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THE EVOLUTION OF AND IMPACT OF CLOUD COMPUTING IN THE DIGITAL ERA ADAM ZACKHARY BIN HALIM DAYANG NUR NAZIHAH BINTI M ROSLAN MUHAMMAD IMRAN BIN ROSLI NGE ZHE YU NUR RISA EMYLIA BINTI MOHD KHAIRIN YAESHVAANT A/L SELVAM UNIVERSITI TEKNOLOGI MALAYSIA ABSTRACT Cloud computing has revolutionized the way

organizations manage digital and IT resources, evolving from a basic data storage solution in the early 2000s to a comprehensive platform offering services related to infrastructure, platform development, and software applications. This report explores the evolution of cloud computing and its profound impact across sectors such as business, healthcare, education, and government. Cloud computing enables organizations to achieve greater scalability, cost-efficiency, and rapid innovation, with widespread adoption of public, private, and hybrid cloud models. These models allow businesses to optimize resource allocation, streamline operations, and foster collaboration, making cloud technology a critical component in today's digital landscape.Despite its many advantages, the rapid growth of cloud computing also presents significant challenges. Organizations must navigate complex issues related to security risks, data privacy, and compliance with international regulations, particularly in sensitive sectors like healthcare and government services. The increasing reliance on cloud technology for critical infrastructure heightens the need for robust security measures and regulatory adherence to protect personal and organizational data.This report also delves into the broad applications of cloud computing, including data storage, software development, big data analytics, collaboration tools, e-commerce, and the Internet of Things (IoT). While these applications offer vast opportunities for efficiency and innovation, they also underscore the need to address the risks associated with cloud adoption. Understanding the evolution of cloud computing, its benefits, and its challenges is essential for stakeholders looking to harness its full potential while mitigating associated risks and ensuring long-term sustainability. ABSTRAK Pengkomputeran awan telah merevolusikan cara organisasi mengurus sumber digital dan IT, berkembang daripada penyelesaian penyimpanan data asas pada awal 2000-an kepada platform yang komprehensif yang menawarkan perkhidmatan berkaitan infrastruktur, pembangunan platform dan aplikasi perisian. Laporan ini meneroka evolusi pengkomputeran awan dan kesannya yang mendalam ke atas sektor seperti perniagaan, penjagaan kesihatan, pendidikan, dan kerajaan. Pengkomputeran awan membolehkan organisasi mencapai kebolehskalaan yang lebih besar, kecekapan kos, dan inovasi yang pantas dengan penggunaan model awan awam, swasta, dan hibrid secara meluas. Model-model ini membolehkan perniagaan mengoptimumkan peruntukan sumber, menyelaraskan operasi, dan meningkatkan kerjasama, menjadikan teknologi awan komponen penting dalam landskap digital masa kini.Walaupun mempunyai banyak kelebihan, pertumbuhan pesat pengkomputeran awan juga membawa cabaran besar. Organisasi perlu menghadapi isu-isu kompleks berkaitan risiko keselamatan, privasi data, dan pematuhan terhadap peraturan antarabangsa, terutamanya dalam sektor sensitif seperti penjagaan kesihatan dan perkhidmatan kerajaan. Kebergantungan yang semakin meningkat terhadap teknologi awan untuk infrastruktur kritikal meningkatkan keperluan untuk langkah keselamatan yang teguh dan pematuhan peraturan bagi melindungi data peribadi dan organisasi.Laporan ini juga menerangkan tentang aplikasi luas pengkomputeran awan, termasuk penyimpanan data, pembangunan perisian, analitik data besar, alat kerjasama, e- dagang, dan Internet Benda (IoT). Walaupun aplikasi ini menawarkan peluang besar untuk kecekapan dan inovasi, ia juga menekankan keperluan untuk menangani risiko yang berkaitan dengan penggunaan awan. Memahami evolusi pengkomputeran awan, manfaatnya, dan cabarannya adalah penting untuk para pemegang kepentingan yang ingin memanfaatkan sepenuhnya potensinya sambil mengurangkan risiko yang berkaitan dan memastikan kelestarian jangka panjang. TABLE OF CONTENTS TITLE PAGE ABSTRACT ABSTRAK TABLE OF CONTENTS LIST OF TABLES LIST OF FIGURES LIST OF ABBREVIATIONS LIST OF APPENDICES iii i ii iv v vi vii CHAPTER 1 1.1 1.2 1.3 CHAPTER 2 2.1 2.2 CHAPTER 3 3.1 3.2 3.3 CHAPTER 4 4.1 INTRODUCTION Problem Background Problem Statement Research Question TYPES OF CLOUD COMPUTING Types of Cloud Computing

