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ICT in Business and the Public Sector

Analysis the critical factors of adopting Multi-cloud

Name: Ernest Pui
Student-no: 3296660

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1st supervisor: Werner Heijstek
2nd supervisor: Bas Kruiswijk

MASTER'S THESIS

Leiden Institute of Advanced Computer Science (LIACS)
Leiden University

Niels Bohrweg 1

2333 CA Leiden

Abstract

Cloud topics have been dominating the IT and business domain in different industries for the past decade. This started with moving their on-premise infrastructure to cloud, eliminating the needs for purchasing and supervising their own hardware. Cloud Service Providers (CSPs) give a variety of options for organisations to manage and maintain their core software system, it is difficult to move to other CSPs if the organisation has configured their system specifically for one CSP. It creates a problem of companies being overly-dependent on a single CSP, creating a “vendor lock-in” situation. The “vendor lock-in” situation worsen organisation’s business agility by adding difficulties to change their existing architecture. Under these circumstances, multi-cloud architecture has gradually gained more attention as one of the potential solutions to “vendor lock-in”. Although multi-cloud resolves the “vendor lock-in” condition, it requires more resources and knowledge from an organisation compared to implementing their system on a single CSP. This states the essence of this research, organisations need to resolve the cost versus risk conundrum by selecting the architecture that always saves their costs, but allows them to avoid greater risks.

Previous studies have primarily focused on researching the impact of single-cloud adoption within organisations. Although these studies have explored similar factors for organisations to consider, adopting a multi-cloud approach introduces new perspectives as organisations must now navigate different integrations between multiple CSPs.

To investigate the factors related to multi-cloud adoption, we conducted a quantitative survey. The survey comprised two sections. In the first section, we asked respondents about their experience and knowledge in cloud engineering. In the second section, we referenced 11 factors from previous studies on single-cloud adoption, formulated our questions accordingly, and divided them into 15 statements measured on a 1-5 Likert scale.

We have categorised our data into data tables, displayed in figures for clarity. Utilising a model from previous studies, we analysed the survey results and performed statistical analysis to show the impact of different factors.

Based on our findings, we believe that Perceived Usefulness is critical to the adoption of a multi-cloud architecture. The Quality of Service provided by the service provider, Perceived Ease of Use of the cloud technology, and the Relative Advantage of the cloud provider are related positively and indirectly on the adoption decision. On the other hand, the rest of the factors were dropped from consideration due to weak evidence or unreliability. Lastly, the data suggest that the cloud market is experiencing dynamic growth, with providers heading in different directions regarding the topic of multi-cloud.

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List of abbreviations

Abbreviation	Explanation
CSC	Cloud Service Consumer
CSP	Cloud Service Provider
PU	Perceived Usefulness
PEOU	Perceived Ease Of Use
TAM	Technology Acceptance Model
TOE	Technology-Organisational-Environmental Framework

1. Introduction

This chapter gives an introduction to the research by shaping the research background and its relevant problem, followed by defining research scope, stating the research problem, objectives and questions.

1.1. Background

Moving on-premises applications to the cloud is a popular trend in IT in the last decade. CSPs provide their services in different forms, the major ones are Infrastructure as a Service (IaaS), Platform as a Service (PaaS) and Software as a Service (SaaS). According to Kavis (2014), different models allow various responsibilities and services to be shared between CSPs and CSCs. As organisations increasingly rely on cloud computing to support their business operations, they are faced with a range of options for deploying their applications and workloads. According to Gartner (2022), the spending on cloud services has become the largest chunk in organisations' budget for optimising cost and minimising risks.

One of the emerging pillars in cloud computing is multi-cloud. Multi-cloud computing is characterised as a cloud computing approach that involves using multiple public CSPs to deliver computing services to an organisation (Ferrer et al., 2016). Multi-cloud solutions help solve some existing cloud computing challenges, such as disaster recovery, vendor lock-in, optimised cost saving, etc. (Hong et al., 2021). In recent years, adopting multi-cloud architectural systems is slowly explored by the industry. According to a survey by VMware (2021), the average number of public clouds used by an organisation is 2.185, and 95% of the 1000 surveyed organisations consider multi-cloud an important strategy to adopt. This indicates that companies are slowly embracing the idea of a multi-cloud system, with motives of supporting their company business goals with robust architectural design.

1.2. Research problem

While a single CSP may meet the organisations' business needs, it may be hard to retain a high level of business continuity (Astri, 2015). From the CSCs' perspective, the "vendor lock-in" situation impose threats to the flexibility and continuity of their business, where customers are dependent on a single cloud platform and bear a high cost to transfer their data or application to other platforms (Opara-Martins et al., 2014; Farley et al., 2012). The business needs to find particular expertise to design and migrate platform-dependent solutions that match requirements and aims to minimise monetary expenses due to the heterogeneous nature of the cloud market. This can be supported by two studies of optimising cost-per-performance outcomes in similar cloud service offerings (Farley et al., 2012; Zhang et al., 2016). As Achar stated (2021), more enterprises started to find multi-cloud systems that can offer the benefits of single-cloud systems while avoiding "vendor lock-in".

Adopting multiple clouds can help enterprises scale more effectively, be more resilient, and reduce costs by letting them select the best cloud providers for each application or task (Hong et al., 2019). Companies must comprehend the context of implementing a multi-cloud architecture, particularly the distinction between moving from on-premises to a single cloud and switching to a multi-cloud from a single-cloud architecture (Khajeh-Hosseini et al., 2012). Although some studies have been conducted to identify the characteristics that influence on-premises to cloud migrations, less has been done to identify the elements that influence single-cloud to multi-cloud adoptions.

1.3. Research aim and objectives

This research aims to provide studies on the critical factors of multi-cloud adoption by business organisations. The goal of this research is to identify critical factors and their relevancies while integrating decisions on adopting multi-cloud systems. The critical factors can be used as a reference for business managers and potentially improve the quality of the organisation's business strategic decisions. These critical factors are allocated in different dimensions with a different degree of impact on multi-cloud adoption intention.

1.4. Research scope

The scope of this research study is focused on understanding the critical factors of adopting a new architectural structure from a single-cloud to a multi-cloud from an enterprise-level perspective. The study will investigate the challenges that organisations face when migrating from single to multi-cloud, including strategic, technical, and operational issues, and how these may form the consideration factors affecting the intention of adopting multi-cloud.

Through the use of surveys to relevant cloud practitioners, the study will gather insights from cloud professionals in various organisations who have experience with either single or multi-cloud deployments.

The concept scope of multi-cloud on this research will mainly focus on the adoption of multiple CSPs into the organisation for their applications, more will be discussed in section 2.5.

1.5. Research question

This research study examines the determinants of multi-cloud system adoption from an organisational perspective. The following research question will be the focal point of the research project:

What factors are critical to an organisation adopting a multi-cloud structured system?

A quantitative research approach is used to answer the question in multi-cloud computing decision-making.

1.6. Research outline

This section aims to provide structure and shows the process of breaking down the research question by the research outline. The research consists of the following chapters:

- Chapter 2: Explain how and which literature is examined and bridging them towards the concept of multi-cloud.
- Chapter 3: Deep dive into the research topic, motivates behind multi-cloud adoption and proposing hypotheses.
- Chapter 4: Give details in the methodology, explaining how the research question is answered.
- Chapter 5: Visualising data demographics and reasons for background questions proceeding logic.
- Chapter 6: Demonstrating the variables relationship and stating the quantitative result from the observed response, testing the hypothesis.
- Chapter 7: Providing insights and discussions for the retrieved data, suggesting the interpretation of the results, and giving recommendations.
- Chapter 8: Conclusion of the thesis and giving further research steps.

2. Literature review

This chapter establishes the foundation for this multi-cloud research thesis by offering a complete literature assessment of the research that has already been done on the adoption determinants of single-cloud and multi-cloud projects. While there is a ton of study on cloud computing, particularly regarding single-cloud migration setups, adopting multi-cloud architectures is a relatively new approach that is quickly gaining ground in business and academia. We discuss the techniques and processes used to find appropriate scientific publications for the review in section 2.1. These techniques include keyword searches, citation analysis, and snowball sampling. In order to assess various definitions and variables of success for multi-cloud architectures, covering elements like performance, cost, and scalability. In Section 2.2., we examine a range of studies about the benefits of single-cloud adoption, and we will explore the motives behind the single cloud adoption decision. In Section 2.3, we explore a framework formed for examining the single-cloud architecture's adoption. We concentrate on how enterprise-level incentives, capacities, and strategies affect the adoption process. Finally, in section 2.4. and 2.5., we define the concept multi-cloud, highlight some significant distinctions between multi-cloud and single-cloud systems, and discuss the advantages and difficulties of multi-cloud adoption. Overall, by defining the study background, identifying the major research requirements, and outlining the research methodology to be utilised. Thus, this chapter prepares the ground for the rest of the multi-cloud study.

2.1. Literature search

To conduct a targeted literature review on multi-cloud adoption, a range of search terms were utilised to identify relevant studies. Google Scholar proved to be a reliable and centralised resource for locating pertinent findings using appropriate keywords. A combination of definitions and synonyms were used to refine the search for literature that discusses the critical factors contributing to successful multi-cloud adoption decisions. As multi-cloud adoption is a relatively new area of research, we design the search terms to locate studies that examine the benefits, challenges, and required changes of multi-cloud adoption. The search terms used are listed in Table 2 and it combines with operators such as "OR", "AND", and brackets to refine the search. To identify previously developed questionnaires, indicators, and statements, quantitative research results are filtered, and Likert scales are considered. A final search string that produced relevant studies included terms such as "impact" along with "cloud adoption", "multi-cloud adoption", "survey", and "questionnaire". Overall, these search terms helped locate appropriate literature that provided insights into the factors that influence the successful adoption of multi-cloud architectures, including the impact on performance, cost, security, and scalability.

Terms	Keywords
Multi-cloud	("multi-cloud" OR "multi cloud" OR "multi-cloud architecture" OR "multi-cloud computing"); "multi-cloud migration"; "multi-cloud strategy"; "multi-cloud challenges"; "multi-cloud deployment"; "multi-cloud management" OR "multi-cloud governance"; "multi-cloud performance"; "multi-cloud cost"; "multi-cloud organisational impact"
Adoption intention	"cloud adoption intention"; "cloud adoption"; "cloud migration"; "migrating to cloud"; "cloud benefits"; "variables of organisational adopting cloud"; "cloud adoption challenges"; "cloud benefits"; "Serverless benefits"; "cloud impact"; "cloud adoption reasons"; "cloud providers adoption capabilities"
Quantitative research	"questionnaire"; "survey"; "insights"; "indicators"

Table 1: Search terms and respective keywords

To identify relevant articles on multi-cloud adoption, we utilised a combination of keywords along with operators such as AND, OR, and brackets, resulting in the screening of over 100 papers. Additionally, we use the snowball technique, involving a scan of referenced papers in studies identified during the preliminary search. Our aim is to identify papers that contain an existing research model, quantitative survey statements that support the dimensions in the model, and other relevant information on multi-cloud adoption. The combination of keywords and the snowball technique resulted in a total of 81 papers that met our criteria, which were then prioritised in a Word document based on various criteria such as citations, relevance, and quality. Figure 2 provides a summary of our search process. This approach allowed us to gather valuable insights into the challenges, opportunities, and best practices associated with multi-cloud adoption, including the key factors that contribute to its success and the critical considerations that organisations should bear in mind when adopting multi-cloud architectures.

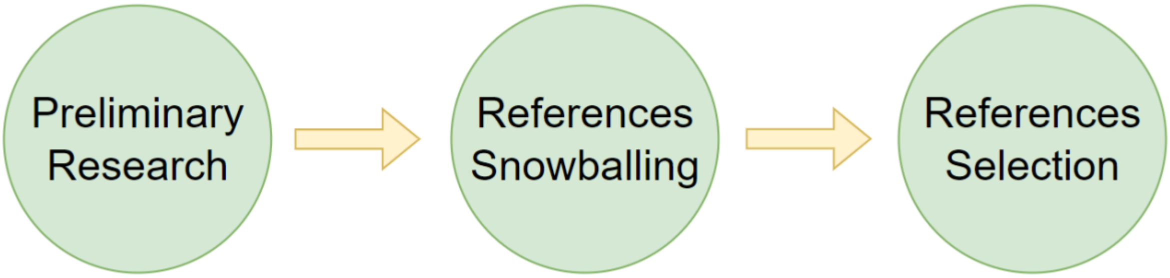

Figure 1: Literature review process

2.2. Benefits and motives of single-cloud adoption

Deploying infrastructure and services on cloud-hosted machines provided by cloud providers is a key benefit of cloud projects for organisations. Zardari and Bahsoon (2011) suggest that a cloud adoption project can be considered successful if it achieves both business and strategic goals, performs as expected or surpasses expectations, and effectively manages any associated risks at the organisational level. Abolfazli et al. (2015) have further expanded on this idea, stating that effectiveness of a cloud adoption project is determined by aspects including the organisation's expertise with adopting cloud technology and the location of data sovereignty.

Single cloud adoption can provide significant benefits when it comes to infrastructure scalability. According to Tweneboah-Koduah et al. (2014), with a single cloud provider, organisations can take advantage of the provider's elastic computing capabilities to easily scale their infrastructure up or down as needed. This can assist firms in better adapting to shifting commercial needs. By adopting a single cloud provider, organisations can take advantage of the tools and services offered by different CSPs, which can help enhance the scalability of their applications and services. With implementing a more scalable infrastructure, businesses can reduce the probability of encountering downtime or performance issues and ensure that they are able to meet or exceed the expectations of their consumers. Integrating a single-cloud provider can give a number of benefits, including the ability to scale up, which can make business applications more agile and adaptable.

Khajeh-Hosseini et al. (2010) agrees that adopting a single cloud provider can yield significant benefits in terms of business agility. With elastic computing capabilities, organisations can reduce upfront investments in infrastructure and hardware, freeing up capital for other business areas. This can help businesses adjust more effectively to changing market demands, seasonal demand spikes, or increasing unforeseen traffic. Due to the on-demand nature of cloud computing, organisations are able to retreat and terminate the services without worrying about the cost of handling physical servers and under-utilising resources. Having the ability to instantly scale up and utilise the on-demand pricing, which can increase responsiveness and cash-flow flexibility for businesses, is one advantage of using a cloud system compared to on-premises.

Other than decreasing the upfront payment, adopting single-cloud can significantly reduce the maintenance cost of organisational infrastructure. Motahari-Nezhad et al. (2009) claims that by combining IT infrastructure into a single-cloud environment, it is possible to minimise the need for physical hardware and the related maintenance costs. The provider is assigned to manage and maintain the cloud infrastructure, including hardware, software, and security upgrades, freeing up IT staff to focus on other business strategic goals. Furthermore, they point out by establishing a single cloud environment, businesses may streamline processes, reduce complexity, and increase efficiency, which can lead to additional resource savings. In general, adopting a CSP can help businesses better regulate their expenditures.

Single-cloud adoption can help organisations reduce their product-to-market time by providing them with access to flexible infrastructure (Avram, 2013). Organisations can quickly provision the resources they need to develop and deploy their services and applications, without bearing the responsibilities about the underlying hardware and infrastructure. This flexibility allows organisations to immediately respond to changing market trends, and to deliver new products and services faster than their competitors. Additionally, Avram claims that cloud computing lowers the barriers to collaboration and communication among teams, which can further streamline the development and deployment process. This ultimately results in a shorter product-to-market time, which can help organisations gain a competitive advantage.

2.3. TAM-TOE framework

A classic model on the enterprise level to help evaluate and integrate new technology is the Technology Acceptance Model (TAM). TAM is a popular theoretical framework for explaining and forecasting user acceptance and adoption of new technologies. Fred Davis (1989) TAM model is based on the assumption that perceived usefulness and perceived ease of use control the users' behavioural intention to use a new and unfamiliar technology. Perceived usefulness relates to how much users believe the technology will improve their performance on a task, whereas perceived ease of use refers to how much users believe adapting to the technology will require no effort. The TAM framework assists organisations in better understanding the aspects that drive technology adoption, allowing them to integrate more effective solutions.

Although TAM is broadly accepted in academia and proved applicability in organisations adopting new ICT concepts, Malatji et al. (2020) argue that the objective measurement of two primary factors can be affected by environmental variables. According to Maruping et al. (2017), social influencing can change the subjective norm of a user when they are being influenced by the word of their colleagues. Thus, the external factors can have heavy weighting on the subjective measurement, it can oversimplify the evaluation process if the behavioural intention of the studied subject has made the decision based on undisclosed context.

On the other hand, the Technology-Organisation-Environment (TOE) framework developed by Tornatzky and Fleischer in 1990 has taken another approach to view the problem of organisations adopting new technology. The framework asserts that three contextual elements influence technology adoption decisions: technological context, organisational context, and environmental context. The technical background encompasses aspects such as the technologies available and their compatibility with existing systems. Organisational context includes factors such as organisational size, structure, and resources. Competition, laws and regulations, and industry features are examples of environmental factors that can impact an organisation's decision to adopt a technology. The TOE framework aims to provide a thorough knowledge of these intersected aspects, allowing companies to make informed decisions about technology adoption and implementation.

The TOE framework has also faced criticism for its usage. According to Bryan and Zuva (2021), the TOE framework lacks specificity with its factors. TOE framework provides a high level overview of the factors influencing the choice of technology adoption, the glossary of variables are not well integrated to the organisational needs. It fails to provide organisational insights of particular view in particular circumstances. For this reason, the TOE framework is considered too generic and results differ context to context.

The TAM and TOE system has been generally integrated to apply research on various researches (Gangwar et al., 2015; Qin et al., 2018). Bryan and Zuva (2021) state that the models complement each other with TAM being flexible with external variables and giving specificity of preference but lack contextual variables for the person's behaviours. TOE gives knowledge to the technical, environmental and organisational elements that have an impact on the adoption decision. In this study, we will utilise the framework developed by Gangwar et al., for their integrated framework is tested and deployed to solve a similar problem in single-cloud adoption intention from an organisational perspective.

2.4. Consideration factors for single-cloud adoption

Avram (2014) has pointed out that system integration and organisational changes involved in cloud adoption are more complex than they appear. To consider cloud adoption, strategic measurement and understanding motives behind the underlying factors is necessary. The transition will require changes in employees' roles and the acquisition of new skill sets to comply with this change. The speed of the change is positively related to the impact of cloud adoption and the added value it brings to the organisation.

