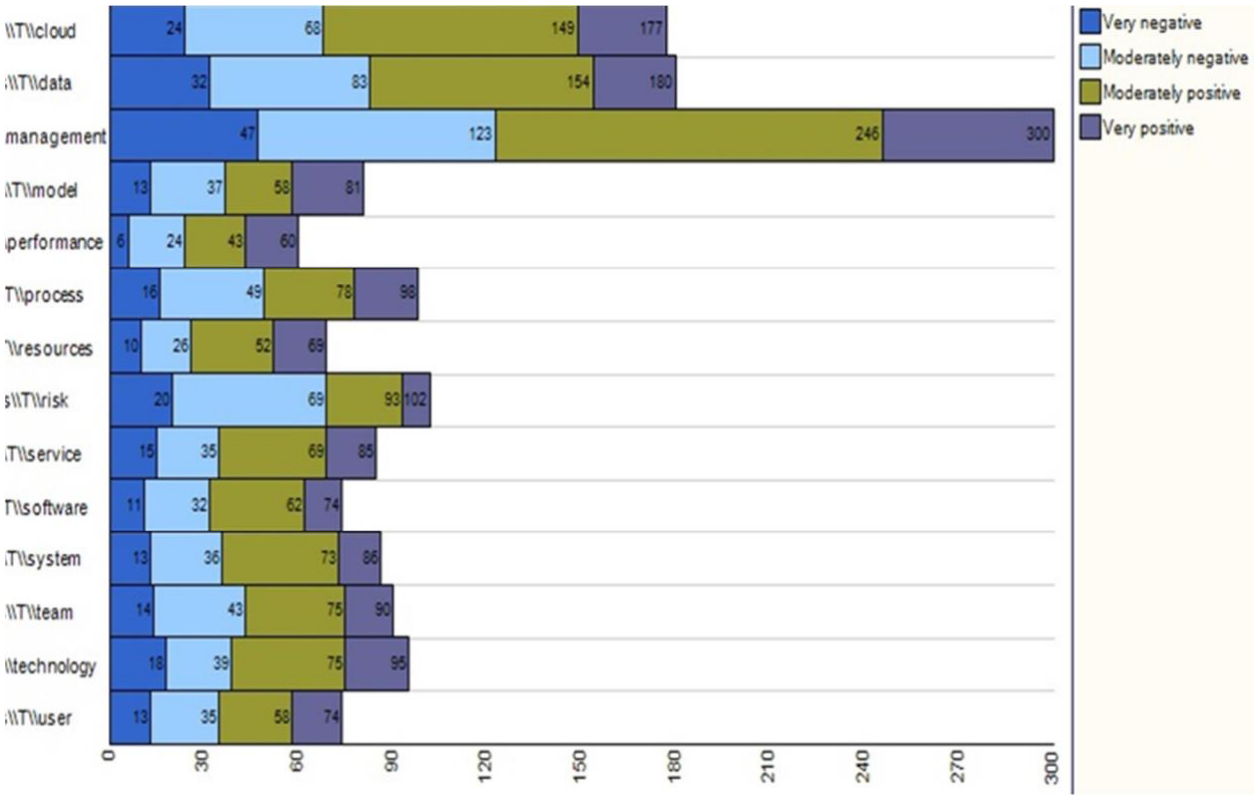

Figure 6 – Bar Graph illustrating sentiment vs. themes.

Companies could benefit from utilizing other specialized services for specific needs, rather than adhering to SaaS PM only. For example MBaaS is useful when dealing with backend cloud storage, for CaaS helps clients centralize their content whereas DaaS focuses on data quality. Mainstream services may not always be able to perform at the same level when dealing in such

specialized circumstances. It can be inferred from the NVivo output that documents mentioning “risks” in relation to Cloud PM had considerable negative sentiment, inferring cyber security may be an area of concern.

	A : Very negative	B : Moderately negative	C : Moderately positive	D : Very positive
\cloud	24	44	81	28
\data	32	51	71	26
\management	47	76	123	54
\model	13	24	21	23
\performance	6	18	19	17
\process	16	33	29	20
\resources	10	16	26	17
\risk	20	49	24	9
\service	15	20	34	16
\\software	11	21	30	12
\\system	13	23	37	13
\\team	14	29	32	15
\\technology	18	21	36	20
\\user	13	22	23	16

