**Cloud Computing on Big Smile**

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# **Introduction**

Here on Big Smile we are dedicated to the art of crafting smiles, because we believe that a radiant and confident smile can impact people positively and change the way people are perceived. The journey of our company has been marked by the pursuit of excellence and client satisfaction. However, as with any other modern business we must stay up to date with the latest technologies and have the perception of when and how to use them to gain efficiency, reduce costs and overcome challenges.

As we know, Big Smile has been succeeding in offering quality dental services and thus receiving each time more positive recognition in the market and expanding its patient base. However, it is important to notice that our current IT infrastructure, while suitable for a small client base, will start to impose constraints in terms of scalability and accessibility soon as we begin to provide our services to a larger number of patients.

In addition to that, Big Smile must also start looking more responsibly into the security of its patient’s data. Data security and anonymity have been the subject of legal battles more often in the last years, and we cannot afford to risk our company’s growing reputation. More than that, many companies have been sued and lost millions for neglecting data security and leaking client’s personal information. And as a cosmetic dental company, Big Smile does hold several patients’ personal and sensitive data, like payment information, document numbers, address, patient records, and sensitive medical information that requires due protection and anonymity. To meet the stringent requirements set forth by healthcare regulations such as the Health Insurance Portability and Accountability Act (HIPAA), we require a solution that is not only robust but also failsafe.

Moreover, as Big Smile moves up in the dental health market, we will start to compete against larger dental companies. And to stand out and overcome the competition, Big Smile must understand patients’ preferences, have the courage to innovate and the ability to adapt. To achieve that, we can make use of services like advanced analytics, real-time collaboration, and customer relationship management tools.

These are just some of the challenges we need to overcome in order to effectively take the next step as a business. And as though as it can sound overwhelming, we shall remember that we are not the first company to come against these challenges, and that the road ahead of us was already paved with tools that can ease this process heavily. The standard solution nowadays for many problems like the ones faced by Big Smile is cloud computing, and on this report, I’ll dissert on the reasons why I believe Big Smile could benefit from implementing cloud computing services and the needs it can address with it.

The goal of this report is not to discuss abstract possibilities, but rather to objectively compare different cloud service providers and critically analyze and propose the application of cloud solutions to the real world challenges faced by Big Smile.

# **Cloud Computing**

# Benefits

Some of the benefits of cloud computing that would fit Big Smile’s need are:

* Scalability and Flexibility

Cloud computing provides the critical advantage of scalability and flexibility. As a small but rapidly growing dental company, it is hard to predict, for example, how many clients Big Smile will have in 6 months. That is why it is important to have the ability to scale computing resources, so the company can respond to these fluctuations in patient load and business growth. This elasticity ensures that the company can efficiently manage increased data storage requirements, accommodate additional employees, and expand its digital infrastructure to support new services or even geographic locations. And in the same way, if eventually the company loses a significant number of clients and doesn’t need as many resources anymore, it is easy to reduce the resources hired and cut costs. That’s a big difference from traditional on-premises solutions, where the company invests in physical hardware and infrastructure, what limits their possibilities and increases the prices when there is need to increase their infrastructure. And in case of scaling down, the traditional physical hardware is also inefficient, because it usually results in resources being underutilized, while in cloud solutions the company doesn’t need to worry about physical infrastructures.

* Cost Efficiency

Cost efficiency is a critical consideration for any business, especially for a small company that does not yet have the financial power of its larger competitors. Cloud computing offers a pay-as-you-go model, where expenses are closely tied to actual resource consumption. That contrasts with the traditional physical hardware approach that requires a significant investment upfront in equipment like servers, storage, and networking equipment, along with ongoing maintenance costs. The cloud solution also provides more cost predictability, which would allow Big Smile to allocate resources strategically, ensuring the investments align with the necessities and optimizing budget allocation for patient care and business expansion.