According to Garrison et al. (2012), an organisation's level of trust in its CSP plays a significant role in the determinants of cloud adoption efforts at a higher level. Organisations must make investments in their technical, managerial, and interpersonal competencies to adopt cloud technology with the greatest possible success. By doing so, organisations need agreements with the CSP on the architectural set-up for their company interests. These organisation-specific capabilities are crucial for ensuring that the cloud adoption project is aligned with the organisation's overall goals and objectives.

Skafi (2017) has noted that organisations with a limited technical stack may increase the complexity of the transition to cloud adoption, while those with more technological familiarity are better positioned for a single-cloud adoption. Also, according to Skafi, the size and innovativeness of an organisation does not have a significant impact on the decision to adopt cloud. Gangwar et al. (2015) support this view and explain that the core values that drive changes in an organisation are often imposed by top management. Therefore, with the support of decision-makers, single-cloud adoption is more likely to be executed as the organisation prioritises moving their on-premises system to cloud as its main objective.

Gangwar et al. (2015) research preliminary identifies 10 primary factors impacting the decision of adopting a cloud structure in the organisation. These variables are collected and formed through previous research as discussed in paragraph 2.2. According to the Gangwar et al.(2015), relative advantage, compatibility, organisational competency, top management support, training and education, perceived usefulness, perceived ease of use, trading partner support and competitive pressure are the 9 positively related to the adoption intention. On the other hand, complexity will be the single factor opposing the adoption intention of a single-cloud structure. He structures his model by utilising the TAM-TOE model, tests the relationships between the factors. Results are shown in the following.

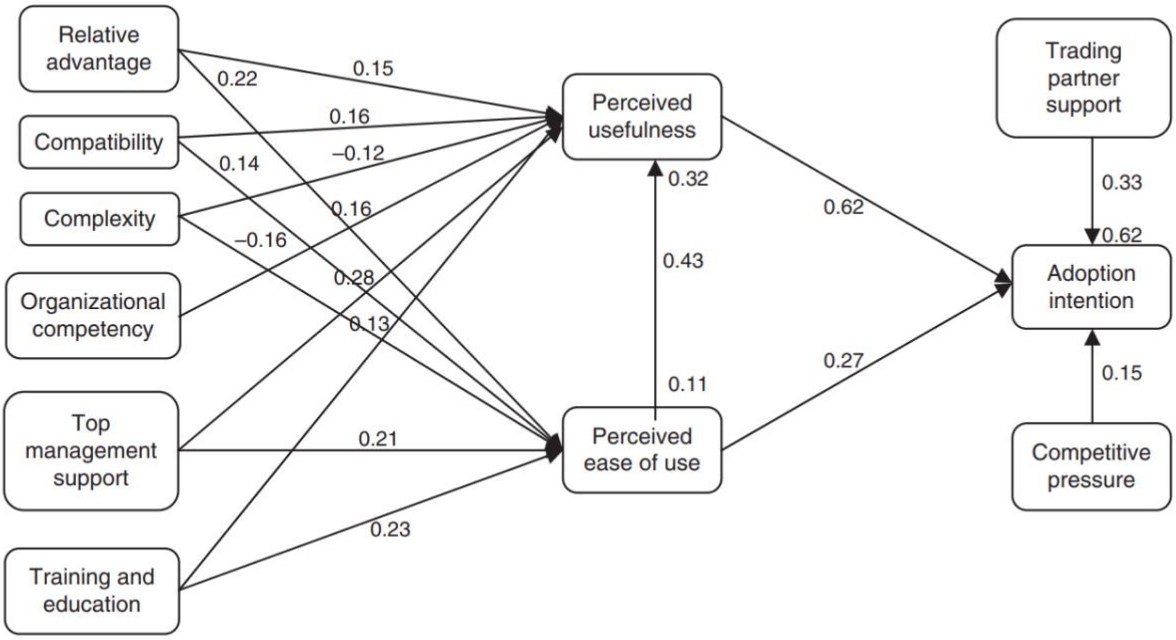

Figure 2: Gangwar et al. (2015)

2.5. Multi-cloud and other clouds

Multi-cloud is often discussed with the terms “hybrid-cloud”, “inter-cloud” and “federate-cloud”. Though these are interchangeable terms in various studies, this section is going to define the multi-cloud context of the study.

According to Hong and Dreibholz, multi-cloud is a strategic approach to host, distribute and manage organisations’ applications, data, and workloads among a heterogeneous network on multiple cloud computing services from different CSPs (2019). It is defined as the use of address varying requirements and minimise the risk by sharing it across different cloud services, including public, private, and hybrid clouds. Multi-cloud targets problems such as “vendor lock-in” enhanced flexibility, cost optimisation, and risk mitigation. As different CSPs provide different degrees of service SLAs, organisations can pick the best option from each provider based on their unique needs and preferences.

Srinivasan et al. describe that hybrid-cloud is a combination of public and private cloud infrastructures, connected by network, and designed to integrate their workloads performing computing tasks (2015). This approach enables organisations to leverage the cost-effective scalability of public clouds, while maintaining the security and compliance control with their private clouds. Hybrid-cloud differs from multi-cloud in that it focuses on integrating and orchestrating two distinct types of clouds, multi-cloud focuses on coordinating multiple CSPs and does not require an existence of a private cloud in the architecture (Cloudflare, n.d.).

On the contrary, Petcu (2013) has stated that Inter-cloud refers to the concept of connecting multiple cloud platforms with a broker that offers dynamic provisioning, enabling the sharing of resources, data, and applications amongst them. This idea aims to create a global network of interconnected clouds, allowing for enhanced interoperability and flexibility. While multi-cloud strategies often involve using inter-cloud connectivity, they are not interchangeable terms. For inter-cloud emphasises the architectural governance and connectivity aspect rather than the strategic use of multiple CSPs.

Federated cloud is a model where multiple independent CSPs collaborate and form a community to offer a unified, standardised set of services and resources to their customers (Petcu, 2013). By pooling resources, federated clouds can provide improved performance, cost-efficiency, and redundancy. Although federated clouds can be part of a multi-cloud strategy, they differ in their focus on provider cooperation and standardisation of services, agreements must be established between different CSPs to form a cloud community.

Thus, after defining the context, this research will focus on understanding the impact of consideration factors on organisations' decision on adopting multi-cloud.

2.6. Motives for multi-cloud (vs single cloud)

Adopting a multi-cloud strategy offers numerous benefits and addresses several challenges that organisations may face when relying on a single CSP. According to Kumar and Mala, one of the key motives is to avoid ”vendor lock-in”. As CSPs provide proprietary technologies, the technical details of these services are not available to their customers, making it difficult for the industry to create standards for data and application (2022). When an organisation becomes dependent on a specific CSP's infrastructure, services, and pricing models, it is difficult to switch providers or move applications and data without incurring significant costs and complexity. Opara-Martins et al. argue it has consequences like limiting the freedom of choice of organisation among alternative technologies for a product (2014). By utilising multiple CSPs, organisations can maintain flexibility and freedom, mitigating the risks associated with being tied to a single vendor.

Another motive for adopting multi-cloud is to address data geolocation and data availability concerns. According to Massonet et al., business data sovereignty regulations and latency requirements often necessitate that data be stored or processed in specific geographic locations (2011). On the other hand, Su et al. has demonstrated that a multi-cloud system can guarantee high data availability as it is unlikely to have outages among multiple CSPs at the same time (2015). With a multi-cloud approach, organisations can orchestrate different CSPs that have data centres in the required regions, ensuring compliance with local regulations and increasing the availability by processing data closer to end users.

Multi-cloud also allows organisations to optimise cost by selecting the best services from each provider based on their unique needs. In contrast to a single-cloud approach, which may limit an organisation to a specific set of tools and capabilities, multi-cloud enables a more tailored and efficient allocation of resources. In the research from Bellur et al., they have shown possibilities to lower the cost of infrastructure in multi-cloud of a given deployment period (2014). This approach can lead to cost savings, and the ability to leverage innovative services offered by different providers.

A multi-cloud strategy offers organisations increased flexibility, better control over data location, and the ability to optimise cost compared to relying on a single CSP. Addressing issues such as vendor lock-in, data compliance, data availability, multi-cloud enables organisations to navigate the complex landscape of cloud computing more effectively and efficiently.

3. Theoretical framework

3.1. Potential factors of multi-cloud adoption

These sections will raise the potential factors of adopting a multi-cloud generated from the literature research. The factors are separated into 4 different classification based on the TAM-TOE framework, technology, organisation, environmental and isolated factors.

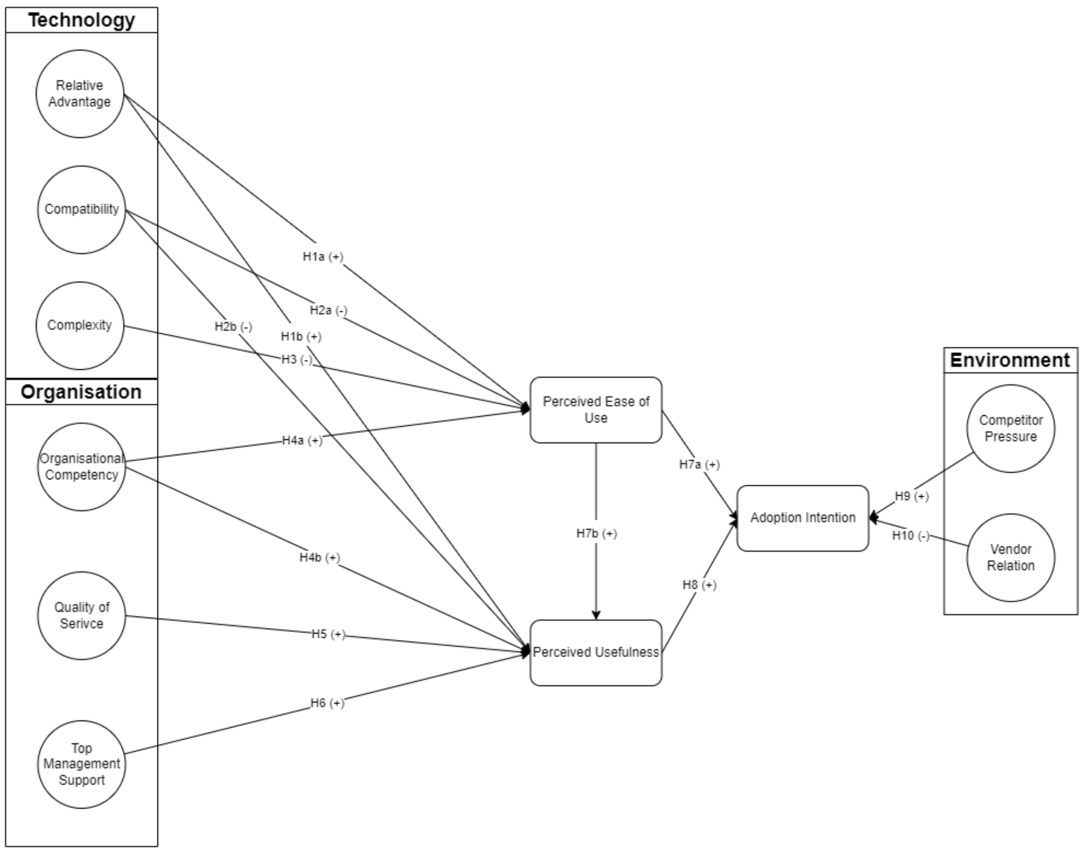

Fig 3: Research theories on variables relation

3.2. Technological factors

3.2.1. Relative advantage

In his famous book – Diffusion of Innovation, Rogers (1962) defines relative advantage as the comparative benefits or improvements an innovation offers over existing technologies, processes, or solutions. Relative advantage can be a significant factor driving organisations to embrace the multi-cloud architecture, as it offers numerous benefits compared to relying on a single cloud provider. These advantages can be observed across various aspects such as cost, availability, reliability, security, disaster resilience, cloud exit strategies, and best suited capabilities.

As mentioned in section 2.6., multi-cloud allows organisations to optimise their cost portfolio by selecting the most cost-effective services from different cloud providers, potentially leading to reduced operational costs and improved return on investment. Additionally, Opara-Martins (2014) has stated from the industrial perspective, the competitive landscape of multi-cloud helps drive down prices, benefiting organisations by providing more cost-effective service options.

Multi-cloud adoption enhances availability and reliability by allowing organisations to distribute their workloads across various CSPs, reducing the risk of service disruption caused by provider outages or cloud termination. Zhang et al. has proposed methods that by replicating existing organisations' data to several CSPs, and combined with specific coding techniques, multi-cloud can provide high availability and reliability with a low storage overhead (2015). This redundancy ensures that critical applications remain accessible even if one provider experiences downtime.

With the mentioned multi-cloud features allowing multiple region storage and reducing single point of failure. We can argue that disaster resilience is further improved with multi-cloud, as it allows organisations to store and process data across multiple geographic locations, reducing the risk of data loss or service disruption due to natural disasters or other large-scale events. Gu et al. (2014) has developed a disaster recovery model in their studies which provides a proof of concept for this argument.

Security is another area where multi-cloud offers relative advantages. According to the result of multiple studies, the partitioning and distribution patterns of multi-cloud reduce the risk of a single point of failure (AlZain et al., 2013; Thillaiarasu et al., 2016). This approach requires less effort for organisations to meet specific security requirements by leveraging the specialised security features of different providers.

Current CSPs are mostly providing proprietary solutions for their customer, Schaffer (2014) argues that it is a necessity to consider exit strategies to prevent failure services. Multi-cloud provides organisations with greater flexibility when it comes to cloud exit plans, making it easier to switch providers or move data and applications without incurring significant costs and complexity, as they are not locked into a single provider's infrastructure and services.

Multi-cloud allows organisations to access the best suited capabilities by leveraging the strengths and specialised services of different providers, resulting in improved performance and tailored solutions that address their unique needs and preferences. The research from Kritikos et al. (2020) lists the strengths and limitations of each individual cloud platform, and how they can achieve organisation objectives with a multi-cloud management platform.

In conclusion, the relative advantages of multi-cloud adoption across various aspects such as cost, security, availability, reliability, disaster resilience, cloud exit strategies, best suited capabilities, and innovativeness of new services make it an attractive and strategic approach for organisations looking to optimise their cloud computing resources and capabilities. Thus, we have proposed two hypothesis regarding relative advantage in the following:

Hypothesis 1a (H1a): Relative advantage is positively associated with PEOU.

Hypothesis 1b (H1b): Relative advantage is positively associated with PU.

3.2.2. Compatibility

Compatibility refers to the extent to which cloud services, platforms, and applications can work together seamlessly, as well as the ease with which they can be integrated into an organisation's existing values, previous experiences and requirements (Calisir et al., 2009). While multi-cloud adoption offers numerous advantages, compatibility concerns can be potential factors that hinder some organisations from adopting this approach. According to Kamateri et al. (2013), the diversity and heterogeneity for these cloud platforms give interoperability challenges to integrate the architecture concept into business usage. These concerns can be examined across aspects such as organisational needs, technology customisation and integration, daily operational modification, and data portability and interoperability between public clouds.

Organisational need for customisation may present compatibility challenges when adopting multi-cloud, as different cloud providers often have distinct service offerings, tools, and platforms. Although Géczy et al. (2012) argues that customisation should be provided by the CSP to help the organisation with integrating to cloud, it is unlikely that CSPs provide support to an organisation adopting multi-cloud strategy for it to require integrating their solutions with the competitors'. This can make it difficult for organisations to find and combine services that meet their specific requirements or customise solutions to address their unique needs, potentially leading to inefficient or suboptimal configurations. Technology integration can be another compatibility concern, Gangwar et al. (2015) state that organisations need to study the technology capabilities to reduce the uncertainty of technology integration and it may require significant effort, time, and resources. This process may involve the development of custom connectors, the modification of application code, or the implementation of additional management tools, which can be complex and costly, deterring some organisations from adopting a multi-cloud approach.

Daily operational modifications may also pose compatibility challenges in multi-cloud environments. According to Petcu (2013), the existing multi-cloud management tools cannot sufficiently fulfil the user demands. Managing multiple cloud providers can introduce complexity in daily operations, such as monitoring, logging, and troubleshooting, as each provider may have different tools and processes. This added complexity may require organisations to invest in additional resources or training for their IT staff, which can be a barrier to multi-cloud adoption.

Lastly, data portability and interoperability between public clouds can be a significant compatibility concern for organisations considering a multi-cloud approach. Transferring data between cloud providers or enabling seamless communication between applications hosted on different clouds can be hindered by varying data formats, APIs, and protocols. According to Ramalingam and Mohan (2021), proprietary solutions by the CSPs lack standards when communicating with each other, thus it requires a middleware to establish the transfer protocol. On the other hand, data structure for cloud computing is not yet standardised, the cloud data is often produced by a process to fit a particular product, it is doubtful that it can be handled by other products on different CSPs with the same format (Opara-Martins et al., 2014). This lack of standardisation can make it difficult to move data and applications between providers or build integrated solutions that leverage multiple cloud services, potentially limiting the benefits of a multi-cloud approach.

In conclusion, compatibility is an important consideration in cloud computing, and potential challenges related to organisational need customisation, technology integration, daily operational modification, and data portability and interoperability between public clouds can be factors that hinder some organisations from adopting a multi-cloud strategy. These compatibility concerns are diminishing the perceived value of ease of use and usefulness. Thus, the following hypotheses are proposed:

Hypothesis 2a (H2a): Compatibility is negatively associated with PEOU.

Hypothesis 2b (H2b): Compatibility is negatively associated with PU.

3.2.3. Complexity

According to Ray, complexity of cloud adoption refers to the challenges and intricacies involved in implementing, managing, and maintaining cloud-based services, platforms, and applications (2016).

When it comes to multi-cloud, the complexity associated with adopting and managing multiple cloud providers can be a potential factor that hinders some organisations from embracing this approach. This complexity can be examined across aspects such as deployment difficulty, management challenges, and other factors such as security, compliance, and vendor management.

Deployment difficulty can be a significant factor in the complexity of multi-cloud adoption. Although there are existing production ready products for assisting the deployment on deploying and managing through a broker architecture for multi-cloud, Petcu (2013) again states that these products are not fulfilling the system requirements of multi-cloud networks. Implementing multiple cloud services from different providers or intermediate brokers may require substantial effort and resources to integrate them with existing systems, processes, and workflows. Organisations need to pay the labouring cost to develop custom connectors or modify application code. Additionally, without an universal standard deployment interface across different public CSPs, ensuring consistent deployment methodologies and configurations across multiple providers can be a complex task, deterring some organisations from adopting a multi-cloud strategy.

