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THE ECONOMIC IMPACT OF THE CLOUD IN DENMARK

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AUTHORS

Dr Bruno Basalisco

Dr Federico de Michiel

Elena Salmaso

Dr Henrik Ballebye Okholm

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EXECUTIVE SUMMARY

Cloud computing technology is taking an increasingly relevant role in supporting business operations in Europe. Covid-19 crisis has led to a speeding up of the adoption rate as organisations needed data storage and data processing capacity to ensure businesses continuity and adopt work-from-home models, internet sales and services, etc. This growing demand for analytics and big data technologies has prompted the expansion of cloud solutions in the post-pandemic period.

Cloud computing and the digital transformation that it enables is a defining opportunity for business growth. Cloud technologies enable firms to scale up quickly, providing them with the means to innovate products, services, processes, and business models. Moreover, cloud is a game-changer for security and can play a pivotal role in supporting companies and organizations facing sustainability and energy efficiency challenges.

In this study we provide new evidence on the role of cloud as a force multiplier for Danish businesses- and quantifies the value generated to whole economy thanks to the adoption of cloud services such as AWS. The values for Denmark are extrapolated based on a novel, Pan-Nordic online survey (“our survey”), run in March 2023 across Denmark, Finland, and Norway. The survey reached 918 firms, 87 percent of which were cloud users.

Moreover, the study sheds new light on the ways in which businesses in Denmark of all shapes and sizes can leverage cloud not only to save costs and enhance revenues but also to accelerate innovation, boost productivity, ensure data security and achieve greater environmental sustainability.

Cloud adoption enables digital transformation in Denmark

Cloud computing is at the core of the EU’ and Denmark’s digitalisation strategies and policy actions. Cloud adoption has shown a remarkable increase in the last seven years, as cloud users almost doubled. According to Eurostat latest available data, as of 2021, **64,8 percent of Danish companies are cloud users, a share that is well above the EU average.** The adoption rates differ across class size and sector of activity, with smaller firms and firms active in the transportation and storage sector lagging behind.

Cloud generates value to the overall economy

According to our survey, more than two thirds of businesses using cloud services in Denmark consider benefits related to cost savings, productivity, and security as important. More sophisticated users seem to be more aware of the importance of benefits derived from cloud.

Moreover, we observe that **cloud users surveyed for this study report higher revenue growth rates relatively to non-cloud users, with higher growth rates especially among AWS users.**

In general, the vast majority (92 percent) of cloud users surveyed report that their business is able to generate extra revenue from using cloud computing services. **Additional revenue reported**

by cloud users thanks to cloud range from an average of DKK 158,000 for micro firms (0-9 employees) to more than 2.9 DKK million on average for large firms (more than 250 employees).

In parallel, the study quantifies savings occurred to businesses thanks to cloud adoption. Cloud users in our survey report **annual cost savings by using cloud services** instead of maintaining their own on-site servers and physical data centres that **range from an average of DKK 110,000 for micro firms (0-9 employees) to more than 2.6 DKK million for large firms (more than 250 employees).**

Based on this survey, as well as official national statistics on the composition of the economy, we have modelled the economy-wide impacts on cloud that can be inferred from the firm-reported evidence. On this basis, we estimate that, in one year, **AWS cloud services enable businesses to generate up to 6.5 DKK billion in economic value added for the entire Danish economy. This equals around 0.23 percent of the Danish GDP in 2022.**

In parallel, firms that have adopted cloud also displayed a higher employment growth than non-users in the past three years.

Finally, young companies are reliant on cloud technologies to offer their services and remain competitive in the market: **24 percent of young cloud users reported their business would not be possible without cloud.** Based on that, we calculate that the adoption of **AWS cloud services is likely associated with the creation of over 9.200 jobs by young firms in Denmark.**

Cloud supports businesses to grow and reach new markets

Enhanced competitiveness is recognized as a key benefit of cloud adoption. 67 per cent of cloud users say that cloud helps their business to remain competitive in the market, while 81 percent of AWS user specifically states that cloud allows them to compete with larger companies.

Cloud users are able to reinvest their costs savings from cloud into business growth as reported by 70 percent of cloud users. Overall, **82 percent of cloud users expanded their product or service portfolio in the last three years, against only 55 per cent of non-users.**

Moreover, two third of cloud users recognise the importance of cloud services to expand geographically by scaling their businesses and export to international markets.

Cloud fuels innovation

Cloud plays an important role in the overall innovation process of businesses and allows better and more efficient experimentation.

Cloud technologies allow users to **reduce the time necessary to launch a product to the market**, as reported by 62 percent of cloud users. Moreover, 61 percent of users highlight the role of cloud in **reducing the software development cycles.**

These time savings enabled by cloud adoption allow **IT experts to allocate time on more strategic tasks.**

This translates into improvements in the way businesses can serve their clients. In fact, over **two thirds of cloud users agreed that the use of cloud makes it easier to provide better and more tailored products and services to end consumers. The same share rises to 81 percent for AWS users.**

Moreover, cloud also facilitates the implementation of other new technologies that have the potential to unlock further growth. More specifically, the use of cloud has made it easier for 64 per cent of cloud users to adopt new technologies requiring a lot of data processing such as AI and Machine Learning. Finally, **AWS users are heavy adopters of advanced technologies, and show a higher take up rate on all the most advanced use cases proposed.**

Cloud has wider societal benefits by lowering environmental impact

Cloud computing can **support firms** facing **environmental and energy efficiency challenges.** This can be achieved in two ways:

1. **cloud providers** can guarantee more **economic** and **environmentally efficient storage** of data and computing power, and
2. **cloud services** can **help firms** to **improve operational efficiency** and developing more sustainable processes.

Cloud users are aware of the environmental footprint of their cloud provider. **72 per cent of AWS users reported that, when choosing which cloud services to procure, they considered the sustainability profile** of different cloud providers, against only 66 percent of the overall sample of cloud users.

Moreover, cloud technologies represent an ally to achieve sustainability objectives. **64 per cent of businesses agree that the use of cloud help them to achieve their net-zero carbon emissions goals and 68 per cent of businesses report that the use of cloud improves their energy efficiency.**

The use of cloud can also increase companies' efficiency, while reducing their emissions, by facilitating information sharing and collaboration across different locations and teams.

Finally, **cloud** has also being pivotal in **supporting** the **birth and expansion of** new firms, **green tech** and sustainability start-ups, whose business model would have not been possible without the cloud.

Cloud ensures business security

Security related features of cloud are indicated by users as some of the **most relevant benefits.** Moreover, **69 percent of cloud users considered cloud infrastructure as more secure than traditional IT.**

Cloud technologies support firms in fighting cyberthreats, as reported by more than 60 percent of cloud business users surveyed for this study (the share increases for AWS users). Cloud service providers help **increase security by enabling teams to automate basic security tasks and focus their time on the most complex threats, increase early detection, reduce probability of errors, and provide professional support**. Enhanced security enables start-ups to compete with larger companies.

Cloud can unlock further opportunities

According to our survey, a general **lack of knowledge and understanding** of cloud technologies is among the **main reasons preventing non-users to adopt cloud technologies**.

Among non-users, 36 percent consider **cloud computing services adoption** as **likely** in the **next five years** citing as a way **to increase competitiveness, lower IT costs, improve security and better data management and increased operational efficiency**.

Encouraging cloud take up can unlock further growth opportunities for Denmark. Additional value can be generated by:

- a) **increasing the intensity of adoption** (e.g., only 20 percent of users in our sample employed cloud for more than five applications); and
- b) **increasing adoption among small firms**.

Based on the above evidence and modelling, **an increase of just 10 percent in the cloud adoption** in the cloud adoption rate of SME would translate into an estimated **additional 1 DKK billion in economic value added for the Danish economy**.

CHAPTER 1

INTRODUCTION***Objective of the study***

The benefits of cloud technologies are generally well documented in the literature. However, there is still limited quantitative and qualitative evidence on the extent to which these benefits are perceived and experienced by companies and organisations using cloud, and specifically AWS, in Denmark. Furthermore, the dynamics of adoption and usage of cloud services is such that the situation is evolving very fast and thus the extent and drivers of benefits from cloud are correspondingly evolving.

This study provides new evidence on the role of cloud as a force multiplier for Danish businesses- and quantifies the value generated to whole economy thanks to the adoption of cloud services such as AWS.

Moreover, the study sheds new light on the ways in which businesses in Denmark of all shapes and sizes can leverage cloud not only to save costs and enhance revenues but also to accelerate innovation, boost productivity, ensure data security and achieve greater environmental sustainability.

Research Methods

The empirical base of this study is a novel, purpose-designed large-scale Pan-Nordic online survey (“our survey”), run in March 2023 across Denmark, Finland, and Norway. The survey is unique in the type of economic questions investigated and reached 918 firms, 87 percent of which were cloud users. The sample captured firms of different sizes and different sectors of activity. The survey targeted IT decision makers in the firms, thus ensuring that all collected information was provided by an informed respondent within the firm.

The survey collected both qualitative information concerning the role that cloud computing played for businesses, and the quantitative estimations on additional revenues and cost savings achieved thanks to cloud. These latter, coupled with information on cloud spending, were employed to calibrate a model that allowed to estimate the overall contribution of AWS cloud to the Danish economy in terms of value added and employment.

Additionally, the study included case study evidence based on businesses using AWS cloud services. Interviewing AWS users allowed us to gather insights on the benefits and challenges of having adopted cloud solutions.

What is cloud?

Cloud computing allows companies/organisations to use a vast range of IT resources on an as-needed basis, without having to buy, own and maintain own data centres and servers.

Following the definition used for European Union Eurostat statistics, cloud computing refers to ICT services that are used over the internet to access software, computing power, storage capacity etc., where the services have all of the following characteristics:

- are delivered from servers of service providers;
- can be easily scaled up or down (e.g. number of users or change of storage capacity) ;
- can be used on-demand by the user, at least after the initial set up (without human interaction with the service provider) ;
- are paid for, either per user, by capacity used, or they are pre-paid.