Application of Cloud Computing EVOLUTION OF CLOUD COMPUTING Early Concepts and Technologies Development of Virtualization Current Trends and Future Directions 3.3.1 AI as a Service (AIaaS) 3.3.2 Hybrid & Multi-Cloud Strategies 3.3.3 Edge AI Computing 3.3.4 Sustainable Cloud Computing IMPACT OF CLOUD COMPUTING Economic Effects 4.1.1 Economic Benefits 1 1 1 2 3 3 4 7 7 8 10 10 10 10 11 12 12 13 ii 4.2 4.3 4.4 4.5 CHAPTER 5 5.1 5.2 5.3 5.4 5.5 5.6 5.7 CHAPTER 6 6.1 6.2 REFERENCES Operational Efficiency Convenient Collaboration Environmental Considerations Conclusion CHALLENGES IN CLOUD COMPUTING Introduction Security and Privacy Issues Compliance and Legal Concern 5.3.1 Data Privacy and Protection Regulations Downtime and Reliability Vendor Lock-in Cost Management Chapter Summary CONCLUSION Research Outcomes Contribution to knowledge 13 14 15 16 17 17 17 19 19 20 21 21 22 23 23 23 25 iii LIST OF TABLES TABLE NO. TITLE Table 5.1 Security Incident in Cloud Computing iv PAGE 19 LIST OF FIGURES FIGURE NO. TITLE Figure 2.1 Applications of Cloud Computing Figure 3.1 Central Mainframe Computer in 1990s Figure 4.1 Economic Impact between Relative Price Production and Direct Price Figure 4.2 Examples of an Improved Collaboration and Accessibility Figure 4.3 Environmental Considerations Differences Around Traditional Data Center and Cutting-Edge Data Center PAGE 4 8 12 14 15 v LIST OF ABBREVIATIONS AIaaS API AWS CapEx CRM CSP ERP GDPR HIPAA IAM ICT IoT IT LAN OpEx PHI PII SDK VPN WAN - Artificial Intelligence as a Service Application Programming Interface Amazon Web Services Capital Expenditure Customer Relationship Management Cloud Service Provider Enterprise Resource Planning General Data Protection Regulation Health Insurance Portability and Accountability Act Identity and Access Management Information and Communication Technology Internet of Things Information Technology Local Area Network Operational Expenditure Personal Health Information Personally Identifiable Information Software Development Kit Virtual Private Network Wide Area Network vi LIST OF APPENDICES APPENDIX TITLE PAGE Appendix A Presentation Slide 27 Appendix B Turnitin Originality Report 41 vii CHAPTER 1 INTRODUCTION 1.1 Problem Background Cloud computing has revolutionized the way many organizations operate and interact with the digital worlds and IT resources. From its humble beginnings in the 2000s, where it began as a basic way for large organizations to store their data's without investing in private resources, to a more mature platform where it is able to provide services that is related to infrastructures, platforming, and software. With this, many company are able to scale operations efficiently, reduce costs, and innovate rapidly. With time, cloud computing has received its numerous fair of challenges. This ranges from security concerns that the company may not notice, data privacy that are breached and is being exploited everyday, and international regulatory that are not complied with are the many of the issues that it has to circumvent. With the ever increasing reliance on cloud computing technology from more critical infrastructures such as hospitals and government facilities. Understanding the history and the what's of cloud computing, is crucial for every stakeholder relying on this infrastructure to make informed decision and use this technology to its full potential. 1.2 Problem Statement Ever since the invention of cloud computing in 1990s and its popularity in the 2000s, it has evolved rapidly throughout the years, significantly transformed the digital landscape. Cloud computing has impacted various sectors including businesses, healthcare, education, and government with mass adoptions around the world. It has proved itself to be one of the more important inventions of humanity providing massive benefits for everyone. Despite its positives, there are ongoing challenges related to the security, privacy, and regulatory compliance. This study aims to explore the evolution of cloud computing and its enormous impact on the digital era that we are currently living in whilst identifying the benefits and deficits it presents 1.3 Research Question How has the evolution of cloud

computing change the landscape of the digital era, what are its impact on a broader scale? What is the benefits and the deficits associated with this technology with its adoptions across different sectors. CHAPTER 2 TYPES OF CLOUD COMPUTING 2.1 Types of Cloud Computing Cloud computing can be categorized into three main types: public cloud, private cloud, and hybrid cloud, each offering distinct features and benefits. The public cloud refers to services provided by external vendors over the internet, accessible to anyone who wishes to use or purchase them. This model allows users to tap into a wide range of resources, such as storage, computing power, development platforms, and applications, on a pay-as-you-go basis. Public clouds are highly scalable and flexible, making them suitable for businesses looking to reduce infrastructure costs and dynamically manage resources. In contrast, the private cloud is an infrastructure used exclusively by a single organization, typically operated behind the company's own firewall. It offers enhanced control, customization, and