



Work Placement Report

NHL Stenden University of Applied Science

In association with:

Quality-ICT

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Preface

Information About the Report

This document serves as a work placement report to the author to submit to the work placement lecturer, and well as extensive research to the company that the author was doing an internship for.

About the Author

Christopher Sulistiyo is a 4th year international ICT student from NHL Stenden, university of applied science Emmen campus. He is the sole author of this document.

Target Group

The target audience for this report will be mainly for the Q-ICT, NHL Stenden, and Q-ICT's clients who have a warranted interest on the successful new ERP software system product at Quality ICT:

- Q-ICT: will be the primary beneficiary of this report itself. The report serves to help them to choose which cloud provider they would want to rely on for their future projects.
- NHL Stenden: this report allows the author to gain valuable experience in a real IT working environment, and furthermore enhance the author's knowledge on how to conduct extensive research on a subject regarding ICT. Furthermore, this document serves as proof to the work placement lecturer that obtains some insights into the nature and scope of activities conducted by the author.
- The author of this document: through the obligation to write a work placement report during the work placement, the author is continuously forced to examine various, usually technical, problems in depth. Independently writing down what has been studied and/or investigated forms an important contribution to the formation of the Higher Professional Education bachelor. Furthermore, the learning effect that the author gets from the work placement will further on conducted into situations elsewhere where the author will need to put research skills into action one more time.
- IT Practitioners and general audience: the range of the report for this population is overly broad, for all the general audience who has a profound interest in this report's findings. From 9-12 graders, community college students, to junior software developers who have a curiosity regarding the topic of Firebase and Microsoft Azure cloud solutions. This report can be a guideline before implementing a new cloud solution and evaluating their

key features and services before introducing them into their organization. This report will require little to no technical knowledge to understand the contexts that are about to be presented.

Acknowledgement

The author would like to thank the following people for their contribution to the report and preparation in the form of feedback, remarks, and suggestions:

Manuel Weidijk and Mark Kolk as the work placement supervisor for giving the opportunity for the author to do the work placement at their company, as well as their invaluable guidance and extensive resources throughout this research that has made a great deal of contribution and preparation to this work placement report in the form of remarks and suggestions.

René Laan as the work placement lecturer for providing necessary background knowledge, sharing his ideas, and for his endless unwavering supports and understanding he has given to the author during the entire work placement duration. The tribute also goes out to the colleagues at the institute of NHL Stenden, University of Applied Science, for their helpful feedback and encouragement.

Supervisor Approval

This work placement research paper report entitled Work Placement report prepared by the author, Christopher Sulistiyo, an ICT student at NHL Stenden University of Applied Science, Emmen as part of the work placement requirement for the ICT & CT Information Technology Bachelor Emmen program, is hereby approved by:

Company Supervisor

Manuel Weidijk

Senior Software Developer

Q-ICT

Glossary

Malware Refers to broad category of software programs created with malicious intent, including viruses, worms, Trojans, ransomware, spyware, adware, and other harmful software that can compromise the security and functionality of a computer or network. 27

Kubernetes an open-source container orchestration solution that schedules and automates deployment, scaling, managing, load balancing and more for container-based applications. 35

Meritocracy is the notion of a political system in which economic goods and political power are vested in individual people based on ability and talent, rather than wealth or social class. 32

NoSQL is an approach to Database design that enables and focuses on providing a mechanism for storage and retrieval (querying) of data that is modeled in means other than the traditional tabular relations found in relational databases (non-tabular). 52

SCRUM is an agile project management system commonly used in software development and other industries. 24, 57

Acronyms

NIST CSF NIST Cybersecurity Framework. 19

2FA Two-Factor Authentication. 54

AD Active Directory. 37, 45, 46, 52, 54, 56, 58

AES Advanced Encryption Standard. 45

AI Artificial Intelligence. 9, 31, 41, 43, 51, 52, 59, 60

AKS Azure Kubernetes Service. 41

APA American Psychological Association. 17

API Application Programming Interface. 36, 37, 41, 43, 52, 55, 56

B2B Business to Business. 37, 45, 46

B2C Business to Consumer. 37, 45

Blob Binary Large Object. 40

CCPA California Consumer Privacy Act. 45

CDN Content Delivery Network. 35

CEH Certified Ethical Hacker. 25

CEO Chief Executive Officer. 8

CPU Central Processing Unit. 47, 48

CRM Customer Relationship Management. 15, 25, 30, 54

CSA Cloud Security Alliance. 45

CSP Cloud Service Provider. 31

DB Database. 4, 8, 10, 26, 38, 39, 41

DDoS Distributed Denial of Service. 60

DOM Document Object Model. 63

DTU Database Transaction Unit. 10, 58, 61

EA Enterprise Agreement. 53

GB Gigabyte. 47–49, 51, 52

GCP Google Cloud Platform. 8, 9, 29, 34–36, 38–45, 47–51, 53, 54, 59, 60

GDPR Global Data Protection Regulation. 45

GKE Google Kubernetes Engine. 41

GPU Graphics Processing Unit. 48–51

HDD Hard Disk Drive. 40, 51

HIPAA Health Insurance Portability and Accountability Act of 1966. 45

HRM Human Resource Management. 15, 25

HTML HyperText Markup Language. 56

HTTP Hypertext Transfer Protocol. 37

I/O Input Output. 39

IAM Identity Access Management. 9, 37, 39, 45, 46, 58, 60

ICT Information Communication Technology. 18, 62

IOPS Input/Output Operations Per Second. 39

IoT Internet of Things. 9, 41

ISO International Organization for Standardization. 45, 60

IT Information Technology. 8, 18, 27, 29, 62, 63

JSON JavaScript Object Notation. 36, 38

JWT JSON Web-Based Tokens. 54

Malware Malicious Software. 4, 27

MFA Multi-Factor Authentication. 30, 54

ML Machine Learning. 9, 41, 43, 59, 60

MSPs Managed Service Providers. 30

NIST National Institute of Standards and Technology. 5, 19

OIDC OpenID Connect. 56

OS Operating System. 47, 48, 50

OTP One-time Password. 54

PAYG Pay-As-You-Go. 9, 37, 47, 49–51

PCI DSS Payment Card Industry Data Security Standard. 45

Q-ICT Quality-ICT. 1, 3, 8, 14, 15, 18, 19, 21–26, 28–32, 35, 36, 39, 45, 47, 49, 60

Q/A Question and Answer. 37

QaaS Quality as a Service. 8, 14, 21, 22

RAM Random Access Memory. 47–49

RBAC Role-Based Access Control. 39

RMM Remote Monitoring and Management. 30

SDK Software Development Kits. 39, 55

SLA Service-Level Agreement. 40

SME Small Medium Enterprise. 14, 18

SQL Structured Query Language. 4, 10, 34, 38, 41, 52, 56, 61

SSD Solid State Drive. 40

SSO Supporting Single-On. 52

STAR Security, Trust, Assurance and Risk. 45

TB Terabyte. 48

TOTP Time-based One-time Password. 30

UI User Interface. 29, 55, 59, 63

UI/UX User Interface and User Experience. 28, 55, 63

VAT Value-Added Tax. 30

VHD Virtual Hard-Disk. 40

VM Virtual Machine. 40, 41, 47–53, 60

VPC Virtual Private Cloud. 41

VPN Virtual Private Network. 60

VS Visual Studio. 53

Summary

In this rapidly era of ever evolving technologies, the concept of cloud computing has risen above the rest, becoming a beacon of innovation, reshaping the many aspects of everyday life because the amount of software being mitigated to the cloud network. Cloud computing is the delivery of computing services, such as servers, storage, databases, networking, software, analytics, intelligence, and more over the Internet (the cloud). The essence of cloud computing is a vast, interconnected web of powerful servers and resources, accessible at the touch of a button, regardless of geographical location. This completely transforms the concept of how data and information was stored, processed, and shared before. Business operations and individuals would be amiss to not start considering implementing cloud solutions to their operations. This report will delve further into the depths of cloud computing, comparing the differences between two giant cloud service providers, GCP and Azure.

Q-ICT (the company where the author did the work placement and the sole beneficiary of this report) is a small cybersecurity company based in Emmen and Groningen, the Netherlands. It was founded by Mark Kolk in 2014, who also acts as the sole director. It has 2 sister-companies, MKBiT and QaaS, both directed by Luuk Admiraal and Pierre Kleine Schaars respectively. It is important to note that while those 2 companies has their own director, Mark Kolk is still the Managing Director/ CEO of those 3 companies. The reason behind these branching of companies lies in mitigating potential reputational risk. This structure ensures that any negative impact on the reputation of one company does not adversely affect the other two entities under Mark's ownership. Together they perform various IT services such as providing IT and cybersecurity consultancy, security scans, patch-management, online back-up, DB migration, offering Microsoft 365 products, anti-viruses, anti-spam software, cloud solutions, software monitoring, and tailor-made software applications for their clients. It currently has fifteen employees with 2 interns. In the future, they are looking to expand their region and clients, implement more process automation in their infrastructure, and brings more transparency to the clients. It follows a horizontal organizational structure, with multiple departments such as help desk (first and second call with outdoor customer service), software developers, financial administrator, accountant, accountant, and strategic advisor. It has official partnership with Silver Microsoft, CyberSterk, Jamzone Stressjam, NewChannel, and Resello, along with unofficial partnerships with MemoICT, Ondernemend Emmen, Peat Digital, and Indiv Solutions, all of those are located in the same shared-building with Q-ICT. Currently, Q-

ICT is utilizing tools to help them running their organizations, those tools include Computicate (named Acronis now), TOMTelecom, SnelStart, N-Central, PerfectView, and Resello (now overtaken by and fused with Pax8).

Azure boasts a robust global network infrastructure with data centers strategically located across the globe. Its scalability reaches through the seamless integration of services like Azure Virtual Machine and Kubernetes Service, enabling businesses to scale their operations efficiently. GCP offers similar scalability features backed by Google's vast network backbone, with services like Compute Engine and Kubernetes Engine, ensuring high availability and reliability for applications. Azure encompasses a diverse set of services, ranging from computing and storage to IoT. Moreover, its integration with Microsoft products such as Office 365 and Dynamics 365 offers a seamless experience for business deeply in the Microsoft ecosystem. In contrast, GCP excels in data analytics and AI/ML services, with products like BigQuery and AI Platform, leveraging Google's expertise in data management and analysis. Both providers provide companies with comprehensive solutions under one roof. Azure and GCP also prioritize security and compliance, adhering to many stringent industry standards and regulations. Azure offers Security Center for advance threat protection and Azure Policy for governance. GCP offers Google IAM and a secure-by-design infrastructure with encryption both at rest and in transit, making both providers ensure a secure cloud environment. Azure and GCP also offer flexible pricing models, allowing users to choose between PAYG and/or reserved instances. Azure's Hybrid Benefit program provides cost advantages for organizations with existing Microsoft licenses, whereas GCP offers more sustained discounts of use and committed use for consistent workloads, ensuring cost-effectiveness for long-term usage.