Figure 7 – Overall sentiment analysis of themes

Recent data breaches of government databases and systems make this issue more severe. For example, the Australian National University (ANU) suffered data breaches at least two times in recent years, compromising the data of many students (Giggacher, 2019); which in turn resulted in huge reputational loss. Hence cloud providers would certainly benefit from strengthening their cyber security, giving consumers the confidence to use them as a substitute for traditional project management. While there are plenty of tools available making cloud PM better than traditional PM, there is no one tool providing all-encompassing functionality. An all-in-one tool would definitely be more encouraging to people and prompt them to switch to cloud PM. For example while tools such as Zoho projects specialize in providing auditing tools, BaseCamp provides useful scoping tools. However neither of them provide both, potentially detering customers from using them. If there are reservations about moving into a cloud project management environment from a traditional PM setup, one can also perform a gradual transition by moving one of the PMBOK to the cloud. This can act as a trial of cloud PM, and if successful be expanded to all ten PMBOKs. For example a company can transition all its communication management strategies to the Google Suite or an equivalent cloud tool; if this enhances communication management, then cloud PM tools such as BaseCamp can be applied to other fields of the PMBOK. As evident from figures 8 and 9, the overall outlook on cloud PM is moderately positive, however there are a few areas, such as risk, having major negative sentiments. If the aforementioned solutions are implemented, then these negative sentiments can further be reduced. As seen in table 1, the cloud is already enhancing PM with respect to the ten areas of the PMBOK because of various cloud tools. Again, implementation of the aforementioned solutions will further improve cloud project management.

	A : Very negative	B : Moderately negative	C : Moderately positive	D : Very positive
autodesk	1	4	10	6
SaaS PM	11	7	9	6
E learning	8	20	35	4
bentley azure	1	3	11	2
cloud expected to keep rising	0	4	6	1
3D	0	2	4	1
bim in cloud	1	1	5	1
cloud is not a product	5	6	12	8
automatic	1	2	5	2
] badly	3	6	7	0
] change	6	6	13	9
] collaboration	2	0	5	2
] Secure User Data in Cloud Computin...	4	10	8	3
] sharpest edge	4	7	8	6
] classroom	9	18	56	19
] navy	0	1	2	0

Figure 8 – Sentiment analysis articles published 2009-2014

	A : Very negative	B : Moderately negative	C : Moderately positive	D : Very positive
cisco	2	1	8	1
cloud to complete projects	4	5	23	3
IaaS	0	0	0	1
Cloud computing security	14	44	39	13
intelligent business	0	1	4	3
1889-Article Text-4056-1-10-20180517	2	3	23	13
billion	0	1	4	3
journey to cloud	0	3	5	1
microsoft	0	0	3	2
] SaaS CRM project systems	14	30	46	18
] OneDrive	0	4	3	2
] A method for achieving provable data...	7	15	12	5
] asset	0	0	3	2
] atlassian freemium	0	0	0	1
] china	8	12	24	2
] Cloud Computing Security using Bloc...	4	11	14	3
] Cloud Programming Simplified	9	43	53	13
] Issues and Challenges in Cloud Com...	4	3	12	6
] On Producing Reliable and Affordabl...	7	24	16	12
] risk	24	73	42	15
] top pm software vendors	3	6	23	7
] US-China policies on AI, Big Data, a...	7	12	17	12
] Cloud computing in high tech startups	10	16	30	12
] Toward ML-Centric Cloud Platforms	8	17	15	16

Figure 9 – Sentiment analysis articles published 2015-2020

Conclusion

Cloud computing is still new and on the upward adoption trajectory. It is very flexible (Schneckenberg, 2014) and can be applied to a variety of areas - project management being one of them. Project management is key to organizational success. Enhancing PM with cloud services has benefits. This paper discussed both, cloud and project management in detail, before considering their integration. Cloud computing may be distinguished by two categories – Deployment Models and Service Models. These categories can be further broken down into specific terms. There are four deployment models – private, public, hybrid and community cloud. There are plenty of service models, 13 of which were covered. The mainstream services, i.e. IaaS, PaaS and SaaS were part of these 13 service models. Project Management is about accomplishing all project goals within given time and cost constraints. The cloud increases the capabilities of project management in every area of the Project Management Bodies of Knowledge (PMBOK), such as scope, integration, time, cost, due to the advanced tools for cloud project management such as BaseCamp and Zoho Projects. We then conducted a qualitative analysis. Results obtained were discussed in depth and patterns in the raw data identified, such as many documents having neutral sentiment. A limitation was the uneven distribution of documents based on time period, but in general cloud project management has been positively received in the articles qualitatively examined. Some recommendations are promoting use of non-mainstream services such as CaaS, MBaaS, etc., strengthening cyber security, creating tools with a broad range of functionality, and making a gradual transition to cloud. It may be concluded cloud project management is here to stay and in fact will only become more popular (Bianchini et al., 2020).

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