The complexity of cloud adoption, particularly in multi-cloud environments, can be a potential factor that deters some organisations from embracing this approach. Aspects such as deployment difficulty, management challenges contribute to this complexity. Addressing these challenges and streamlining the adoption process is essential to ensure an effective multi-cloud adoption. Thus, the following hypothesis is proposed:

Hypothesis 3 (H3): Complexity is negatively associated with PEOU.

3.3. Organisational factors

3.3.1. Organisational competency

Organisational competency in the context of cloud adoption refers to an organisation's functional and technological knowledge, skills, and abilities to effectively implement, manage, and leverage platforms and applications (Edgar and Lockwood, 2008). Adopting a multi-cloud architecture can yield several benefits for organisations with strong organisational competency across aspects such as employee experience and understanding, organisational readiness, organisational project experience, and organisational capabilities.

Employee experience and understanding play a crucial role in the successful adoption of multi-cloud architecture. According to Imeri and Memeti, during the cloud migration planning phase, employee skills and experience helps the organisation with adoption and maintenance with the migrated service entities (2018). When employees possess a deep understanding of various cloud providers' offerings and technologies, they can more effectively assess, select, and manage the best-suited services from different CSPs. This can help improve the stability of the technical architecture after the migration.

Organisational readiness is another factor that can positively impact multi-cloud adoption. According to Carcary et al., the readiness of an organisation can impact the outcome of the migration and it can be increased with certain strategies and assess the IT services that are cloud-ready (2014). When an organisation has a well-defined cloud migration strategy, robust governance models, and a culture that supports innovation and change, it is better positioned to successfully navigate the complexities of multi-cloud environments. This readiness enables organisations to capitalise on the benefits of multi-cloud.

Lastly, organisational capabilities, including technical expertise, resource management, and business process integration, can contribute to the successful adoption of multi-cloud architecture. According to Ramdani et al. (2013), past ICT experience will influence the perceived view of adopting a new technology into the organisation. These past experiences can help develop the capabilities for lowering the barrier to multi-cloud. When an organisation possesses strong experience and capabilities in these areas, it is better equipped to manage the complexities of multi-cloud, ensuring seamless integration and interoperability across different CSPs. This can result in greater operational efficiency, innovation, and competitive advantage for the organisation.

In conclusion, organisational competency is a critical factor in the successful adoption of multi-cloud architecture. By leveraging employee experience and understanding, organisational readiness, and organisational capabilities, organisations can effectively navigate the challenges of multi-cloud environments. Thus, the following hypotheses are proposed:

Hypothesis 4a (H4a): Organisational competency is positively associated with PEOU.

Hypothesis 4b (H4b): Organisational competency is positively associated with PU.

3.3.2. Quality of service

Quality of Service (QoS) in the context of cloud computing refers to the performance, reliability, and overall experience provided by cloud services, platforms, and applications to meet the specific requirements and expectations of an organisation (Ardagna et al., 2014). QoS is an essential consideration when selecting cloud providers and can be a potential factor in affecting the perceived usefulness of multi-cloud adoption. This can be examined across aspects such as expected Service level agreements (SLAs).

More organisationally fitting SLAs are an aspect that can drive multi-cloud adoption. According to Patel et al. and Alhamad et al., SLAs are contractual agreements between cloud providers and their customers, outlining the performance, reliability, availability, and support commitments that the provider is expected to meet (2009; 2010). By adopting a multi-cloud approach, organisations can formulate a package of SLAs that best align with their specific requirements and risk tolerances. This enables organisations to ensure that their cloud services are delivered with the expected QoS, while also providing recourse in the event that a provider fails to meet their commitments.

QoS is a crucial factor in cloud computing, and adopting a multi-cloud architecture can enable organisations to achieve better expected outcomes. By considering these aspects, organisations can ensure that their multi-cloud environment delivers the required QoS to support their operational needs and strategic objectives, thus having a positive relation with the perceived usefulness of the technology. Thus, the following hypothesis is proposed:

Hypothesis 5 (H5): Quality of service is positively associated with PU.

3.3.3. Top management support

Top management support in the context of cloud computing refers to the commitment and involvement of an organisation's senior leadership in the planning, implementation, and assimilation of cloud-based services, platforms, and applications (Ogan, 2015). This support is crucial for the successful adoption of multi-cloud architecture, as it ensures that the organisation's cloud strategy is aligned with its overall business objectives and priorities. Key aspects to consider are strategic alignment, fostering a culture of innovation, and risk mitigation.

Strategic alignment is essential, as it ensures that the adoption of the IT infrastructure is in line with the organisation's business goals and objectives (Avila et al., 2009) . Senior leadership plays a critical role in defining the organisation's cloud strategy, identifying the desired benefits and outcomes, and ensuring that the multi-cloud approach is designed to support these goals. Senior leadership is also responsible for allocating the necessary resources to support the planning, implementation, and maintenance of multi-cloud environments.

Fostering a culture of innovation is another area where top management support can play a significant role in multi-cloud adoption. Ray (2016) states that an organisation increases its openness to new technology by embracing an innovative culture. By encouraging experimentation, risk-taking, and collaboration, senior leaders can create an environment where employees are empowered to explore new technologies and approaches, including multi-cloud solutions.

Risk evaluation is another important aspect where top management support plays a crucial role in multi-cloud adoption. By actively engaging in the identification, assessment, and management of risks associated with multi-cloud environments, senior leaders can help ensure the organisation's cloud adoption initiatives are implemented (Ogan, 2015). Top management can help establish a comprehensive risk management framework, promote a culture of security and compliance, and manage vendor-related risks in a multi-cloud environment.

In conclusion, top management support is a critical factor in the successful adoption of multi-cloud architecture. By ensuring strategic alignment, fostering a culture of innovation, and effectively managing risks, senior leaders can help their organisations navigate the complexities of multi-cloud environments and realise the usefulness of this approach to support their business goals and objectives. Thus, the following hypothesis is proposed:

Hypothesis 6 (H6): Top management support is positively associated with PU.

3.4. Environmental factors

3.4.1. Competitor pressure

Competitor pressure can be a significant factor driving a company to adopt multi-cloud architecture. According to Zhu and Kraemer (2005), this pressure can emerge from various sources, including competitor actions and industry landscape.

When companies in the same industry observe their competitors adopting multi-cloud solutions and reaping benefits such as increased agility, cost savings, and improved performance, they may feel compelled to follow suit to avoid falling behind. This creates a positive influence on technology adoption when it is directly implemented by the competitors (Ramdani et al., 2009; Gangwar et al., 2015). By adopting multi-cloud, companies can ensure they are leveraging the latest technology and innovative solutions provided by the CSPs, allowing them to keep up with or even surpass their competitors in terms of their application performance.

Competitor pressure can be a powerful motivator for companies to adopt multi-cloud architecture. By staying informed about competitor actions and industry standards, companies can make strategic decisions about multi-cloud adoption to ensure they remain competitive and compliant in their respective industries, helping them stay ahead in the ever-evolving landscape of cloud computing. Thus, the following hypothesis is proposed:

Hypothesis 9 (H9): Competitor pressure is positively associated with adoption intention.

3.4.2. Vendor relation

Negative vendor relations can create barriers to multi-cloud adoption by impacting various aspects of the organisation's interactions with cloud service providers. A lack of standards between multiple vendors can hinder multi-cloud adoption, as companies may lack the resources to spend time on infrastructure implementation instead of working on their value-adding products (Munteanu et al., 2014).

Poor vendor support and collaboration, characterised by inadequate technical assistance, onboarding, documentation, and maintenance, can make it challenging for organisations to manage the complexities of a multi-cloud environment. Additionally, rigid vendor relations that lack flexibility and customisation can make it difficult for organisations to create a multi-cloud architecture that addresses their unique requirements, leading to a preference for single-cloud or on-premises solutions. Organisations seeking to adopt multi-cloud solutions should carefully manage their vendor relationships to mitigate potential issues and maximise the benefits of multi-cloud architecture. Thus, the following hypothesis is proposed:

Hypothesis 10 (H10): Vendor relation is negatively associated with adoption intention.

3.5. Isolated factors

3.5.1. Perceived ease of use

Perceived ease of use (PEOU), in the context of technology, refers to the degree to which users believe that adopting a new technology, system, or service would be effortless and straightforward. The TAM model shows that technologies that are easier to use are perceived as more useful (Davis, 1989; Schillewaert et al., 2005; Gangwar et al., 2015). Thus, the following hypotheses are proposed:

Hypothesis 7a (H7a): PEOU is positively associated with adoption intention.

Hypothesis 7b (H7b): PEOU is positively associated with PU.

3.5.2. Perceived usefulness

Perceived usefulness (PU), in the context of technology, refers to the extent to which users believe that adopting a particular technology, system, or service will enhance their job performance or provide significant benefits to the organisation (Gangwar et al., 2015). Thus, the following hypothesis is proposed:

Hypothesis 8 (H8): PU is positively associated with adoption intention.

4. Methodology

This section describes the way of answering the research questions and testing the proposed hypotheses. In paragraph 4.1., we introduce the method and the reasoning behind it. Followed by stating the Unit of Analysis, which is the group of audience being studied. At last, we will walk through the survey design in detail and present on how the responses are collected.

4.1. Research Method

As mentioned in section 1.4, this study examines how the consideration factors affect the adoption intention of multi-cloud architecture from an organisational perspective. To address the previously proposed question and related hypotheses, we adopt a quantitative research approach. A research model is utilised to validate and illustrate the correlations among all the dimensions of multi-cloud adoption that incorporate these consideration factors. Surveys are used to collect data on all dimensions, giving this research a quantitative nature and enabling the findings to be generalised in the cloud community. Scholars have conducted multiple similar studies that utilised surveys as their data collection tool (Skafi et al., 2017; Gangwar et al., 2016; Raut et al., 2017).

4.2. Unit of analysis

The unit of analysis defines the target audience of the study, which may pose possible constraints to the survey's development. The context and nature of this study will divide the unit of analysis into four groups: (1) individuals who have not participated in cloud migration projects or multi-cloud projects, (2) individuals who have participated in cloud migration projects but not multi-cloud projects, (3) individuals who have not participated in cloud migration projects but have participated in multi-cloud projects, and (4) individuals who have participated in both cloud migration projects and multi-cloud projects. These questions are asked in section 4.3.1.2 of the background section to categorise the respondents' suitability and for result analysis.

4.3. Survey

The survey is deployed on MS Forms and Qualtrics and designed according to the principles in the book "Questionnaire Design" by Malhotra et al. (2006). The questions are framed in a way that respondents do not require too much effort to answer and can disclose their true opinions. The demographic data collected in this survey helps us to provide descriptive statistics and inferencing the results.

4.3.1. Survey Design

The survey consists of four parts: Introduction, Background, Statements and Comments.

4.3.1.1. Introduction

The Introduction is the landing page of the survey. It introduces the purpose of the survey and survey expectations, including the survey duration, anonymity, and data usage. The page also reminds participants not to share confidential knowledge.

4.3.1.2. Background

The second section, Background, aims to gather demographic information from the respondents. The first part asks questions about their organisation's size and experience in the cloud. The number of questions can vary depending on the respondents. If the respondents have participated in any cloud migration projects, questions regarding their role in the migration projects will be asked. The respondents will also be asked about their experience in multi-cloud projects and which public CSPs they have engaged with in these projects.

4.3.1.3. Statements

The third section, Statements, focuses on questioning the determinants that impact an organisation's decision to adopt multi-cloud in their current architecture. Eleven topics related to multi-cloud adoption are addressed, including Relative advantage, Compatibility, Complexity, Organisational Competency, Quality of Service, Top Management Support, Competitor Pressure, Vendor Relation, PEOU, PU, and Adoption Intention. As the model's dimensions are latent and cannot be measured directly, we construct measurement metrics based on Gangwar et al. 's (2015) research and measure them using a 5-point Likert scale to assess the statements. The measures range from strongly disagree (1) to strongly agree (5).

The following table shows the mapping of the statement variables to their related question, the question details can be found at the Appendix section of this study.

Variables	**Question Number**
Relative Advantage	Q9 – Q18
Compatibility	Q19 – Q24
Complexity	Q25 – Q28

Organisational Competency	Q29 – Q31
Quality of Service	Q32 – Q33
Top Management Support	Q34 – Q35
Perceived Ease of Use	Q36 – Q38
Perceived Usefulness	Q39 – Q42
Competitor Pressure	Q43 – Q44
Vendor Relation	Q45 – Q46
Adoption Intention	Q47 – Q48

Table 2: Statement variables and corresponding survey question number mapping

4.3.1.4. Comments

The final section comments, allowing for feedback from the respondents. This part is optional for the respondents and is used to identify interesting items for future work.

4.3.1.5. Survey distribution

The survey is distributed in cooperation with Deloitte, a global consulting company with its distribution located in the Netherlands. This enables a substantial network of relevant individuals to participate in this study.

5. Descriptive data results

In this chapter we will show the demographics of the data. Data analysis and hypothesis examination will be further shown in the next chapter. The sample size and characteristics is demonstrated in graphs, figures and tables in the following sections.

5.1. Sample size

The survey was designed for a specific group of cloud engineers and practitioners and was distributed through various sources. Responses were collected anonymously. The total number of individuals reached by the survey was 218, with 160 of them being reached through the Deloitte NL internal connection, and the remaining individuals reached through public posts published in LinkedIn groups. Considering all the distribution methods, 53 respondents participated in the survey, resulting in an approximate response rate of 24%. We carefully examined the data to identify any missing information and conducted data cleansing. After data cleansing, we obtained 52 valid responses, which represents the final size of our dataset. The data was exported from MS Teams to Excel format. For additional analysis, we utilised a statistical analysis tool called JASP.

5.1.1. Organisational size

Participants from various organisation sizes have taken part in the survey. The organisational sizes are categorised based on Gangwar et al.'s research (2015). The majority (38%) of the survey respondents come from large organisations (>10001 employees), followed by 37% from large to mid-sized companies (5001 - 10000 employees). As shown in Figure 4, 13% of the respondents are from mid-sized companies, while 10% come from mid to small-sized companies. Additionally, 2% of the respondents represent small companies, fulfilling the demographics.

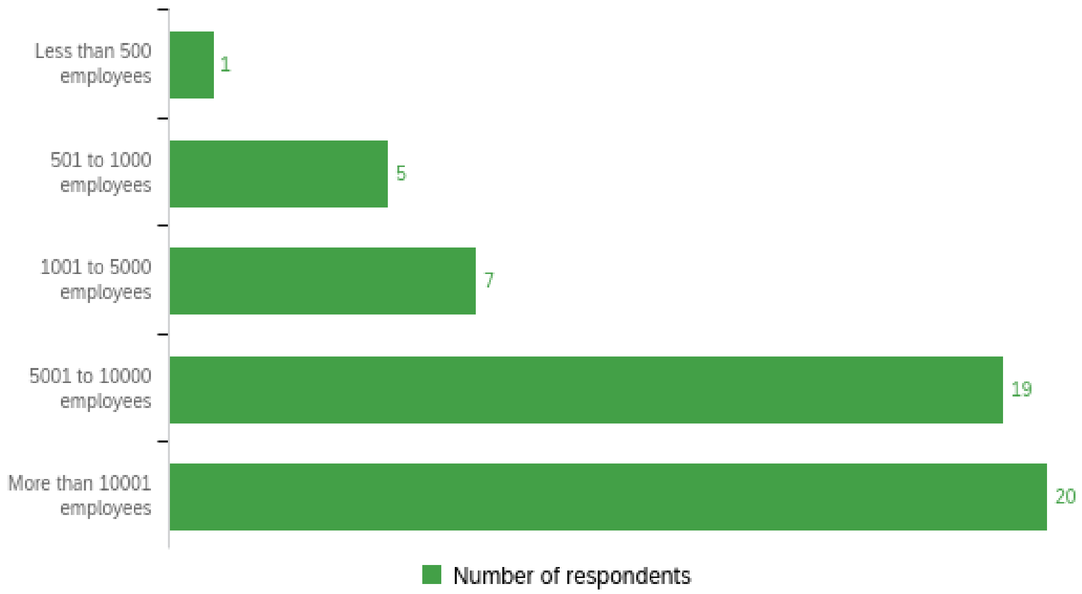

Figure 4: Organisational size demographics

5.1.2. Industry type

Respondents of the survey came from various industries, which were categorised based on Gangwar et al.'s research (2015). The majority of the respondents come from two different industries: Consultancies (46%) and Information Technology (29%). Other industries represented in the survey include Health/Medical (8%), Business Management (6%), Engineering (4%), Logistics (4%), Accounting/Finance (2%), and Education (2%). The statistics are displayed in the following figure.