After a comparative assessment of both Azure and GCP, it is concluded that it depends on the specific needs and preferences of a company. Both providers have their distinct offerings, pricing structures service qualities, as well as advantages and disadvantages. In the end, these disparities have become less prominent over time due to their increasing mutual efforts to enhance their offerings, and these distinctions had led them to differ insignificantly in terms of features and capabilities. Azure stands out as the preferred option for large-sized companies interactively woven into Microsoft ecosystem, while GCP excels as the platform of choice for smaller to medium-sized companies still wanting to scale up with a budget, with better leverage cutting-edge AI and ML.

The author also expresses concern about the compatibility of Node.js with Azure due to a perceived lack of support and documentation from Microsoft. The author believe that a C# API would integrate well with Azure, citing the extensive documentation available from Microsoft. Additionally, the author finds the combination of Flutter an Azure to be also peculiar, once again noting and pointing out about the shortage of documentation, unlike the comprehensive resources available for combining Flutter with Firebase.

Finally, the author suggest that if the company opts to persists with the Azure SQL DB service, selecting the DTU-based tier would be the most preferable choice, as it is cost-effective, providing a low-cost database solution suited for immediate use. However, in the event of the company's expansion and increased sale, it is advisable to consider the vCore-based tier, which offers enhance performance capabilities.

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General Introduction

1.1 Research Background (Why)

In this fast era of ever-evolving technology, cloud computing has emerged to the surface as a transformative force that has reshaped the way individuals, businesses, and organizations access, store, and manage their data and applications. Cloud computing has become a cornerstone of modern technology infrastructure, offering a wide range of benefits, from scalability and cost-efficiency to flexibility and global accessibility. Cloud computing, also known as cloud computing or cloud services [9], is the overarching technology paradigm that enables the delivery of computing services over the internet, while its infrastructure provides value to users and organizations in the form of specific applications and services.

The company under study, Q-ICT, headquartered in Emmen and Groningen, is a cybersecurity consultancy company in North Netherlands with 20+ years of experience. They specialize in helping SME companies with their digital security, offer and help them install anti-viruses, cloud solutions, and Microsoft 365 products. Q-ICT also works with its sister-companies, MKBiT and QaaS, developing software applications for their clients.

This research is conducted on behalf of Q-ICT as part of the work placement assignment. The purpose of this research is to compare different cloud solutions, more specifically Microsoft Azure and Firebase, and determine which one is better for the company's application development and infrastructure. In recent years, Quality ICT has bought and obtained an Azure subscription.

1.2 Problem Definition (What)

This sub-chapter introduces the reader to the research questions that will be answered by the author, to gain more insight and knowledge about the tasks, approaches, and methodologies to use during the report.

1.2.1 Main question

”What are the comparative advantages and disadvantages of Azure and Firebase for Q-ICT’s application development and cloud infrastructure needs, considering factors like easy to build, security, and high maintenance?”

1.2.2 Sub-questions

- What are the specific features for application development and tools provided by Azure that are currently relevant to Q-ICT’s software development projects when using Firebase?
- What are the security measures and protocols provided by Azure and Firebase? Are there any difference and how do they differ?
- What are the potential cost implications of adopting Azure compared to using Firebase to Quality ICT?

1.3 Working Methodology (How)

1.3.1 Structure of the Report

*** Business Research**

This is the foundational chapter of the research, as it delves into a thorough examination of the client company. This includes a detailed exploration such as the company’s mission and vision, organizational structure, key business processes, governance framework, quality standards, competitiveness in the market, CRM, and HRM. Additionally, it identifies and describes the products developed by the company, its client base, target audience, and overarching objectives. This comprehensive analysis sets the stage for the subsequent chapters.

* **Methodology**

This chapter describes the details of research methods and procedures employed in the report. It explains the data collection methods, sample selection, and data analysis techniques. The methodology chapter also discusses the ethical considerations and limitations of the report.

* **Research Result**

Here, the result of the research is presented, supported by data, graphs, and tables. The findings are analyzed in detail and conclusions are drawn based on the evidence presented. This chapter provides insights into the key aspects of this research's main question.

* **Product Developed**

This chapter will describe the product outcome in the realization phase that the author did in his work placement period. The final product will be a software application that the author developed himself with the help and guidance of the work placement supervisor. This is the heart of the work placement experience, representing the culmination of theoretical knowledge and hands-on application.

* **Conclusion and Recommendation**

In this chapter, the key findings of the research are summarized restate the research objectives, and answer the research questions. The contributions of this report to the client company and to the author's study will be highlighted and areas for future research will be suggested. The recommendation also offers a forward-looking perspective and demonstrates the author's ability to think strategically beyond the scope of the current assignment. Please note that the company research details are excluded from this chapter.

* **Evaluation and Reflection**

It focuses on the process and the final product or assignments. The writer's experience during this work placement will be assessed, reflecting on moments of learning and personal development. This section is then represented by the first-person narrative to facilitate a genuine account of the writer's experience. It also offers insights into what the author would do differently in the future.

* **Appendices**

This section contains supplementary materials, such as interview transcripts, survey questionnaires, lengthy tables, intricate diagrams, or additional data which may be referenced in the report. All appendices are numbered sequentially, furnished with titles, and referenced in the main text where necessary.

* **Bibliography**

Finally, this chapter lists all the sources cited in this report according to APA citation style. It provides a comprehensive list of the academic literature and other references used in the research. It ensures transparency and credibility of the research.

Business Research

2.1 Chapter Description

This chapter details of the company's history, vision, mission, organizational structure, size, locations, products/services offered, target market, and any other significant milestones. This sections is more focused on company as it present more detailed information about it.

2.2 Company Description

Q-ICT is a cybersecurity expert consultant company based in Emmen, Drenthe, the Netherlands. Their mission is to help SME companies with their digital security and making the right decisions to protect data and be operational again quickly in the event of disaster. They operate in the northern province of the Netherlands (Groningen-Drenthe-Friesland). Their vision is for the company to grow and help make small and medium-sized companies of all industries and sectors become more cyber resilient and cyber strong, as they see that the cybersecurity part of those companies is often neglected since they are mostly not aware how they increasingly have become the target of cyber-crime over time. They offer a variety of services, from cybersecurity and IT consultancy, ranging from creating back-ups, monitoring customer devices, installing anti-viruses, doing patch managements and cybersecurity scans. Moreover, they also offer and help clients install Microsoft 365 products and develop software applications tailor-made specifically for their clients. Furthermore, they have employees specializing in various departments, from security officers, ethical hackers, system engineers, ICT managers, qualified IT professionals, and software engineers.

2.3 Vision/Mission

- Transparency
- Feasibility
- More automation

2.4 Working Methodology

Q-ICT way of working adheres to the NIST Cybersecurity Framework (NIST CSF) [1], which provides a comprehensive framework for organizations to follow, manage, and improve on their cybersecurity posture. It consists of 5 core functions/ elements, each of which plays a crucial role in enhancing cybersecurity practices.

- **Identify:** this focuses on understanding and managing cybersecurity risk. During this step, cyber security scans are performed to map out the client's organizational environment, along with performing requirement analysis on the client's wants and wishes. It involves:
 - Asset management: identifying and classifying assets that need protection.
 - Business environment: understanding the organization's business context and goals.
 - Governance: establishing policies, procedures, and governance structures for cybersecurity.
 - Risk assessment: identifying and assessing cybersecurity risks and vulnerabilities.
 - Risk management strategy: developing a strategy to mitigate or accept identified risks.
- **Protect:** then the first necessary protection is deployed. It is about implementing safeguards to ensure the security of critical assets. Things such as password manager, backup and recovery plan, encryption, anti-virus, update, and patch management, etc. This includes:
 - Access control: managing and controlling access to systems and data.
 - Data security: encrypting and protecting sensitive data.
 - Training and awareness: providing cybersecurity training and awareness programs.
 - Security policies and procedures: developing and implementing security policies and procedures.
 - Protective measures: deploying defenses like firewalls, intrusion detection system, and antivirus software.
- **Detect:** it focuses on identifying cybersecurity events promptly. With active network and device monitoring, possible threats can then be discovered and traced by the company.

Key activities include:

- Continuous monitoring: monitoring systems and networks for security events.
 - Anomaly detection: detecting unusual or suspicious activities.
 - Incident response: developing and implementing a plan to respond to cybersecurity incidents.
 - Security awareness training: training staff to recognize and report security incidents.
- **Respond:** when a cybersecurity incident occurs, the company then will be responding adequately and proactively to threats, taking immediate action, reporting, and making internal communication. This function helps organizations take action to contain and mitigate the impact. It includes:
 - Incident response planning: developing a structured approach for responding to incidents.
 - Communication: establishing protocols for reporting incidents both internally and externally.
 - Analysis: investigating and analyzing incidents to understand their scope and impact.
 - Mitigation: taking steps to limit the damage and prevent further incidents.
 - Improvements: incorporating lessons learned from incidents into future cybersecurity practices.
- **Recover:** should an event of disaster occur, the company then tries to get things running up and quickly again, evaluating the process, communicating internally within the organization, and training the employees on their cyber awareness and cyber resilience to continue improving their cybersecurity field. It focuses on restoring normal operations after a cybersecurity incident. It includes:
 - Recovery planning: developing plans for the restoration of systems and services.
 - Improvements: identifying areas for improvement in incident response and recovery processes.
 - Communication: keeping stakeholders informed about recovery efforts.
 - Coordination: coordinating efforts with external parties, such as law enforcement or third-party service providers.
 - Lessons learned: incorporating lessons from incidents into recovery plans and overall cybersecurity strategies.



Figure 2.1: Q-ICT's working methodology

2.5 Company Details

- Company name: Quality ICT B.V.
- Founded in: 2014
- Founded by: Mark Kolk
- Specialty: IT consultancy, software development
- Number of employee(s): 15, excluding 4 interns
- VAT number: NL853 827 242 B01
- Training company ID: 100441817
- Chamber of Commerce: 60248661
- Chamber of Commerce registration number: 00029465087
- Telephone number: (+31) 591708004
- Website: www.qict.nl
- E-mail address: info@qict.nl, support@qict.nl
- Branches:
 1. Emmen: Kapitein Nemostraat 20, 7821AC (head office)
 2. Groningen: Zernikepark 12, 9747AN (sales office, for the clients in Groningen to reach out easily - opens on appointments only)
- Subsidiary company to: MKBiT, QaaS

- Partnership(s): Silver Microsoft, CyberSterk, Jamzone Stressjam, NewChannel.nl, Resello, Bodyguard.io
- Organizational structure: flat/ horizontal organizational structure
- Top executive(s): 2, Pierre Kleine Schaars for QaaS and Luuk Admiraal for MKBiT
- Socials:
 1. Facebook: <https://www.facebook.com/QualityICT/>
 2. Linked-In: <https://www.linkedin.com/company/qict/>
 3. Instagram: <https://www.instagram.com/qualityict/?hl=nl>

2.6 Organizational Structure

Q-ICT follows a flat organizational structure, which is a type of organizational design that minimizes hierarchy and promotes open communication and collaboration among employees. In Q-ICT, there are relatively few levels of management or hierarchy, with Mark Kolk being the sole director of the company, and decision-making authority is often distributed more widely throughout the organization.