security, which makes it ideal for organizations with strict regulatory requirements or sensitive data. However, maintaining a private cloud can incur significant costs and resource demands similar to traditional on-premises IT systems, but it provides the benefit of greater data privacy and customization options. A hybrid cloud model combines both public and private clouds, as well as on- premises infrastructure, allowing organizations to manage workloads across different environments. This model is linked via secure networks such as local area networks (LANs), wide area networks (WANs), virtual private networks (VPNs), or APIs. The hybrid approach offers the flexibility to use public clouds for non-sensitive tasks while keeping sensitive data or critical applications in a private cloud. By balancing security and scalability, hybrid clouds provide organizations the ability to optimize their infrastructure and manage costs more effectively. 2.2 Application of Cloud Computing Figure 2.1 Applications of Cloud Computing 1. Data storage Cloud storage provides individuals and businesses with a reliable and cost- effective way to store and access data remotely. Cloud storage providers offer different security, backup, and accessibility options, making it easier for users to manage and protect their data. With cloud storage, users can access their files and data from any device with an Internet connection, eliminating the need for physical storage devices and making it easier to share and collaborate on files with others. 2. Software development and testing Cloud platforms offer developers an easy way to create, test, and deploy applications without expensive infrastructure. Cloud development platforms provide a secure and scalable environment for software development, allowing developers to build and deploy applications more quickly and efficiently. With cloud computing, developers can access the necessary tools and resources, such as Software Development Kits (SDKs), testing tools, and virtual machines, to create and test their software applications. 3. Business applications Cloud-based business applications, such as Customer Relationship Management (CRM) and Enterprise Resource Planning (ERP), provide businesses with a scalable and cost-effective way to manage their operations. Cloud-based business applications are accessible from any device with Internet connectivity, making it simpler for employees to collaborate and work remotely. Cloud-based business applications also provide businesses with real- time data insights and analytics, enabling better decision-making and a competitive edge. 4. Collaboration Cloud-based collaboration tools, like Google Docs and Microsoft Office 365, enable teams to collaborate on documents, presentations, and other projects in real time from any location with an internet connection. These tools provide a secure and effective means for team members to work together, allowing them to make updates and monitor changes instantly. Additionally, cloud-based collaboration tools improve version control and offer audit trails, simplifying the process of tracking edits and managing workflows for businesses. 5. Big data analytics Big data analytics platforms hosted in the cloud enable businesses to process and analyze information

swiftly and efficiently, resulting in improved insights and decision-making. Cloud-based big data analytics platforms provide a scalable and cost-effective method for storing, processing, and analyzing data, making it easier for businesses to manage and extract value from their data. With cloud-based big data analytics, companies can quickly identify patterns, trends, and insights, leading to better business decisions and improved performance. 6. E-commerce Cloud-based e-commerce platforms provide businesses with a scalable and reliable way to manage online transactions, inventory, and customer data. Cloud-based e-commerce platforms offer companies the flexibility and scalability to handle increased traffic and demand, ensuring customers have a seamless shopping experience. With cloud-based e-commerce, companies can easily manage their online stores, inventory, and payments while providing customers with a secure and efficient way to shop. 7. Internet of Things (IoT) Cloud platforms can provide a centralized hub for managing IoT devices and data, enabling businesses to develop and deploy IoT solutions more efficiently and cost-effectively. With cloud-based IoT, companies can collect, store, and analyze data from multiple IoT devices in real-time, leading to better insights and decision-making. It also provides businesses with better security and scalability options, making it easier to manage and scale IoT solutions as needed. CHAPTER 3 EVOLUTION OF CLOUD COMPUTING 3.1 Early Concepts and Technologies In 1961, the concept "cloud computing" was first introduced by John