* Data Security and Compliance

As exposed beforehand, data security is a matter of discussion to every company that collects client data. As a dental service provider, Big Smile operates within the highly regulated healthcare sector and must comply with the Health Information Privacy Code from 2020, that states that sensitive patient data, treatment records, and medical histories should be safeguarded from unauthorized access. And it may be difficult for a small dental company to have, on-site, the same levels of data security it would have on a cloud-based system. Providers of cloud computing make significant investments in robust security safeguards, encryption protocols and compliance certifications. These precautions guarantee that private patient information is protected from unauthorized access or unwanted breaches. Big Smile can reduce the difficulties of data security and compliance by utilising these cloud services, allowing them more time to focus on patient care and the dental service excellence.

* Accessibility

Another big benefit is the accessibility factor. Using cloud services, whoever needs to manage or access the company’s data or systems, can do so from anywhere in the world, if authorized by the company. And although in most cases employees will be working from the company, specially when it is a small sized company, working from home is becoming more and more common, and usually

The accessibility and mobility features of cloud computing significantly enhance Big Smile's operational efficiency. Dental practitioners and staff can securely access patient records, appointment schedules, and treatment plans from any location with an internet connection. This remote accessibility streamlines patient care by facilitating real-time collaboration among team members, enabling timely consultations, and reducing administrative bottlenecks.

In contrast, relying solely on on-premises systems limits accessibility to the physical office environment, hindering flexibility and responsiveness to patient needs. Cloud services empower Big Smile to transcend geographical constraints, ultimately benefiting both practitioners and patients through improved communication and more convenient scheduling.

* Disaster Recovery and Business Continuity

Cloud computing provides Big Smile with a robust disaster recovery solution, mitigating the risks associated with data loss and downtime. Cloud providers maintain redundant data centers in geographically diverse locations, ensuring data resilience and availability even in the face of unexpected events, such as hardware failures, natural disasters, or cyberattacks.

In contrast, on-premises data backup and recovery solutions can be cumbersome, costly, and less reliable. The potential consequences of data loss in a healthcare setting are profound, ranging from compromised patient care to regulatory penalties. Cloud-based disaster recovery safeguards Big Smile's critical patient data, treatment histories, and operational continuity, reinforcing the practice's commitment to unwavering dental care provision.

In summary, cloud computing offers Big Smile a strategic advantage by addressing specific business needs and goals. These advantages encompass scalability and flexibility, cost efficiency, data security and compliance, accessibility and mobility, and disaster recovery. By adopting cloud solutions, Big Smile can position itself for sustainable growth, cost-effective operations, enhanced data protection, streamlined patient care, and resilient business continuity within the dynamic landscape of cosmetic dentistry.

# Popular Cloud Service Providers

Amazon Web Services (AWS):

Key Features and Advantages:

Elasticity and Scalability: AWS offers a wide array of scalable computing resources, including Amazon EC2 instances and AWS Lambda, which align perfectly with Big Smile's need for scalability.

Security: AWS provides robust security features, including Identity and Access Management (IAM), encryption, and DDoS protection, ensuring the safety of patient data.

HIPAA Compliance: AWS offers HIPAA-compliant services, crucial for healthcare providers like Big Smile.

Data Analytics: AWS has powerful analytics tools like Amazon Redshift and QuickSight that can assist in patient data analysis.

Microsoft Azure:

Key Features and Advantages:

Integrated Ecosystem: Azure's integration with Windows OS and Microsoft tools like Office 365 can enhance the productivity and collaboration of Big Smile's staff.

Azure Health Data Services: Tailored for healthcare, this service helps in secure data management and compliance.

Azure Site Recovery: Ensures business continuity by providing disaster recovery solutions.

Google Cloud Platform (GCP):

Key Features and Advantages:

Data Analytics: GCP offers BigQuery and Dataflow for advanced data analytics, which can be valuable for patient data analysis.

Machine Learning: Google's expertise in AI and machine learning can aid in patient diagnostics and treatment planning.

Security: GCP provides encryption and identity management services, enhancing data security.

Alibaba Cloud:

Key Features and Advantages:

Global Presence: With a strong presence in Asia, Alibaba Cloud can be suitable for Big Smile if expansion into that region is on the horizon.

Elastic Computing: Alibaba Cloud Elastic Compute Service (ECS) allows for dynamic scaling.