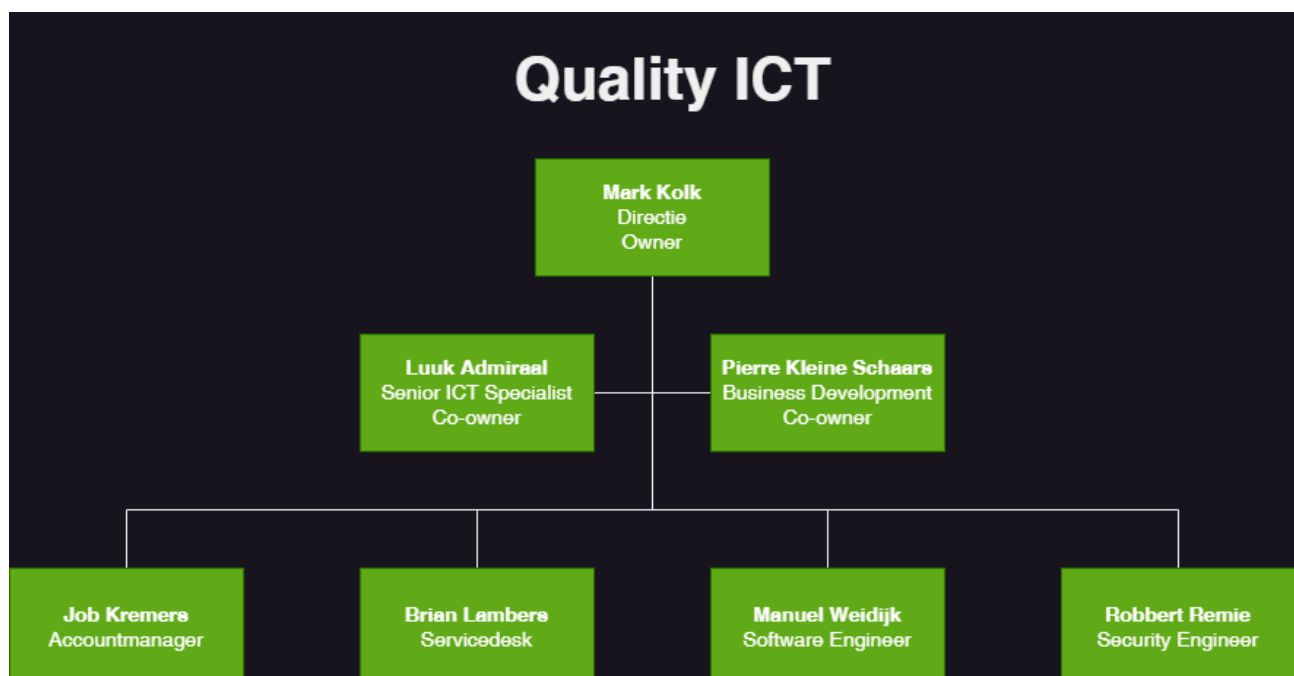


Figure 2.2: Q-ICT's organizational structure in diagram

Below are the key departments of Q-ICT with their explanations:

2.6.1 Director

These are the people who fall under management and normally are always in charge of the organization's processes. The responsibility falls solely on Mark Kolk. He is the one who leads the organization, and coordinates and monitors all activities. Matters that do not fall under management are often delegated to another department within Q-ICT.

2.6.2 Service Desk

The service-desk is one of the departments of Q-ICT. This department is comprised of four people. The service-desk provides support for Q-ICT clients and customers if they have questions or problems. This department has several roles to make this function. There is a manager at the service desk to take charge of this department. In addition, there are the normal employees who have their own task within the service desk. These employees also have active interaction with the customers. This department is managed by Brian Lambers, with Bram Regtop as the team leader.

Indoor and outdoor customer service

These are the division roles within the service desk department. The office staffs are available at the Q-ICT location and are responsible for assisting customers in the opening hours. Depending on the customer's needs, different services can be offered. This allows the company to monitor the problem from a distance using a remote desktop application. If needed, these employees can go to the clients' locations to check and fix the problem the first hand. In addition, e-mail contact and phone calls can be recorded to determine what could happen and easily reiterate to understand the problem definition better.

First-call Helpdesk

This is a sub-department within the Help-desk department. Their job is to provide initial support and assistance to users who are experiencing technical issues with their computer systems, software applications, or other technology-related problems. When the clients encounter problems or have questions, they typically contact the first call helpdesk for immediate assistance. This duty falls to Wesley Keizer, Bram Regtop, Brian Lambers, and Dax Moorman as the system engineer.

Second-call Helpdesk

A second-call helpdesk is tier 2 or level 2 support. It operates at a higher level than the first-call helpdesk. When an issue cannot be resolved by the first-call helpdesk due to its complexity or technical nature, it is escalated to the second-call helpdesk for further assistance. The second-call helpdesk team consists of more experienced and specialized technicians who have deeper understanding of the systems and applications within the organization. This duty falls to Luuk Admiraal and Anthony Fictorie as the senior system engineer.

2.6.3 Software Developers and Interns

The developers are busy developing new software products. A developer within Q-ICT will have an executive role because of the activities associated with the task. There are also interns in this department who work and have the same responsibilities as the employees. These employees go through an agile software development lifecycle (SCRUM). They start a new sprint every week and try the tasks that have been set in the new sprint. This applies to both normal developer employees and interns as well. The software developer department consist of Manuel Weidijk as the senior software developer, and Robin Kolk.

It is also important to take note that within this department that the author was doing his work placement project. This department serves as a second most valuable department in the company, as Q-ICT operates as a cybersecurity consultancy firm with also an expertise in software development. The other interns excluding the author are the following: Batuhan Gezgin, Andre van Vliet, and Jeroen Wind.

2.6.4 Project/Product Manager

Because there are various projects underway within Q-ICT, people are also needed to manage this section of the organization. This department's job is to ensure that the projects come to an acceptable condition for use.

2.6.5 Security Consultant & Ethical Hacker

Both roles play crucial roles in ensuring security of computer systems, networks, and data. The security consultant is a professional who specializes in assessing and improving the security measures of the clients' internal organization. Their primary role is to identify potential

security risks and vulnerabilities within the clients' infrastructure, operations, or policies. While the ethical hacker is someone who tests the security of clients' securities, they legally and systematically attempt to exploit clients' computer systems, networks, applications, websites, and other technology platforms. Q-ICT also lately provides clients with security scans to evaluate clients' security vulnerabilities. These security vulnerabilities, if left unchecked could potentially lead to malicious hackers exploiting and compromising the confidentiality, integrity, or availability of the clients. Both duties fall to Robbert Remie. Having the official CEH certification from the ECC council is one of the mandatory requirements when working at this department. Moreover, this department also holds one intern from a ICT student from NHL Stenden, Batuhan Gezin.

2.6.6 SCRUM Master

During the development of a product, it must be announced weekly how the development of the product is progressing. It is the job of SCRUM master to ensure that this process runs smoothly [23]. A SCRUM master arranges the SCRUMs for a project by planning for the developers so that they can focus on development. The SCRUM master also arranges weekly meetings (sprint review) with stakeholders, project managers, and team members to discuss progress and evaluate the process. This responsibility falls to Manuel Weidijk, the supervisor for all interns and the senior software engineer. Manuel had been doing this responsibility for 3 years by the time this document was written.

2.6.7 CRM & HRM

Because of the size of the company is currently still small, both Customer Relationship Management (CRM) and Human Resource Management (HRM) departments are handled by the director, Mark Kolk, with help with a CRM software application.

2.6.8 Administrative Support

These tasks that fall under the financial administration department are currently managed by the upper management. The size of the company is still small for this role to be handed in to someone else, and since there is no staff within the company to oversee this, this job is currently overseen by the director. This work includes looking at invoices that still need to be processed. When a new customer arrives, an invoice must be made, and the past invoices are looked at to see if there are any errors. If there are errors in the invoices, they will be corrected. This duty

falls to Marieke Bouwers. It is also important to note that Marieke is only working part-time here for this duty, as she also works at MemoICT, a unofficial partner company who shares the same building with Q-ICT.

2.6.9 Accountant

This department consists of professionals who are responsible for a wide range of financial tasks within an organization. Their role is to manage and ensure that financial records are accurate, complete, and in compliance with relevant laws and regulations, and providing valuable financial insights to support decision-making. This duty falls to Job Kremer.

2.6.10 Strategic Advisor

The director solely hires this department to challenge and critique the director when he is making decisions, providing him with constructive valuable feedback. They are brought in for their expertise and objectivity to assess decisions, offer alternative viewpoints, and ensure that the choices made by the director are well-informed and considered from various angles. Their role is crucial in providing useful criticism and helping the director make more informed decisions. This duty falls to Peter Hoekstra.

2.7 Company's Sister-companies

Q-ICT has 2 other sister companies who are also under the ownership of Mark Kolk, which are MKBiT and QaaS respectively.

2.7.1 MKBiT

It is a child-company of Q-ICT who provides IT solutions and consultation to its clients. It was founded to support Q-ICT business operations. It shares the same office with Q-ICT. Its services including cloud solution, Microsoft 365 products, patch-management, online-backup, anti-virus, anti-spam, and monitoring software applications.

- Online-backup: the company offers a service where the clients can store copies of their files, documents, and data on remote servers via the internet. These remote servers are hosted in secure data centers. Furthermore, MKBiT also provides DB migration in case any event of disasters occurred.

- **Active monitoring:** the company will offer its customers the chance to oversee, track, and manage their computer systems, networks, or applications in real-time. It serves various purposes, including ensuring system stability, optimizing performance, enhancing security, and providing valuable insights into the usage patterns and behaviors of users or devices. In the future, it wants to bring more automation to its system, providing customers with automatic messages when a disk space becomes full, or when there is an error message in clients' computers.
- **Anti-spam software:** a specific type of software application that is designed by MKBiT to detect, prevent, and block unsolicited and unwanted e-mail messages, commonly known as spam, from reaching clients' e-mail inboxes. They are typically sent in bulk to many recipients without their consent, often containing advertisements, phishing attempts, malware, or other malicious content. It has features such as whitelist, blacklist, and filter e-mails per e-mail account or e-mail address.
- **Microsoft 365 products:** the company is also providing access to Microsoft's suite of cloud-based productivity tools and services, including installation services, to its clients. These include Microsoft Word, Excel, PowerPoint, Outlook, and more, which are all accessible online through a web browser or can be installed on local devices such as computers and smartphones.
- **Antivirus software:** it resells and gives clients advice and comparisons on good antivirus software from manufacturers like McAfee, Bitdefender, and Kaspersky. This software is designed to detect, prevent, and remove Malware from computer systems.
- **Cloud services:** the company also provides clients with a tailor-made cloud solution based on their specific wishes and problems, whether it is using a public, private, or hybrid cloud. It delivers a range of computing resources, applications, and services over the internet through cloud computing technologies. These services enable the clients to access and use computing resources without the need to own or maintain physical hardware and software infrastructure, enabling their employees to access their files anytime, anywhere, without others having to access them.

