Current and Potential Utilisation of Cloud Computing for a Further Education Provider

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Introduction

This document explores the usage of cloud technology within [OMMITED FOR ANONYMITY], a further education provider. As well as current usage, this report will review how cloud computing could be utilised further in [OMMITED FOR ANONYMITY], where it isn't implemented already.

Use of Cloud Deployment Models

[OMMITED FOR ANONYMITY] would be considered a hybrid environment due to its use of both on-premises and cloud-based deployments. On-premises technology is often used in [OMMITED FOR ANONYMITY] to meet bespoke requirements of the business that either are not achievable through external providers or would require drastic changes of the college's procedures. An example of this would be the enrolment system, which is a web application for enrolling students, hosted on a server on-site. The creation of the [OMMITED FOR ANONYMITY] enrolment system is shaped specifically around the college's enrolment processes and cohort of students; hence why it is hosted on-premises by [OMMITED FOR ANONYMITY] directly.

This is not to say that these services cannot be hosted in the cloud. Using the same example, the enrolment system could be hosted in the cloud and result in benefits such as increased scalability, since the IT resources would not be reliant on a single server, as echoed by Google (2023), a widely used cloud provider. This would be advantageous for the enrolment system since the volume of traffic it receives fluctuates greatly at fixed times of the year, thus the IT resources for it could scale accordingly. Although, the potential drawbacks of shifting these on-premises solutions to the cloud must also be considered, an example being that downtime of systems would occur if the company network failed, since it would always be reliant on an internet connection (Apostu et al, 2013, p121).

These on-premises services exist in [OMMITED FOR ANONYMITY] alongside Microsoft 365 for uses such as business applications and online file storage (Microsoft, 2023d). Microsoft 365 is a cloud-based, software as a service (SaaS) deployment model since the applications are hosted by the cloud provider and accessed over the internet (Microsoft, 2023f). One of the key reasons [OMMITED FOR ANONYMITY] uses Microsoft 365 is for SharePoint, which allows files to be uploaded, accessed, and shared across the organisation (Microsoft, 2023g). This enables most stakeholders in [OMMITED FOR ANONYMITY] to easily work with the same files and even access them outside of the campuses, providing they are connected to the company network. Notably, [OMMITED FOR ANONYMITY]'s mixture of on-premises and cloud-based systems seems in-line with most other schools' implementations in the UK, according to a survey by the Department for Education (2021).

Cloud Data Architecture

In terms of how [OMMITED FOR ANONYMITY]'s data architecture operates, the business currently employs an on-premises methodology. A data warehouse, hosted on a server on site, is heavily utilised for this. This is defined as a data management system created from numerous sources, as described by cloud provider Oracle (2023). The present process is that data is extracted, transformed, and loaded into the data warehouse and then visualised using Microsoft Power BI, SQL Server Reporting Services or Microsoft Excel.

While [OMMITED FOR ANONYMITY]'s data warehouse has proved invaluable over the years for insights, there is scope for improving the current data architecture. One of the more straightforward

implementations to achieve this could be to upgrade from the on-premises Power BI Report Server to the Power BI Service, in other words using the SaaS version of the product. The main benefit of this upgrade would be that Power BI could integrate directly with other Microsoft 365 services (Microsoft 2023b). [OMMITED FOR ANONYMITY] could use this functionality to visualise Microsoft Excel spreadsheets stored in SharePoint as an example. There are other notable benefits as well, notably the ability to create real-time dashboards and receive alerts on the data (Microsoft 2023b).