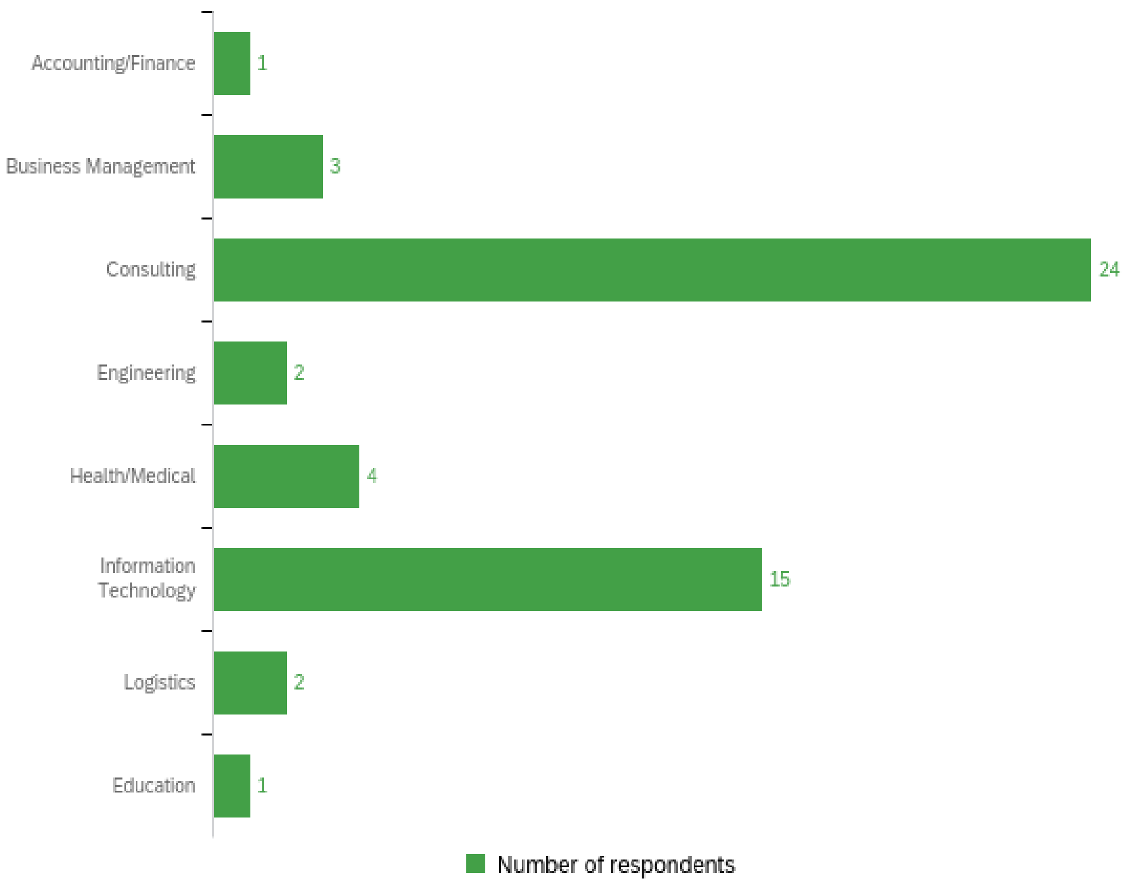

Figure 5: Industry demographics

5.1.3. Experience

The question asked respondents about their exposure time to cloud technologies on an annual basis. The majority of respondents (49%) reported having experience in cloud technologies ranging from 4 to 6 years. The second largest group of respondents (29%) reported having experience ranging from 1 to 3 years. The remaining three groups constituted smaller portions of the audience, with 12% having 7 to 9 years of experience, 6% having more than 10 years of experience, and the smallest group consisting of 4% with less than one year of experience. Figure 6 displays the statistics of the experience groups.

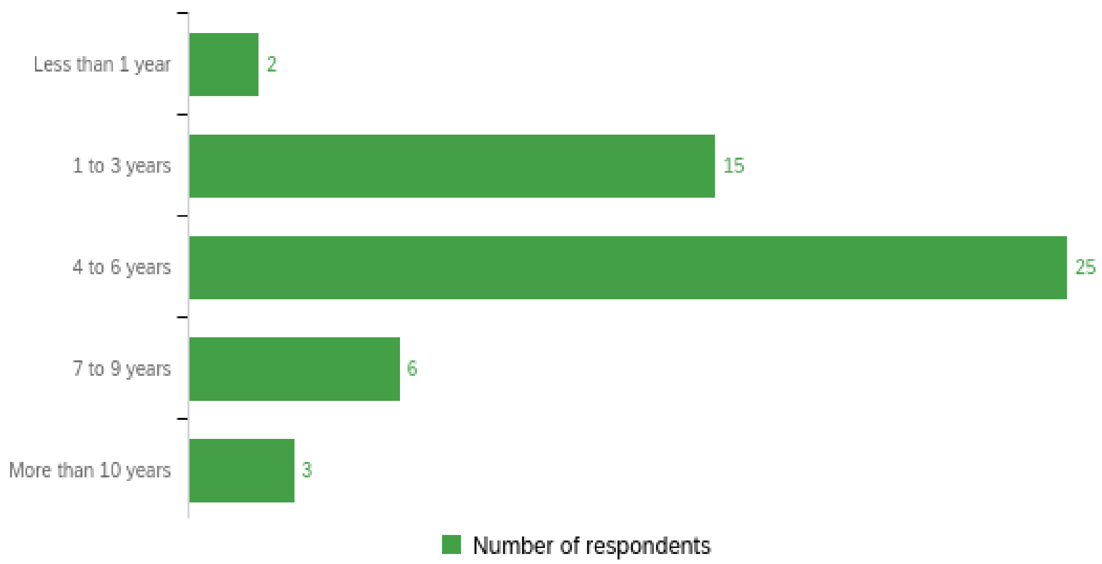

Figure 6: Experience demographics

5.1.4. Involvement in cloud migration

This section modifies the question logic based on the respondents' answers. The objective of this section is to understand the role of the respondent in a cloud migration project if they have participated in one. The response options are developed based on the VMware white paper by Kevin et al. (2013) and a study by Balalaie and Heydarnoori (2016) on team composition and required roles in a cloud migration project. The roles within a cloud operations team are categorised into five roles: "Business Leader," "Architect," "Analyst," "Developer," and "Administrator."

The Leader is responsible for executing the cloud strategies defined in the project and facilitating communication among multiple interested parties. The Architect establishes the architectural standards and procedures for the cloud project, creates the project roadmap, and defines the requirements. The Analyst's main responsibility is to monitor the cloud project to ensure compliance with policies and review various operational analytics. The Developer builds the cloud systems according to requirements and optimises them to meet the desired capabilities. The Administrator is responsible for configuring the cloud environment and plays a critical role in setting up the project environment, leveraging their expertise in deployments and cloud security.

These roles are presented in a matrix for the respondents to choose from accordingly. If the respondents cannot find an answer that describes their role, they have the option to manually enter their role under the "other" option. The table below will display the survey options along with their respective roles:

Process	Roles
Business case development	Business leader
Cloud strategy development	
Infrastructure assessment	Architect
Migration planning	
Ongoing management and monitoring	Analyst
Optimisation and refinement	Developer
Application migration	
Environment preparation	Administrator
Governance and security	

Table 3: Surveyed process and respective roles

Based on the statistics of question 4, it is evident that the majority of respondents (83%) have been involved in cloud migration projects. This specific segment of the audience will proceed to answer the next question, which focuses on the process and further explores their roles in their respective projects.

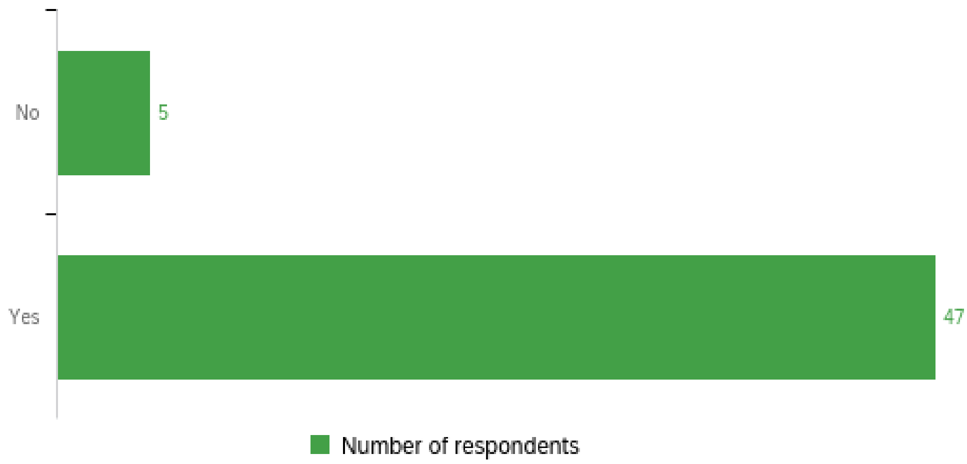

Figure 7: Cloud migration demographics

When analysing the responses to question 5, interesting results emerge. The majority of respondents have engaged in various processes related to cloud migration projects. These processes include Application migration (17%), Cloud strategy development (14%), Infrastructure assessment (14%), and Optimisation and refinement of the cloud infrastructure (13%). Additionally, a portion of the respondents reported involvement in Business case development (7%), Governance and security (8%), Environment preparation (8%), and Ongoing management and monitoring (7%). These responses provide insights into the diverse range of processes in which the respondents have participated.

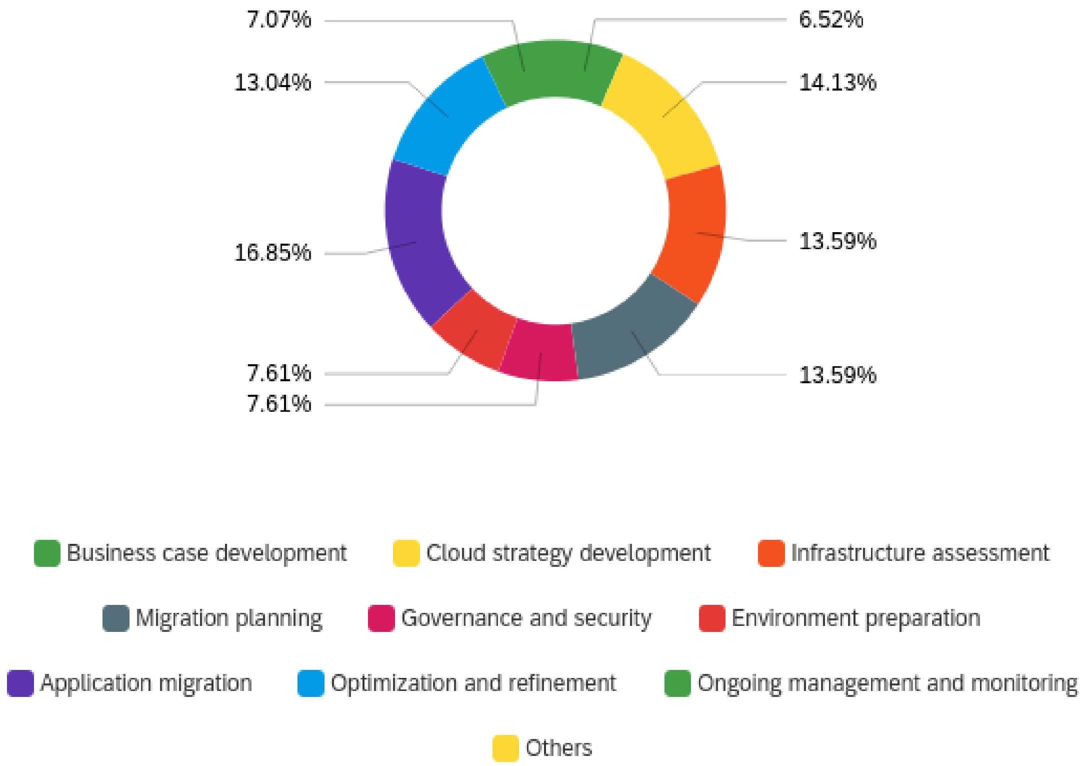

Figure 8: Cloud migration process demographics

If we group the responses into pairs based on their simultaneous existence, the top pair consists of Application migration with Optimisation and refinement with 23% of respondents experiencing both processes in their projects. The second most common pair is Business case development and Cloud strategy development, with 17% of respondents undergoing these processes together.

On the other hand, when grouping the responses into pairs based on the exclusion of existence, we observe that the pairs Migration delivery and Ongoing management and monitoring have the lowest frequency of occurrence. The pair Business case development and Ongoing management and monitoring rank second lowest in terms of appearing together. This can be attributed to the fact that these responsibilities are rarely assigned to the same role, as the functions of a business leader and a developer or administrator differ.

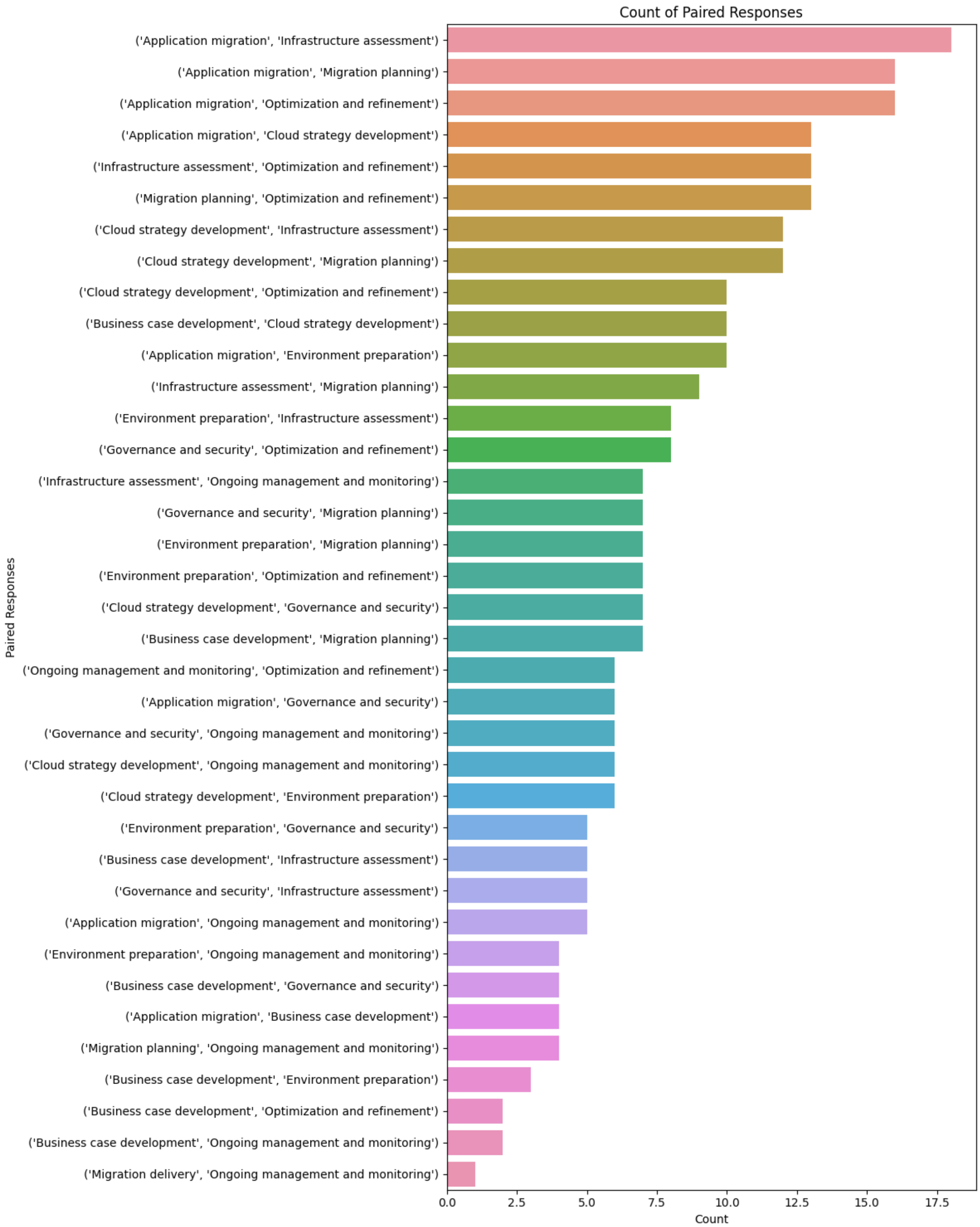

Figure 9: Cloud migration processes for paired responses

5.1.5. Involvement with multi-cloud

Following the approach taken in the previous question, this section also modifies the question logic based on the respondents' answers. The objective of this section is to gain insights into the most popular combinations of Cloud Service Providers (CSPs) to work with under the scope of multi-cloud. The response matrix is developed by referencing the market share of public CSPs, as researched by

Statista (2023). Considering that AWS, Azure, and Google Cloud are the dominant players in the market, we include them as the main choices for the respondents.

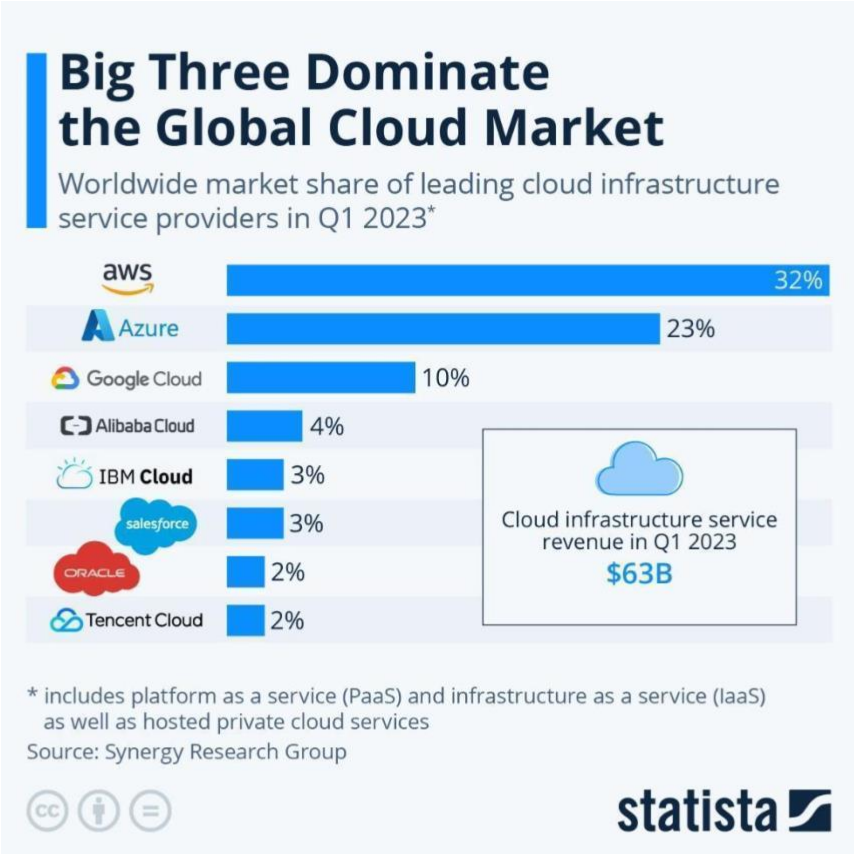

Figure 10: Statista's research on cloud market share (2023)

In question 6 of this section, the majority of respondents (78%) have indicated their participation in multi-cloud projects. For those respondents, a follow-up question will be prompted regarding the specific Cloud Service Providers (CSPs) involved in their projects. This question aims to gather information on which CSPs were utilised in the context of their multi-cloud projects.