Luuk Admiraal is directing this company. Because the company is an IT service provider, it has a vast network of suppliers and partners to provide them with the products and brands to support their business. Here is the list of the suppliers: SentinelOne™, DrayTek, HP, Microsoft, and Ubiquiti Network.

2.7.2 QaaS

This company is responsible for the software development of Q-ICT. It is still a small company which was set up not a while ago, so there is not a lot of info feasible for the author to write about it. Their upcoming projects are still proof-of-concept. The company is directed by Pierre Kleine Schaars.

2.8 Unofficial Partnerships

2.8.1 MemoICT

It is a Shopware company. It is primarily focused on web development, where it creates and installs e-commerce solutions for Shopware E-commerce stores. It was founded in 2015 by Johan Moormann. Their specialty is to provide front-end development for websites, especially in the context of Shopware and E-commerce, and focuses on creating UI/UX for online stores. Front-end development involves designing and implementing the visual elements that users interact with when they visit a website. In the case of e-commerce platforms like Shopware, the focus is on creating visually appealing and intuitive interfaces that facilitate seams-less online shopping experiences for customers. It has official partnership with Studio Impaqt, Shopware, Peat Digital, Mollie, Hipex, Dasistweb. The company shares its office location in the same building with Q-ICT.

2.8.2 Ondernemend Emmen

It is a company that focuses on international entrepreneurship, knowledge sharing, networking, park management, technology, and industry, and stimulating the local economy in the broadest sense of the word. Its official partnerships are Growing Emmen, Rabobank, Clok, VNO-NCW, and Wirtschaftsverband. They also share their office in the same location with Q-ICT.

2.8.3 Peat Digital

It is a firm that specializes in marketing agencies. It is a business company that specializes in providing numerous services to help other businesses promote their products or services, reach their target audience, and achieve their marketing objectives. They are hired to develop and execute marketing strategies tailored to their specific needs and goals. They share their office

in the same building with Q-ICT. They are also responsible for advising Q-ICT about their logo, design, how to create their Facebook, Instagram, and Linked-In page.

2.8.4 Indiv Solutions

Just like MemoICT, this company also focuses on front-end website development. They designed Q-ICT official website [22]. This company does not share the same building with Q-ICT office in Emmen.

2.8.5 Webba

This company does web application development for its clients.

2.9 Company's Tools and Technologies

2.9.1 IT Toolkit

The company utilizes these tools and technologies to build, manage, and deploy their software products and services. They are integral components of an IT company technological infrastructure. These tools enable them to develop applications, manage data, host services, and provide solutions to their clients.

Programming Language, Frameworks, and Libraries The company mainly utilizes Flutter for all of their web application development. Flutter is an open-source UI framework toolkit that uses Dart as the programming language. It is created by Google for building natively compiled applications for mobile, web, and desktop from a single code-base.

Cloud Solutions The company utilizes Firebase from GCP as a comprehensive platform and service suite developed by Google, offering a wide array of tools and services to develop and grow mobile and web applications.

2.9.2 API Calls

The company has its own internal applications, which consist of software programs or tools designed to be used exclusively within the organization's private network. Unlike external applications that are accessible over the internet, the internal applications are restricted to

authorized users, which will be the company and its customers, within the company's internet. The company's internet itself is a private network that is isolated from the internet. The 7 primary APIs that the company's internal application that the company is using with their special scripts are described and listed in the following:

Computicate (now newly renamed Acronis)

It is used as their ticketing system, providing ticketing solution services to customers for a wide range of events and activities. Ranging from business, entertainment and travel needs from all income groups. Its software comes from a South African company who was founded by Percy Tucker in August 1971.

TOMTelecom

It is used for their company's phone system. It is responsible for the structured process of call routing on incoming calls from customers to the appropriate department or individuals, ensuring effective communication and issue resolution.

SnelStart

It is user-friendly accounting software that comes from Snelstart software company. The software packages include features such as scanning receipts, fast online invoicing, and VAT returns. Its clients include: KNVB, Marieke Webdesign, Schut, and Verbunt Hockey.

N-Central

It is a RMM platform developed by N-Able technologies. RMM is a software used by MSPs and IT professionals to monitor client networks, manage devices & complex networks remotely, and provide remote support. It helps Q-ICT with:

- Proactively monitor everything on a customer network - including servers and workstations - and troubleshoot.
- Stay on top of threats with features like MFA and TOTP.

PerfectView

It is a CRM software application that helps Q-ICT in managing their interactions and relationships with both current and potential customers. These are used to streamline processes, improve

customer service, and increase profitability by organizing, automating, and synchronizing sales, marketing, customer service, and technical support.

Resello (part of Pax8)

It is a cloud-service distributor and Microsoft CSP indirect provider from the Netherlands. Q-ICT uses its automation process to sell cloud-service solutions and products to its clients. This automation helps Q-ICT to manage customers provision products and usage all in one place. Pax8 focuses on simplifying the process of offering cloud solutions to end-users by providing a wide range of services through its platform.

SentinelOne

This technology has just recently been integrated within the company internal API connection system. It is an endpoint security, from an American cybersecurity company, specializing in advance solutions to protect devices such as computers, servers, and mobile devices from various threats. It utilizes AI-powered platform to provide autonomous endpoint protection.

2.10 Company Culture

Below are the cultural and key characteristics that Q-ICT embodies to its employees:

- Fewer levels of hierarchy: in Q-ICT, there are only a few layers of management and middle managers, which leads to shorter chains of commands and faster communication.
- Open communication: one thing that the author has noticed during his work placement in Q-ICT is that the company encourages open and direct communication among all its employees. Team members are more likely to interact with each other and with upper management without the need to go through multiple layers of hierarchy.
- Increase autonomy: employees in Q-ICT often have more autonomy in their roles. They are trusted to manage their work and make decisions independently, which can boost job satisfaction and creativity.
- Quick adaptability: the core idea of Q-ICT organizational value is to be more agile and adaptable to change as it has during the past. When decision-making is distributed, the company can respond more swiftly to market shifts and emerging trends.
- Employee empowerment: employees and interns are encouraged to take ownership of their work and contribute to the organization's success, which leads to higher employee engagement and job satisfaction.

- Focus on skills and expertise: this aligns well with the previous point, in which the training and development programs that the company has for their employees are based on their personal goals and desires. Promotions and recognition are based on employee's skills, expertise, and contributions rather than their position in the hierarchy. This can lead to a more meritocratic culture (*see Meritocracy*).
- Cost efficiency: by having little management layers, Q-ICT can be more cost-effective since they have fewer managerial salaries and associated overhead.
- Decentralized decision-making: this authority is often delegated to employees at various levels of the company, especially the front-line workers. This empowers employees to make decisions related to their work, which can lead to quicker response to challenges and opportunities.
- Innovation and creativity: with open communication (2.10) and greater autonomy (2.10), employees are more likely to contribute innovative ideas and solutions to challenges.

2.11 Competitors

Because of the size of the company that is still yet relatively small, employing only 15 individuals excluding 4 interns, according to the director Mark Kolk, Q-ICT currently does not face any direct competitors that poses immediate issues that require significant attention. It is still limited in its ability to larger counterparts in major Dutch cities such as Amsterdam and the Hague, and in the broader northern region of the Netherlands. Furthermore, the director also states that due to its size, the company has not yet made a significant impact on the cybersecurity industry.

Methodology

3.1 Instruments

According to the original wiki (*Methods - ICT Research Methods, n.d.*) [21], the research methods pack include five strategies: Library, Field, Workshop, Lab, and Showroom. Based on the available time, resources, and goal of the research, Library (Literature Study) and Field (Interview, Document Analysis, and Problem Analysis) are the most suitable strategies to answer the research questions as only qualitative data will be collected and those research strategies provide effective results and requires the least amount of time and effort to gather the required information.

Library research provides the author with already existing information, theories that can be easily accessible through the internet. The selected methods from this category are available product analysis, best good and bad practices, and literature study.

Field research is done in a way to provide context for the application. This strategy is used to get to know and meet stakeholders' end needs as well as the organizational context. This concept is furthermore relevant to the report as it may be necessary later for the author to study the diverse range of the company's organizational contexts, using various aspects of case studies, surveys, and social network analysis.

Workshop, Lab, and Showroom are not suitable as used strategies because they require more time to get valuable results. Furthermore, their implementation is harder as most of the included methods require third-party, or an already existing software application by the company that can be tested and analyzed, which do not align well with the objectives of this report.

3.2 Research Samples

The research samples were selected based on their purpose and convenience. Multiple articles online and academic books have been used regarding the report, research, as well as tech sampling.

3.3 Limitations

The effectiveness of Firebase and Microsoft Azure cloud computing platforms are limited to Q-ICT's, might be differ for other organizations as it is influenced by factors such as team composition, budget, software development project size and scope, organizational culture, and scope. This is because this report is solely made to help the author's client company with his work placement to apply the report's findings to their own organizational needs, and not the general audience.

To address this issue, the writer tried to use mixed methods of approach to collect qualitative data and consider a range of industries and organizational contexts. Therefore, the readers are encouraged to conduct their own pilot studies or experiments in their specific software development projects and adapt them based on their unique needs and constraints.

3.3.1 DTU-based vs vCore-based Azure SQL Database

The author later will compare the pricing of 2 purchasing models that Azure offers to its customers in their SQL database. Mostly, the author is going to talk about the cost-effective side of the equation. However, the author is going to omit talking about other external factors, such as Serverless-tier, and the differences between Business Critical and HyperScale that are included in the 2 purchasing models for the sake of simplicity as they do change the topic in a substantial matter.

Furthermore, since Firebase is backed by GCP in 2014 and since then it integrated with GCP product suite fully, the author will proceed to compare GCP functionalities with Azure's. This due to the reason that GCP is more comprehensive platform and delivers more services than

Firebase, like computing engine, storage, CDN, Kubernetes, BigQueries, which will help the author when comparing the 2 providers in order to determine which providers best suited for Q-ICT. Users can create their projects in both GCP and Azure and they will provide a visual container for data, code, configuration, and services. A Firebase project on the other hand, is just a GCP that has additional Firebase-specific configurations and services enabled for it.

Research Results

4.1 Research Question 1: What Are the Specific Features for Application Development and Tools Provided By Azure That Are Currently Relevant to Q-ICT's Software Development Projects When Using Firebase?