There are different service models for the provision of cloud computing services. These include software, infrastructure, and platforms that are hosted by third-party providers. Types of services can be as follows:

- **Infrastructure as a service (IaaS):** A service model that offers users access to IT infrastructure on a pay-as-you-go basis. IaaS users can access cloud-hosted infrastructure that they can configure and use the same way as they use on-premises hardware. Services in this category include data storage, computing power, machine virtualisation, and network services.. IaaS allows business to scale up computing power very quickly without increasing IT expenditure and ensuring high security standards and a reliable environment.
- **Platform as a service (PaaS):** A pre-packed bundle of cloud computing hardware and software resources. PaaS is the provision of on-demand tools for development of software applications through a web-based environment and are used to construct and send apps. E.g., AWS Elastic Beanstalk is a PaaS used to handle many programming languages, where one can send and test apps for different gadgets and scale them up and down easily. PaaS allows customers to upload and deploy web applications in a simple and fast way. Moreover, it frees enterprises to dealing with hardware and operating systems and instead focus on the deployment and maintenance of their applications.
- **Software as a service (SaaS):** A model that offers cloud users the possibility to use ready-to-use application software centrally hosted on a cloud provider's cloud infrastructure. SaaS applications run on the provider's server, and the customer gets access to the service without having to install and maintain complex software and hardware management. Examples of services provided within the model include backup data system, web-based email, project management tools and file storage. SaaS models allow cloud users to access to software that is easily customisable, frequent updated and secure, at low infrastructure and setup costs.

CHAPTER 2

**CLOUD ADOPTION ENABLES DIGITAL
TRANSFORMATION IN DENMARK****Key findings**

- Cloud computing is at the core of the EU' and Denmark's digitalisation strategies and policy actions.
- Cloud adoption has showed a remarkable increase in the last seven years, as cloud users almost doubled.
- According to Eurostat, in 2021, 64,8 percent of Danish companies¹ were cloud users, a share that is well above the EU average.
- Cloud adoption rates differ across class size and sector of activity, with smaller firms and firms active in the transportation and storage sector lagging behind.

**2.1 CLOUD UNLOCKS AMBITIONS FOR DENMARK'S
DIGITAL TRANSFORMATION***Denmark is a frontrunner in digital development in the EU*

Cloud computing has been at the core of the EU' digitalisation strategy, considered as key asset to enable uptake of more advanced technologies and spur innovation based on data and digital services. Cloud adoption is as an integral part of the Digital Compass strategy (see Box 1), the initiative launched in 2021 by the European Commission that sets concrete targets to help support the digital transformation of the EU. and it is at the heart of Denmark's numerous advanced digitisation policy initiatives.

¹ It should be noted that Eurostat's estimate only includes companies with at least 10 employees.

Box 1 Digital Compass and Digital Decade

In March 2021, the European Commission laid out its objectives and concrete targets for the digital transformation of Europe by 2030 in its "2030 Digital Compass: the European way for the Digital Decade". The stated ambition of this framework is to pursue digital policies that empower people and businesses to seize a human centred, sustainable and more prosperous digital future.

The main targets of the Digital Compass are:

- In addition to the target on basic digital skills established in the European Pillar of Social Rights Action Plan, reaching 20 million employed ICT specialists in the EU, with convergence between women and men;
- All European households should be covered by a Gigabit network, with all populated areas covered by 5G;
- Increasing the production of cutting-edge and sustainable semiconductors in Europe including processors reaching at least 20 percent of world production in value (meaning manufacturing capacities below 5nm nodes aiming at 2nm and 10 times more energy efficient than today);
- Deploying 10,000 climate neutral highly secure edge nodes in the EU, distributed in a way that will guarantee access to data services with low latency (few milliseconds) wherever businesses are located;
- 75 percent of European enterprises should have taken up cloud computing services, big data and Artificial Intelligence
- More than 90 percent of European SMEs should reach at least a basic level of digital intensity
- Growing the pipeline of Europe's innovative scale ups and improve their access to finance, leading to doubling the number of EU unicorns;
- 100 percent online provision of key public services available for European citizens and businesses;
- 100 percent of European citizens should have access to medical records (e-records);
- 80 percent of citizens will use a digital ID solution.

An annual cooperation mechanism involving the Commission and Member States strategic roadmaps to attain targets are planned and adopted.

Source: (European Commission, 2023)

At the national level, the Danish Digital Strategy for 2022-2025 has set new ambitious goals for the digital transition that cover both the public and the private sector. The Strategy focuses on promoting the adoption of new technologies and helping business removing barriers to innovate. The total budget for the digitisation programme is reported as more than DKK 2 billion over 5 years. In addition, the National Strategy on Artificial Intelligence² stresses the focal role of cloud technology as a prerequisite for successfully harnessing the potential of AI in Denmark (Initiative 2.3).

In parallel, the "Visions and recommendations for Denmark as a digital pioneer" report³, issued in May 2021, highlights the role of cloud, as one of the enabling technologies key "to create value and

² (The Danish Government, 2019)

³ (The Danish Government Digitisation Partnership, 2021)

growth in the business sector and public sector and development for new and established businesses”.

More than 20 years of policy action to foster the digital infrastructure and business investments in the digital transformation have resulted in top placements for Denmark in digital economy rankings. In 2022, Denmark placed second, after Finland, in the 2022 European Commission’s Digital Economy and Society Index (DESI)⁴.

Denmark ranked first in some of the index’s sub-dimensions relevant to enterprises digitalisation, such as the use of Artificial Intelligence in business, and e-commerce uptake, especially across SMEs. Digitalisation and access to digital skills of SMEs is also a key element of Denmark’s Recovery and Resilience Plan, that addresses the productivity gap with larger companies.

The uptake of cloud by businesses in Denmark is increasing

In this context, the digital transformation of the Danish economy relies heavily on the availability and uptake of secure, affordable, and high-quality cloud computing.

Cloud adoption has showed a remarkable increase in the last seven years, as cloud users almost doubled. At present, according to Eurostat official statistics, 64,8 percent of Danish companies⁵ have adopted cloud computing service, a share that is well above the European Union average but still slightly behind 2030 Digital Decade Target, set at 75 percent. Based on current trends, Denmark is expected to see 75 percent of companies adopting the cloud by 2025 - five years ahead of the 2030 deadline⁶.

⁴ (European Commission, 2022) . The index summarises and monitors the evolutions of Member States’ digital performance, across five main dimensions: Connectivity, Human Capital, Use of Internet, Integration of Digital Technology, Digital Public Services.

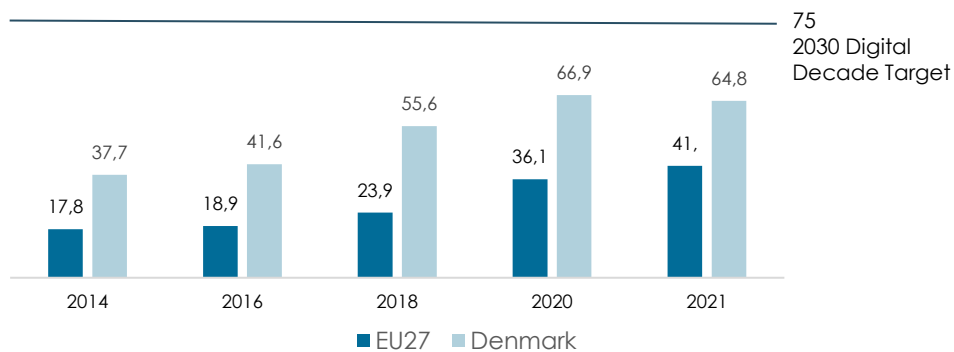
⁵ It should be noted that Eurostat’s estimate only includes companies with at least 10 employees.

⁶ (PublicFirst, 2022)

Figure 1

Cloud adoption in Denmark continues to grow

Percentage of all companies with 10 or more employees (excluding financial sector) using cloud computing services

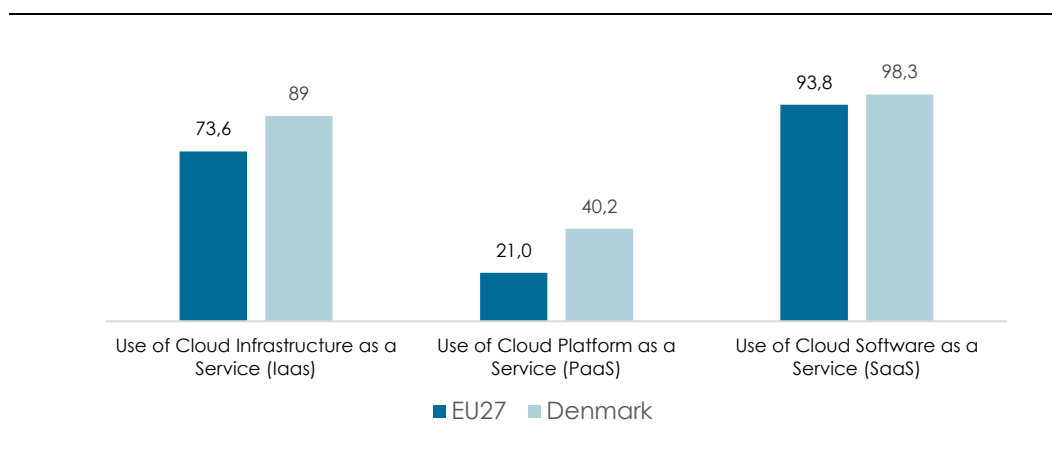


Note: No data is available for EU27 for 2015, 2017 and 2019

Source: Copenhagen Economics on Eurostat data

Among companies using cloud services, cloud Software-as-a-Service (SaaS) technologies are the most common, see Figure 2. According to Eurostat’s taxonomy, this category includes e-mail, office software, finance or accounting software applications, ERP, CRM, or security software applications as a cloud service and almost all Danish companies that are cloud users report employing at least one of these. A large proportion of cloud users also uses at least one cloud Infrastructure-as-a-Service’ product, i.e., hosting enterprise’s database, storage of files or computing power to run enterprise’s own software as a cloud computing service. Lastly, only 40 percent use Platform-as-a-Service (i.e., computing platform providing a hosted environment for application development, testing or deployment as a cloud service). In all three categories, Danish enterprises report higher adoption rates than the EU27 average, the gap is larger for PaaS, where the share of Danish users is twice that of the EU27.