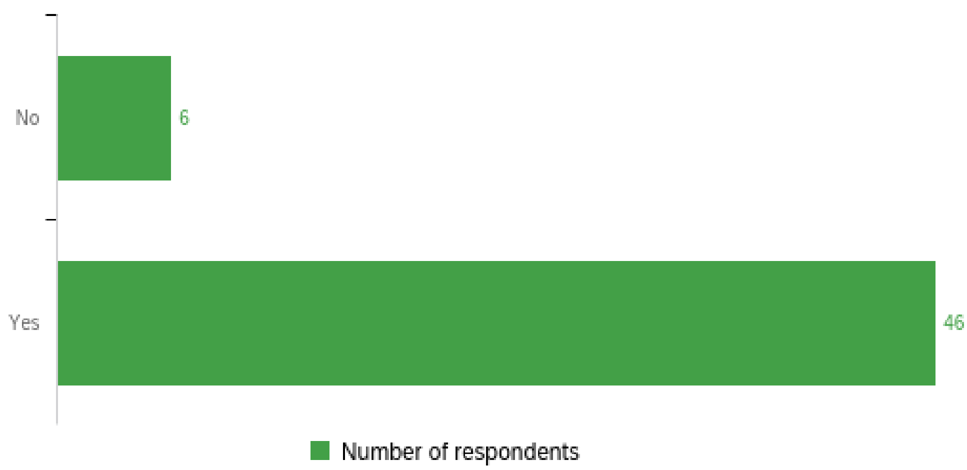

Fig 11: Multi-cloud involvement demographics

According to the responses to question 7, the majority of respondents have worked with public Cloud Service Providers (CSPs) as follows: 40% of the respondents have engaged with AWS, 31% of them have worked with Azure, 20% have worked with Google Cloud, and 8% have worked with Oracle Cloud. When grouping the responses by pairing up the most common combinations, it is found that the combination of AWS and Azure Cloud was the most prevalent (52%). The second most common combination was AWS and Google Cloud (23%). These statistics align with the trends observed in the market.

Furthermore, it should be noted that some respondents have worked with other cloud providers, such as Oracle Cloud (8%). Additionally, there were respondents who utilised other cloud providers not specifically mentioned, which are denoted as "others" (1%). It is worth mentioning that these responses indicate the use of Salesforce Cloud in a multi-cloud project.

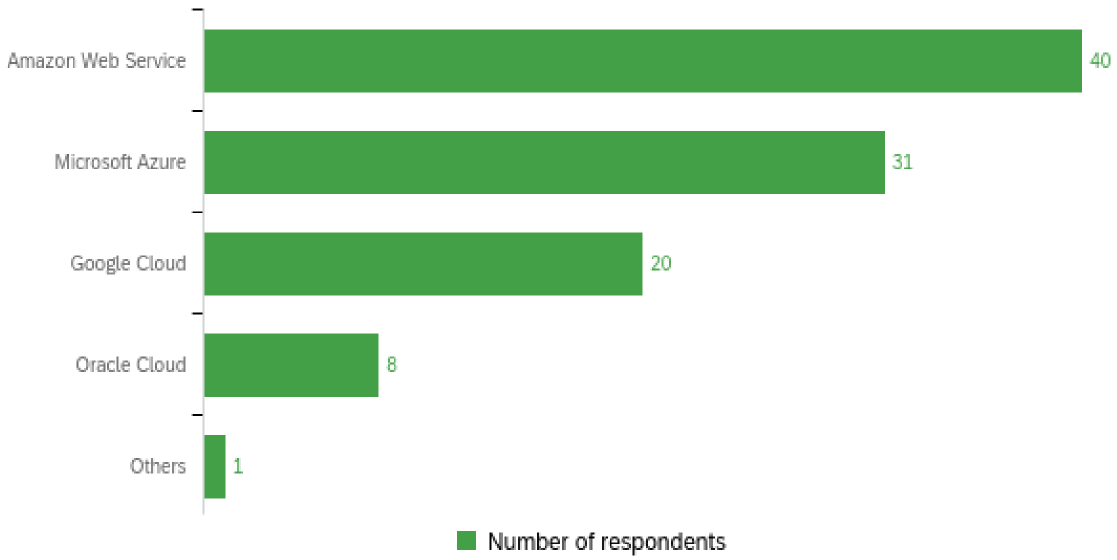

Figure 12: Multi-cloud project choice of CSP

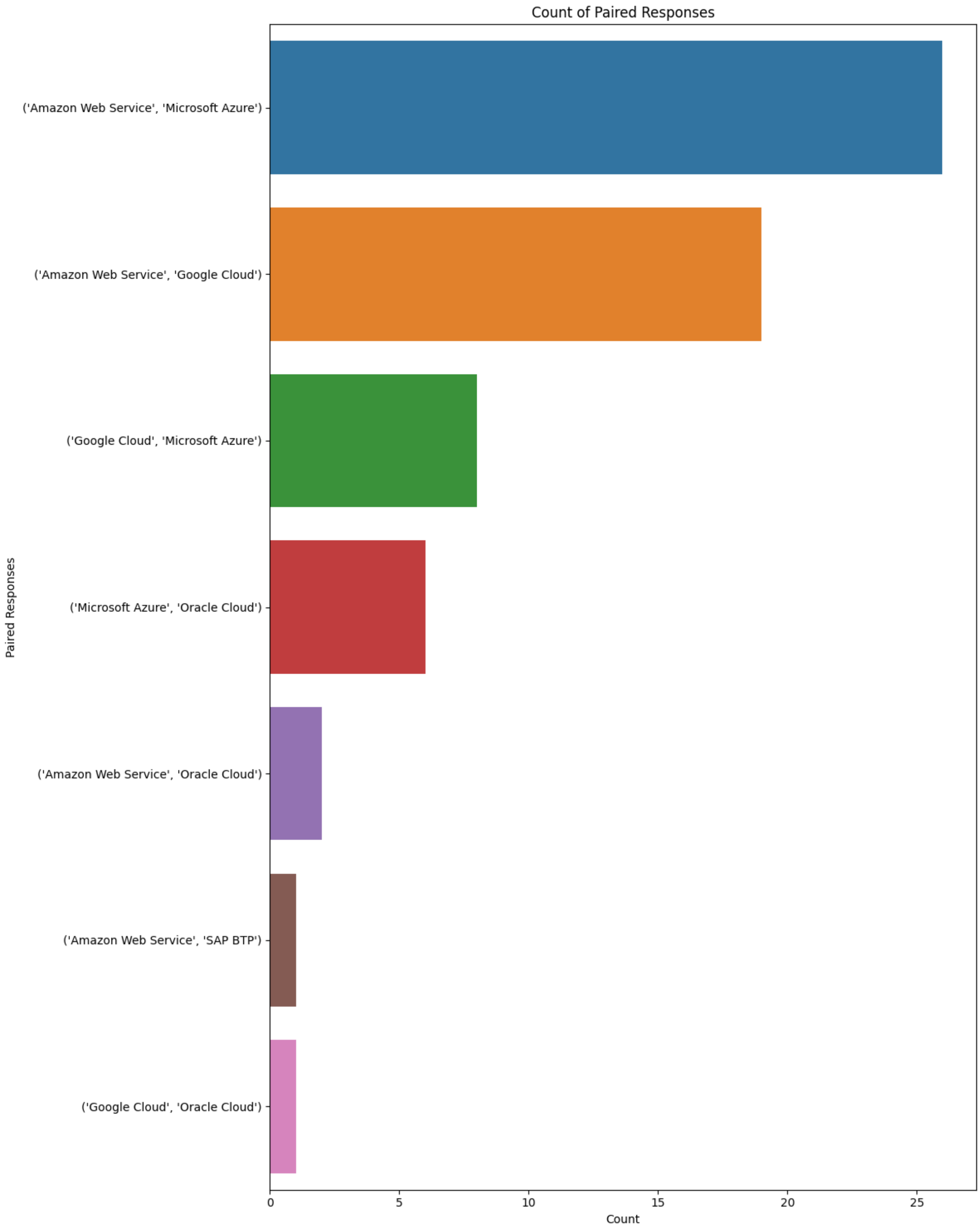

Figure 13: Multi-cloud project CSPs pairing

5.2. Survey statement results

In this section, we are going to display the demographic results for each and every segment of the proposed hypothesis variables. These statements are generated from previous studies and research, for further details of the statements, see Appendix.

The following table maps the questions into synonyms for a better overview for the following statements results of the survey.

Statements	Synonyms
Using multi-cloud can increase the reliability of my application	RA_1
With multi-cloud, we can provide our service without geographical constraint	RA_2
With multi-cloud, we are able to host our application with higher availability	RA_3
With multi-cloud, it makes my application more resilient to disasters	RA_4
I have more security options with the multi-cloud system	RA_5
Multi-cloud provides more option to my organisation's cloud strategy when coming to exit plans	RA_6
With multi-cloud, we can achieve our TCO (Target Cloud Overview) more easily	RA_7
Using multi-cloud, we can optimise our cloud portfolio cost efficiently	RA_8
With multi-cloud, we can use the best suited capabilities from different CSPs	RA_9
With multi-cloud, we are able to adapt the newest service from different CSPs	RA_10
Multi-cloud services are easy to customise	CPB_1
Different CSPs' services are compatible with existing technological architecture of my company	CPB_2
The changes introduced by cloud computing are consistent with existing practices in my company	CPB_3
Multi-cloud computing development is compatible with my firm's existing format, interface, and other structural data	CPB_4
There is no difficulty in importing applications/data between cloud services	CPB_5
There is no difficulty in exporting applications/data between cloud services	CPB_6
I understand the topic of multi cloud computing	OC_1
Our organisation have sufficient expertise for adopting multi-cloud system	OC_2
Our organisation has experience in working with different CSPs	OC_3
With multi-cloud, our application produce expected outcome	QoS_1
With multi-cloud, we can find the best fitted customised SLA to our requirements	QoS_2
My top management is likely to consider multi-cloud adoption as strategically important	TMS_1
My top management is willing to take the risk involved in adoption of multi-cloud	TMS_2

It is easy for us to learn managing multi-cloud	PEoU_1
It is easy to make use of multi-cloud computing	PEoU_2
The procedure of using multi-cloud computing is understandable	PEoU_3
Using multi-cloud computing allows me to manage business operation in an efficient way	PU_1
Using multi-cloud computing allows me to increase business productivity	PU_2
Using multi-cloud computing enables allow me to accomplish my organisational task more quickly	PU_3
Using and understanding multi-cloud computing advances my competitiveness	PU_4
We are aware of multi-cloud implementation in our competitor organisations	CP_1
We understand the competitive advantages offered by multi-cloud in our industry	CP_2
With multi-cloud, we are confident that we can negotiate a better deal from the CSPs	VR_1
Using multi-cloud, we are more likely to get less support from our current partnered CSP	VR_2
Overall, I think that using a multi-cloud system is advantageous	AI_1
Overall, I am in favour of using multi-cloud system	AI_2

Table 4: Mapping the questions to synonyms

The statistics show that the agreeableness level is measured for the relative advantage statements. The results are presented in Figure 14. These statements were gathered with a 1-5 Likert scale, ranging from “Strongly disagree” to “Strongly agree”.

5.2.1. Technological factors

The following figure shows the agreeableness level of a group of technology factors and how respondents contribute their opinions to the study in this sector.

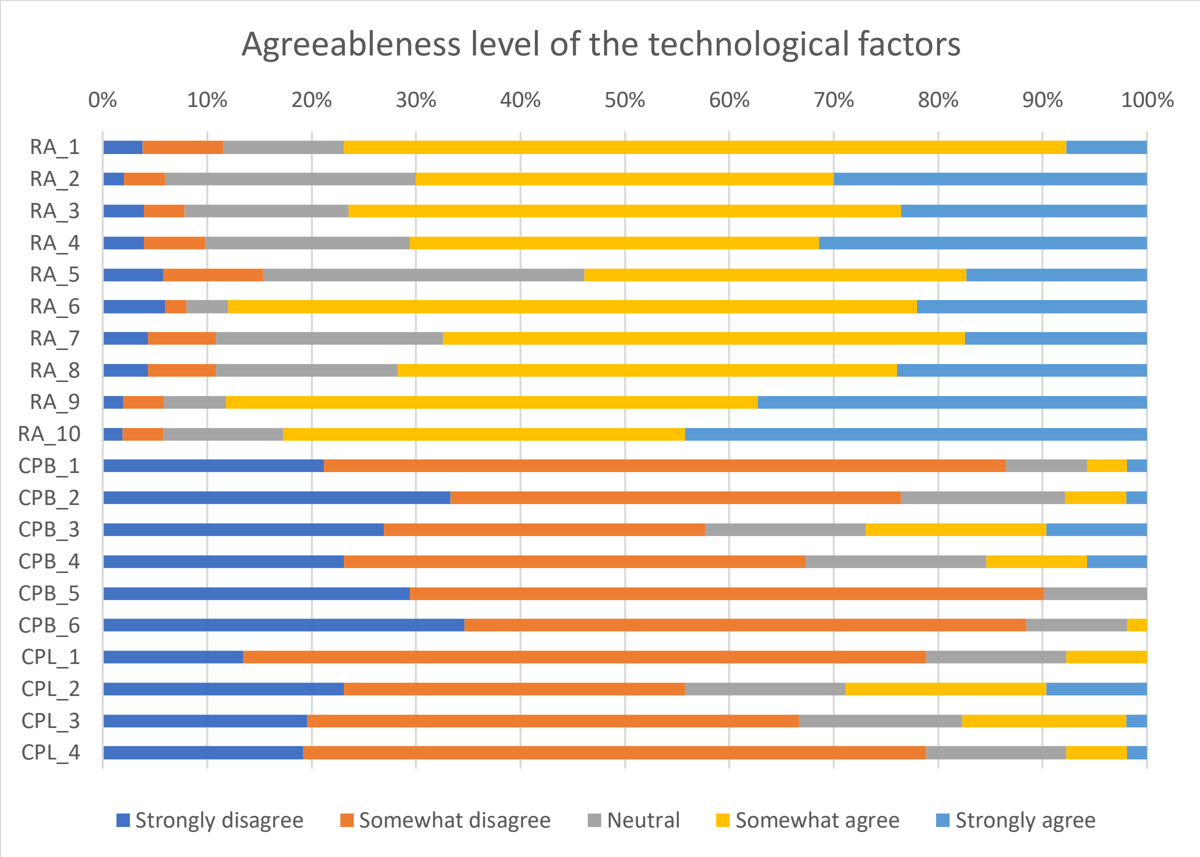

Figure 14: Showing the agreeableness level of the technological factors

5.2.2. Organisational factors

The following figure shows the agreeableness level of the group of organisational factors and how respondents contribute their opinions to the study in this sector.

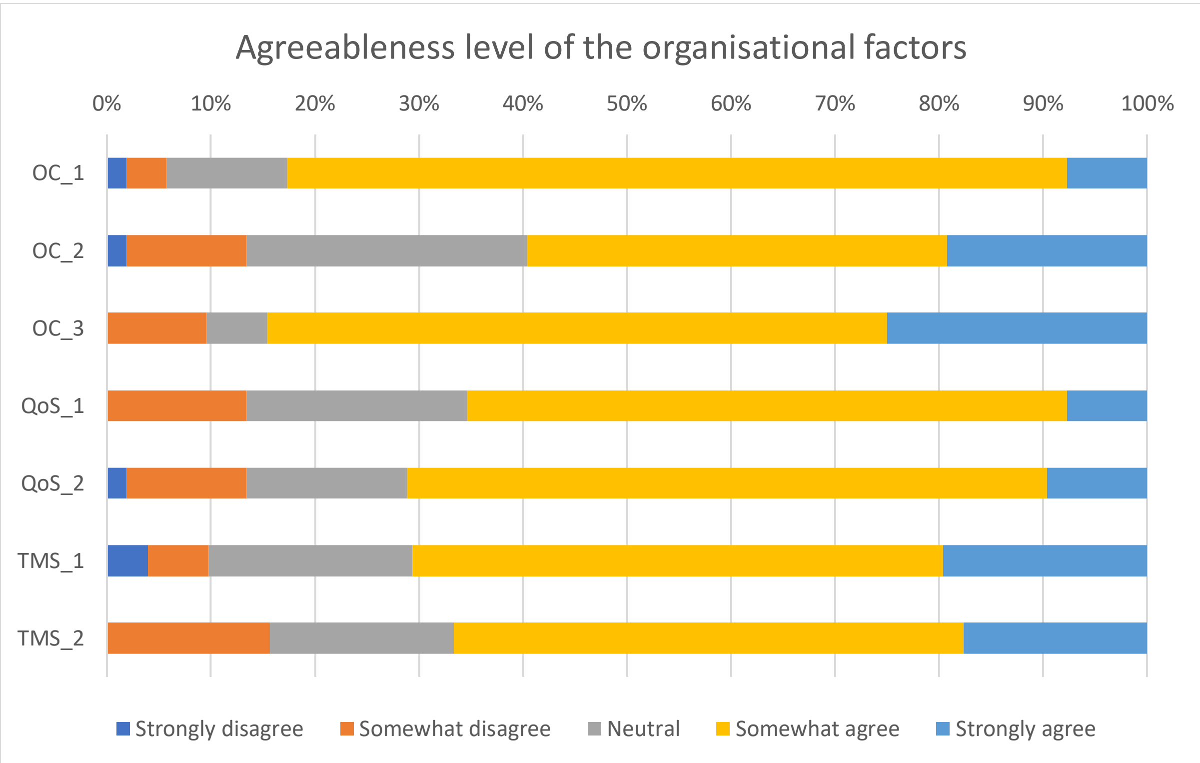

Figure 15: Showing the agreeableness level of the organisational factors

5.2.3. Environmental factors

The following figure shows the agreeableness level of a group of environmental factors and how respondents contribute their opinions to the study in this sector.