McCarthy. He proposed an imagination that in one day, computing can be organized as a public utility just like telephone systems. At that time, to people, cloud computing is a new concept which represent a time-sharing system that allows multiple users to access a central mainframe computer simultaneously. It is an invention that increases the flexibility and efficiency of managing data and applications. Although this concept was introduced in 1961, it only started to take off in the 1990s. In 1999, Salesforce introduced a website named Salesforce.com which is a cloud-based platform used to manage relationship with customers. Companies can use it to manage their sales, customer service and application development. Anyone with internet access can just download it for free while it also provides an on-demand version which can be purchased by companies. After a long hard journey, cloud computing finally got on the right track in the early 2000s. In 2002, Amazon introduced its web-based retail services which uses cloud computing infrastructure model since this infrastructure allows them to manage their computer's capacity more efficiently. This makes other companies follow in their steps and greatly promoted cloud computing. Later in 2006, Amazon launched Amazon Web Services (AWS) which provides online services to other websites and clients. Among AWS' sites, 2 of them help a lot in the advancement of cloud computing. The first site is the Amazon Mechanical Turk, a website which provides various cloud-based services, including storage, computation, and "human intelligence". At that time, this website helps people to know cloud computing better. Another site is the Elastic Compute Cloud, which allows people to rent virtual computers to do their own work. This helps people a lot in insufficient computer capacity to carry out a heavy task. Figure 3.1 Central Mainframe Computer in 1990s 3.2 Development of Virtualization To start this part, we should first know that what virtualization actually is. According to International Business Machines Corporation (IBM), virtualization is a process that allows physical computer hardware to be used in a more efficient way and is the foundation of cloud computing. It is usually used to run multiple operating systems on the same hardware system simultaneously. The root of virtualization goes back to 1960s, where people are still using big mainframe computers that can only work with a process at a time. Customers then demand for the solutions to support more than one user or a process at a time, and so an operating system with virtual memory is introduced by IBM. However, there are other solutions introduced at that time and virtualization does not become

widespread due to its complexity of implementation. Later in 1990s, enterprises are challenged to follow their single-vendor IT stacks and legacy applications steps and they realized that it is crucial for to use their server resources wiser which is underused previously. This challenge forces them to adopt with virtualization so they can divide their server infrastructure into parts more efficiently and run their legacy apps on different types and version of OS. As virtualization is more commonly used, it reduced vendor lock-in for servers and served as a foundation for the development of cloud computing. 2000s is the significant years for virtualization from a niche tool in specialized environment to a mainstream technology that is widely used by enterprises and also individuals. AWS launched in 2006 and Hyper-V in 2008 both contribute to the advancement of cloud computing. Later, hardware-assisted virtualization and live migration enhanced the performance and reliability of cloud computing further. Today, virtualization is part of the backbone of cloud computing, which enables efficient resource utilization, scalability, and flexibility. Its function of allowing multiple operating systems to run on a single physical server helps businesses and individuals in reducing costs, improving system performance, and deploying applications more efficiently. Virtualization remains a core technology driving the growth of cloud services and modern IT infrastructures. 3.3 Current Trends and Future Directions 3.3.1 AI as a Service (AIaaS) AI, as another popular technology in this era, is one of the technologies that cloud computing is trying to integrate with. By introducing cloud infrastructure, enterprises realized the economic and social benefits they can gain through AI. If enterprise wants to train their own AI models, such as ChatGPT, they need a large amount of data and computing resources. AIaaS, as an option provided by cloud platforms, that allow enterprise to experience the power of AI without the constraints of managing resources. Which means that enterprise does not have to build their own AI infrastructure. AIaaS offers pre-built AI models, tools, and APIs hosted on cloud platforms, which allows enterprises to implement AI in their services, even without specialized AI expertise and infrastructure. 