Figure 2
Cloud adoption by service model, 2021
 Percentage of companies using cloud computing services



Note: No data is available for companies with less than 10 employees

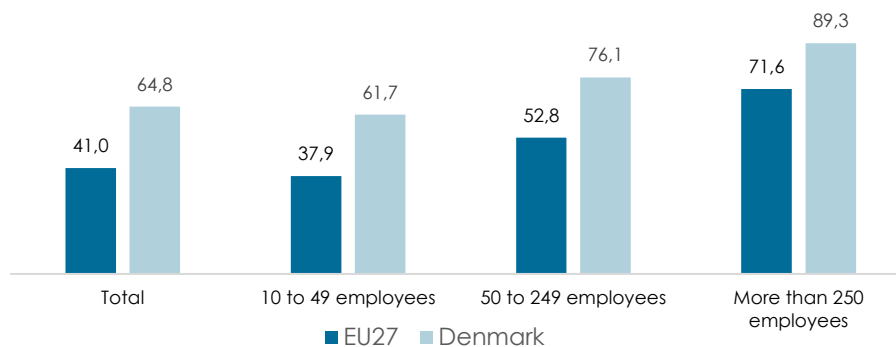
Source: Copenhagen Economics on Eurostat data

Cloud adoption grows along with size. Almost 90 percent of large companies in Denmark are cloud users, while only 61,7 percent of small companies (10 to 49 employees) rely on cloud services, see Figure 3. Despite the gap with larger enterprises, Danish SMEs display a high level of digital intensity (their Digital Intensity index⁷ is on average 79 percent, against an EU level of 55 percent) that reflects on a cloud uptake rate which is well above the EU average. SMEs face a number of challenges that prevent them from adopting advanced technologies and benefit fully from the digital transition. According to a recent study by the European Parliament⁸, these include, among others, a) structural barriers, which relate to lack of digital skills of managers and employees, and b) financial barriers, which refer to difficulties in accessing finance to invest in digital transformation.

⁷ The EU Digital Intensity Index (DII) measures the use of different digital technologies by enterprises and its score (0-12) is determined by how many of the 12 selected digital technologies the enterprises use.

⁸ (European Parliament, 2022)

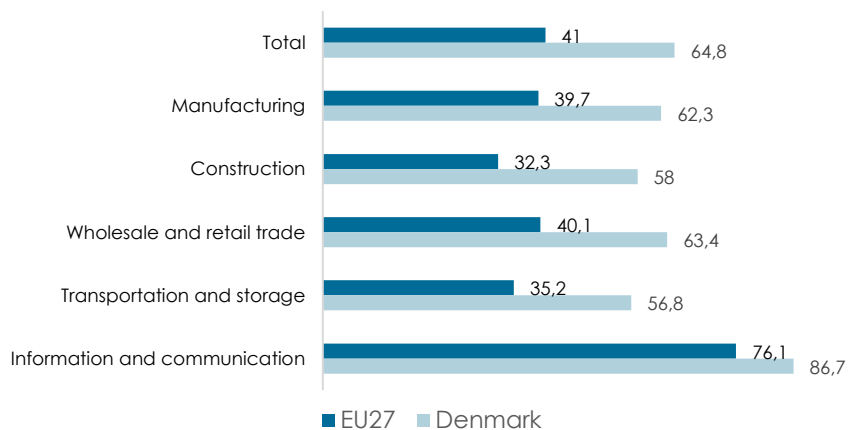
Figure 3
Cloud adoption by company size, 2021
Percentage of companies using cloud computing services



Note: No data is available for companies with less than 10 employees
Source: Copenhagen Economics on Eurostat data

Cloud adoption appears fairly spread across all sectors of the economy, especially compared to the European average, see Figure 4. However, some gaps remain: information and communication display a take up rate significantly higher than the overall average, while the transportation and storage sector lags behind, with only 56,8 percent of companies adopting cloud services. Therefore, increasing cloud uptake across all sectors of the economy is a key challenge to strengthen innovation and productivity across all the economy.

Figure 4
Cloud adoption by sector of activity, 2021
Percentage of companies using cloud computing services



Source: Copenhagen Economics on Eurostat data

CHAPTER 3

**CLOUD GENERATES VALUE TO THE
OVERALL ECONOMY****Key findings**

- More than two thirds of businesses using cloud services in Denmark consider benefits related to cost savings, productivity, and security as important.
- More sophisticated users seem to be more aware of the importance of benefits derived from cloud.
- The vast majority (92 percent) of cloud users surveyed report that their business is able to generate extra revenue from using cloud computing services. Additional revenue reported thanks to cloud range from an average of **DKK 158,000** for micro firms (0-9 employees) to more **than 2.9 DKK million** for large firms (more than 250 employees).
- Cloud users in our survey report annual cost savings by using cloud services instead of maintaining their own on-site servers and physical data centres that range from an average of **DKK 110,000** for micro firms (0-9 employees) to more than **2.6 DKK million** for large firms (more than 250 employees).
- We estimate that, in one year, AWS cloud services enable businesses to generate up to **6.5 DKK billion** in economic value added for the entire Danish economy. This equals around 0.23 percent of the Danish GDP in 2022.
- Firms that have adopted cloud display a higher employment growth than non-users in the past three years.
- Young companies are reliant on cloud technologies to offer their services and remain competitive in the market: 24 percent of young cloud users reported their business would not be possible without cloud. From that, we calculate that the adoption of AWS contributes to the creation of over 9.200 jobs in young firms in Denmark.

**3.1 KEY CLOUD BENEFITS SPAM FROM COST SAVINGS
TO ENHANCED SECURITY**

Cloud adoption entails a number of benefits in terms of cost savings, productivity and innovation enhancements, security, and sustainability that are well-documented in the literature and recognised by cloud users.

Regarding cost savings, the use of cloud allows businesses to access IT infrastructure that would not be otherwise available and thus to save on costly investments and server maintenance. This translates into general lower IT costs and the capability of operate with fewer dedicated IT staff members.

In terms of productivity, cloud benefits include more scalable and flexible IT capacity that enable shorter development cycles, and thus, in turn, increased operational efficiency and the ability to increasing the speed from idea to implementation. Cloud infrastructure can be indeed harnessed to

scale products and services almost instantaneously to a broader set of customers, segments, channels and geographies.

The use of cloud also entails innovation enhancements, as it enables, among other things, the adoption of other advanced technologies (e.g., Big Data AI, and Machine Learning) enabling data-driven decision making.

As for security, cloud adoption brings about benefits that go from "security and better data management", to "disaster recovery" and "increased reliability".

Lastly, cloud benefits include "sustainability and reducing carbon footprint" from a twofold perspective: the use of more energy-efficient centralised data centres and the capability to develop more sustainable processes.

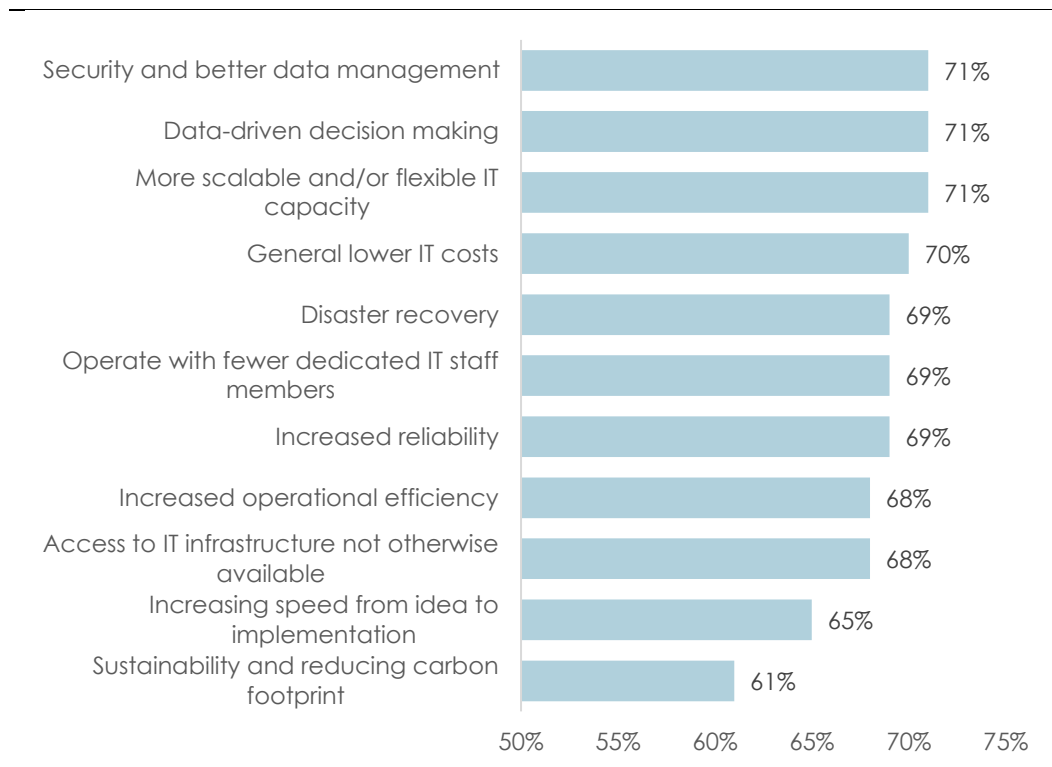
Insights from our survey suggest that more than 60 percent of businesses using cloud services in Denmark consider the type of benefits described above as important. More specifically, benefits related to cost savings, productivity and security were found important by more than two thirds of cloud user companies surveyed, see Figure 5.

Security and better data management was considered particularly important to business users. In fact, 40 percent reported the benefit as "very important".

Figure 5

What are the most important benefits of cloud computing to your company?

Percentage of respondents saying it is moderately important, important, or very important



Source: Copenhagen Economics on survey data

Multiple benefits are considered similarly important across businesses using cloud. Nevertheless, our survey highlights interesting differences in sets of benefits valued the most depending on characteristics of cloud users.

For example, some benefits are even more salient for early adopters (users having used cloud for more than 5 years⁹). In our samples, 38 percent of early adopters reported more scalable and/or flexible IT as a very important benefit of using cloud (76 percent consider it important, overall), against 28 percent of more recent users. An even greater emphasis is given to “Access to IT infrastructure not otherwise available”: 43 percent of early adopters agreed it is a very important (72 percent report it as important) advantage of using cloud (compared to only 28 percent of new users). Businesses with more experience in using cloud have a different, more "mature" view on cloud and they may have more (successful) experience in how cloud services enable scalability.

Moreover, we also find that young (founded less than 10 years ago) and old businesses have different perceptions on benefits of cloud. For younger businesses, for instance, “data-driven decision making” is the most important benefit of cloud. In contrast, old firms consider “Security and better data management” as the most relevant advantage of cloud.