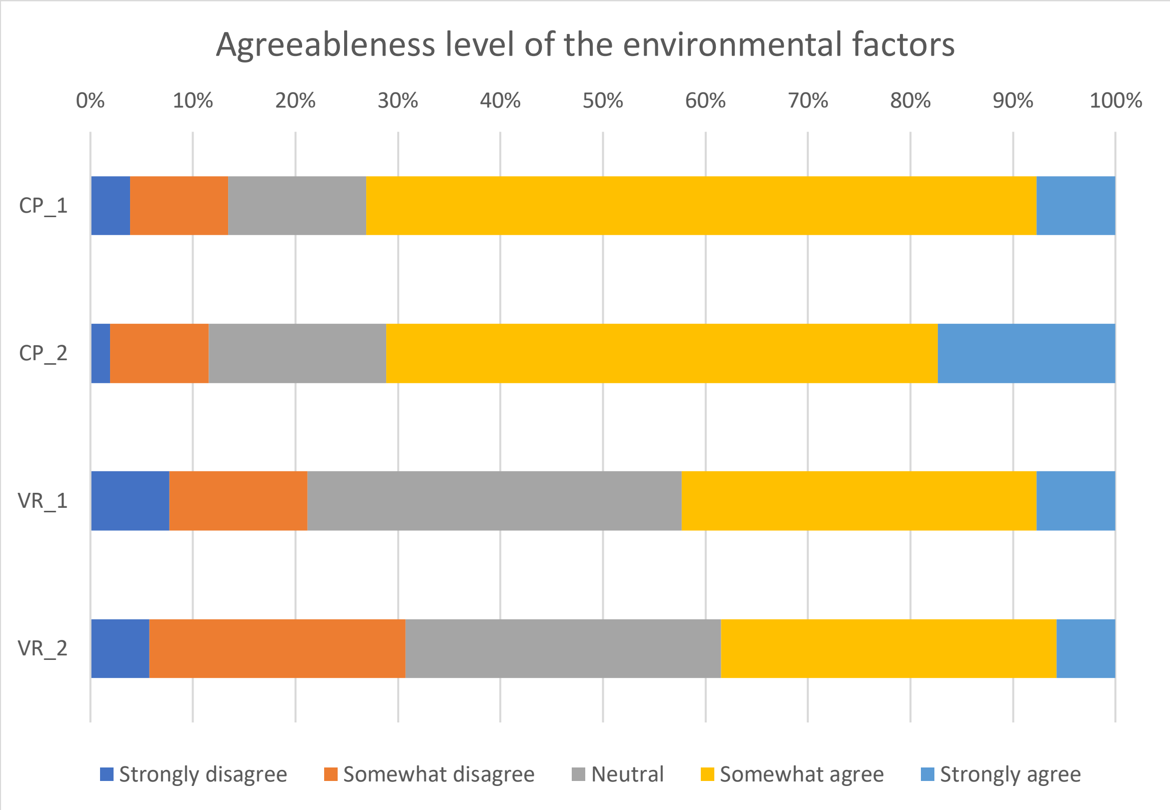

Figure 16: Showing the agreeableness level of the environmental factors

5.2.4. Individual factors

The following figure shows the agreeableness level of a group of environmental factors and how respondents contribute their opinions to the study in this sector.

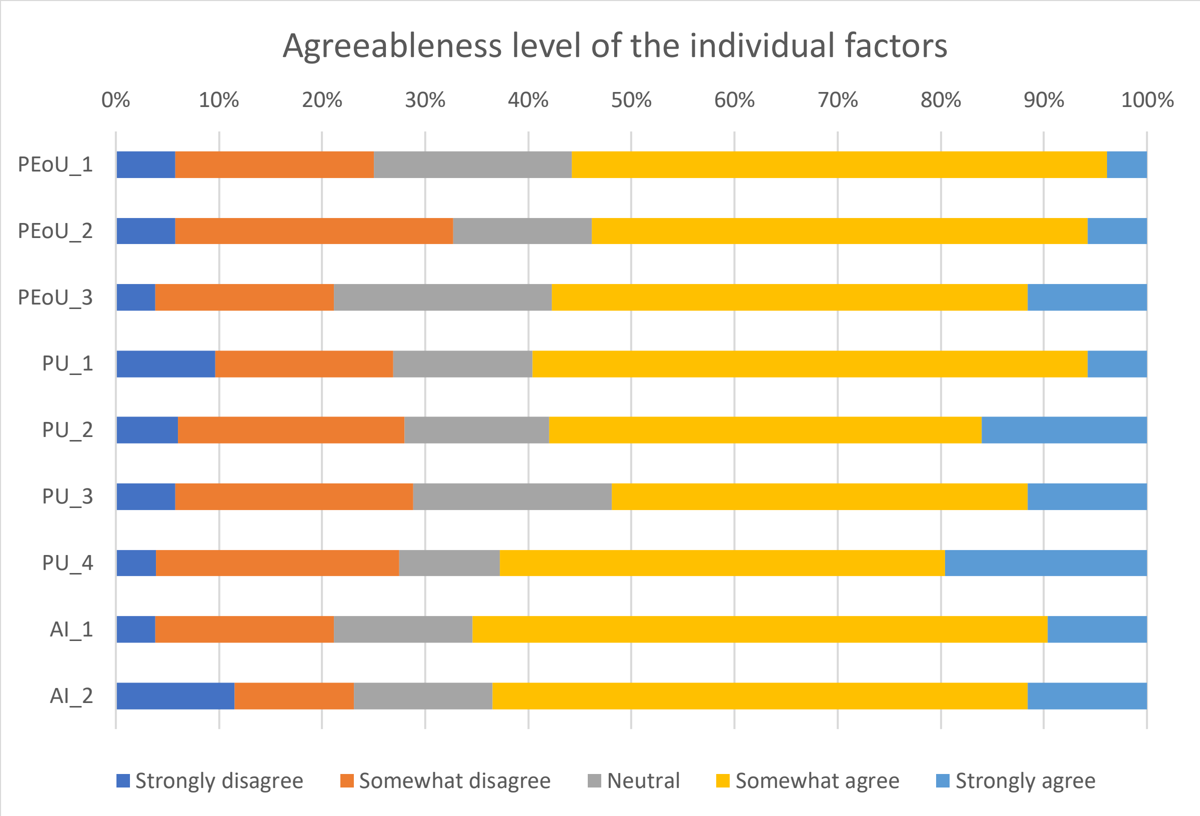

Fig 17: Showing the agreeableness level of the individual factors

6. Data analysis and hypothesis testing

This chapter analyses the data and tests the proposed hypothesis. We state our preparation in section 6.1., applying synonyms to the tested variables. In section 6.2., we show the descriptive result of the data in a table from our respondents. In section 6.3., we present the result of a reliability test for each variable for further processing in the hypothesis testing. In section 6.4., we present the correlation analysis result. In section 6.5., we test our hypotheses using linear regression method.

6.1. Data synonyms

Before the analyses, we defined some synonyms for the testing variables for easier analyses, the data was exported and cleaned in Excel and further analysed in JASP. Following Table shows the variables and respective synonyms.

Variables	Synonyms
Relative Advantage	RA
Compatibility	CPB
Complexity	CPL
Organisational Competency	OC
Quality of Service	QoS
Top Management Support	TMS
Perceived Ease of Use	PEoU
Perceived Usefulness	PU
Competitor Pressure	CP
Vendor Relation	VR

Adoption Intention	AI

Table 5: Variables with their respective synonyms

6.2. Result and statistics

The survey has been conducted in a 1-5 Likert-scale, stating the agreeableness of the respondents ranging from Strongly disagree to Strongly agree. The following table has presented the descriptive statistics of the studies. Table 6 showed the combination of different responses for individual variables.

	RA	CPB	CPL	OC	QoS	TMS	PEoU	PU	CP	VR	AI
Valid	52	52	52	52	52	52	52	52	52	52	52
Missing	0	0	0	0	0	0	0	0	0	0	0
Mode	4.000	2.000	2.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000	4.000
Median	4.000	2.000	2.000	4.000	4.000	4.000	4.000	4.000	4.000	3.500	4.000
Mean	3.808	2.231	2.500	3.885	3.769	3.923	3.269	3.404	3.827	3.385	3.538
Std. Deviation	0.595	0.645	0.754	0.732	0.731	0.882	0.910	0.995	0.785	0.844	0.999
Minimum	2.000	1.000	1.000	2.000	2.000	2.000	1.000	1.000	2.000	1.000	1.000
Maximum	5.000	4.000	4.000	5.000	5.000	5.000	4.000	5.000	5.000	5.000	5.000

Table 6: Descriptive statistics for the whole study

In table 6 showed the agreeableness level across the whole study. With mode defined as the most mentioned number in our dataset and 1 being the lowest score and 5 being the highest score, we can see the majority of our respondents answers are giving a positive agreeableness level of the survey questions. The expected standard deviation range is expected to be 0.5 to 1 as the range of response is defined from 1 to 5.

6.3. Reliability testing

We have performed an unidimensional reliability test on the variables mentioned in table 5. The test is done by researching Cronbach's Alpha for individual variables. In table 7, we have referenced an indicator from previous studies to assess the reliability results. The results are presented below.

Variables	**Reliability criteria**
$0.90 \leq \alpha \leq 1$	Excellent
$0.70 \leq \alpha < 0.90$	High
$0.50 \leq \alpha < 0.70$	Moderate
$\alpha < 0.50$	Low

Table 7: Interval of Cronbach's Alpha reliability (Suyidno et al., 2017)

Variables	**Alpha value (α)**	**Reliability Level**
RA	0.88	High
CPB	0.76	High

CPL	0.62	Moderate
OC	0.78	High
QoS	0.6	Moderate
TMS	0.84	High
PEoU	0.75	High
PU	0.87	High
CP	0.44	Low
VR	0.36	Low
AI	0.97	Excellent

Table 8: Reliability testing result

After performing the reliability testing, the above results show the variable Competitor Pressure (CP) and Vendor Relation (VR) have an Alpha value lower than 0.5, thus they are considered not reliable in the scope of testing. The two variables will be dropped in the sections of further analysis. We will further discuss the low reliability score in section 7. For more details of these variables, see Appendix for full results.

6.4. Correlation analysis

In the following section of correlation analysis, we are going to display the result for three groups of studied responses. In section 6.4.1., we will show the analysis result of the whole valid dataset and the corresponded

6.4.1. All sample analysis

Correlation analysis is performed with the remaining 11 variables mentioned in section 6.3. The sole dependent variable in this context will be Adoption Intention (AI), as we aim to investigate the relationship between the variables and how they will affect the organisation's decision-making process. We collected our data using a Likert scale, and there exists a linear relationship among the data variables in our dataset. Therefore, we employed Pearson's correlation as the method for computing the correlation analysis. The results indicate that certain variables are strongly correlated with each other.

Pearson's Correlations

Pairs			Pearson's r
RA	-	PEoU	0.496 ***
RA	-	PU	0.465 ***
CPB	-	PEoU	-0.008
CPB	-	PU	0.157
CPL	-	PEoU	-0.200
CPL	-	PU	0.013
OC	-	PEoU	0.136
OC	-	PU	0.227
QoS	-	PEoU	0.331 *
QoS	-	PU	0.535 ***
TMS	-	PEoU	0.075
TMS	-	PU	0.371 **
PEoU	-	PU	0.505 ***
PEoU	-	AI	0.484 ***

Pearson's Correlations

Pairs		Pearson's r
PU	- AI	0.802 ***

* p < .05, ** p < .01, *** p < .001

Table 9 for Correlations result and significant correlations showing in pairs

In the following paragraphs, we would like to focus on the relations that we indicated in our proposed model in the previous section. With the sample size of 52 responses, we can conclude that RA [$p < 0.001$] and QoS [$p < 0.05$] are the only two variables that are strongly related to the PEoU and the PU of multi-cloud technology. The results also stated that TMS [$p < 0.05$] and PEoU [$p < 0.001$] are strongly related to the PU. In the relation between AI, we can see both PEoU [$p < 0.001$] and PU [$p < 0.001$] are considered strongly related as they both have low p-values, indicating the occurrence of the relationship is rarely denoted by chance.

On the other hand, the results indicate that that both CPB and CPL in the technology sector, and OC in the organisational factor have a high p-values, which indicates that the observed effect of these variables in this data set may not have significant influence of the correlated variables (Goodman, 2008). Thus, on the following hypothesis testing analysis, we will exclude these variables and reject their respected hypothesis for we cannot confidently state that they are correlated to the proposed related variables.

From the above table, we can denote that QoS [$r(52) \geq 0.331$] has the weakest linkage amongst the strongly correlated variables with PEoU in the layer between the technology factors and the independent factors. Subsequently, we can denote that the pair of PU and AI has the strongest linkage between all pairs [$r(52) \geq 0.802$].

6.5. Hypothesis testing

We performed both single and multiple linear regression analyses with RA, QoS, TMS, PEoU, PU and AI. As the proposed model suggested, AI will be the sole dependent variable in our model as it is the tested subject. The remaining variables will be the independent variables in this testing. The below table concludes the result of the hypothesis testing, further detailed results are appended in the later parts of this section.

No.	Hypothesis	Path coefficient (β)	Findings
H1a	Relative advantage is positively associated with PEoU	0.757	Supported ($p < 0.001$)
H1b	Relative advantage is positively associated with PU	Not applicable	Rejected ($p > 0.05$)
H2a	Compatibility is negatively associated with PEoU	Not applicable	Rejected ($p > 0.05$)
H2b	Compatibility is negatively associated with PU	Not applicable	Rejected ($p > 0.05$)
H3	Complexity is negatively associated with PEoU	Not applicable	Rejected ($p > 0.05$)
H4a	Organisational competency is positively associated with PEoU	Not applicable	Rejected ($p > 0.05$)
H4b	Organisational competency is positively associated with PU	Not applicable	Rejected ($p > 0.05$)

H5	Quality of service is positively associated with PU	0.403	Supported ($p < 0.05$)
H6	Top management support is positively associated with PU	Not applicable	Rejected ($p > 0.05$)
H7a	PEoU is positively associated with adoption intention	Not applicable	Rejected ($p > 0.05$)
H7b	PEoU is positively associated with PU	0.301	Supported ($p < 0.05$)
H8	PU is positively associated with adoption intention	0.752	Supported ($p < 0.001$)
H9	Competitor pressure is positively associated with adoption intention	Not applicable	Rejected ($\alpha < 0.5$)
H10	Vendor relation is negatively associated with adoption intention	Not applicable	Rejected ($\alpha < 0.5$)

Table 10: Full sample correlation and findings

6.5.1. Model result analysis

The following figure stated the main research model depicts all of the variables' correlating values. The unstandardised value of beta (β) value is represented between 0 and 1, underlying the quantified effect sizes between variables. The p-value (probability) is indicated with 0 to 3 asterisks next to the β value.

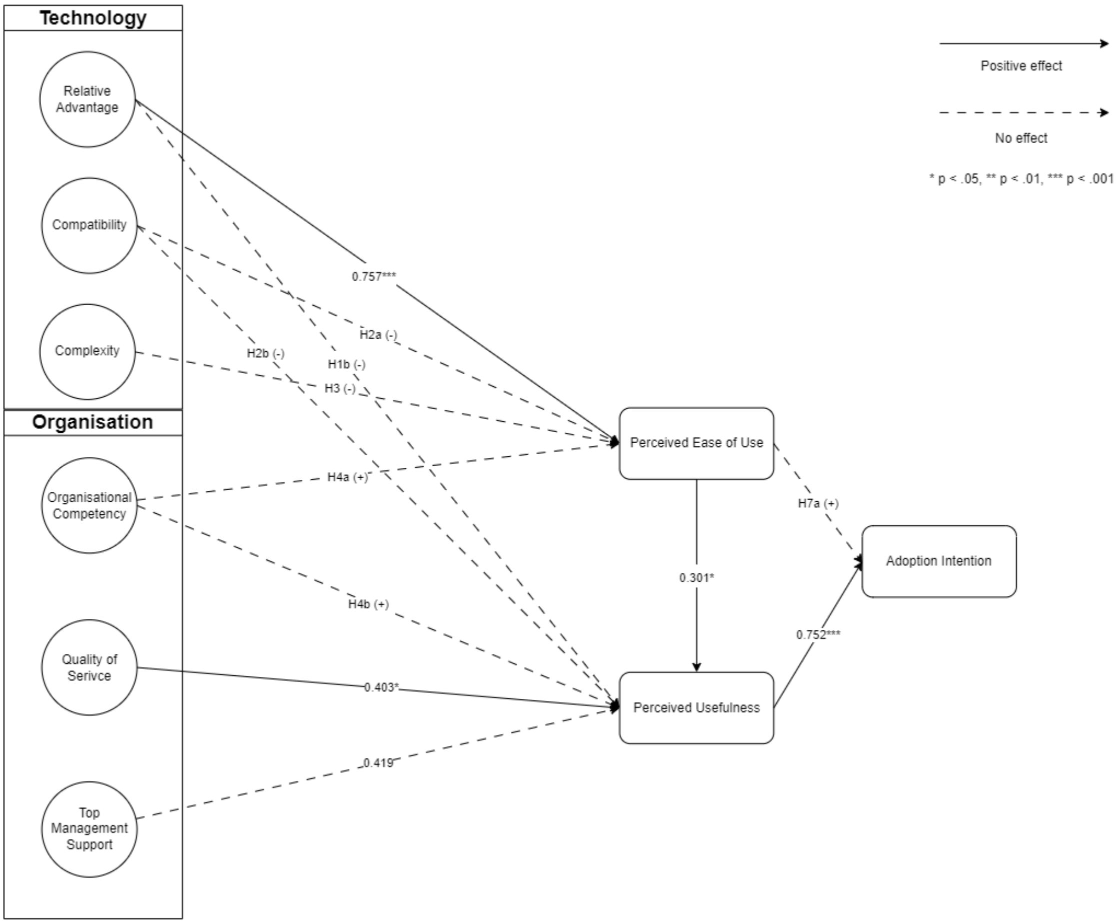

Figure 18: Resulting research model

In the following sections, we will present the detailed results of the regression model and their quantified effects of the variables. The data table in this section will show the unstandardised and standardised coefficients (β), the standard error of the model, and the t-value and p-value for null hypothesis testing respectively.

6.5.2. Perceived usefulness

From the research model figure, we can see the model [$F(4,47) = 10.96$, $p < 0.001$] explained around 48.3% (Adjusted $R^2 = 0.483$) of the variance in the outcome variable. For further detailed results of the model, see Appendix 10.5.1.

Coefficients

Model		Unstandardised β	Standard Error	Standardised β	t	p
H_1	(Intercept)	-1.501	0.823		-1.823	0.075
	PEoU	0.301	0.137	0.276	2.207	0.032
	RA	0.393	0.203	0.235	1.933	0.059
	QoS	0.403	0.168	0.296	2.395	0.021
	TMS	0.230	0.131	0.204	1.751	0.086

Table 11: PU variable analysis

From the above table, we can interpret the following results:

- RA and TMS are not concluded to have an effect relation with PU in the model due to high p-values ($p > 0.05$).
- QoS has a significant and positive ($β = 0.403$, $p < 0.05$) relationship with PU.
- PEoU has a significant and positive ($β = 0.301$, $p < 0.05$) relationship with PU.