3.3.2 Hybrid & Multi-Cloud Strategies Hybrid &multi-cloud solutions are also becoming popular around the world. This is because that it builds public cloud services from multiple providers, which enables portability across different cloud infrastructures. This reduces the dependency of enterprises to a single-vendor, thus reduce the risk of facing vendor lock-in. Besides, hybrid cloud solutions also provide a more flexible way for people to manage their data storage complexities. When public and private cloud environments are integrated, organizations can leverage existing infrastructure and at the same time gain scalability, security and redundancy. This helps in optimizing the allocation of storage resources, strengthening disaster recovery capabilities, and fosters agility in response to evolving business requirements. 3.3.3 Edge AI Computing In normal cloud computing, data processing and storage relies on centralized cloud data centres, which handle the lot of computational tasks and store large amounts of data. These centralized centres offer scalability and efficiency but can also introduce latency especially when users are far from the data centres. Hence, edge computing is introduced. Instead of centralized cloud data centres, edge computing process data near its source (e.g., IoT devices, local servers). This change reduces latency of data transmission thus enables real-time analysis and decision-making. 3.3.4 Sustainable Cloud Computing Global warming, as one of the biggest problems faced by humans make sustainable cloud computing more important. According to a few organizations, including IBM, the global greenhouse gas emitted by the information and communication technology (ICT) sector is approximately 1.8% to 3.9%. Although 1.8% to 3.9% seems small in terms of percentage, but ICT sector should only contribute around 2-3% of the global emissions. Green computing includes practices across the lifecycle of computers, chips, and other technology components, starting from design and manufacturing to usage and disposal of them.

These practices are related to environment and help in decreasing carbon emissions and energy consumption across all stages thus contribute in overcoming global warming. CHAPTER 4 IMPACT OF CLOUD COMPUTING 4.1 Economic Effects The model for sustained economic competition has now evolved based on cloud computing and, in so doing, provided significant relief to the corporate world by dramatically minimizing physical infrastructure investments. Rather than make excessive investments in nonmoving servers and hardware, companies could lease computing power and storage from cloud service providers, usually offered in an on- demand manner. Figure 4.1 Economic Impact between Relative Price Production and Direct Price 4.1.1 Economic Benefits 1. Cost Saving: The shift from traditional goods to a cloud model of service represents a step reduction in the CapEx of businesses, hence reversing this into an OpEx way of doing. 2. Enhanced Scalability: Integrated, cloud-based solutions afford companies the opportunity to scale their infrastructure needs up or down instantly, circumventing inefficient practices, such as over-provisioning and underutilization of resources. 3. Lower Maintenance Costs: Since cloud providers handle upgrades and maintenance of hardware and software, companies do not incur personnel, electricity, and cooling costs as part of the maintenance. 4. Rapid Time to Market: The organizations will now be able to introduce new products and services faster, whereby they will leverage the cloud for pre-packaged platforms and infrastructure solutions to minimize the development time. 4.2 Operational Efficiency The cloud makes operational efficiency all the more accessible based on hastening IT management as well as the pace of innovation and operations. Automation, simplified maintenance, and greater agility stand out as key aspects in organizational favor. Manual intervention is costly, and these are the main efficiency benefits: 1. Automation: There are many automation tools available as a feature of cloud architectures to allow for repetitive tasks, such as provisioning, operational performance monitoring, and scaling. This has minimized daily manual oversight and optimized workforce productivity. 2. Disaster Recovery: Cloud service provisions guarantee companies a sound disaster recovery option, allowing them access to critical data and applications that remain in use even while a disaster strikes. 3. Simplified Management: Companies have no longer to worry about managing proprietary hardware and data centers-instead, they can simply offload these burdens to the cloud service providers and then focus their resources on the company strategy. 