⁹ In our sample, 42% of companies surveyed have used cloud for more than 5 years

Zooming in on high performing young firms, those companies in our sample that were founded less than 10 years ago and reported more than 20 percent revenue growth since 2020¹⁰, we observe that 78 percent perceive “more scalable and/or flexible IT capacity” as an important benefit. High performing young firms also give more emphasis to “increasing speed from idea to implementation”, as it is considered an important benefit by 70 percent of them, with respect to 63 percent of the rest of the sample.

Finally, we considered benefits brought by cloud for more sophisticated cloud users, defined as companies employing cloud services for five or more use cases.¹¹ Sophisticated cloud users report “general lower IT costs” as the most important benefit of cloud, 83 percent of them consider it as important, against only 67 percent of less sophisticated users. In addition, in general more sophisticated users seem to be more aware of the importance of benefits derived from cloud, with an average of 76 percent responses indicating moderately important, important, or very important across all benefits. In contrast, only 67 percent of less sophisticated users considered those benefits as such.

Benefits like increased operational efficiency, increased security and reliability, and the possibility to transfer firm level investment and resources from in-house computing and server maintenance to other activities such as research and development allow firms that migrate to the cloud to realize important productivity gains and increase their competitiveness.

This translates into a) additional revenues and costs savings for businesses and b) overall gains in economic value and jobs created for the entire economy in Denmark.

3.2 CLOUD HELPS BUSINESSES TO GROW REVENUES AND CUT COSTS

Cloud enables businesses to become more competitive and grow revenues, by, among other things, supporting new operating models and enabling innovation.

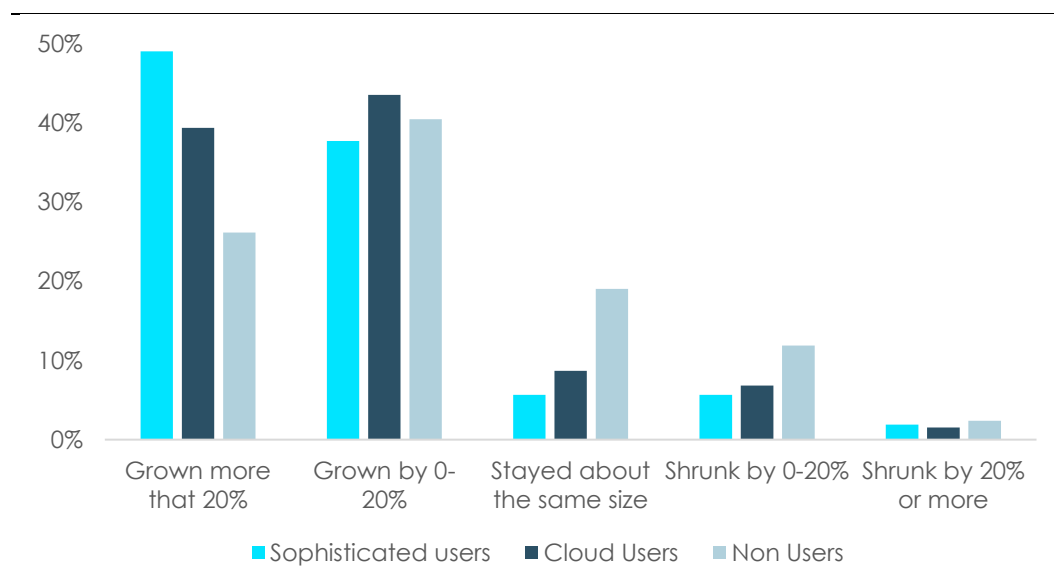
Firstly, in line with this idea, we observe that cloud users surveyed for this study report higher revenue growth rates relatively to non-cloud users. Almost 83 percent of cloud users, and, among these, 88 percent of AWS users, reported they have experienced revenue growth since 2020, compared with only 66 percent of non-users, see Figure 6. Moreover, 39 percent of businesses that use of cloud reported that their revenue has increased by more than 20 percent in the last three years, against 26 percent of non-users.

¹⁰ In our sample, this group represent 30 percent of cloud users.

¹¹ In our sample, this group represent 20 percent of cloud users. In our survey, 55 percent of cloud users reported to use cloud for only 1 or 2 use cases. Uses cases considered are: Archiving, Artificial Intelligence, Augmented Reality (AR) and Virtual Reality (VR), Back-up and Restore (disaster recovery), Blockchain, Business Applications, Cloud Financial Management, Containers & Microservices, Database Migration, Datacenter Migration, Data Lakes and Analytics, DevOps, E-commerce, Edge Computing and End-user computing, Front-End Web & Mobile Development, High Performance Computing, Internet of Things, Machine Learning, Management & Governance, Networking & Content Delivery, Security, Identity & Compliance, Serverless Computing, Storage, Web Hosting

The better performance of cloud users is even more evident when looking at more sophisticated cloud users. Sophisticated users display higher growth rates than overall users and non-users, almost half of them (49 percent) reported their revenues have grown by more than 20 percent in the last three years. We note that these should be interpreted as correlations without claiming direct causality.

Figure 6
Average revenue growth by use of cloud platforms since January 2020
Percentage of respondents



Source: Copenhagen Economics on survey data

Secondly, in the survey we directly asked cloud users whether cloud supported them to generate additional revenues. The vast majority (92 percent) of cloud users surveyed report that their business is able to generate extra revenue from using cloud computing services.

Additional revenue reported thanks to cloud range from an average of DKK 158,000 for micro firms (0-9 employees) to more than DKK 2.9 million for large firms (more than 250 employees).

Cost savings, even when scaling up, using more cloud

Cloud also generates efficiencies on the cost side. Flexible, on-demand infrastructure brings cost savings as businesses are not required to invest in on-premises data centres and their maintenance. This includes more efficient use of IT staff with limited/no IT experts dedicated solely to set up and maintain local servers.

Moreover, business can harness more cost benefits than just saving up on the cost of IT infrastructure investment and IT maintenance costs. The ability to scale IT processes up and down and on-demand infrastructure allow to meet demand fluctuations, thus in turn reducing risk for shortage of capacity or the need to pay for capacity that is not being used. According to a recent study by

Accenture¹², greater workload flexibility combined with higher server utilization rates translate in savings that are estimated to be up to 30-40 percent in total cost of ownership of IT for firms.

Thus it was important to test the above literature findings to see whether and to what extent this applies in a range of businesses across the country and economic sectors. It turns out that national firms' evidence supports the above findings. Indeed, cloud users in our survey report annual cost savings by using cloud services instead of maintaining their own on-site servers and physical data centres that range from an average of DKK 110,000 for micro firms (0-9 employees) to more than DKK 2.6 million for large firms (more than 250 employees).

3.3 CLOUD CONTRIBUTES TO GENERATE VALUE FOR THE OVERALL ECONOMY IN DENMARK

3.3.1 The use of cloud services generates value added for the entire economy

The cloud-enabled additional revenues and cost savings reported by cloud users in our survey are tangible examples of how and to what extent cloud technology empowers firms to generate additional value added for businesses and, in turn, the overall economy.

Based on extrapolations of the firm level figures of additional revenue and cost savings associated to cloud adoption, we estimate that, in one year, AWS cloud services enable businesses to generate up to DKK 6.5 billion ¹³ in economic value added for the entire Danish economy. This equals around 0.23 percent of the Danish GDP in 2022.

This is more than the entire Danish fashion manufacturing industry¹⁴.

This estimate aligns with existing research in other countries. Similar studies conducted in the UK and Germany estimated a value-added gain of £8.7 billion and EUR 11.2 billion, respectively, corresponding to around 0.4 and 0.3 per cent of UK and German GDP¹⁵.

Furthermore, academic study done by Etro¹⁶ also estimated a similar GDP yearly contribution of around 0.4 percent in the medium term under fast adoption of cloud computing. According to Etro, the change in the cost structure brought by cloud, from fixed costs to marginal cost of production would have a significant impact on the incentives to start a new business, by lowering the barriers to entry, and would foster investment. These benefits would be mostly felt by smaller firms, that could take advantage of the same computing power and capacity that was previously only available to larger firms. The positive impact on GDP growth has also being confirmed by 2016 study from the European Commission on the impact of cloud on the economy.¹⁷

¹² (Accenture, 2020)

¹³ We estimated cloud's economic impact using the per-firm additional revenue associated with take up rates of cloud (information retrieved from the survey). More details on the methodology employed in the Appendix.

¹⁴ Production value of wearing apparel in 2022, Eurostat data.

¹⁵ It should be noted than in UK and Germany cloud adoption rates are much lower than those recorded in Denmark.

¹⁶ (Etro, 2011)

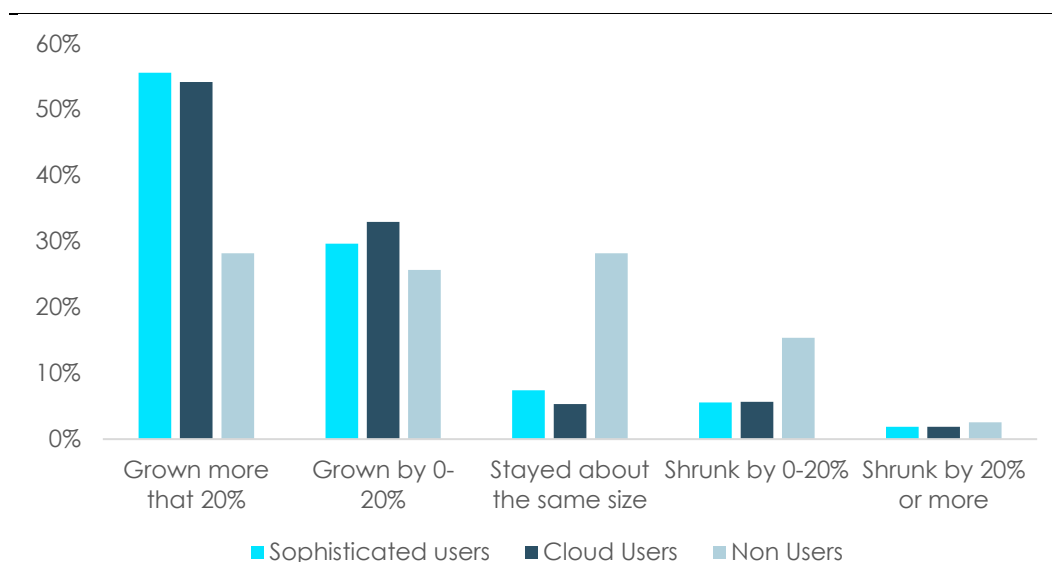
¹⁷ (European Commission, 2016)

3.4 CLOUD CONTRIBUTES TO EMPLOYMENT IN DENMARK

The use of cloud services is also associated with firm-level job creation and job growth.