Firstly, according to Manuel Weidijk, Q-ICT is currently using Firebase for its application development and cloud infrastructure needs. It is also important to note that Firebase is not a separate standalone from GCP. It is possible to use Firebase services without explicitly signing-up for a GCP subscription, however, the charges for Firebase usage are still billed through the associated GCP billing account. Firebase only provides specialized platform specifically tailored for mobile and web-app development, but it is still part of GCP ecosystem. With that out of the way, below are the Firebase features that the company mostly use:

- Cloud Functions: for executing back-end code to call the APIs.
- Google Authentication: is used for their extra security measure, utilizing multi-factor authentication, user sign-up and sign-in, secure access control, and account recovery and reset in their software applications.
- Cloud Storage: this is where they have their database. Their database is a cloud-based NoSQL real-time document database, storing data in JSON like documents for building scalable web and mobile applications. This is where their customers' data are stored.
- Cloud Firestore: it is used for storing, hosting, and sharing files and binary data, such as images, videos, audio files for their software development.
- Google Secret Manager: is a cloud service that enables secure storage and management of sensitive information such as API keys, passwords, certificates, and other credentials.

It is designed to help developers securely store, access, and manage application secrets and sensitive data in a centralized and protected environment. The company uses this extension to securely store their API keys which also will impact their pricing plan.

- **Hosting Service:** it is used for the company's static web hosting. It simplifies the process of deploying web applications, single-page apps, or static sites.

Furthermore, Algolia [2] is also used as well by the company, to get fast, interactive, and relevant search experiences since Manuel considers that Firebase does not often offer an effective search query. The company is currently using PAYG service models for cloud providers, offering flexibility and cost-efficiency. The company has not yet paid for Azure as they have never started making projects with it. The last payment of September 2023 for Firebase, on the other hand, cost them €15.39 for both test and live environments. The test environments are often created by developers separately when starting new projects for testing purposes. The projects are used for testing new features, conducting Q/A, and identifying bugs. The live environments are projects used for the production version of the application. This is what end-users interact with. The Azure counterpart for the six features that are just listed above are the following:

Azure Functions

It is a serverless compute service that enables users to run event-triggered code without having to explicitly provision or manage their infrastructure. There are important factors when comparing a cloud function aspect of the service such as computation speed, execution time, memory, language support, available and custom run-time, scalability, cold start time, concurrency, latency, HTTP integration, hosting plans, ease of development and deployment [15]. As of January 2024, there was not any clear consensus or official benchmark that decisively talk and demonstrated significant performance differences between one another [26]. Both functions seem to be comparable to the other two, and it is important to note that both providers continuously trying to optimize their services.

Azure AD

Both Azure AD B2C and B2B support IAM feature which is the counterpart of Firebase Authentication. This section will be later discussed in a subsection of the next research sub-question (4.2.4).

Azure Database Service

In general, Azure provides more extensive DB than GCP, along with actual Backup service, with Site Recovery service and Archive Storage. Some of the databases that Azure offers are Azure SQL DB, Azure DB for PostgreSQL, MySQL, MariaDB, Azure CosmosDB for a NoSQL database, Azure Cache for Redis, and Azure Managed Instance for Apache Cassandra[13]. It also has a Data Warehouse service as well as Cosmos DB and TableStorage for NoSQL. When comparing Firebase's Firestore which provides a NoSQL database, then Azure Cosmos DB would be its significant counterpart. Azure Cosmos DB is a globally distributed, multi-model DB service designed for highly responsive and scalable applications. It is classified as a NoSQL database, and is designed to provide high-performance, low-latency, scalable data storage solutions for modern applications. It supports multiple data models, including document, key-value, graph, and column-family. Below is the comparison of their features [28]:

Comparison		
Description	Azure	Firestore
Data model	Is a multi-model DB service supporting document, key-value, graph, and column-family data models. It provides more flexibility in terms of data modeling compared to Firebase	Is a NoSQL document database that stores data in JSON-like documents. It supports collections and documents within those collections. The data model is more flexible and allows nesting of objects and arrays within documents
Scalability	Offers automatic and instantaneous scaling of both throughput and storage. It can handle large volumes of data and high request rates, suitable for globally distributed and high-traffic applications	Is designed to scale automatically based on demand. Can oversee many concurrent connections and provides automatic scaling for both storage and read/write operations

Integration	Integrates well with other Azure services, providing a wide range of possibilities for building complex applications. It also supports real-time analytics and integration with Azure Functions (counterpart to Firebase's Cloud Functions).	It integrates perfectly with other Firebase services and provides SDKs for various platforms, making it easy to develop applications for web, mobile, and server environments
Security	Offers various security features, such as encryption at rest and in transit, network security, and RBAC. This ensures the security of the data stored in the database	Provides robust security features such as encryption at rest and in transit, IAM, and network security
Pricing model	Offers different pricing models, such as provisioned throughput, serverless, and auto-scale. This allows for flexibility in pricing based on the specific requirements of the application	Firestore pricing is based on the amount of data stored, read, write, with additional charges for network egress and operations

Table 4.1: Comparison between Microsoft Azure and GCP

Overall, Cosmos DB is recommended if Q-ICT needs a highly scalable and globally distributed database service with flexible data modeling options. It opts for large, globally distributed applications with high availability and performance requirements, whereas Firestore is useful for building small to medium-sized applications, especially mobile apps, with a simple setup with real-time synchronization.

Azure Storage

This provides several services, including Blob storage, table storage, and Azure Files. Storage and disk types of the computer that the cloud provider utilizes will affect I/O, max IOPS per volume/instance, and the ability to burst capacity for short times, which have a significant impact on performance.

Block Storage

It is essentially a virtual disk running on a cloud-based VM. GCP delivers block storage utilizing persistent disks, offering HDD and SSD storage, which can attach to instances running on Compute Engine or Google Kubernetes Engine.

Azure, on the other hand, delivers its block storage solution in the form of page Blobs, stored on Azure VHDs, running on an Azure VM.

Apart from the method of data storage, GCP persistent disks and Azure VHDs are very similar. Each offers network-attached disk volumes and the ability to attach local disks should the need arise.

Distributed Object Storage

It is a way of storing data as objects, also referred to as Blobs. It is used for storing large amounts of unstructured data like images and videos. Each object comprises of the data itself, several metadata, and a key acting as a unique identifier. Object storage can be implemented at multiple levels including the device-level, system-level, and interface-level.

The distributed object storage offering from Azure is called Azure Blob storage, and from GCP it is called Cloud Storage. They are similar in many ways, using unique keys to identify objects, and support metadata information that includes object size, date of last modification, and media type. They both support the functionality to edit and add custom metadata fields and are most used for data types including static web content and media.

Each platform supports additional features including object encryption, replication, versioning, lifecycle management, and change notifications. Along with an up-time SLA and policies in place to credit the users should they do not meet these requirements.

Azure Key Vault

Azure Key Vault is Microsoft's solution to Google Secret Manager. In essence, they contain the same functionality. Azure Key Vault is a cloud service offered by Microsoft to secure sensitive data information, and it acts as a centralized repository for safeguarding cryptographic keys and secrets that applications and services need but should be protected from unauthorized

access. Azure offers 2 features, which are Secure Key Managements and Secrets Managements. **Secure Key** allows users to create, import, store, and manage cryptographic keys and secrets used in applications or services. These keys can be used for encryption, decryption, signing, and verification. **Secrets** enable the storage and management of application secrets, such as connection strings, and API [19].

Azure App Service

It is a fully managed platform that enables developers to build, deploy, and scale web apps, APIs, mobile back-ends, and even functions (server-less computing). It supports multiple programming languages, frameworks, and tools, namely .NET (C#), Node (JavaScript), Java, and Python. App services includes Web Apps, API Apps, and Functions, providing different options for hosting and scaling applications based on workload requirements. Additionally, Azure also provides various other services for hosting applications, providing a range of options catering to the different application types, scalability needs, and deployment preferences, such as AKS, Azure VMs, Azure Batch, Azure Service FABRIC, and Azure Logic Apps.

With that out of the way, the report will then proceed to move the focus from Firebase to GCP to make a proper direct comparison. Below is the direct comparison of GCP and Azure:

Description	Azure	GCP
Compute	Azure VMs, Azure App Service	Google Compute Engine, Google App Engine
Pricing Storage	Per-minute basis Azure Blob Storage, Azure Files	Per-minute basis Google Cloud Storage, Google Cloud DB
Databases	Azure SQL Database, CosmosDB	Google Cloud Bigtable, Firestore
Networking	Azure Virtual Network, Azure Cognitive Services	Google VPC, Cloud Interconnect
AI/ ML	Azure Machine Learning, Azure Cognitive Services	Google AI Platform, TensorFlow
IoT	Azure IoT Hub	Google Cloud IoT Core
DevOps	Azure DevOps, AKS	Google Cloud Build, GKE

Table 4.2: Comparison between Microsoft Azure and GCP

4.1.1 Regions and Availability

When selecting a cloud provider, the supported regions and availability are the first things to consider, because this can have an impact on the performing cloud. Further distance to the cloud provider may bring issues such as latency and compliance regulations, especially when dealing with data. GCP and Azure each offer a global network of data centers across multiple regions, countries, and locations. Each provider has distinct availability zones which are great for redundancy. Below are the data for those 2 big cloud providers as of September 2021:

Azure currently has 116 availability zones in 58 regions and 140 zones. Those availability zones including Brazil (3), Canada (3), Chile, Mexico, USA (18), Azure government (3), Asia Pacific (6), and Australia (3) [14].



Figure 4.1: Microsoft Azure Regional Network

GCP has 106 availability zones comprises of 35 cloud regions, 60+ zones, and 200+ countries, with new regions recently added such as Seoul (South-Korea) and Salt Lake City (Utah, USA). Those availability zones including Asia, Australia, Europe, North, and South America [8].



Figure 4.2: Google Cloud Regional Network

With that being said, it is concluded that Azure offers a larger range of regions, while GCP has a significantly higher number of locations.

4.1.2 AI/ML

Both providers offer a wide range of services from speech-to-text, DevOps, and other applications. GCP offers a suite of AI/ML under the Google AI umbrella, including Google AI Platform, Cloud AutoML, and TensorFlow. GCP is known for its expertise in AI, thanks to its history in developing ML technologies like TensorFlow and its leadership in AI research.

Azure's various AI/ML services include Azure ML, Azure Cognitive Services and Azure Databricks. Microsoft has also made significant investments in AI research and development.

If value pre-trained models and APIs are what a user needs, prefer TensorFlow and user-friendly AutoML tool, then GCP might be their best solution. Azure is ideal if a user want flexibility in ML frameworks and need strong enterprise support.

4.2 Question 2: What Are the Security Measures and Protocols Provided by Azure and Firebase? Are There Any Difference and How Do They Differ?