A more significant change could be to shift to a modern, cloud-based data architecture. Since [OMMITED FOR ANONYMITY] is mostly Microsoft oriented in terms of its technologies, Microsoft Azure Data Lake could be implemented as a step for achieving modern data architecture. One of the ways [OMMITED FOR ANONYMITY] stands to gain from this is that extract, load and transform pipelines could then be implemented via tools such as Hadoop and Spark (Microsoft, 2023c). This would be useful in scenarios such as when education legislation or business rules change and causes the shape of the data to change, which in turn needs reflecting across [OMMITED FOR ANONYMITY]'s databases. This has proved challenging in the past where most data has already been transformed for the business' needs. However, it needs reiterating that migrating to the cloud has potential drawbacks, such is being locked into the cloud vendor as switching to another provider becomes too difficult for reasons including costs or technical implications (Central Digital and Data Office, 2019).

Cloud Database Formats

[OMMITED FOR ANONYMITY] has almost exclusively employed relational databases within the data warehouse up to this point in time. This consists of data stored in formats such as star or snowflake schemas (Oracle, 2002). This has proved effective for the array of structured data sources available to [OMMITED FOR ANONYMITY] and has enabled analysis to be performed on key business performance indicators such as student attendance. Though the benefits of this database format can still be leveraged, there exists opportunities to make use of other types of databases by using cloud technologies.

If [OMMITED FOR ANONYMITY] were to migrate to a cloud-based solution, additional database formats could be made use of, including unstructured and NoSQL databases. MongoDB Inc. (2023), a provider of such databases, states that cloud storage would allow for the hosting of unstructured data whilst enabling the systems to capably scale since physical hardware upgrades would not have to be performed on site-based servers using this method. Consequently, this would mean that [OMMITED FOR ANONYMITY] could henceforth leverage unstructured data types such as images, internet of things (IoT) and large text files.

By combining the use of these cloud-oriented database formats with modern data architecture, [OMMITED FOR ANONYMITY] could achieve functionality not previously possible. An example which [OMMITED FOR ANONYMITY] could replicate, could be to use unstructured data generated from remote e-learning platforms, processing the data using methods such as Hadoop clusters (Logica and Magdalena, 2015, p285) and then utilising the velocity of this data to provide feedback to students in real time or even make amendments to the course environment during the lesson (Logica and Magdalena, 2015, p279). Another use case could be to use the unstructured data from student or staff surveys and perform sentiment analysis to obtain a better understanding on the overall impressions from the surveys.

Ethical & Legislative Implications of Cloud Computing

Often, one of the greatest concerns when adopting the cloud are the ethical and legislative implications of this technology; [OMMITED FOR ANONYMITY] would share this apprehension. For starters, if a full cloud-based model was implemented, the college's own policies would have to be reviewed, and potentially updated, in accordance with this. The [OMMITED FOR ANONYMITY] Data Protection Policy is likely the most prominent example of this. In particular, the sections pertaining to the controlling, processing, and sharing of data may need to be reviewed by the relevant stakeholders of the college, like the Data Protection Team and ICT Team, in case incorporating the cloud requires these to be amended.

In terms of the legislative impact, [OMMITED FOR ANONYMITY] must be cautious the way it implements the cloud to ensure compliance with relevant laws, including the UK General Data Protection Regulation and Data Protection Act. One significant aspect of them relates to the processing of special category data. This is because in the UK, data relating to certain characteristics of persons can only be processed under certain conditions, such as vital interest, and must be utilised fairly (Information Commissioner's Office, 2023). For instance, if [OMMITED FOR ANONYMITY] created a machine learning model based on cloud data which discriminated against a special category belonging to its students, inadvertent or otherwise, this would violate the law. This can serve as an example of how the legal requirements must be considered if new cloud technologies were incorporated into the college.

To ensure [OMMITED FOR ANONYMITY] is in the best position for governing ethical and legislative concerns related to the cloud, best practices should be employed. To name some, proper identity access management (IAM), encryption of data (both in transit and at rest) and cloud security controls (Paul and Aithal, 2019, p3-4). Focusing on IAM, If [OMMITED FOR ANONYMITY] were to use Microsoft's cloud services, Microsoft Entra ID could be integrated which would enable the college to properly control access within the cloud environment, while also benefiting from the integration of the compatible services that the college currently uses (Microsoft, 2023e).