In our survey, we observe that firms that have adopted cloud display a higher employment growth than non-users in the past three years. 54 per cent of businesses using cloud reported their headcount grew by more than 20 per cent, while only 28 per cent reported a comparable increase, see Figure 7. Again, we note that this positive association may not represent a direct causal effect.

Figure 7
Average headcount growth by use of cloud platforms since January 2020
Percentage of respondents



Source: Copenhagen Economics on survey data

More directly, cloud adoption supports job creation thanks to enhanced survival rate of young firms that rely on this technology and service, increased productivity and business expansion. There is also an increasing number of cloud-native businesses which have been created around cloud and may not have been viable without it.

Young companies are in fact particularly reliant on cloud technologies to offer their services and remain competitive in the market: 24 percent of cloud user businesses founded less than 10 years ago reported their business would not be possible without cloud.

What does this mean for the entire economy? We have constructed an estimate using the above share and the share of AWS users in our survey, together with public statistics on the number of people working in young firms in Denmark. In doing so, we extrapolate a conservative estimate of the jobs facilitated by cloud adoption, and in particular AWS services, in Denmark.¹⁸ Based on

¹⁸ We follow the approach adopted by IW Consult on a similar study for Germany (IW Consult, 2022).

Eurostat data¹⁹, more than 273,600 people in Denmark work for a firm founded less than 10 years ago (around 9.4 percent of people employed in Denmark²⁰). In our survey, around 16 percent young firms use AWS, while 24 percent report cloud is indispensable for their business. Accordingly, if we consider AWS cloud as enabler of survival and growth of this portion of young companies, we can estimate that adoption of AWS is partly responsible for the creation of over 9.200 jobs in Denmark²¹ (around 3.4 percent of employment in young companies). We note that this provides a conservative figure that focus only young businesses enabled by cloud and it does not consider new jobs created by established companies that grow and expand their workforce thanks to cloud.

This estimate is comparable (on a scale-adjusted basis) to what was found in a recent study for Germany, i.e. a finding of a contribution to 3 percent of the overall employment in companies of 10 years of less - that otherwise would not have created.²²

Indeed, broader academic and policy studies have explored and demonstrated further the positive link between cloud adoption and employment growth. In a 2016 European Commission study measuring the impact of cloud on the economy²³, all analyses have indicated a positive impact on business creation and employment. Moreover, key studies, such as the IDC study on cloud uptake²⁴, estimated a cumulative impact on employment of about 1.6 million jobs created in the EU28 between 2008 and 2020 (2.5 million according to the optimistic scenario and slightly over 1 million in the pessimistic scenario).

Etro²⁵ quantified the impact on EU employment at 300 000 new jobs under the slow adoption scenario and at more than 1 million jobs under the fast adoption scenario in the short run. This would translate in a reduction of the employment rate in the EU between 0.1 and 0.3 percent in the short run.

Other recent empirical studies confirmed the beneficial effect of cloud adoption on employment. Using worker-level data from the UK HMRC tax agency and ONS E-commerce survey and business census, DeStefano et al. (2020)²⁶ find that cloud adoption relates to a significant annual increase in the number of employees for both young (28 percent) and incumbent firms (15 percent) between 2008 and 2015.

¹⁹ (Eurostat, 2023)

²⁰ (Statistikbanken, 2023)

²¹ The approach employed to quantify jobs creation follows closely the one adopted by IW Consult in its Impact Study of AWS in Germany. Jobs created are measured as number of employees for companies of 10 years or less (in order to consider only start-ups and young companies) multiplied by the share of AWS usage in this segment and the share of those companies with a business model not possible without cloud from our survey. This can be seen as a conservative approach as it does not consider new jobs created by existing companies that expand their revenues thanks to cloud.

²² (IW Consult, 2022).

²³ (European Commission, 2016)

²⁴ (IDC, 2013)

²⁵ (Etro, 2011)

²⁶ (DeStefano, Kneller, & Timmis, 2020)

CHAPTER 4

**CLOUD SUPPORT BUSINESSES TO GROW
AND REACH NEW MARKETS****Key findings**

- Enhanced competitiveness is recognized as a key benefit of cloud adoption: 67 per cent of cloud users surveyed for this study agree with the statement "The use of cloud helps our business to remain competitive in the market".
- For 81 per cent of AWS users in our sample, cloud allows them to compete with larger companies.
- Costs savings from cloud allow to invest more in business growth according to 70 percent of cloud users - with AWS users being even more aware of the role of cloud as enabler of business growth.
- Overall, 82 percent of cloud users expanded their product or service portfolio in the last three years, against only 55 per cent of non-users.
- Cloud enables geographic expansion: 66 percent of cloud user businesses agreed with the statement "The use of cloud enables us to scale our business and to export to international markets/go global"

The positive economic impact of using cloud services described in previous section is the result, among other things, of:

- cloud technologies enhancing firms' competitiveness,
- cloud technologies supporting young companies to grow and challenge the market,
- cloud technologies facilitating entry and expansion into new geographic and product markets.

4.1 CLOUD ENHANCES COMPETITIVENESS

The role of digitalisation in improving competitiveness of firms is undisputed in the literature and in policy action. As part of the advanced digital technologies, and enabler of others (AI, machine learning, big data process), cloud is a cornerstone for business competitiveness.

Cloud can support firms to become more competitive by increasing their productivity in two ways. First, as we already saw, cloud can help firms to reduce expensive inputs such as IT-capital while producing the same level of output (with lower costs). Second, cloud technologies may enable firms to improve and innovate their production processes and operations.

Increased firm-level productivity and subsequent enhanced competitiveness related to cloud adoption has been long documented. A study by OECD²⁷ based on cross-country firm-level data on productivity and industry-level data on digital technology adoption finds that digital adoption is associated with significant productivity returns at the firm level. In particular, the authors estimate

²⁷ (OECD, 2019)

that a 10-percentage point increase in adoption of cloud computing is related to an increase in (multi-factor) productivity growth by 0.9 percentage point. Additionally, they find cloud computing is more beneficial for smaller firms. Academic literature confirms the positive impact on productivity and sales from cloud adoption. For example, a recent article by Wang Jin²⁸ analyses 2010-2019 US firms' data, including the use of cloud. The study finds that adoption of cloud services is associated with significant productivity gains and 6.9 percent higher average revenue growth in the long run. These gains are driven by the substitution away from costly IT equipment and capital and the seamless information and data flows facilitated by the cloud.

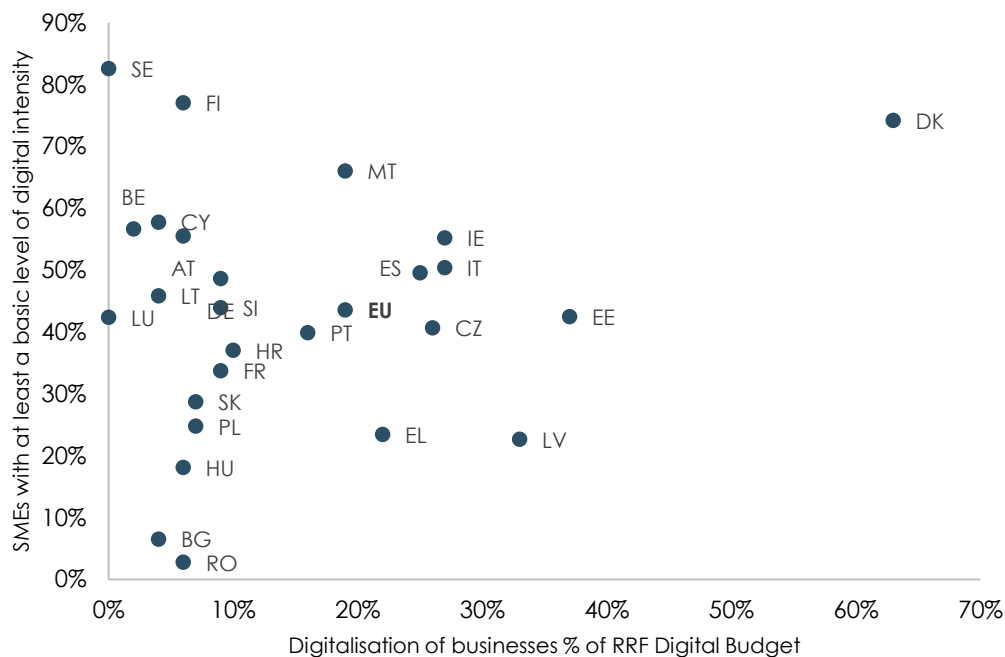
In the context of Denmark, 67 per cent of cloud users surveyed for this study agree with the statement "The use of cloud helps our business to remain competitive in the market". Moreover, competitiveness is recognized as a key benefit of cloud adoption not only by cloud users. In our survey, non-cloud users cite "Improving competitiveness" as the first reason to start using cloud computing services in the future.

Denmark has also been the EU country that has put relatively more efforts on digitalization of businesses to support firms', and SMEs' in particular, competitiveness in the context of the Recovery and Resilience Plan. Denmark has more than 60 percent of its RRF Digital Budget dedicated to digitalisation of business (see Figure 8)²⁹.

²⁸ (Jin, 2022)

²⁹ (European Parliament, 2022)

Figure 8
Expenditure on digitisation of businesses in relation to the digital intensity level of SMEs



Source: (European Parliament, 2022), Figure 8

4.2 CLOUD SUPPORTS YOUNG COMPANIES TO GROW AND CHALLENGE THE MARKET

The ability to rent IT capacity as needed and access to instant on-demand elasticity in cloud storage and computational power is particularly critical for smaller and newborn businesses to expand and grow quickly. Jin and McElheran (2018)³⁰ showed empirically that cloud computing adoption is associated with significantly higher survival and growth among young firms while investments in traditional IT capital increased the likelihood of failure. Cloud technology is changing how firms learn about their IT requirements and benefit from shared economies of scale before they achieve significant experience and scale of their own.