4. Uptime and Reliability: Availability and redundancy levels vary comparatively, cloud providers offer better uptime for their services than most on-premise systems. 4.3 Convenient Collaboration Cloud computing maximized accessibility and collaboration at the workplace by granting freedom to employees who can now access resources and engage in collaboration in real time from any part of the globe. Figure 4.2 Examples of an Improved Collaboration and Accessibility Some of the benefits of collaboration include: 1. Accessibility: Cloud-based services give users access to files, applications, and data from anywhere there's an internet connection, allowing for remote work and mobility. 2. Real-Time Collaboration: Tools like cloud-based document editors or project management platforms allow team collaboration in real time, allowing for faster and uninterrupted project workflow. 3. Centralized Storage: Cloud services provide for centralized data storage which quickens access by all team members to the most relevant information while ensuring that updates are in unison across all devices. 4. Cross-Platform Integration: Cloud platforms often support integration with other tools and services to promote a seamless continuum of workflows across various applications. 4.4 Environmental Considerations Cloud computing provides a much more significant environmental benefit than regular IT infrastructure, permitting the reduction of carbon footprints and an increase in energy efficiency. Figure 4.3 Environmental Considerations Differences Around Traditional Data Center and Cutting-Edge Data Center First environmental impacts may include: 1. Energy

Efficiency: Huge data centers run publicly by cloud providers are very optimized for energy efficiency and consume less power per computing unit than smaller, on-premise data centers. Also, many public cloud companies invest in renewables. 2. Resource Optimization: Cloud computing optimizes the consumption of shared resources, indeed allowing businesses to reduce their personal or individual hardware/yet under-utilized occupational needs, which enables something that will reduce e-waste and prevent other ecological consequences related to data-centre storage. 3. Smaller Carbon Footprint: Data centers are centralized, operated efficiently, and usually located in regions where renewable energy is widespread. This allows businesses, by utilizing this model of hosting in the cloud, to considerably reduce their carbon footprint. 4. Reduced IT Waste: Cloud computing reduces the pressure for businesses to replace their hardware, dramatically lowering the amount of e-waste caused by old servers and other equipment. 4.5 Conclusion Some transformative benefits would include economic gains, operational efficiencies combined with increased accessibility and lessened environmental impacts. By leveraging the cloud, companies can improve their cost structure, streamline operations, enhance team collaboration, and eliminate waste, positioning themselves for greater agility and sustainability in the future. CHAPTER 5 CHALLENGES IN CLOUD COMPUTING 5.1 Introduction Cloud computing has quickly become one of the main supports for the information technology baseline, demonstrating, perhaps for the very first time, the level of comfort, expansion and flexibility. Yet at the same time, given the growing dependence on such services for storing sensitive information as well as for running key processes, a number of serious issues have arisen, that have made embedding and keeping the cloud that much more burdensome. The considerations in this chapter cater for the following issues which would be key to a successful deployment of cloud computing, complex security and privacy issues due to variances of content compliance regimes, service availability and reliability threats, phenomena of industrial captivity, and last but not least, cost management challenges. Responding to these challenges will therefore be necessary and very important for organizations so that the full value of cloud computing is obtained without any risks that may come with it. 5.2 Security and Privacy Issues In the sphere of cloud computing, the issues of security and privacy are some of the most daunting challenges faced by organizations, owing to the risks involved in a shared infrastructure with a third party controlling their data. The estimated benefits to be gained from moving away from the conventional on premise systems to the cloud introduces several layers of risk. For example, data breaches rank as one of the critical concern, as Ristenpart et al. (2014) reported on weaknesses in the cloud storage model which made it susceptible to abuse characterized by data leakage. This is worsened by the fact that cloud environments are usually multitenant, whereby several different users rely on the same physical facilities. Hence, if a system used by one tenant