This document will focus on the underlying technologies, controls, processes, and policies which combine to protect customers cloud-based systems, data, and infrastructure.

Azure and GCP are renowned for a deep commitment to providing the highest level of cloud security. With each provider continuing to evolve a security model built on a development history spanning more than a decade. They offer bug bounties for security researchers, drawing from both the independent security researcher community and their own top-tier security teams.

At a prominent level, they deliver cloud security in three ways:

- Security **of** the cloud platform - delivering security capabilities that are built into the infrastructure of the cloud platform, providing protection by default.
- Security **in** the cloud platform - delivering security products and services within the platform that can be configured to protect your applications and data.
- Security **anywhere** - expanding security capabilities beyond the cloud platform to protect assets regardless of location.

4.2.1 Firewall

Firewalls provide the first line of network defense for any infrastructure. Both GCP and Azure provide state-of-the-art firewalls, offering configuration capabilities through firewall rules so customers can control who has access to the network.

Azure offers additional firewall-as-a-service products including its Azure Firewall [5], Azure Web Application Firewall [7], and the newly launched Azure Firewall Manager [6], all of which are cloud-native.

4.2.2 Encryption

One of the critical requirements is to encrypt important data, regardless of whether it is in the cloud. Encoding the data ensures that, should it be intercepted, it is almost impossible to

decipher without a decryption key.

Within their cloud infrastructure, Azure and GCP support encryption as default by using 256-bit AES. They also offer the ability to control owned encryption keys and deliver encryption at rest and in transit. GCP refers to its service as the Cloud Key Management Service [10], while Azure refers it as Key Vault [19].

4.2.3 Compliance

With the continuing rise in regulatory control of information by both governments and industry, compliance of the controlled cloud platform is critical. GCP and Azure are rigorously secured. Azure has proven compliance with privacy regulations across 50 global regions [4]. GCP's security meets compliance across the globe as well [11], meeting many ranges of ISO standards, GDPR, CCPA, HIPAA, CSA STAR, PCI DSS and many more, all of which Azure also covers.

To this date, Azure has the highest compliance of any cloud provider, meeting 90+ compliance standards across 50 global regions. GCP on the other hand, meets with 45 compliance standards.

4.2.4 IAM

An IAM system will give users control over who can access the system, stopping unwanted visitors at the front door.

Both providers offer an in-built IAM system, Azure has Azure AD [3] while Google has Cloud IAM [18] (simply Authentication for Firebase). Azure AD offers 2 services, B2B and B2C, which both provide IAM but are tailored for different scenarios and user types

Azure AD B2C is focused on providing IAM services for external customers. This is the services that the author recommends Q-ICT would take if they decided to use Microsoft for their cloud provider. It is particularly useful to use when they need to manage user identities for external consumers (customers), making highly customizable user experience tailored for consumer applications, and enabling social identity integration and self-service profile management. It allows Q-ICT to manage their customer identities, facilitate user registration, enable self-service password-reset, and offer secure authentication and authorization mechanism. It provides features like social identity integration, user profile customization, and

fraud detection, ideal for targeting a broad customer base.

Azure AD B2B: is designed to facilitate collaboration between businesses and their partners, suppliers, or other external entities. It allows organizations to invite external users as a guest user, granting them controlled access to specific resources or applications. It provides secure authentication and access control mechanism for these guest users, ensuring that they can collaborate effectively without compromising security. It is useful when a company needs to collaborate with external partners, suppliers, or business-to-business entities. Furthermore, it can be used to integrate external users into the existing Azure AD for seamless collaboration and inviting external users as guest users to access specific resources.

Both Azure AD and Cloud IAM combine a similar range of features and functionality that include user roles, user provisioning, user authentication, access management policies, authorization, and security features such as multi-factor authentication and conditional access policies to deliver control over who has access to the applications and data, what they can access, and what they can do to the data.

4.3 Research Question 3: What Are the Potential Cost Implications of Adopting Azure Compared to Using Firebase to Q-ICT?

Pricing is the one aspect that is the most difficult to look and compare at the cloud providers. In terms of Q-ICT, the company already has a Azure PAYG subscription set-up approximately 3 months ago before this report was written, along with the same type of Firebase subscription. Furthermore, the company does not look forward to changing the type of subscription soon. The decision is rooted in the company's desire to maintain flexibility, given its size, committing to long-term subscription at this stage does not align with its current strategic goals. Therefore, comparing the PAYG subscription model from both providers will be the wisest direction that the report will take. However, the report will compare other subscription types as well should the company ever want to change its current subscription.

The IT community believes Azure has the lowest on-demand cost, while Google Cloud is the highest. All three systems provide all users with competitive price plans and extra cost control features (reserved instances, budgets, and resource optimization). Several factors and variables that will influence and determine the cost of the cloud platform, including:

- Customer specification
 - Geographic location - where customer's data center area/region is located.
 - Payment model - opting for PAYG, reserved instances or a long-term contract mode.
 - Subscription model - purchasing by the second, minute, hour, day, month, or year.
- The specific services utilized
 - VMs: number of instances, CPUs, GB of RAM required, OS.
 - Data processing: the volume data stored per month, quantity and types of operations performed on the data.
 - Network usage.
 - Storage-disks: type of data, size of storage, data redundancy option requirements.

The following table comprises of comparison of the pricing of Azure and GCP based on the machine type that each provides:

Machine Type	Azure	GCP
Smallest instance	In Azure, the same type of instance, i.e., an instance with 2 CPUs and 8GB of RAM, will cost roughly US\$70/£53 per month	Google will supply with the most basic instance, including 2 virtual CPUs and 8GBs of RAM, at around US\$52/£39 every month
Largest instance	Azure's largest instance includes 3.89TB of RAM and 128 vCPUs. It costs about US\$6.79/£5.1 per hour	GCP leads the competition compare to Azure with its largest instance, 3.75TB of RAM and 160 vCPUs. It will cost approximately US\$5.32/£3.98 per hour

Table 4.3: Comparison between Azure and GCP regarding the price of machine type

With the basic information out of the way, the report will dive further into and look more closely at pricing comparison for both platforms. It will focus specifically on the compute costs of Google Compute Engine and Azure VMs -as compute resources typically amount to two-thirds of total cloud spend. They also form the foundation for most other services.

4.3.1 Assumptions for the Cloud Pricing Comparison

This document will compare both cloud providers' plan in the same region, with same CPUs, and OS for Azure VMs and Compute Engine:

- Region: US East - North Virginia (GCP: us-east4, Azure: east-us).
- OS: Linux - Free (CentOS).
- vCPUs/Cores: 4.

The instances with comparable RAM and 4 CPUs, across the instances/VM types have been chosen and listed below:

- General Purpose.
- Compute-optimized.
- Memory-optimized.
- GPU instances/VMs.

Below is the table containing the chosen instances for the comparison:

Instance Type	Azure VM	Azure RAM (GB)	Compute Engine	GCP Google RAM (GB)
General purpose	B4MS	16	n1-standard-4	15
Compute optimized	F4	8	c2-standard-4	16
Memory optimized	E4 v3	16	n1-highmem-4	26
GPU	NC6	56	NVIDIA® Tesla® T4	64

Table 4.4: Both Chosen Instances for the Comparison

4.3.2 Pay-As-You-Go

Both cloud providers offer PAYG models. This is the subscription that Q-ICT currently has for both providers. This subscription allows users to pay for the resources they consume without any upfront costs. While this type of pricing models gives users flexibility to control spending, it comes at a cost, with PAYG being the most expensive pricing per hour. Below is the comparison of price of PAYG plan for both cloud providers. Keep in mind that the 4 categories of chosen instances are already explained in the table above 4.4.

Instance Type	Azure Price per hour	GCP Price per hour
General purpose	\$0.166	\$0.15
Compute optimized	\$0.199	\$0.167
Memory optimized	\$0.252	\$0.166
GPU	\$0.9	\$1.4

Table 4.5: Comparison between Azure and GCP regarding the price of PAYG model rates

From the table above, GCP has the lowest price for the 3 instances. This is due to differences in billing methods. Azure only offers a flat rate for PAYG instances, GCP applies Sustained Usage Discounts which are automatically added once a user passes a certain threshold. This discount amount scales up the more the services are used, with savings starting at 15% and ramping up to 60%.

4.3.3 Reserved Instances vs Committed Use Discount

Before proceeding to compare both long-term solutions, it is wise to know what both cloud providers name their pricing models. Both Azure and GCP support long-term pricing models, offering to reward upfront commitments of 1 year or 3 years. [20]

Azure's long-time subscription is called Reserved Instances, promises impressive savings up to 80%. While the GCP's equivalent would be Committed Use, promises saving up to 75%.

If the user is serious about their cloud deployment and willing to make a long-term commitment upfront, he/she can make significant savings over the PAYG model. But as with all things cloud, there are several variables that will influence the level of discount that users can receive. Factors such as instance types, location, and OS are just a few of the variables that will influence savings.

4.3.4 1-Year Commitment

The table below shows hourly rates for 1 year of Committed Use for Compute Engine (GCP) vs 1 year of Reserved Instance of Azure [24]:

Instance Type	Azure Price per hour	Google Price per hour
General Purpose	\$0.0974	\$0.128
Compute Optimized	\$0.1248	\$0.1407
Memory Optimized	\$0.1564	\$0.1594
GPU	\$0.5733	\$0.88

Table 4.6: Comparison between Azure and GCP regarding the price of 1 year commitment

In here, Azure Reservations offers discounts up to 40% for 1 year of commitment. Azure VMs has become a cheaper option for all 4 categories. In this section, GCP was revealed to be up to 30% more expensive.

4.3.5 3-Year Commitment

Below is the comparison of the 3-year commitment between Committed Use and Reserved Instances:

Instance Type	Azure Price per hour	Google Price per hour
General Purpose	\$0.0626	\$0.128
Compute Optimized	\$0.0786	\$0.094
Memory Optimized	\$0.1	\$0.1239
GPU	\$0.3995	\$0.64

Table 4.7: Comparison between Azure and GCP regarding the price of 1 year commitment

There has been no change as to which provider is cheaper over the 1-year commitment. Azure continues to offer higher discount levels of up to 62%, versus GCP's 39%, against its equivalent PAYG model, ensuring GCP remains more expensive across all 4 categories. In this scenario, GCP's machine types were up to 46% more expensive than Azure's.

4.3.6 Free Trials

In the event of just trying out and not ready to commit, both providers offer a free tier with trials across a range of their products and services.

GCP

The GCP free tier is comprised of two components [16]:

- A 12-month free trial with access to any Google Cloud services and \$300 of credit, which must be spent within the 12-month trial.
- Access to common Google Cloud resources that are always free of charge, with a limited usage policy.

Unfortunately, and unsurprisingly, there is a range of eligibility requirements for the free tier, such as not having been a paying customer or having previously completed a free trial. Should a user qualify, they will gain 'always free' access to 18 core of Google Core products which span compute, database, storage, data analytics, management & developer tools, AI & machine learning and security services.