Database Services: Offers a variety of database options for patient record management.

Oracle Cloud:

Key Features and Advantages:

Healthcare Solutions: Oracle Cloud provides industry-specific solutions, including healthcare, which may align well with Big Smile's requirements.

Database Services: Oracle's expertise in databases can be beneficial for managing patient records.

Security: Oracle Cloud offers robust security features.

IBM Cloud (Kyndryl):

Key Features and Advantages:

Hybrid Cloud Solutions: IBM Cloud offers hybrid cloud solutions, which could be valuable if Big Smile wants to maintain some on-premises infrastructure.

Security and Compliance: IBM Cloud has a strong focus on security and compliance, catering to the healthcare industry's stringent requirements.

DigitalOcean:

Key Features and Advantages:

Simplicity: DigitalOcean is known for its simplicity and ease of use, which can be advantageous for smaller businesses like Big Smile.

Scalability: While it may not offer the same breadth of services as larger CSPs, DigitalOcean's services can scale effectively for growing businesses.

Cost-Effectiveness: DigitalOcean is cost-effective and transparent in its pricing, which can be suitable for businesses on a budget.

Evaluation:

AWS, Azure, and GCP offer comprehensive healthcare-specific solutions, making them strong contenders for Big Smile, particularly due to their robust security and data analytics offerings.

Alibaba Cloud might be considered if Big Smile plans to expand into the Asian market.

Oracle Cloud could be a choice if Big Smile seeks industry-specific solutions and has a preference for Oracle databases.

IBM Cloud (Kyndryl) may be suitable if Big Smile requires a hybrid cloud approach, combining cloud services with on-premises infrastructure while maintaining a focus on security and compliance.

DigitalOcean is a cost-effective option for small businesses but may lack some of the specialized healthcare features of larger CSPs.

In conclusion, the choice of CSP for Big Smile should be based on its specific requirements, including scalability, data security, compliance, and data analytics needs, while considering factors like budget and expansion plans. Each CSP offers unique advantages, and a careful evaluation is essential to align the selected provider with the company's goals and objectives.

# Regions and Availability Zones

here is an analysis of the number of regions and availability zones offered by each of the specified Cloud Service Providers (CSPs) and how their geographical distribution can impact the operations, data resilience, and performance of Big Smile:

Amazon Web Services (AWS):

Regions: AWS operates in 25 geographic regions worldwide, with multiple availability zones in most regions.

Availability Zones: There are currently over 80 availability zones globally.

Microsoft Azure:

Regions: Microsoft Azure boasts a presence in 60+ regions worldwide, which includes Azure Government regions.

Availability Zones: Azure offers more than 160 availability zones across its regions.

Google Cloud Platform (GCP):

Regions: GCP spans 26 regions, providing global coverage.

Availability Zones: Google has multiple availability zones within most of its regions.

Alibaba Cloud:

Regions: Alibaba Cloud operates in 25 regions worldwide, including regions in Asia, Europe, the Americas, and the Middle East.

Availability Zones: Alibaba Cloud provides multiple availability zones in most of its regions.

Oracle Cloud:

Regions: Oracle Cloud offers 30+ regions across the Americas, Europe, Asia, and the Middle East.

Availability Zones: Availability zones are available within many of Oracle's regions.

IBM Cloud (Kyndryl):

Regions: IBM Cloud has a presence in 60+ global regions.

Availability Zones: IBM typically offers multiple availability zones in most regions.

DigitalOcean:

Regions: DigitalOcean operates data centers in multiple regions, including North America, Europe, Asia-Pacific, and more.

Availability Zones: DigitalOcean's availability zones vary by region, with some regions having multiple zones.

Analysis:

Data Resilience: The presence of multiple regions and availability zones across these CSPs enhances data resilience for Big Smile. In the event of a regional outage or hardware failure, data can be seamlessly replicated to alternative locations, minimizing downtime and data loss.

Performance: Geographical distribution of regions and availability zones can improve performance by reducing latency. Proximity to data centers allows for faster data retrieval and application responsiveness, critical for real-time patient care.