is compromised, then tenants who use the same environmental facilities are also likely at risk. Additionally, the risk posed by insiders in cloud systems has to be taken into consideration as well. Al though security measures are very advanced in cloud infrastructures, a high number of intrusions are committed by the persons inside the organization who are granted access, either by accident or on purpose. Based on the findings by Egelman and others in 2013, insider threats comprise quite a big share of information security threats related to the cloud. This problem become worse in cloud environments when limited access could result in disastrous information exposure or information vandalism. Therefore, organizations must ensure through identity and access management (IAM) systems, as well as perpetual surveillance to counteract such threats. Based on Table 5.1 it shows security issue incident in cloud. NUM. TYPE OF THREAT BUSINESS IMPACT SECURITY ISSUE 1 In 2016, Uber’s AWS account was hacked, exposed 57 million users’ personal information globally. Loss of reputation and trust

from customers or business partners Data Breach 2 Voipo's database that included customer call histories and logins has been data breach in 2019 Legal and contractual risk Data Breach 3 In 2017, Accenture made the mistake of spilling sensitive information across four Amazon S3 buckets that were configured unsecured, leading to exposed credentials and private encryption keys High business impacts such as loss of revenue and damage to a company's goodwill Absence of cloud security design and policy Table 5.1 Security Incident in Cloud Computing 5.3 Compliance and Legal Concern One of the major challenges that businesses face with cloud computing involves compliance and legal concerns. This essentially revolves around compliance issues with regulatory requirements and legal obligations concerning security in data stored, processed, and transmitted within the cloud, and handled responsibly. Cloud computing is governed by a plethora of diverging data privacy laws that every organization should comply with, address cross-border data sovereignty issues, and also hold contracts that would spell out liability and ownership of data with cloud providers. Non-compliance may result in huge fines, judicial punishments, and loss of goodwill. Compliance and legal issues that will ensure integrity and safety have become very important with increasing utilization of cloud services in different sectors; healthcare, finance, technology and more. 5.3.1 Data Privacy and Protection Regulations Large amounts of sensitive data are involved in cloud computing, usually operating through borders. Compliance with data privacy laws, such as the General Data Protection Regulation of Europe or the Health Insurance Portability and Accountability Act of the US, becomes very crucial in order for the security of customer data to be ensured. These regulations shall ensure that data is stored, processed, and transferred accordingly by the businesses. 1. General Data Protection Regulation (GDPR) that came into force on May 25th 2018, has emerged as one of the toughest data, privacy and security laws globally. It shall apply to any organization processing or planning to process Personally Identifiable Information (PII) of individuals in the UK or EU irrespective of the organization's location. The GDPR is essentially built on principles which aim to strengthen individuals' control over their own personal information while specifying that organizations must inform the subjects about the data collection process, acquire consent, and ensure proper protection of the individual's data. 2. Health Insurance Portability and Accountability Act of 1996 (HIPAA) is an American law that decrees even oversee health care enterprises cannot use health care sensitive data for dubious reasons. Health plans, healthcare clearinghouses and providers like doctors and clinics are called care covered entities. They call Personal Health Information (PHI) anything that can be used to identify a person, and those are billing and medical records. HIPAA ensures compliance in handling privacy and security along with damaging your reputation and will cost you with fines and possible imprisonment. 5.4 Downtime and Reliability Downtime and service reliability are the key challenges in cloud computing. When cloud services which are websites or applications may fail and become unavailable is called downtime. For instance, downtime can be a result of dedicated technical issues, server failures, scheduled maintenance and even many other reasons. Any business that relies on cloud services can sustain serious consequences from even a few moments of downtime. Reliability refers to the uptime (or lack thereof), meaning that data needs to be available and accessible all the time instead of merely working and yielding correct results during peak hours when many dependent applications utilize it. But the use of third party management carries risks, for instance system outages, that result in disruptions and financial losses. 5.5 Vendor Lock-in Vendor lock in is an organization being dependant on a specific cloud service provider (CSP) beyond reasonable limits with making a switch to a different provider or going back to an on premise system an option. This dependency, however, often originates from the use of proprietary technologies or complex integration that demand non interoperability, or from restrictive licensing agreements that