Below are some of the key products along with their service restrictions [17]:

- 1 F1-micro VM instance with a 30GB HDD per month - only available in the US region.
- 5GB of cloud storage - with 5,000 Class A operations and 50,000 Class B operations per month.

- 1 NoSQL document database with 1GB storage - 50,000 reads, 20,000 writes and 20,000 deletes per day.
- 38 instance hours a day of App Engine.

Azure

Azure Free Trial adopts a similar approach with two components, there are however some key differences [12]:

- A 12-month free trial of certain Azure services with limited usage and \$200 of credit (\$100 for using student account) - which must be spent in the first 30 days.
- Access to common Azure resources that are always free of charge, also subject to a limited usage policy.

Azure also has a few eligibility restrictions to be met before a user can be qualified for the free tier. Unlike Google, a user that qualifies for the free account only has access to 20 Azure services. These includes key products like Linux and Windows VMs, managed disk, file and blob storage, and SQL databases. These services will come with limited usage, which can be expanded with the free \$200 credit.

The users also unlock forever free access to a wider 25+ Azure products which include compute, databases, networking, identity, security, developer tools, analytics, management & governance, AI & machine learning, and container services.

Below are some of the core products:

- Azure App Service for 10 webs, mobile, or API apps with 1GB storage.
- Azure AD for identity management - SSO for 10 apps per user.
- 5 free users on Azure DevOps.
- Free access to DevTest Labs to create quick, simple, and lean app testing environments.

4.3.7 Highlights

Here are the highlights of all the points that were discussed above regarding the pricing:

Azure:

- 1-3 years commitment for reserved VM instances grant a significant discount.
- A discount on Azure Hybrid Benefit up to 40% can be granted to customers who has

Microsoft software on-premises.

- Substantial discounts for development and testing Microsoft Azure instances for VS users.
- Additional discounts for cloud computing services can be granted if customers have a Microsoft EA.
- Microsoft Azure offers a free tier with minimal services, many more popular services for 12 months, and around \$100 - \$200 credit to try any other paid service.

GCP:

- Users are eligible for a sustained use discount of up to 30% if they use the same instance for most of a given month.
- For jobs that can be stopped and restarted later (not requiring high availability), users can use Preemptible VM Instances with discounts of up to 80%.
- Discounts of up to 80% are eligible users who make a long-term commitment to use a VM (like Azure reserved VMs)
- Google offers a free tier with some basic services that are always free and a \$300 credit to try other services.

Another crucial point to note is Azure also offers pay-per-minute-billing, while Google already offers pay-per-second billing models which let users save way more than using Azure. GCP also offers various discounts to help customers save up to 50% in some cases when compared to Azure.

Product Developed

5.1 Product Description

The application made from the realization part of this work placement is in the form of a template CRM-like application. The application is a company's proof of concept to evaluate the feasibility of using Microsoft Azure as the cloud provider. Mainly, within the internal app, the company is using Flutter as their go-to front-end framework language, while utilizing GCP Firebase functionalities, primarily Cloud Functions, Firestore, Google Authentication, Cloud Messaging, Cloud Storage, Google Analytics, hosting services, and real-time database. If proven beneficial to the company, they would later use this as a showcase of template app to show to their potential client, as per one of the company's core activity of creating a customized software solutions.

Authentication

The app uses Azure AD (now newly re-named Azure Entra ID by Microsoft as of December 2023) for its way of authenticating users. On the Azure portal, the author can enforce the users to use MFA (mainly 2FA with the OTPs provided by Microsoft Authenticator) when they are trying to log in. It follows OpenID authentication protocol that allows users to log-in in to multiple applications or websites using a single set of credentials. Furthermore, it also utilizes OAuth 2.0 authorization framework that enables third-party applications to access user data without exposing user credentials.

Authorization

The authorization of this app primarily utilizes JWT. The way it works is that after a successful authentication, the signed-in user will get two tokens, access and refresh tokens. The access

token is used primarily to show permission gain necessary access according to user permissions (User.Read, User.Write, Mail.ReadBasic, AuditLog.ReadAll, etc,.). The access token is short lived, usually only lasts for 1 hour. The user would therefore need to utilize their refresh token in order to gain a new access token to continue using the application. When logging out a user, it is crucial to delete the refresh token of the user as a malicious as if it still remains active, someone with access to the device or browser history could potentially use the refresh token to obtain new access token without the user's consent. It is generally recommended to for the server to store these tokens in in-memory database, such as Redis.

5.2 Programming Languages and Frameworks

5.2.1 Client-side Front-end

Flutter [15] is an open-source UI SDK created by Google in 2018 for crafting natively compiled applications for mobile, web, and desktop from a single code base. It is a comparatively a new framework, but since release Flutter has gained significant traction in the software development community due to its efficiency, speed, and cross-platform capabilities.

Moreover, Flutter utilizes the Dart programming language, offering a reactive framework that empowers developers to build visually appealing and high-performance applications. Its hallmark feature, the "hot reload," enables developers to instantly view code changes reflected in the app, fostering rapid iteration and experimentation during the development process.

Widgets

At its core, Flutter utilizes widgets as a fundamental way to creating UI/UX elements. It provides a comprehensive collection of customizable widgets, allowing developers to create intricate UI designs and interactions with ease. Flutter's widget-based architecture contributes to creating visually appealing and consistent user interfaces across platforms. Widgets range from simple UI components like buttons and text to complex layouts and interactive elements.

5.2.2 Server-side Back-end

The server is built using Node.Js Express. Together, they make a combination of flexible web application with robust set of features for building REST API, which key features including

endpoints, routing, middle-ware, template engines support to render dynamic HTML content, and easy integration with database and pother Node.js.

Libraries

- Passport-azure-ad: is a extension library from Passport.js, a popular widely used authentication middle-ware from Node.js. Passport-Azure-AD itself enables integration with Azure AD for authentication and authorization purposes.
 - OIDCStrategy: is a strategy in authentication middle-ware, particularly Node.js, for implementing OIDC authentication. It is often use3d with Passport.js.
- MSAL-Node: is a library provided by Microsoft functioning as a token manager that for Node.js applications to authenticate users and acquire access tokens to access Microsoft APIs, such as Microsoft Graph, Azure AD, and other Microsoft services supporting OAuth 2.0 and OpenID Connect Protocols.
- Microsoft Graph client: is a Node.js library or package that allows developers to access Microsoft Graph. Microsoft Graph is a RESTFUL API provided by Microsoft that allows developers to access data and services across Microsoft 365 and other Microsoft cloud services. It allows developers to perform operations such as querying user information, accessing e-mails and calendar events, and managing files in OneDrive or SharePoint.
- @azure/identity and @azure/keyvault-secrets: these two libraries collaborate to access Azure Key Vault in which otherwise will not be accessible to the external audience. This key vault is used to store credentials such as Azure AD client ID, tenant ID, and secret passwords as opposed to storing them in dotenv (.env) file on the server.

5.2.3 Cloud Provider

The template application mainly uses Microsoft Azure as its cloud provider. The services utilized mainly are Microsoft AD, Application Services (for hosting the API and client app), Azure Vnet, Azure SQL server and database, Azure Function App, and Azure Key Vaults. In in Figure 5.1, the entities within the blue rectangle represents the elements that are inaccessible by the external party on the Internet.

backlog item, test case, impediment, code improvement, and bug. This board serves as the visual guide, clearly indicating the state of each task, whether it is in development (new or To Do items), testing, reviewed, approved, committed, and done. This structure approach ensures that the development stays organized, enabling the author to deliver high-quality work efficiently.

- Programming language: Dart, Typescript
- Cloud provider: Azure
- Azure services: App Services, SQL Databases, SQL Servers, Azure AD, Azure IAM, Azure Managed Identity,
- Database: SQL
- Framework: Flutter (front-end), Node.js (back-end)
- Development tool: Azure DevOps
- Working methodology: Agile SCRUM

5.4 Difficulties

During the development, the author encountered a slight hindrance, mainly due to the high costing of the database which exceed the budget limitation the company has set for this project. Later down the line, the author realizes that this issue was caused by the database being on the vCore-based purchasing model. In essence, Azure offers 2 purchasing models when creating a new SQL database, DTU-based and vCore-based. vCore offers the flexibility in scaling the processing power based on the performance and needs of the workload automatically. The pricing often correlates with the number of v-cores allocated, where higher v-core configurations typically incur higher costs due to the increased processing capabilities provided. DTU-based, on the other hand, offers advantage in fractional compute. It remains competitive as the users can assign very small fractions of compute with very high amounts of storage both possible and included, especially for the low compute commitment. This can also be an advantage for a low-volume, underutilized database that the user need to keep online for occasional reference.

Conclusion and Recommendation

6.1 Chapter Description

This chapter of the report serves as a summary of the key findings and insights obtained from the technical research. It should provide a conclusive summary of the research study. This chapter will not introduce new information but reiterate the main points and findings discussed throughout the report. It also offers practical recommendations based on the research findings. These recommendations should provide actionable insights or suggestions for addressing identified issues, improving practices, or implementing changes.

6.2 Conclusion

Both Azure and GCP are well-known hyperscale cloud providers, each with unique strengths. Each provider provides responds to every business unique demands. Azure is a very strong competitor, with a broad range of services, good hybrid cloud support, and it excels in integration and security. GCP, on the other hand, shines in data management, ML, and AI; it also proves to be the most affordable provider compare to Azure.

In terms of computing power, GCP cannot compete with Azure's massive data center infrastructure, but makes up for it with stronger support for container and Kubernetes use case, and a smoother learning curve across all types of deployments. In terms of storage service, again, Azure has more advantages than Google as it provides a well-rounded set of storage services and features, but can have a steep learning curve, especially for users without a background in Microsoft technology. Azure's UI is also not as user-friendly as GCP's which is easier to use, but GCP offers fewer features. In terms of networking, Azure is superior as it offers the ability to

connect and deliver hybrid and cloud-native applications. From connecting to VM and VPN connections, Azure is customize from security to traffic ensuring the network from inbound to outbound connections, native firewalls, network firewalls, and delivery of 5G networks give the customers exactly what they need. Connecting to customers, traffic, and other sites are all connected within a unified portal, something that GCP does not provide.

Azure also provides integration seamlessly with various Microsoft products and services. It is designed to work well with Microsoft's ecosystem, allowing Q-ICT to leverage their existing tools and technologies. Some of the products that Azure supports are: Office 365 and Microsoft 365, SQL Server, Windows Server and Hyper-V, Power BI, Dynamics 365, Visual Studio and DevOps, Active Directory and Identity Services, SharePoint, etc.,.

On the other side, GCP wins on price and provides more flexible pricing across almost all cloud services. However, Azure provides a discount model that can attract existing Microsoft customers. Additionally, Azure's AI and ML cannot compete with GCP's, as it provides more robust data tools and services for big data processing and machine learning, enabling advanced analytics and insights.