As a consequence, cloud computing enables young and small businesses to compete with larger companies, thanks to increased and more scalable IT capacity that in turns enhances efficiency and productivity. Almost one third (32 percent) of businesses surveyed strongly agreed with the statement “The use of cloud allows us to compete with larger companies”. Sophisticated users display

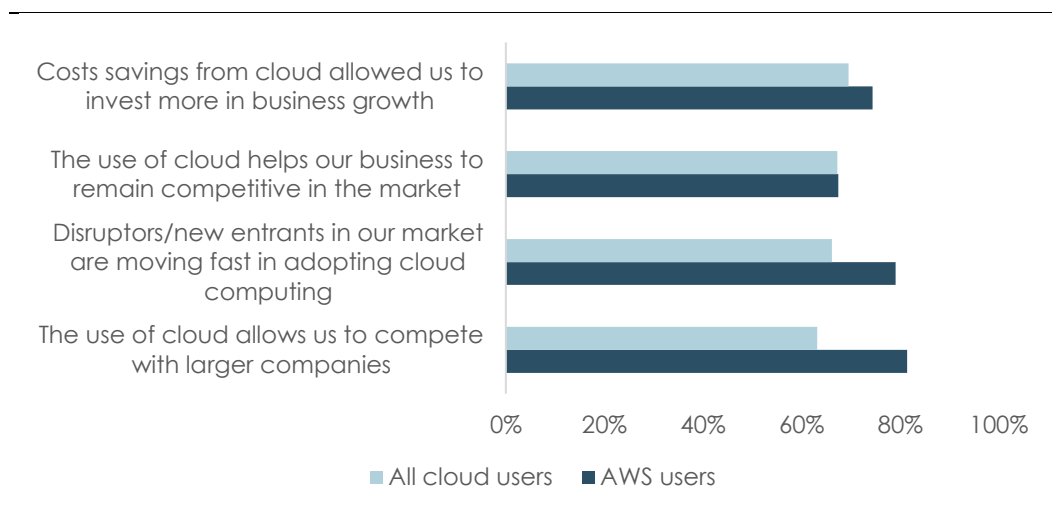
³⁰ (Jin & McElheran, Economies Before Scale: Survival and Performance of Young Plants in the Age of Cloud Computing, 2018)

even higher agreement on this statement (44 percent) suggesting that heavy cloud users perceive this benefit as even more relevant.

Moreover, also high-performing young firms are aware of the critical role of cloud computing as key asset to achieve competitiveness. In that case, 81 percent of them state that disruptors/new entrants in their market are moving fast in adopting cloud computing, against only 66 percent of the overall sample of cloud users.

In general, almost 70 per cent of business agreed on the statement “Costs savings from cloud allowed us to invest more in business growth” with AWS users being even more aware of the role of cloud as enabler of business growth. 81 percent of AWS in our sample reported that cloud allows them to compete with larger companies, and 74 percent declared that costs savings from cloud allowed us to invest more in business growth, see Figure 9.

Figure 9
Cloud fosters competitiveness and enables business growth
Percentage of respondents saying they strongly agree or somewhat agree



Source: Copenhagen Economics on survey data

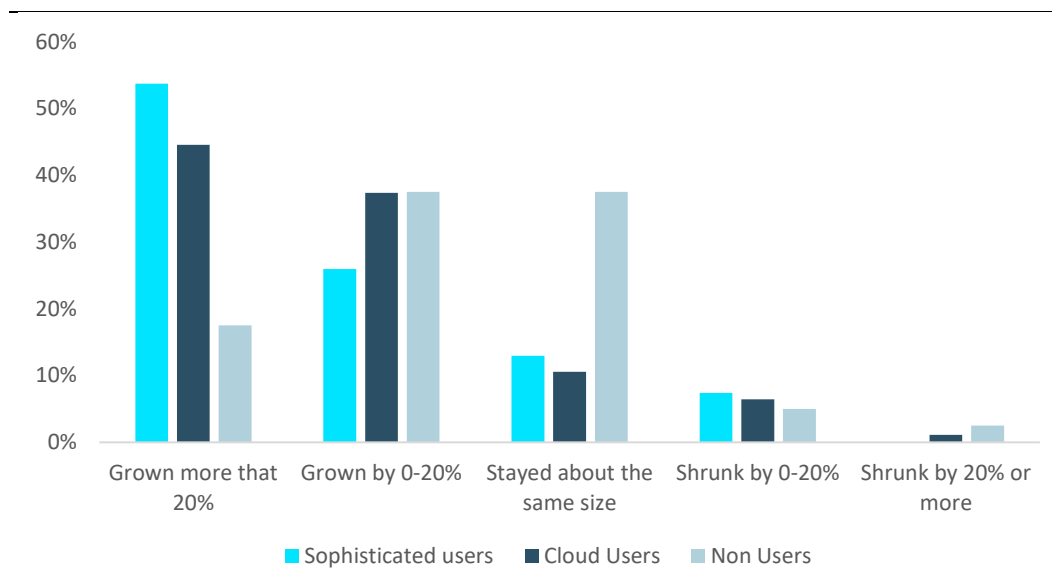
Finally, the experience of Danish start-ups using AWS cloud services such as Veo, Monta and Factbird presented in this report (see Box 3, Box 4, Box 5, respectively, in following sections for more detailed case study) shows how the use of AWS cloud technologies can enable fast growth and support rapid scale ups that would have not been possible without cloud. For instance, Monta, active in the electric vehicles (EV) charging ecosystem, could reach in less than three years more than 90,000 users on its app and add more than 4,000 charge points monthly thanks to cloud’s scalability. This allowed Monta to compete with large legacy players in the automotive industry. Moreover, the use of cloud allowed Factbird to scale up faster in the production of solutions for lean manufacturing and offer the highest level of security standards, like the largest incumbents in the market.

4.3 CLOUD MAKES IT EASIER TO ENTER AND EXPAND INTO NEW GEOGRAPHIC AND PRODUCT MARKETS

Cloud users also emphasized the role of cloud as accelerator for product and geographic expansion. Comparing product/ service portfolio growth across respondents, we observe a relevant gap between cloud users and non-users. Among the first, 54 per cent of sophisticated cloud users report their product or service portfolio growth grew by more than 20 per cent since January 2020, while only 18 per cent of non-users reported a comparable growth. Overall, 82 percent of cloud users expanded their portfolio in the last three years, against only 55 per cent of non-users, see Figure 10.

Figure 10
Cloud users have experienced higher growth in product/service portfolio since January 2020

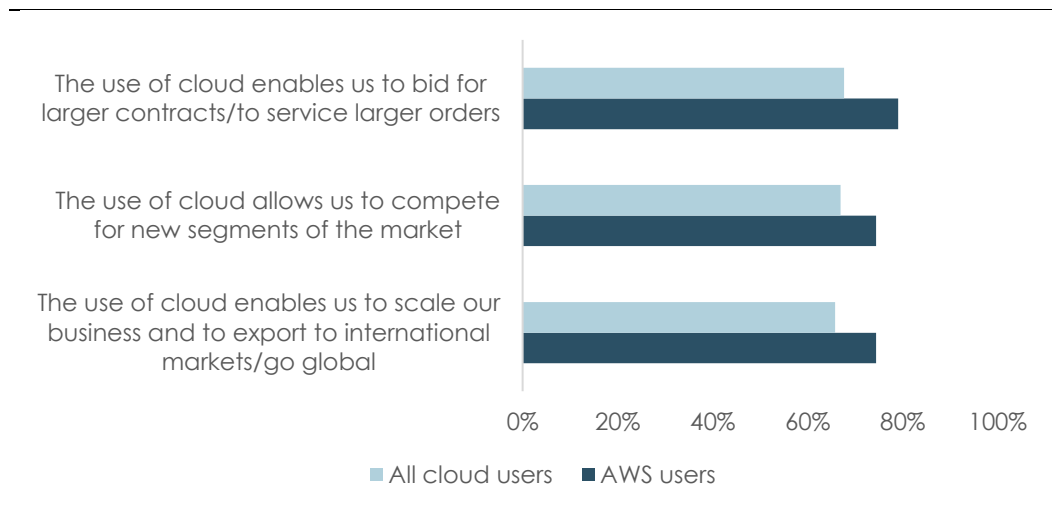
Percentage of respondents



Source: Copenhagen Economics on survey data

This positive association is also confirmed by qualitative statements of the companies surveyed. 67 percent of cloud user businesses agreed with the statement “The use of cloud allows us to compete for new segments of the market” while 66 percent state “The use of cloud enables us to scale our business and to export to international markets/go global”. In addition, 68 per cent of cloud users report the use of cloud enables them to bid for larger contracts/to service larger orders. Also in this case, AWS users continue to have a higher perception of how cloud helps them to expand their business as their agreement is consistently higher across all proposed statements, see Figure 11.

Figure 11
Cloud enables firms to compete and expand in new markets
Percentage of respondents saying they strongly agree or somewhat agree



Source: Copenhagen Economics on survey data

CHAPTER 5

CLOUD FUELS INNOVATION**Key findings**

- More than two thirds of cloud users in our survey agreed that the use of cloud makes it easier to provide better and more tailored products and services to end consumers. The same share rises to 81 percent for AWS users.
- Cloud technologies reduce the time necessary to launch a product to the market, as reported by 62 of cloud users.
- 61 percent of cloud users agree cloud helps reducing the software development cycles.
- 64 per cent of cloud business users state the use of cloud has allowed IT experts to allocate time on more strategic tasks.
- 77 percent of cloud users report that the use of cloud allowed us to improve and innovate their overall business model.
- 64 per cent of cloud users in our survey report that the use of cloud has made it easier to adopt new technologies requiring a lot of data processing (e.g., AI and Machine Learning).
- AWS users are heavy adopters of advanced technologies and show a higher take up rate on all the most advanced use cases proposed.

Cloud technologies are not only a digital technology to adopt *per se*, but also a driver to further innovation.

First, cloud technologies may empower complementary innovation related to better, more tailored services to customers, more efficient processes and new business models at lower costs and greater speed. Additionally, as anticipated in the previous sections, cost savings and additional revenues enjoyed by cloud users can be re-invested in business growth and other innovative processes.

Second, cloud services allow companies to experiment with cutting edge, emerging technologies (e.g., machine learning, AI, augmented and virtual reality, blockchain, etc.) thanks to greater computing power and IT infrastructure accessible on cloud.