We can also conclude that QoS (Standardised $β = 0.296$) has a stronger effect on the model than PEoU (Standardised $β = 0.276$). The linear regression equation for PU is *PU = -1.501 + (PEoU * 0.301) + (QoS * 0.403).*

We can yield the following hypotheses based on the result from the research model:

- H1b is rejected and retains the null hypothesis as we cannot conclude RA has a significant relationship with PU ($p > 0.05$).
- H5 is accepted and rejected null hypothesis as we can conclude QoS has a significant and positive relationship with PU ($β = 0.403$, $p < 0.05$).
- H6 is rejected and retains the null hypothesis as we cannot conclude RA has a significant relationship with PU ($p > 0.05$).
- H7b is accepted and rejected null hypothesis as we can conclude PEoU has a significant and positive relationship with PU ($β = 0.301$, $p < 0.05$).

6.5.3. Perceived ease of use

Subsequently, we present the model result from the research model [F(1,50) = 16.276, p < 0.001] and explain around 24.6% (Adjusted R^2= 0.246) of the variance of the outcome variables. It also denotes that RA has a significant and positive relationship with PEoU (β = 0.757, p < 0.001). See Appendix 10.5.2 for more detailed results.

Coefficients

Model		Unstandardised β	Standard Error	Standardised β	t	p
H_1	(Intercept)	0.385	0.723		0.532	0.597
	RA	0.757	0.188	0.496	4.034	< .001

Table 12: PEoU variables analysis

The linear regression equation for PEoU is *PEoU = 0.385 + (RA * 0.757).* From the above results, we can state the following for our hypothesis:

- H1a is accepted and rejected null hypothesis as we can conclude RA has a significant and positive relationship with PEoU (β = 0.757, p < 0.001).

6.5.4. Adoption intention

The model research result also investigated the relationship between PEoU and PU with AI. The model explained around 65.2% (Adjusted R^2= 0.652) of the variance results from the outcome variable with a significantly predicted result [F(2, 48) = 45.9, p <0.001] . We can also conclude that PU has a significant and positive relationship (β = 0.752, p < 0.05) with AI. On the other hand, we cannot conclude that PEoU has a significant and positive as the p-value is high (p > 0.05) which implies the null hypothesis is retained. For further details of the AI model see Appendix 10.5.3.

Coefficients

Model		Unstandardised	Standard Error	Standardised	t	p
H_1	(Intercept)	0.599	0.351		1.709	0.094
	PEoU	0.116	0.107	0.106	1.084	0.284
	PU	0.752	0.098	0.749	7.666	< .001

Table 13: AI variables analysis

The linear regression equation for AI is *AI = 0.599 + (0.752 * PU).* From the above results, we can state the following for our hypotheses:

- H7a is rejected and retains the null hypothesis as we cannot conclude PEoU has a significant relationship with AI (p > 0.05).
- H7b is accepted and rejected null hypothesis as we can conclude RA has a significant and positive relationship with PEoU (β = 0.752, p < 0.001).

7. Discussion

The proposed research question is revisited and answered in the part of the discussion section. The following paragraphs will highlight and mention the key findings from this study subjected to the main research question, which is the starting point of the thesis:

What factors are critical to an organisation adopting a multi-cloud structured system?

The previous analysis sections indicate that PU is the main critical decision factor, and QoS, RA, and PEoU are supporting decision factors for adopting multi-cloud projects in an organisation. As illustrated in paragraph 6.5.2, PU is the deciding factor for an organisation's decision on multi-cloud architecture adoption. It has a significant actionable influence on the adoption intention but also acts as a mediator between the other factors and their influence on the adoption intention. PU is measured using indicators based on respondents' views of multi-cloud technologies and how they bring value to their organisation. QoS is a main contributor to PU, followed by PEoU, both of which affect AI through the mediator of PU. Lastly, RA contributes to the effect of PEoU, indicating that it has a small effect on AI and causes two mediators, PEoU and PU, to denote the effect.

7.1. Perceived usefulness is key to adoption

The research models in Section 6.5.1 state that perceived usefulness (PU) is a critical factor in the decision to adopt a multi-cloud architecture within the organisation. This factor has a significant influence on AI, with a large effect size ($\beta = 0.752$), while mediating the effects of PEoU ($\beta = 0.301$) and QoS ($\beta = 0.403$).

According to prior research by Gangwar et al. (2013; 2016), the PU factor has a significant but relatively lighter impact ($\beta = 0.618$; $\beta = 0.612$) on the adoption intention of single cloud computing technologies in their research models. However, it exhibits the highest impact coefficient among all the variables. Our data aligns with these previous findings and indicates that cloud operators believe that new technologies can enhance their productivity and performance within the organisation. The findings also suggest that multi-cloud adoption is dependent on the organisation's views of its current architecture. Organisations are only likely to move towards a multi-cloud approach if it can solve specific problems such as "vendor lock-in" and align with needs that a single cloud service provider (CSP) architecture failed to achieve. Furthermore, as suggested by Davis (1989), perceived usefulness (PU) can increase when users have a self-predicted usage scenario. In certain situations where the multi-cloud approach can effectively address a particular problem, it should be considered as it is not necessarily a fundamentally different approach from single cloud computing.

Our data, as depicted in Figure 17, also indicates that cloud operators are not as enthusiastic about multi-cloud technologies compared to previous studies. For instance, in a survey on multi-cloud success conducted by Microsoft, 88% of the respondents agreed that the multi-cloud setup contributed to their business successes (2022). Similarly, research conducted by Kearn-Manolatos with Deloitte US showed that approximately 80% of the 500 investigated organisations considered the multi-cloud approach as an important strategic asset for achieving more beneficial impacts on their business (2022). In contrast, our data highlight that around 60% of our respondents provided positive feedback regarding the usefulness of the multi-cloud approach.

Zhai & Shi (2020) stated that the perceived usefulness of a certain technology can be influenced by the different roles of the users. This can explain the findings in our data, as our investigated audience has diverse backgrounds in their cloud operations. Over time, they developed different perspectives on the multi-cloud architecture, resulting in a lower level of agreement with previous studies. Da Silva & Sadovykh (2014) have stated that while deciding on a suitable architecture, cloud operators face difficulties in balancing the cost and performance matrix, especially when considering the transfer of data across multiple clouds. This may reduce the value of multi-cloud computing for the operators.

In summary, our findings emphasise the crucial role of perceived usefulness in adoption intention for a multi-cloud architecture. Our data support previous research and underscores the importance of considering organisational perspectives, challenges, and specific needs in multi-cloud adoption. These insights can inform decision-making processes and guide organisations toward the successful adoption and implementation of multi-cloud technologies.

7.2. Quality of service has good effect on how organisation view multi-cloud usefulness

Our research models in Section 6.5.1 indicate that Quality of Service (QoS) plays a significant role in the perceived usefulness (PU) of the respondents and indirectly affects the adoption intention (AI) of the multi-cloud project. It is the most important factor that mediates through PU, with a medium effect size ($\beta = 0.403$).

QoS is measured using indicators such as the expected outcome and service level agreements (SLAs) for the requested services. In comparison to the previous study by Gangwar et al. (2016), our data shows a higher coefficient loading than their model ($\beta = 0.104$). This suggests that our audience places a higher value on the quality of service. However, our study aligns with his model that QoS positively influences PU. This result also indicates that with a multi-cloud architecture that offers the desired SLAs, organisations perceive higher value in the technology.

The adoption intention for organisations opting for a multi-cloud approach relies on the combination of different cloud service providers (CSPs) and tailored agreements for various scenarios (Serrano et al., 2015). The ability to customise and configure the expected SLAs is crucial to an organisation's view of the multi-cloud architecture. For instance, an organisation with data processing needs may choose to host their processing job on GCP Cloud while deploying their data storage solution on a more consistent CSP like AWS. By combining multiple clouds, they can obtain SLAs that provide better volume, speed, and efficiency compared to what a typical CSP can offer.

Our findings highlight the importance of QoS in influencing PU and adoption intention in the context of multi-cloud architecture. The ability to meet specific SLAs and customise the cloud services according to organisational needs can significantly enhance the perceived value of the technology and indirectly drive adoption.

7.3. Relative advantage is the major factor affecting PEoU, but not PU

In our survey, we examined RA using eight different indicators: cost, security, availability, reliability, disaster resilience, cloud exit strategies, best suited capabilities, and innovativeness. Our data shows that RA has a significant impact on the factor of PEoU. As stated in our research models in Section 6.5.1, RA directly influences PEoU ($\beta = 0.757$) and indirectly affects PU. Compared to the previous study conducted by Gangwar et al. (2013), our factor loading coefficient is significantly higher than their model ($\beta = 0.223$). Our study aligns with the previous research, as we also find that RA is a positively influential factor for PEoU.

When considering the adoption of another cloud service provider into the current architecture, cloud operators often prioritise finding the most suitable and technologically advanced service available in the market. These popular services tend to offer capabilities that align closely with their specific needs and provide valuable case study examples for the operators.

The positive relationship between RA and PEoU indicates that cloud operators perceive the adoption of a new cloud service provider to simplify tasks, streamline organisational processes, and overcome complexities associated with their current architecture. It provides them with solutions that may not be readily available within their current setup. As a result, the relative advantage of adopting a new provider reduces the effort required to trial and test the newly adopted technology. By recognising and appreciating the advantages associated with adopting a new cloud service provider, organisations can facilitate a smoother adoption process and enable easier usage of the technology.

On the other hand, we cannot confidently state that RA has a positive influence on PU as we have a higher p-value than expected ($p = 0.059$, $p > 0.05$). The weak evidence of the data is discussed more in the section 7.5.

7.4. Perceived ease of use is second most important factor to PU

Our data indicates that PEoU has a positive impact on PU in the adoption of multi-cloud architecture. As shown in the research model in section 6.5.1, PEoU has a medium-sized effect ($\beta = 0.301$) on the PU of the technology. Comparing our results to the studies conducted by Gangwar et al. (2013; 2016), we observe similar factor loadings with respective values of ($\beta = 0.434$; $\beta = 0.328$). Thus, our data confirms that PEoU is the second most influential factor on PU after QoS.

According to Schillewaert et al. (2005), technologies with lower barriers to utilisation are considered more useful, as they save effort and time in overcoming complexities compared to complex systems. In the context of adopting multi-cloud within an organisation, cloud operators tend to first explore options they are familiar with before considering newer alternatives in the market. Even when there are similar options available, the implementation and usage processes can differ depending on the system and situation. The extent of barriers that cloud operators need to overcome can vary, greatly influencing the perceived value of a cloud technology.

As depicted in section 5.1.5., the "big three" providers (AWS, Azure, GCP) dominate the cloud market, even in the case of multi-cloud adoption. These providers offer comprehensive tools and support for a wide range of cloud deployment scenarios, and they have large and active user communities. This dominance affects the barriers faced by cloud operators when entering the cloud market, as they can readily access the resources and support provided by these major providers. Thus, we observe that PEoU acts as a mediating factor between RA and PU.

The PEoU dimension highlights that the ease of technology use directly influences its perceived usefulness. However, it's important to note that the ease of use can vary in different situations as barriers constantly change and evolve.

7.5. Unreliability and weak evidence of the data

In section 6 of data analysis and hypothesis testing, we made a conscious decision to exclude the environmental variables from the data analysis for the rest of our study. During our examination in section 6.3, we found that the factors CP ($\alpha = 0.44$) and VR ($\alpha = 0.36$) exhibited low levels of reliability.

In contrast, Gangwar et al. conducted studies that involved surveying the environmental variables to test the factors and dimensions (2013). Although their qualitative study supported the inclusion of these variables, their study data indicated that both factors had minimal effects ($\beta = 0.234$; $\beta = 0.152$) on the adoption of single cloud computing. Considering the unique nature of adopting a multi-cloud architecture, we can deduce that stronger incentives are required beyond merely following the success of competitors at the current given moment. Hence, this may explain that the environmental variables have little to no reliability on the measurement for the decision to adopt multi-cloud.

As mentioned in section 6.5, several hypotheses were rejected due to weak evidence in our data during the correlation and regression analyses phase. According to Goodman (2008), a high p-value does not provide strong enough evidence to support our hypotheses. However, despite the rejection of these hypotheses, we can examine and compare them with previous studies. In Appendix section 10.5, we have included the results of the linear regression model. From an individual factor perspective, our data aligns with Gangwar et al.'s (2013) study regarding the influence of factors on PU and PEoU, respectively. However, the effect sizes of the dropped factors are minimal in relation to the cloud adoption decision. Contextual factors, such as industry-specific considerations and technological advancements, can introduce variability and weaken the observed associations. Since our audience primarily consists of professionals from the consultancy sector, various specific assumptions and organisational factors are considered in multiple situations. According to an example from the study done by Kearns-Manolatos, different industries prioritise their multi-cloud benefits differently (2022). While the healthcare industry is prioritising choice and full-stack capabilities, the financial sectors are more concerned on the resilience and reliability of their solution architecture. This may explain the low reliability and weak evidence observed in our collected data.

7.6. Future of the cloud market

The cloud market is undergoing a gradual transformation in 2023. Organisations that aim to adopt cloud solutions are exploring various methods to extract the ultimate benefits from service providers and gain a competitive edge. From an organisational perspective, their cloud operators can choose the technologies they work with and exert influence over decisions when partnering with service providers. Making the right choices in combining cloud services can reduce infrastructure costs and maximise the benefits derived from these decisions.

A study conducted by Deloitte on the future of the US cloud market reveals that organisations achieving a high level of innovation in their priority areas are obtaining the most value from their providers (2022). These companies work closely with their existing providers, influencing their cloud development road map that satisfies their specific business needs (2007). This approach may result in more customised services that make it challenging for customers to switch their service choices easily. Additionally, major providers are gradually increasing the complexity of integrating their services with other cloud providers, thereby reinforcing their market position.

According to the latest survey from Stack Overflow, although the “big three” providers continue to dominate the market, it is hard to ignore the desirability of other cloud providers such as Cloudflare and Hetzner within the developer community (2023). From the providers’ perspective, these companies have a limited market share and are more willing to collaborate with their competitors to achieve their business goals (Bengtsson & Kock, 1999). For example, Cloudflare offers various options to encourage customers to integrate their solutions with other cloud providers (Cloudflare, n.d.). The growing trend of collaboration and integration among cloud providers reflects the dynamic nature of the cloud market. Businesses need to stay agile to adapt to these changes efficiently and effectively.

7.7. Practical recommendations

Firstly, assuming the organisation is open to adopting a multi-cloud infrastructure, there must be a strong strategic approach for constructing a well-suited SLA for their business with various cloud providers. Businesses must have a clear approach to leverage the advantages and disadvantages offered by multiple service providers. Business leaders need to understand the fundamental characteristics and capabilities of different cloud platforms to make informed choices. According to Rampérez et al., since SLAs can differ in terminology and be distinct for each individual cloud provider, it is crucial for business decision makers to eliminate the cognitive barrier between the CSPs (2021). Therefore, we recommend that the organisation should build a certain level of knowledge about the capabilities of each potential cloud candidate before transitioning to a multi-cloud architecture.

Furthermore, we believe that providing training to the organisation’s cloud operators will help the company experience a smoother transition when embracing a multi-cloud environment. Petcu's study suggests that a multi-cloud infrastructure requires developers to understand different interfaces for implementation and maintenance (2013). Through knowledge sharing sessions, organisations can foster closer alignment with the architectural change and ensure that cloud operators know what to expect and understand the impact on their operational processes. As a result, it can reduce dissatisfaction and minimise the shock of change when developers transition to a new cloud environment.

By implementing these practical implementations, organisations can enhance their readiness for a multi-cloud infrastructure. It is important for organisations to invest time and resources in investigating if multi-cloud adoption matches their strategic goals. This proactive approach will contribute to the successful adoption of multi-cloud architecture and maximise the value derived from the cloud services.

7.8. Limitations and Threats to validity

This paragraph discusses some of the major limitations and threats to the validity of the research. Firstly, a small sample size may hinder the analysis of the data. Our total sample size was 53 responses, with 52 being valid. The size of the audience group is prone to selection bias, as most of our respondents come from two major industry types, which may limit the generalisability of the study's findings.

One possible example of selection bias in our study is that half of our responses were obtained using in-house resources with Deloitte Netherlands. As we utilised the network of Deloitte Netherlands to gather our data, the data may have been generated from the same group of individuals who hold similar views.

Furthermore, our study's reach is mainly concentrated in Europe and the Netherlands. According to research by McKinsey (2022), the cloud market potential in America and Asia, including Australia, ranks higher than that in Europe. The potential bias due to different perspectives from individuals in various regions with differing market maturity levels should be considered.

We used qualitative tools like the Likert Scale in the survey for our study. One disadvantage of this approach is that it provides no way to determine the respondents' attention span regarding our thesis, which may result in skewed responses. Although we attempted to generalise the questions as much as possible, we cannot guarantee that every question was fully understood by the respondents.

Lastly, due to the emerging nature of the field of multi-cloud adoption, we were unable to find numerous papers on multi-cloud computing. While scholars have made efforts to establish standards and expectations for multi-cloud architecture, limited resources are available on how organisations are to adopt a multi-cloud architecture. Therefore, we relied primarily on studies focused on single cloud adoption for organisations as references.

8. Conclusion and further research

This chapter will conclude our research, explain the findings, and conclude with an answer to the statement. Recommendations and suggestions are provided for further research.

8.1. Conclusion

Our study aims to investigate the factors that influence the adoption of multi-cloud architecture from an organisational perspective. We conducted a quantitative survey to research the validity of the relationship between these factors and their respective effect sizes. With the support of previous studies and 52 valid responses, we gained valuable insights into the main research questions. The respondents were mainly reached through the internal network of Deloitte Netherlands, while some were reached using emails and LinkedIn messaging.

Based on our data, we believe that PU is the most significant factor impacting the adoption of multi-cloud architecture within an organisation. QoS, PEoU, and RA also have a significant impact on the adoption decision of multi-cloud architecture. However, we couldn't establish a clear connection between the adoption of multi-cloud architecture and other factors due to weak evidence or unreliable data. Lastly, the current trend in the cloud market shows dynamic growth, and cloud services providers are either rejecting or embracing the concept of multi-cloud.

In conclusion, by giving a good perception on the PU of incoming technology, composing a tailor-made SLAs solution, and decreasing the learning curve and chances of interruption to existing processes in the architecture, your company can increase the likelihood of adopting a multi-cloud system.