Disaster Recovery: The availability of numerous regions and zones enables effective disaster recovery planning. Big Smile can design robust disaster recovery strategies that involve replicating data and applications to geographically distant regions for failover, ensuring uninterrupted services.

Data Sovereignty: Depending on regulatory requirements, Big Smile may need to store patient data within specific geographic regions. The CSPs' diverse regional presence allows flexibility in adhering to data sovereignty laws and regulations.

Scalability: The geographic distribution of regions and availability zones supports scalability. Big Smile can expand its operations into new geographic areas, leveraging the CSPs' local data centers to meet growing patient demands.

Redundancy: The redundancy offered by multiple regions and availability zones minimizes the risk of data loss and service interruptions, reinforcing Big Smile's commitment to patient data security and business continuity.

In conclusion, the extensive global presence of these CSPs, with multiple regions and availability zones, provides Big Smile with the geographical diversity needed to enhance operations, strengthen data resilience, optimize performance, ensure regulatory compliance, and support the scalability and redundancy requirements of a growing cosmetic dental company. The choice of CSP should consider the alignment of these geographical capabilities with Big Smile's specific needs and strategic objectives.

Cost Analysis of Cloud Service Providers

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# **Regions and Availability Zones**

According to the AWS website (2023), “the AWS Cloud spans 102 Availability Zones within 32 geographic regions around the world, with announced plans for 12 more Availability Zones and 4 more AWS Regions in Canada, Malaysia, New Zealand, and Thailand”.

Amazon Web Services

|  |  |  |
| --- | --- | --- |
|  | Region | Availability Zones |
| NORTH AMERICA | US West (Oregon) | 4 |
| US East (Northern Virginia) | 6 |
| US West (Northern California) | 3 |
| US East (Ohio) | 3 |
| Canada (Central) | 3 |
| GovCloud (US-West) | 3 |
| GovCloud (US-East) | 3 |
| SOUTH AMERICA | Brazil (São Paulo) | 3 |
| EUROPE | Europe (Ireland) | 3 |
| Europe (Frankfurt) | 3 |
| Europe (London) | 3 |
| Europe (Paris) | 3 |
| Europe (Stockholm) | 3 |
| Europe (Milan | 3 |
| Europe (Zurich) | 3 |
| Europe (Spain) | 3 |
| MIDDLE EAST | Middle East (Bahrain) | 3 |
| Middle East (UAE) | 3 |
| Israel (Tel Aviv) | 3 |
| AFRICA | Africa (Cape Town) | 3 |
| ASIA PACIFIC | Asia Pacific (Singapore) | 3 |
| Asia Pacific (Tokyo) | 4 |
| Asia Pacific (Seoul) | 4 |
| Asia Pacific (Mumbai) | 3 |
| Asia Pacific (Hong Kong) | 3 |
| Asia Pacific (Osaka) | 3 |
| Asia Pacific (Jakarta) | 3 |
| AWS Asia Pacific (Hyderabad) | 3 |
| Mainland China (Beijing) | 3 |
| Mainland China (Ningxia) | 3 |

Microsoft Azure

|  |  |  |
| --- | --- | --- |
|  | Region | Availability Zones |
| NORTH AMERICA | Canada Central | 3 |
| Central US | 3 |
| East US | 3 |
| East US 2 | 3 |
| South Central US | 3 |
| US Gov Virginia | 3 |
| West US 2 | 3 |
| West US 3 | 3 |
| SOUTH AMERICA | Brazil South | 3 |
| EUROPE | France Central | 3 |
| Italy North\* | 3 |
| Germany West Central | 3 |
| Norway East | 3 |
| North Europe | 3 |
| UK South | 3 |
| West Europe | 3 |
| Sweden Central | 3 |
| Switzerland North | 3 |
| Poland Central | 3 |
| MIDDLE EAST | Qatar Central | 3 |
| UAE North | 3 |
| Israel Central\* | 3 |
| AFRICA | South Africa North | 3 |
| ASIA PACIFIC | Australia East | 3 |
| Central India | 3 |
| Japan East | 3 |
| Korea Central | 3 |
| Southeast Asia | 3 |
| East Asia | 3 |
| China North 3 | 3 |