In terms of security, both are equally as impressive, meeting the ISO standards and privacy regulations across the globe, ensuring data privacy and regulatory compliance. Both of the providers offer features such as DDoS protection, IAM, encryption services, multi-layered authentication, threat detection and response, and secure and private global network.

6.3 Recommendation

The final choice, however, is entirely dependent on Q-ICT itself. Because of its small size, and the future plans of still looking to scale up, the author would recommend using GCP, as it offers the most cost-efficient pricing strategies, especially for compute and storage services. Furthermore, it emphasizes on innovation and cutting-edge technologies, offering support for Kubernetes-based container orchestration with notable strength in big data analytics, ML, AI services, preferable to a business that prioritize advanced data-driven analytics.

If, however, in the future the company already grows well and still want to focus more on running Microsoft software and Windows, then Azure might be the better solution. It offers

deep integration with Microsoft products like Windows Server and Office 365, making it an ideal choice for businesses heavily reliant on Microsoft technologies. Azure's robust global network, extensive data center presence, and strong hybrid cloud solutions make it particularly attractive for large enterprises seeking seamless integration between on-premises infrastructure and the cloud. The platform offers a comprehensive portfolio of services, appealing to businesses with diverse computing needs.

Furthermore, following the completion of realization phase, the author holds general sentiment that the combination of Node.js back-end API server does not seamlessly align with certain Azure employed during realization. The author encountered numerous documentations and resources online guiding and demonstrating the use Azure functionalities primarily within C# API application. Moreover, Firebase provides more extensive support for Flutter more than Azure, which is rational considering both Flutter and Firebase are made and developed by Google. To summarize, the author perceives that the pairing of Google's Flutter and Microsoft's Azure creates an overall peculiar combination.

Lastly, in terms of picking the right purchasing models from Azure SQL database, the author recommends the company to pick the DTU-based purchasing tier as long as they only need a low-cost database that is always available but does not have meaningful compute requirements. Once the utilization of Azure SQL database scales up to above 100 DTU, and they have much more better understanding of their workload, then the vCore-based approach may be more predictable and understandable.

Evaluation and Reflection

7.1 Chapter Description

This chapter focuses on assessing the methodology, findings, and outcomes of the report while reflecting on the entire research process from the author's point of view. Moreover, this chapter encourages self-reflection, allowing the author to discuss personal insights gained, unexpected challenges faced, and lessons learned during the research journey. By emphasizing both the accomplishments and areas for improvement, the evaluation and reflection section contributes to the overall credibility and validity of the research study.

7.2 Evaluation

During the duration of my work placement, I encountered numerous challenges that became invaluable opportunities for personal growth and problem-solving. While some of these challenges were more demanding than each other, each served as a catalyst for enhancing my skills and resilience in the field of ICT.

My roles during this internship were meticulously crafted to offer a comprehensive experience aligned with my academic pursuits and future career in software development, engineering, and technology. They significantly contributed to both my academic growth and the foundation for my professional career.

7.2.1 Moments of genuine learning

For me, it was making an IT project entirely from scratch by myself. They all require proper planning and designing which were time-consuming. It was also my first time jumping deep

into Azure, which is something I did not have enough experience when I was studying at NHL Stenden.

Learning Flutter is also quite a unique experience. In essence, Dart, which is the language the framework Flutter is based from, shares some logical similarities with C# and Java (in which I am familiar with) in terms of programming logic, data structure, and certain concepts, such as being object-oriented programming language. With that being said, they are still a clear distinction with their syntax, semantics, and ecosystem.

In terms of UI/UX, Flutter utilizes a system of Widgets to create UI elements similar to React, Angular, Vue, and even Swift and Kotlin. Widgets in Flutter are analogous to React components, allowing me to build UI by composing different widgets together. Both Flutter and React focus on component-based approach of UI development, enabling the creation of interactive and dynamic UIs.

However, it must be said that these framework handle the creation of UI elements and manage state can differ. Flutter uses a reactive framework where changes to the state trigger a rebuild of the UI, while React uses a virtual DOM to efficiently update the actual DOM when the state changes.

7.2.2 What I would do differently in the future

I would put more emphasis on better time management, enhance research abilities specific IT topic, project planning and designing, enhance my communication skill such as clarity and articulation for better teamwork, code commenting and refactoring, and making sure all the aspect of the project are being well documented and tested.

7.3 Reflection

With that being said, it sufficed to say that I have enhanced my IT skill by learning Flutter, how to use Azure, and honing my Node.js and TypeScript skills. Furthermore, during this work placement I also gained substantial experience of doing SCRUM in a real professional working environment in an IT company, better software testing, designing, code refactoring, project planning, time management, quality assurance, and understanding the importance of

software security, proper software documentation, and code maintainability. These skills I consider pivotal for my future career as a junior full-stack software developer.

Bibliography

- [1] Anonymous. (2018, April 12). *NIST cybersecurity framework*. NIST. Retrieved on September 18, 2023, from <https://www.nist.gov/cyberframework/online-learning/five-functions>.
- [2] Anonymous. (n.d.). *AI Search that Understands*. Algolia. Retrieved on December 03, 2023, from <https://www.algolia.com/>.
- [3] Anonymous. (n.d.). *Azure Active Directory*. Microsoft Azure. Retrieved on October 10, 2023, from <https://www.microsoft.com/en-gb/security/business/identity-access/microsoft-entra-id>.
- [4] Anonymous. (n.d.). *Azure Compliance*. Microsoft Azure. Retrieved on October 10, 2023, from <https://azure.microsoft.com/en-gb/explore/trusted-cloud/compliance/>.
- [5] Anonymous. (n.d.). *Azure Firewall*. Microsoft Azure. Retrieved on October 10, 2023, from <https://azure.microsoft.com/en-us/products/azure-firewall/>.
- [6] Anonymous. (n.d.). *Azure Firewall Manager*. Microsoft Azure. Accessed: 10.10.2023. Retrieved on October 12, 2023, from <https://azure.microsoft.com/en-us/products/firewall-manager/>.
- [7] Anonymous. (n.d.). *Azure Web Application Firewall*. Microsoft Azure. Retrieved on October 11, 2023, from <https://azure.microsoft.com/en-us/products/web-application-firewall/>.
- [8] Anonymous. (n.d.). *Cloud Locations*. Google Cloud. Retrieved from October 10, 2023, from <https://cloud.google.com/about/locations>.
- [9] Anonymous. (n.d.). *Cloud solutions*. Suse.com. Retrieved on September 11, 2023, from <https://www.suse.com/suse-defines/definition/cloud-solutions/>.
- [10] Anonymous. (n.d.). *Cloud Key Management*. Google Cloud. Retrieved on October 10, 2023, from <https://cloud.google.com/security-key-management?hl=en>.
- [11] Anonymous. (n.d.). *Compliance Resource Center*. Google Cloud. Retrieved on October 10, 2023, from <https://cloud.google.com/security/compliance/>.
- [12] Anonymous. (n.d.). *Create Your Azure Free Account Today*. Microsoft Azure. Retrieved on September 26, 2023, from <https://azure.microsoft.com/en->

us/free.

- [13] Anonymous. (n.d.). *Databases on Azure*. Microsoft Azure. Retrieved on October 09, 2023, from <https://azure.microsoft.com/en-us/products/category/databases>.
- [14] Anonymous. (n.d.). *Find the Azure Geography That Meets Your Needs*. Microsoft Azure. Retrieved on October 10, 2023, from <https://azure.microsoft.com/en-gb/explore/global-infrastructure/geographies/#overview>
- [15] Anonymous. (n.d.). *Flutter (software)*. Wikipedia Free Encyclopedia. Retrieved on December 12, 2023, from [https://en.wikipedia.org/wiki/Flutter\(ssoftware\)](https://en.wikipedia.org/wiki/Flutter(ssoftware)).
- [16] Anonymous. (n.d.). *Free Cloud Features and Trial Offers*. Google Cloud. Retrieved on September 21, 2023, from <https://cloud.google.com/free/docs/free-cloud-features>.
- [17] Anonymous. (n.d.). *Free tier products*. Google Cloud. Retrieved on September 25, 2023, from <https://cloud.google.com/free>.
- [18] Anonymous. (n.d.). *Identity and Access Management (IAM)*. Google Cloud. Retrieved on October 10, 2023, from <https://cloud.google.com/iam/>
- [19] Anonymous. (n.d.). *Key Vault*. Microsoft Azure. Retrieved on October 10, 2023 from <https://azure.microsoft.com/en-gb/products/key-vault/>.
- [20] Anonymous. (n.d.). *Resource-based Committed Use Discounts*. Google Cloud. Retrieved on October 09, 2023 from <https://cloud.google.com/compute/docs/instances/signing-up-committed-use-discounts>
- [21] Anonymous. (n.d.). *Methods - ICT Research Methods*. HBO-I. Retrieved on September 11, 2023, from <https://ictresearchmethods.nl/Methods>.
- [22] Anonymous. (n.d.). *QICT - De grootste cyber security specialist van noord nederland*. Q-ICT. Retrieved on October 04, 2023, from <https://www.qict.nl/>.
- [23] Anonymous. (n.d.). *What is scrum?* Scrum.org. Retrieved on September 19, 2023, from <https://www.scrum.org/resources/what-scrum-module>.
- [24] Chapel, Jay. (February 15, 2019). *How to analyze google cloud committed use discounts*. Medium. Retrieved on October 09, 2023, from

<https://jaychapel.medium.com/how-to-analyze-google-cloud-committed-use-discounts-bf9eb587ccfb>.

[25] D, Sudhansu. (2023, December 30). *Who's Driving the Success of Microsoft Azure? Discover the Top Customers and Their Impact on a \$150 Billion Platform*. CIS. Retrieved on October 02, 2023, from <https://www.cisin.com/coffee-break/who-are-biggest-customers-of-the-microsoft-azure-platform.html>

[26] Chukwujama, Osinachi. (2020, September 27). *Azure Functions vs Firebase Functions*. Dev.to. Retrieved on October 05, 2023, from <https://dev.to/vicradon/azure-functions-vs-firebase-functions-16o3>.

[27] Rifai, Moneer. (2023, June 08) *Serverless Showdown: AWS Lambda vs Azure Functions vs Google Cloud Functions*. Accessed: 14.12.2023. Pluralsight. Retrieved on October 05, 2023, from <https://www.pluralsight.com/resources/blog/cloud/serverless-showdown-aws-lambda-vs-azure-functions-vs-google-cloud-functions>.

[28] Larson, Benjamin. (n.d.). *Microsoft Azure Cosmos DB vs Google Cloud Firestore: Which tool is better for your next project?* Projectpro.io. Retrieved on October 10, 2023, from <https://www.projectpro.io/compare/microsoft-azure-cosmos-db-vs-google-cloud-firestore>

PDP (Personal Development Plan)