8.2. Further research

Stated in the previous section 7.9, our sample size for the study consisted of 52 responses, with the majority of respondents located in the Netherlands. Therefore, for future research, we recommend targeting a larger and more diverse audience with different demographic backgrounds to ensure a more well-rounded study. This approach can enhance the validity of the research and potentially yield different insights.

Additionally, throughout this research, respondents provided interesting ideas in the comments sections that may not have been captured in the final data. We suggest that qualitative research could be employed to examine the factors affecting the adoption of multi-cloud from an organisational perspective. This qualitative approach can help capture unique perspectives and ideas that might not surface in quantitative research.

Given that multi-cloud is still a relatively new field, it is likely that more research will be conducted, and new resources will become available on the topic. Utilising newer research can aid in obtaining more accurate and mature data on the subject, thus contributing to a deeper understanding of multi-cloud adoption.

9. References

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10. Appendix

10.1. Overview of previous studies statements

Variables	Indicator	Statement	Based on
Relative Advantage	RA	At the early phases of the adoption decision, the newly adopted system provides advantage(s) that the current system cannot give.	Gangwar et al. (2013); Saedi (2016); Polyviou et al. (2015)
Compatibility	CPB	The newly adopted system can seamlessly merge with the current architecture without major impact on the	Gangwar et al. (2013); Borgman et al. (2013)

		business and technical process.	
Complexity	CPL	A complex system with a difficult integration is most likely to be ignored in the system adoption phase.	Gangwar et al. (2013); Borgman et al. (2013)
Organisational Competency	OC	The abilities and qualifications of the organisation to implement the changes.	Borgman et al. (2013); Polyviou et al. (2015)
Quality of Service	QoS	The provided service must align with the organisation's requirements and objectives to yield a better chance of adoption.	Ardagna et al. (2014); Al khater et al. (2017); Garg & Stiller (2015)
Top Management Support	TMS	The willingness and determination of the business leaders to bring new changes into current architecture.	Gangwar et al. (2016); Astani (2015)
Perceived Ease of Use	PEoU	The conceptual viewing of the ease to use a newly adopted technology.	Gangwar et al. (2013)
Perceived Usefulness	PU	The perceived value of a newly adopted technology.	Gangwar et al. (2013)
Competitor Pressure	CP	The pressure for organisations to adopt new systems due to competitors.	Ramdani et al. (2009); Gangwar et al., (2015)
Vendor Relation	VR	The relationship between the service provider and organisation.	Munteanu et al. (2014)

Table 14: Measurement instrument for research theories

10.2. Survey

Start of Block: Background

Q1 Dear participants,

As organizSations increasingly adopt multi-cloud strategies, it's important to understand what factors contribute to successful implementation. As a cloud professional, your insights are invaluable to identifying these factors and improving multi-cloud adoption.

This survey aims to gather your perspectives on the successful factors of adopting multi-cloud, including your experience, challenges, and opportunities. Your participation will help us gain a better understanding of multi-cloud trends and enable us to provide better solutions to address the challenges faced by organizations.

The survey will take approximately 10 minutes to complete, and your responses will be kept confidential. Thank you for taking the time to share your thoughts with us. Your feedback is greatly appreciated.

Page Break

Q2 What is your organization size in terms of employees?

- Less than 500 employees (1)
- 501 to 1000 employees (2)
- 1001 to 5000 employees (3)
- 5001 to 10000 employees (4)
- More than 10001 employees (5)

Q3 Which of the following sectors best describes the industry you primarily work in?

▼ Accounting/Finance (1) ... Others (16)

Q4 How many years of experience you have engaged with cloud computing?

- Less than 1 year (1)
- 1 to 3 years (2)
- 4 to 6 years (3)
- 7 to 9 years (4)
- More than 10 years (5)

Q5 Have you been involved in a cloud migration project?

○ No (5)

○ Yes (6)

Display This Question:

If Have you been involved in a cloud migration project? = Yes

Q6 What process(es) have you been involved?

▢ Business case development (1)

▢ Cloud strategy development (2)

▢ Infrastructure assessment (3)

▢ Migration planning (4)

▢ Governance and security (5)

▢ Environment preparation (6)

▢ Application migration (7)

▢ Optimization and refinement (8)

▢ Ongoing management and monitoring (9)

▢ Others (10) ____

Q7 Have you been involved in projects with multi-cloud technologies?

- No (1)
- Yes (2)

Display This Question:

If Have you been involved in projects with multi-cloud technologies? = Yes

Q8 What major public cloud provider(s) has been involved in that project?

- Amazon Web Service (1)
- Microsoft Azure (2)
- Google Cloud (3)
- Oracle Cloud (4)
- Others (5) ____

End of Block: Background

Start of Block: Relative Advantage

Q9 Using multi-cloud can increase the reliability of my application

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q10 With multi-cloud, we can provide our service without geographical constraint

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q11 With multi-cloud, we are able to host our application with higher availability

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q12 With multi-cloud, it makes my application more resilient to disasters

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q13 I have more security options with the multi-cloud system

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q14 Multi-cloud provides more option to my organization's cloud strategy when coming to exit plans

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q15 Using multi-cloud, we can optimize our cloud portfolio cost efficiently

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q16 Using multi-cloud, we can reach our TCO (Target Cloud Overview) effectively

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q17 With multi-cloud, we can use the best suited capabilities from different CSPs

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q18 With multi-cloud, we are able to adapt the newest service from different CSPs

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

End of Block: Relative Advantage

Start of Block: Compatibility

Q19 Multi-cloud services is easy to customize

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q20 Different CSPs’ services are compatible with existing technological architecture of my company

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q21 The changes introduced by cloud computing are consistent with existing practices in my company

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q22 Multi-cloud computing development is compatible with my firm's existing format, interface, and other structural data

◯ Strongly disagree (1)

◯ Somewhat disagree (2)

◯ Neither agree nor disagree (3)

◯ Somewhat agree (4)

◯ Strongly agree (5)

Q23 There is no difficulty in importing applications/ data between cloud services

◯ Strongly disagree (1)

◯ Somewhat disagree (2)

◯ Neither agree nor disagree (3)

◯ Somewhat agree (4)

◯ Strongly agree (5)

Q24 There is no difficulty in exporting applications/ data between cloud services

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

End of Block: Compatibility

Start of Block: Complexity

Q25 It is easy to integrate multiple cloud services with my existing work

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q26 When we perform many tasks together, using multi-cloud computing takes up too much of my time

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q27 It is easy to deploy my existing services to various public cloud platforms

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q28 It is easy to manage my existing services on a multi-cloud platform

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

End of Block: Complexity

Start of Block: Organisational Competency

Q29 I understand the topic of multi cloud computing

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q30 Our organization have sufficient expertise for adopting multi-cloud system

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q31 Our organization has experience in working with different CSPs

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

End of Block: Organisational Competency

Start of Block: Quality of Service

Q32 With multi-cloud, our application produce required outcome

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q33 With multi-cloud, we can find the best fitted customized SLA to our requirements

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

End of Block: Quality of Service

Start of Block: Top Management Support

Q34 My top management is likely to consider multi-cloud adoption as strategically important

- Strongly disagree (6)
- Somewhat disagree (7)
- Neither agree nor disagree (8)
- Somewhat agree (9)
- Strongly agree (10)

Q35 My top management is willing to take the risk involved in adoption of multi-cloud

- Strongly disagree (6)
- Somewhat disagree (7)
- Neither agree nor disagree (8)
- Somewhat agree (9)
- Strongly agree (10)

End of Block: Top Management Support

Start of Block: Perceived Ease of Use

Q36 It is easy for us to learn managing multi-cloud

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q37 It is easy to make use of multi-cloud computing

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q38 The procedure of using multi-cloud computing is understandable

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

End of Block: Perceived Ease of Use

Start of Block: Perceived Usefulness

Q39 Using multi-cloud allows me to manage business operation in an efficient way

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q40 Using multi-cloud allows me to increase business productivity

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q41 Using multi-cloud enables allow me to accomplish my organizational task more quickly

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q42 Using multi-cloud advances my competitiveness

○ Strongly disagree (1)

○ Somewhat disagree (2)

○ Neither agree nor disagree (3)

○ Somewhat agree (4)

○ Strongly agree (5)

End of Block: Perceived Usefulness

Start of Block: Competitor Pressure

Q43 We are aware of multi-cloud implementation in our competitor organizations

○ Strongly disagree (1)

○ Somewhat disagree (2)

○ Neither agree nor disagree (3)

○ Somewhat agree (4)

○ Strongly agree (5)

Q44 We understand the competitive advantages offered by multi-cloud in our industry

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

End of Block: Competitor Pressure

Start of Block: Vendor Relation

Q45 With multi-cloud, we are confident that we can negotiate a better deal from the CSPs

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q46 Using multi-cloud, we are more likely to get less support from our current partnered CSP

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

End of Block: Vendor Relation

Start of Block: Adoption Intention

Q47 Overall, I think that using a multi-cloud system is advantageous

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Q48 Overall, I am in favour of using multi-cloud system

- Strongly disagree (1)
- Somewhat disagree (2)
- Neither agree nor disagree (3)
- Somewhat agree (4)
- Strongly agree (5)

Page Break

Q49 Do you have any comments for this Survey?

____

End of Block: Adoption Intention

10.3. Reliability testing results

Unidimensional Reliability [RA]

Frequentist Scale Reliability Statistics

Estimate	Cronbach's α	mean	sd
Point estimate	0.883	38.212	6.769
95% CI lower bound	0.825	36.372	5.673
95% CI upper bound	0.924	40.051	8.394

Note. Of the observations, pairwise complete cases were used.

Frequentist Individual Item Reliability Statistics

	If item dropped		
Item	Cronbach's α	mean	sd
RA_1	0.859	3.692	0.875
RA_2	0.863	3.885	0.963
RA_3	0.863	3.865	0.950
RA_4	0.870	3.885	1.041
RA_5	0.878	3.500	1.076
RA_6	0.862	3.960	0.947
RA_7	0.884	3.686	0.948
RA_8	0.884	3.745	1.017
RA_9	0.878	4.176	0.865
RA_10	0.867	4.192	0.930

Unidimensional Reliability [CPB]

Frequentist Scale Reliability Statistics

Estimate	Cronbach's α	mean	sd
Point estimate	0.755	12.346	3.819
95% CI lower bound	0.648	11.308	3.200
95% CI upper bound	0.836	13.384	4.736

Note. Of the observations, pairwise complete cases were used.

Frequentist Individual Item Reliability Statistics

	If item dropped		
Item	Cronbach's α	mean	sd
CPB_1	0.715	2.000	0.792
CPB_2	0.689	2.000	0.959
CPB_3	0.678	2.519	1.321
CPB_4	0.698	2.308	1.112
CPB_5	0.771	1.804	0.601
CPB_6	0.737	1.788	0.696

Unidimensional Reliability [CPL]

Frequentist Scale Reliability Statistics

Estimate	Cronbach's α	mean	sd
Point estimate	0.625	9.154	2.803
95% CI lower bound	0.435	8.392	2.349
95% CI upper bound	0.761	9.916	3.476

Note. Of the observations, pairwise complete cases were used.

Frequentist Individual Item Reliability Statistics

	If item dropped		
Item	Cronbach's α	mean	sd
CPL_1	0.584	2.154	0.751
CPL_2	0.515	2.596	1.302
CPL_3	0.505	2.333	1.033
CPL_4	0.595	2.115	0.855

Unidimensional Reliability [OC]

Frequentist Scale Reliability Statistics

Estimate	Cronbach's α	mean	sd
Point estimate	0.782	11.462	2.137
95% CI lower bound	0.661	10.881	1.791
95% CI upper bound	0.865	12.042	2.650

Frequentist Individual Item Reliability Statistics

Item	If item dropped Cronbach's α	mean	sd
OC_1	0.805	3.827	0.706
OC_2	0.685	3.635	0.991
OC_3	0.588	4.000	0.840

Unidimensional Reliability [QoS]

Frequentist Scale Reliability Statistics

Estimate	Cronbach's α	mean	sd
Point estimate	0.595	7.250	1.440
95% CI lower bound	0.306	6.859	1.207
95% CI upper bound	0.773	7.641	1.786

Unidimensional Reliability [TMS]

Frequentist Scale Reliability Statistics

Estimate	Cronbach's α	mean	sd
Point estimate	0.838	7.308	2.044
95% CI lower bound	0.722	6.752	1.713
95% CI upper bound	0.909	7.863	2.535

Note. Of the observations, pairwise complete cases were used.

Unidimensional Reliability [PEoU]

Frequentist Scale Reliability Statistics

Estimate	Cronbach's α	mean	sd
Point estimate	0.747	9.942	2.562
95% CI lower bound	0.593	9.246	2.147
95% CI upper bound	0.848	10.639	3.178

Frequentist Individual Item Reliability Statistics

Item	If item dropped Cronbach's α	mean	sd
PEoU_1	0.517	3.288	1.016
PEoU_2	0.641	3.212	1.091
PEoU_3	0.801	3.442	1.037

Unidimensional Reliability [PU]

Frequentist Scale Reliability Statistics

Estimate	Cronbach's α	mean	sd
Point estimate	0.865	13.288	3.887
95% CI lower bound	0.791	12.232	3.258
95% CI upper bound	0.916	14.345	4.821

Note. Of the observations, pairwise complete cases were used.

Frequentist Individual Item Reliability Statistics

Item	If item dropped Cronbach's α	mean	sd
PU_1	0.841	3.288	1.126
PU_2	0.790	3.400	1.178
PU_3	0.841	3.288	1.126
PU_4	0.836	3.510	1.173

Unidimensional Reliability [CP]

Frequentist Scale Reliability Statistics

Estimate	Cronbach's α	mean	sd
Point estimate	0.444	7.385	1.471
95% CI lower bound	0.046	6.985	1.232
95% CI upper bound	0.689	7.784	1.824

Unidimensional Reliability [VR]

Frequentist Scale Reliability Statistics

Estimate	Cronbach's α	mean	sd
Point estimate	0.366	6.288	1.613

Frequentist Scale Reliability Statistics

Estimate	Cronbach's α	mean	sd
95% CI lower bound	-0.088	5.850	1.352
95% CI upper bound	0.645	6.727	2.000

Unidimensional Reliability [AI]

Frequentist Scale Reliability Statistics

Estimate	Cronbach's α	mean	sd
Point estimate	0.965	6.904	2.181
95% CI lower bound	0.943	6.311	1.827
95% CI upper bound	0.979	7.497	2.704

10.4. Full table for correlation analysis

Pearson's Correlations

Variable		RA	CPB	CPL	OC	QoS	TMS	PEoU	PU	AI
1. RA	Pearson's r	—								
2. CPB	Pearson's r	-0.086	—							
3. CPL	Pearson's r	-0.175	0.645 ***	—						
4. OC	Pearson's r	0.038	0.348 *	0.213	—					
5. QoS	Pearson's r	0.257	0.157	0.036	0.206	—				
6. TMS	Pearson's r	0.083	0.101	0.118	0.442 **	0.428 **	—			
7. PEoU	Pearson's r	0.496 ***	-0.008	-0.200	0.136	0.331 *	0.075	—		
8. PU	Pearson's r	0.465 ***	0.157	0.013	0.227	0.535 ***	0.371 **	0.505 ***	—	
9. AI	Pearson's r	0.507 ***	0.168	-0.026	0.328 *	0.523 ***	0.493 ***	0.484 ***	0.802 ***	—

* p < .05, ** p < .01, *** p < .001

10.5. Linear regression detailed results

10.5.1. PU

Model Summary - PU

Model	R	R^2	Adjusted R^2	RMSE	Durbin-Watson Autocorrelation	Durbin-Watson Statistic	Durbin-Watson p
H_0	0.000	0.000	0.000	0.995	-0.052	2.059	0.832
H_1	0.695	0.483	0.439	0.746	0.002	1.988	0.971

ANOVA

Model		Sum of Squares	df	Mean Square	F	p
H_1	Regression	24.381	4	6.095	10.960	< .001
	Residual	26.138	47	0.556		
	Total	50.519	51			

Note. The intercept model is omitted, as no meaningful information can be shown.

Coefficients

Model		Unstandardised	Standard Error	Standardised	t	p
H_0	(Intercept)	3.404	0.138		24.662	< .001
H_1	(Intercept)	-1.501	0.823		-1.823	0.075
	PEoU	0.301	0.137	0.276	2.207	0.032
	RA	0.393	0.203	0.235	1.933	0.059

Coefficients

Model		Unstandardised	Standard Error	Standardised	t	p
	QoS	0.403	0.168	0.296	2.395	0.021
	TMS	0.230	0.131	0.204	1.751	0.086

10.5.2. PEoU

Model Summary - PEoU

Model	R	R^2	Adjusted R^2	RMSE	Durbin-Watson Autocorrelation	Durbin-Watson Statistic	Durbin-Watson p
H_0	0.000	0.000	0.000	0.910	-0.186	2.321	0.242
H_1	0.496	0.246	0.230	0.798	-0.223	2.422	0.122

ANOVA

Model		Sum of Squares	df	Mean Square	F	p
H_1	Regression	10.371	1	10.371	16.276	< .001
	Residual	31.860	50	0.637		
	Total	42.231	51			

Note. The intercept model is omitted, as no meaningful information can be shown.

Coefficients

Model		Unstandardised	Standard Error	Standardised	t	p
H_0	(Intercept)	3.269	0.126		25.907	< .001
H_1	(Intercept)	0.385	0.723		0.532	0.597
	RA	0.757	0.188	0.496	4.034	< .001

10.5.3. AI

Model Summary - AI

Model	R	R^2	Adjusted R^2	RMSE	Durbin-Watson Autocorrelation	Durbin-Watson Statistic	Durbin-Watson p
H_0	0.000	0.000	0.000	0.999	0.130	1.689	0.256
H_1	0.807	0.652	0.638	0.601	-0.111	2.215	0.401

ANOVA

Model		Sum of Squares	df	Mean Square	F	p
H_1	Regression	33.202	2	16.601	45.904	< .001
	Residual	17.721	49	0.362		
	Total	50.923	51			

Note. The intercept model is omitted, as no meaningful information can be shown.

Coefficients

Model		Unstandardised	Standard Error	Standardised	t	p
H_0	(Intercept)	3.538	0.139		25.535	< .001
H_1	(Intercept)	0.599	0.351		1.709	0.094
	PEoU	0.116	0.107	0.106	1.084	0.284
	PU	0.752	0.098	0.749	7.666	< .001