5.1 CLOUD EMPOWERS FIRMS' INNOVATION

Cloud technologies help businesses across different types of innovations:

- Cloud makes it easier to innovative and bring new products to the market;
- Cloud enables more efficient internal processes and reduces time to market;
- Cloud supports new and innovative business models.

5.1.1 Cloud makes it easier to innovate and bring new products to the market

The ability to accelerate product development and innovation is one of the main advantages that firms recognize to cloud. In our survey, 65 per cent of cloud users state that the use of cloud makes

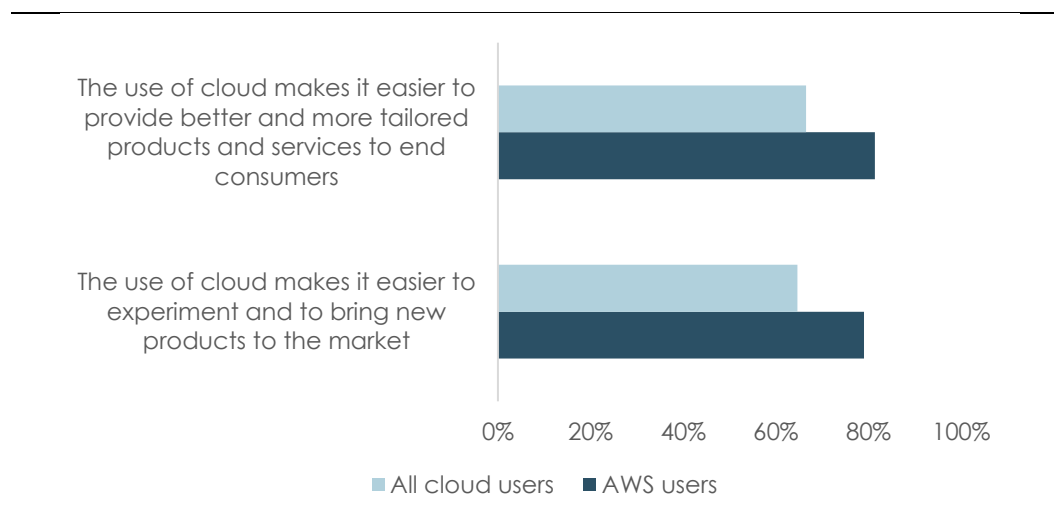
it easier to experiment and to bring new products to the market. This share goes up to 79 percent if we consider only AWS users, see Figure 12.

Additionally, 67 percent of cloud users in our survey agreed that the use of cloud makes it easier to provide better and more tailored products and services to end consumers. The same share rises to 81 percent for AWS users.

Figure 12

Cloud enables firms to bring new products to the market

Percentage of respondents saying they strongly agree or somewhat agree



Source: Copenhagen Economics on survey data

Furthermore, the ability to leverage cloud to experiment and create new products seems particularly high among sophisticated users and young high performing firms:

- 80 percent of sophisticated users agree that cloud makes it easier to experiment and bring new products to the market;
- 79 percent of young high performing firms agreed that the use of cloud makes it easier to provide better and more tailored products and services to end consumers.

Finally, in line with the above, our survey shows that firms using cloud services have experienced higher growth in product/service portfolio since January 2020 compared to non-cloud users, see Figure 10 in section 3.3.

5.1.2 Cloud enables more efficient internal processes and reduces time to market

Besides product innovation, cloud technologies affect positively process innovation and ensure more efficient internal processes. 64 percent of cloud users stated that the use of cloud allowed them to improve and innovate their processes. This positive channel can take multiple forms and effects, see Figure 13.

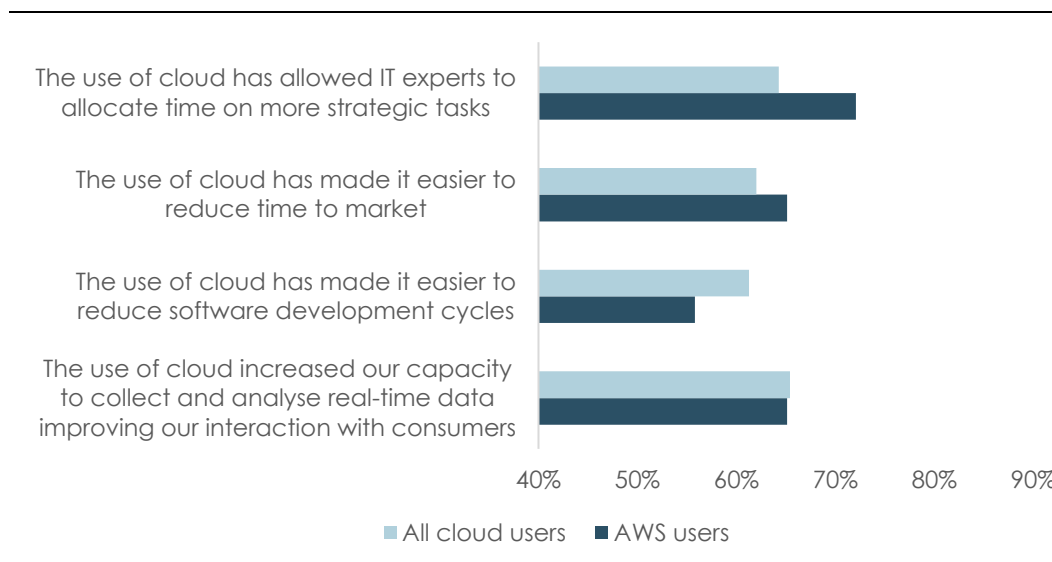
In general, cloud technologies reduce the time necessary to launch a product to the market, as reported by 62 of cloud users.

This outcome is also relevant for the specific case of software. 61 percent of cloud users in our survey reported that cloud helps reducing the software development cycles. This has also been confirmed in interviews with AWS users. Monta, a Danish innovative start-up active in developing software for EV charging stations, confirms this benefit (see Box 4 in section 6.2 for the complete case study). Monta reported that the process automation of moving code from testing environments into production enabled by AWS, allows to move to production around four times faster than it would be by doing it manually.

Better processes are also the results of more data-driven operations. 65 per cent of businesses agree that the use of cloud increased their capacity to collect and analyse real-time data improving their interaction with consumers. The ability to analyse large datasets in real-time can also support companies in the retail sector in inventory optimization.

In addition to the above, more efficient operations can free up time for skilled resources to dedicate on other tasks. 64 per cent of cloud business users state the use of cloud has allowed IT experts to allocate time on more strategic tasks.

Figure 13
Cloud supports better processes and reduces time to market
Percentage of respondents saying they strongly agree or somewhat agree

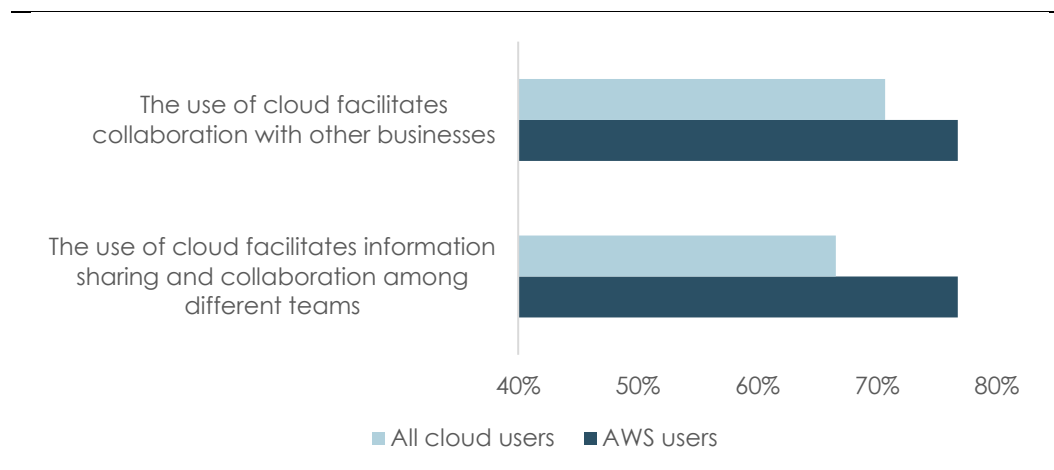


Source: Copenhagen Economics on survey data

Finally, we note that better processes and information sharing within organisations usually translate into more efficient and effective use of human capital in the company. According to our survey, cloud adoption has favoured collaboration with the firm and with other businesses: 66 percent of

businesses reported that the use of cloud facilitates information sharing and collaboration among different teams and 71 percent agreed that cloud facilitates collaboration with other businesses. This has become especially evident during the COVID-crisis.

Figure 14
Cloud favours collaboration and information sharing
Percentage of respondents saying they strongly agree or somewhat agree



Source: Copenhagen Economics on survey data

5.1.3 Cloud supports new and innovative business models

The adoption of cloud technologies may enable new and/or innovative business models. In our survey, more than 77 percent of cloud users report that the use of cloud allowed us to improve and innovate their overall business model. Also, as put forward in section 2.2, 24 percent young businesses report their business model not possible without cloud.

Cloud services and, in particular, AWS, are thus enabling the creation and development of new businesses in highly innovative and important industries. For example, AWS supports businesses operating in highly innovative sectors in Denmark such as EV vehicles and the ecosystem around them (e.g., Monta), connected devices, smart manufacturing/IoT (e.g., Factbird) and smart devices (e.g., Veo).

In sum, the innovation created also thanks to cloud helps to support business growth. According to a recent McKinsey report³¹, innovation-driven growth enabled by cloud could deliver between \$ 50 and 160 billion in 2030 EBITDA only across the Fortune 500 companies in the US. The report highlights how cloud can unlock substantial value in all industries through innovation.