Cloud Data Engineering

With [OMMITED FOR ANONYMITY]'s current on-premises environment, the majority of data engineering processes occur overnight via extract, transform and load (ETL) scripts to update data from various systems and sources in the data warehouse. Consequently, this batch processing approach means that anything using the warehoused data, including reporting, is limited to updating on a daily basis. A key reason that this methodology exists is to prevent slowing down of systems or crashes caused by excessive activity, during the college's operating hours. However, if the college were to migrate to a cloud-based solution, this would create opportunities to implement alternative data engineering strategies.

Streaming data is a prominent avenue for how [OMMITED FOR ANONYMITY] could benefit from cloud data engineering. This format would allow for the processing of data to happen almost near real-time, a substantial increase on the current methodology. By creating streaming data pipelines, micro batches or even single records of data can be processed extremely quickly using cloud services such as Amazon Kinesis (Amazon Web Services, 2023). This enhancement to data velocity would open new possibilities

for the college's data to be utilised, such as creating a streaming pipeline for ID badge scans when students and staff enter and exit the campuses. Where this would allow monitoring of all persons on-site, it could prove invaluable for accounting of all persons in emergencies like fires.

It is also worth mentioning the elasticity of cloud technology, where computing resources can scale up or down on demand (Al-Dhuraibi et al, 2017, p430-431), is useful in these cases. With the aforementioned example, it could scale upwards during the times when large volumes of people are entering or leaving the campuses, and downwards all other times. This versatility is not possible or difficult to achieve with the college's current infrastructure since it is challenging to adjust the resources on physical servers quickly.

Cloud-Driven Organisational Realignment

The adoption of cloud-based solutions could contribute to [OMMITED FOR ANONYMITY]'s strategic priorities, especially the aim of being a "pioneer for the adoption of technology". With respect to this, the college could be considered on par with other educational providers where, like other UK schools, it uses cloud computing for purposes including remote learning and managing of files (Department for Education, 2022, p62). Ergo, it could be surmised that if [OMMITED FOR ANONYMITY] were to increase its use of cloud technology then this would further contribute to this strategic aim.

A way in which this could be achieved is by introducing cloud-based machine learning models, since this technology is not in use at the college currently. Considering [OMMITED FOR ANONYMITY]'s use of Microsoft products, Azure Machine Learning (Microsoft, 2023a) may be a viable option for this. For instance, a machine learning model could be created that can identify the contributing and detrimental factors to a learner's success in the college using inputs like student attendance. If implemented correctly, this may advance [OMMITED FOR ANONYMITY] in digital transformation and the resulting data could even be used to enhance the quality of education, another of [OMMITED FOR ANONYMITY]'s values. Although, as stated in the section pertaining to cloud ethical & legislative implications, the college must exercise caution in ensuring that these models, and their usage, do not create ethical dilemmas or break laws.

Another angle to consider is that further adoption of cloud technology may cause or require structural changes within [OMMITED FOR ANONYMITY]. Likely, the most obvious one is the upskilling of relevant areas in the college, particularly the ICT Team. Where these new technologies may require new skills, training for staff and potentially even hiring of new employees may be necessary to facilitate this. This may be an area of concern for [OMMITED FOR ANONYMITY] since technical ability is one of the most prominent barriers to UK schools in becoming fully cloud-based (Department for Education, 2022, p62).

Concluding Thoughts

Although [OMMITED FOR ANONYMITY] can be considered a hybrid environment, due to its use of both on-premises and cloud-based technologies, the college's use of the cloud is limited to mainly file sharing and remote delivery of learning. There are many ways in which its use of the cloud can be extended for the purpose of benefitting the organisation, such as advancing in its strategic priorities, though equally there may exist as many risks if implemented improperly, including ethical issues. Therefore, further adoption of cloud computing should be considered but with due diligence, perhaps by consulting other cloud focused educational providers or cloud consultants for creating an effective adoption strategy.

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