reduce flexibility. This means that organizations' applications and data may have a hard time migrating, and those organizations would suffer large costs and challenges trying to do so, stifling innovation, and impeding their ability to be reactive to shifts in their business needs. 5.6 Cost Management Cloud computing requires cost management, so that businesses can effectively use resources without over spending. While cloud services can save a company substantial cost by enabling scaling without too much hardware investment, the lack of budgeting and monitoring can cause high costs. Industry reports say companies typically run 15% over budget when using the cloud, but expect to see that gap widen in future growth. This challenges can be mitigated by organizations through using strategies like automated resource monitoring, shutting down the unused workloads, and use of the multi cloud management tools. These methods help monitor usage, allocate spending and to ensure efficiency in spending. With more enterprises embracing the cloud, they also deploy financial analytics and elastic pricing models to enhance alignment of spending with operational requirements. This proactive cost management and optimization combination delivers a miser wherever in the cloud they are spending, and maintains that money spent in the cloud remains both beneficial and in support of the business. 5.7 Chapter Summary a) Cloud computing creates security and privacy issues of shared infrastructure, multitenancy and insider threat and requires strong identity management and continue monitoring for sensitive data security b) When it comes to cloud computing compliance and legal, maintaining data protection laws such as GDPR, and HIPAA is always under the scanner to finish out data without any threat. c) Given cloud computing challenges like downtime, lock in and cost management, businesses need to have service reliability, flexibility and cost efficiency ensured by gently monitoring and adopting a multi-cloud strategy. CHAPTER 6 CONCLUSION 6.1 Research Outcomes All the stakeholders including the users, the companies that operate with cloud technologies, and the host must work with each other to ensure that everyone benefits from this advance technology and the innovation that comes along with it. With challenges that shows along itself, it is a must that they overcome this hurdle to prevent this technology from getting out of hands and becoming a burden to everyone. If cloud computing is used correctly and put to its maximum capabilities, it has the ability to change the digital landscape once more potentially impacting the society positively in the near future. 6.2 Contribution to knowledge The findings of this thesis paper may prove to be beneficial to the Ministry of Science, Technology and Innovation of Malaysia, companies that wants to implement this technology within their workforce, and consumers who intend to use cloud computing to help with their productivities. REFERENCES Cloud Computing 101: Scalability, Reliability, and Availability. (2020, November 9). Lucidchart. https://www.lucidchart.com/blog/reliability-availability-in-cloud- computing Skillfloor. (2023, November 2). Challenges of cloud computing - skillfloor - medium. Medium. https://skillfloor.medium.com/challenges-of-cloud-computing- 7a4457faee88 Learn the top cloud computing challenges, risks & issues. (n.d.). RIB Software. https://www.rib-software.com/en/blogs/cloud-computing-risks-and- challenges TheKnowledgeAcademy. (n.d.). 15 Most common challenges of cloud computing. https://www.theknowledgeacademy.com/blog/challenges-of-cloud- computing/ HIPAA vs. GDPR compliance: what's the difference? (n.d.). https://www.onetrust.com/blog/hipaa-vs-gdpr-compliance/ Bigelow, S. J. (2022, November 15). The history of cloud computing explained. WhatIs. https://www.techtarget.com/whatis/feature/The-history-of-cloud- computing-explained Ohri, A. (2023, January 24). Impact of Cloud Computing: A simple overview in 4 points | UNeXT | UNEXT. UNext. https://u-next.com/blogs/cloud- computing/impact-of-cloud-computing/ Virtualization. (n.d.). Hewlett Packard Enterprise Development LP. https://www.hpe.com/my/en/what-is/virtualization.html Technologies,

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