Google Cloud Platform

|  |  |  |
| --- | --- | --- |
|  | Region | Availability Zones |
| NORTH AMERICA | Montréal | 3 |
| Toronto | 3 |
| Council Bluffs | 4 |
| Moncks Corner | 3 |
| Ashburn | 3 |
| Columbus | 3 |
| The Dalles | 3 |
| Los Angeles | 3 |
| Salt Lake City | 3 |
| Las Vegas | 3 |
| Dallas | 3 |
| SOUTH AMERICA | Osasco, São Paulo, Brazil | 3 |
| Santiago, Chile | 3 |
| EUROPE | Hamina, Finland | 3 |
| Warsaw, Poland | 3 |
| Madrid, Spain | 3 |
| St. Ghislain, Belgium | 3 |
| London, England | 3 |
| Frankfurt, Germany | 3 |
| Eemshaven, Netherlands | 3 |
| Zurich, Switzerland | 3 |
| Milan, Italy | 3 |
| Paris, France | 3 |
| Berlin, Germany | 3 |
| Turin, Italy | 3 |
| MIDDLE EAST | Doha, Qatar | 3 |
| Dammam, Saudi Arabia | 3 |
| Tel Aviv, Israel | 3 |
| ASIA PACIFIC | Changhua County, Taiwan | 3 |
| Hong Kong | 3 |
| Tokyo, Japan | 3 |
| Osaka, Japan | 3 |
| Seoul, South Korea | 3 |
| Mumbai, India | 3 |
| Melbourne, Australia | 3 |
| Sydney, Australia | 3 |
| Jurong West, Singapore | 3 |
| Delhi, India | 3 |

# **Price Simulation**

On this section I will illustrate the price comparison between Amazon Web Services, Microsoft Azure, and Google Cloud Platform, comparing results of price simulations made through the official platform of the three cloud service providers. In order to have a fair comparison, I have made an equivalent simulation for the three cloud service providers, consider the hiring of a virtual machine service with 4 virtual CPUs and 16 GB of RAM available. I have also considered that the service would be hired for 3 years, what implied in significant discounts on all the three simulations. I have also chosen free licensed Linux distributions to run on the virtual machines, so operating system license prices wouldn’t affect the final simulation cost. Prices are shown in US dollars because that is the only currency displayed in the Amazon Web Services simulation platform, so the other two platforms were set to use the same currency for comparison purposes.

Amazon Web Services

The amazon cloud solution was the one with the lowest price. According to the simulation results, a 4 virtual CPUs and 16 GB RAM virtual machine would cost 53.66 USD per month. The price became significantly lower because the simulation was for the service to be reserved for a three-year period. In addition to the monthly payment, the platform also provides the options of paying upfront, which would decrease the total cost in around 250 USD, or paying a partial value upfront and the remaining monthly.  
  
Amazon EC2

1 instance  
4 virtual CPUs

16 GB of RAM memory

$53.66 monthly / $1679.29 upfront / $893.52 upfront plus $24.82 monthly

Microsoft Azure

Simulating the hiring of a virtual machine with the same specifications, the Microsoft cloud solution would charge a bit more than the service from Amazon. The price would be of 57.99 American Dollars per month, and it already includes a generous discount of around 62 percent for reserving the service for the next three years. Like AWS, Microsoft Azure also provides the option of upfront payment, however it does not increase the discount. Azure also does not provide a hybrid payment option of upfront plus monthly payments.

Microsoft Azure Virtual Machine B4ms

1 instance  
4 virtual CPUs

16 GB of RAM memory

$57.97 monthly / $2086.89 upfront / $893.52

Google Cloud Platform

Simulating the hiring of a virtual machine with the same specifications, the cloud solution from Google presented the highest cost of the three. Reserving the service for three years implied in a discount of more than 50%, reducing the price to $62.47. In this simulation, there was no option to pay the value upfront.

Google Cloud Compute Engine e2-standard-4

1 instance  
4 virtual CPUs

16 GB of RAM memory

$62.47 monthly / $2086.89 upfront / $893.52

# **Conclusion**

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