³¹ (McKinsey, 2021)

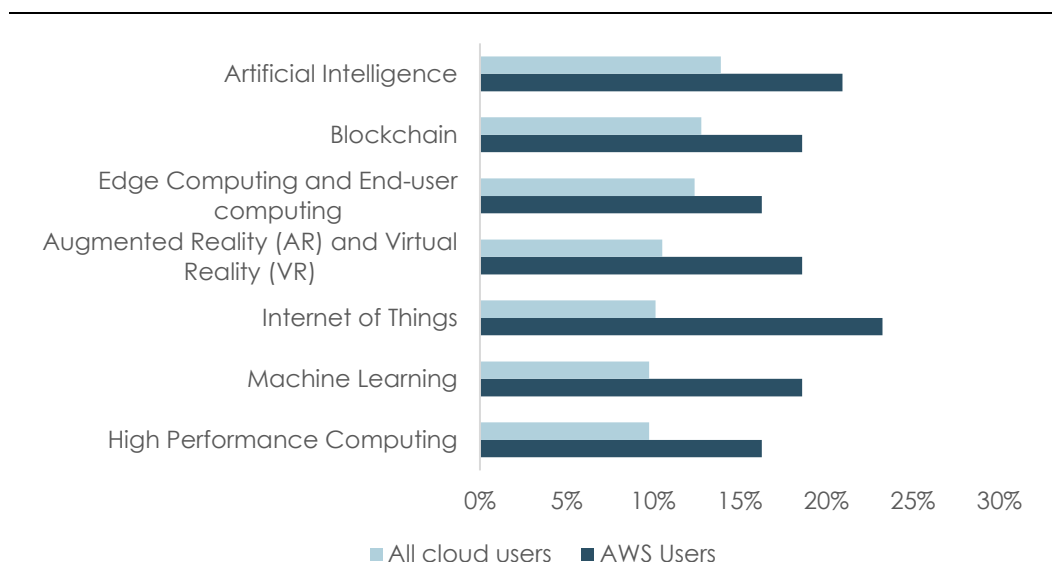
5.2 CLOUD MAKES IT EASIER TO ADOPT ADVANCED TECHNOLOGIES

Cloud can provide better and faster access to innovative and new technologies. 64 per cent of cloud users in our survey report that the use of cloud has made it easier to adopt new technologies requiring a lot of data processing (e.g., AI and Machine Learning).

The most adopted use cases of cloud services in advanced technologies are depicted in Figure 15. As evident from the figure, AWS users are heavy adopters of advanced technologies, and show a higher take up rate on all the most advanced use cases proposed.

Figure 15
For which of the following use cases does your company / organisation procure cloud computing services?

Percentage of respondents



Source: Copenhagen Economics on survey data

Among emerging technologies, machine Learning (ML) and Artificial Intelligence (AI) are particularly important for their broad applications across sectors. Cloud computing provides businesses with the computing power, storage and security to train and deploy Machine Learning (ML) models and fast and scalable Artificial Intelligence (AI) solutions. Globally, more than 100,000 AWS users are using AWS for their ML/AI workloads³².

On this, the experience of Veo, a start-up that manufactures AI-powered sports camera is exemplary. Cloud technologies enables Veo to process content in large videos and apply Machine Learning technics to it in order to develop smart camera and further features (see Box 2).

³² (AWS, 2023)

Box 2 Case Study: Veo



About Veo

- Veo, headquartered in Copenhagen, has developed an AI-powered sports camera that allows to obtain videos with ball and player detectors. In addition, Veo's platform contains analytical and sharing features enabling all users to access and utilise the content.
- Veo was founded in 2015 and today counts more than 250 employees.

The challenge

- Veo wanted to improve filming of automated cameras with AI, deep learning and cloud processing.
- Veo needed to upload large videos to the cloud to do the processing and generate additional content (e.g., highlights of the game) to be accessed and utilised by users.
- Implementing Machine Learning was key to track and analyse footage, as well as provide real-time feedback and insights.

The benefits of using AWS

Business growth and efficiency

- The use of cloud allowed Veo to cut the costs of servers' management and maintenance and save resources and time. This allowed Veo to reduce time to market and serve the clients faster.
"Relying on a cloud infrastructure can help you to expand quick." VP, Engineering, Veo
- AWS enables Veo to handle large amount of data and trigger various tasks simultaneously thus facilitating Veo's business growth.
*"Probably without cloud, this type of business model would not be even feasible."
Co-founder & CTIO, Veo*
- AWS global reach has facilitated Veo's global expansion: Veo is now present in more than 90 countries worldwide.

Innovation

- AWS enables Veo to upload large amount of data that allow to train Veo's Machine Learning model.
- AWS has understood Veo's business needs from the beginning and proposed suggestions that have facilitated Veo's process and product development
- Cloud enables the development of new features and facilitates product improvement.
"the cloud is constantly in mind when we are thinking what the next thing will be" Co-founder & CTIO, Veo

Finally, cloud can also support businesses to accelerate the training, fine-tuning, and deployment of large language and vision models used to create generative AI applications (see Box 3).

Box 3 Cloud services powering the new wave of Generative AI

Generative AI is a type of artificial intelligence that learns patterns from existing data which enables it to generate new and unique outputs. These highly realistic outputs can be of various kinds, such as text, images, videos, and audio. An example of generative AI is ChatGPT, developed by OpenAI, which is designed to generate responses in chat conversations that are indistinguishable from human output.³³

Generative AI provides many advantages to firms of all sizes. These advantages are for example the following:

- Increased efficiency – automating tasks that would otherwise need manual labour, for example data analysis³⁴
- Improved quality – generative AI can create texts, images etc. that are of higher quality than those created by humans
- Faster results – generative AI can be used to do a task in a much smaller timeframe than humans
- Cost savings – using generative AI to automate tasks can help firms reduce their labour costs.³⁵

These advantages have potential impacts on the economy. Generative AI systems such as ChatGPT could spark a productivity boom that would eventually raise annual global gross domestic product by 7 per cent over a 10-year period. As employees could have some part of their work automated, there would be time freed for more productive tasks.³⁶

Generative AI relies on foundation models (FMs) which are ultra-large machine learning models. They are expensive and time-consuming to build, train and deploy and are thus out of reach for many developers. Cloud providers such as AWS offer a number of services aimed at making generative AI more accessible and cost-efficient. One of these services provided by AWS is a new service called Amazon Bedrock that can be used for building and scaling generative AI applications. It gives customers easy access to FMs from the top AI start-up model providers such as Anthropic and Stability AI as well as FMs developed by AWS. This cloud service provides flexibility and choice to customers, enabling them to select the best models for their specific needs.³⁷

³³ (GenerativeAI.net, n.d.)

³⁴ (Workyard, 2023)

³⁵ (Speak Ai, 2022)

³⁶ (Financial Times, 2023)

³⁷ (Amazon News, 2023)

CHAPTER 6

CLOUD HAS WIDER SOCIETAL BENEFITS BY LOWERING ENVIRONMENTAL IMPACT**Key findings**

- 72 per cent of AWS users reported that, when choosing which cloud services to procure, they considered the sustainability profile of different cloud providers, against only 66 percent of the overall sample of cloud users.
- AWS users rely relatively more than the average user on cloud services to reduce their environmental footprint.
- 64 per cent of businesses agree that the use of cloud help them to achieve their net-zero carbon emissions goals.
- More than 25 percent of cloud users state that cloud helps reducing their environmental footprint by becoming more operationally efficient in the company processes beyond IT
- 68 per cent of businesses report that the use of cloud improves their energy efficiency.
- The use of cloud might increase companies' efficiency, while reducing their emissions, by facilitating information sharing and collaboration across different locations and teams

Cloud services can play a pivotal role in supporting companies and organisations facing sustainability and energy efficiency challenges. Reducing carbon footprint and achieving greater energy efficiency has become an imperative to increase businesses' competitiveness.

Cloud computing, by enabling a reduction in carbon footprint represents a key ally to firms facing environmental and efficiency challenges. This can be achieved in two ways:

- cloud providers can guarantee more economic and environmentally efficient storage of data and computing power, and
- cloud services can help firms to improve operational efficiency and developing more sustainable processes.

6.1 CLOUD SERVICES ALLOW FOR MOST ECONOMIC AND ENVIRONMENTAL STORAGE OF DATA AND COMPUTING

According to the International Energy Agency (IEA), “the shift away from small, inefficient enterprise data centres towards more efficient cloud and hyperscale data centres” can help reducing energy consumption for computing and data storage. In fact, in recent years, increasing connectivity and digitalization have led to an exponential growth in demand for data-driven services and computing power, triggering, in turn, demand for energy. Despite the growing demand for digital services, with global internet traffic expanding more than 5-fold since 2015, the increase in energy demand from data centres and data transmission networks has been limited to less than 60 percent³⁸.

³⁸ (IEA, 2022)

By pooling the server needs of many businesses and reducing the number of on-premises servers, cloud infrastructure allows to reduce dramatically the carbon footprint of IT operations. According to a study conducted by 451 Research³⁹, moving from own IT premises to the cloud would allow European businesses to achieve carbon efficiency related to running business applications up to a reduction of 96 percent in carbon emissions and nearly 80 percent in energy usage. A result that holds true also for the most energy efficient organisations surveyed. Some differences exist across European countries. In the Nordics, for instance, the study calculated that Swedish companies, which operate in similar environment as Denmark, could potentially save 67.5% of energy on average from server infrastructure and another 15.4% of energy on average from data centre infrastructure by moving workloads to the cloud, for a total of 79.9% energy savings. More in detail, this reduction is achieved through:

- More efficient servers and higher server utilisation.
- More efficient data centre facilities.
- Reduced electricity consumption and renewable energy usage.

A study conducted in 2020 by Accenture⁴⁰ presents similar figures, suggesting that an average enterprise-owned-to-cloud migration can lead to a 65 percent energy consumption reduction and 84 percent carbon reduction.

Furthermore, further research conducted by 451 Research⁴¹ shows that this carbon efficiency is expected to grow in the future, and data centers will be able to improve their efficiency faster than on-premises infrastructure. AWS has committed to power all its operations with 100% renewable energy by 2025, five years ahead of the original 2030 target, and reach net-zero carbon by 2040.

Moreover, to support cloud users to keep track of their carbon footprint, AWS has developed a tool that uses simple visualizations to show customers their historical carbon emissions, estimate emissions avoided by using AWS instead of an on-premises data centre, and review forecasted emissions based on their current use.

The efforts of cloud providers are recognised by cloud users and especially AWS users:

- 72 per cent of AWS users reported that, when choosing which cloud services to procure, they considered the sustainability profile of different cloud providers, against only 66 percent of the overall sample of cloud users, and
- 66 percent of AWS users reported “sustainability and reducing carbon footprint” as main benefit from the use of cloud computing services, while 61 percent agreed in the overall sample.

More practically, we find that AWS users rely relatively more than the average user on cloud services to reduce their environmental footprint (see Figure 16):

- 51 per cent of AWS users report that the use of renewable energy by cloud provider is one of the ways in which cloud computing help them reduce their carbon footprint, compared to only 35 per cent in the overall sample;

³⁹ (451 Research, 2021)

⁴⁰ (Accenture, 2020)

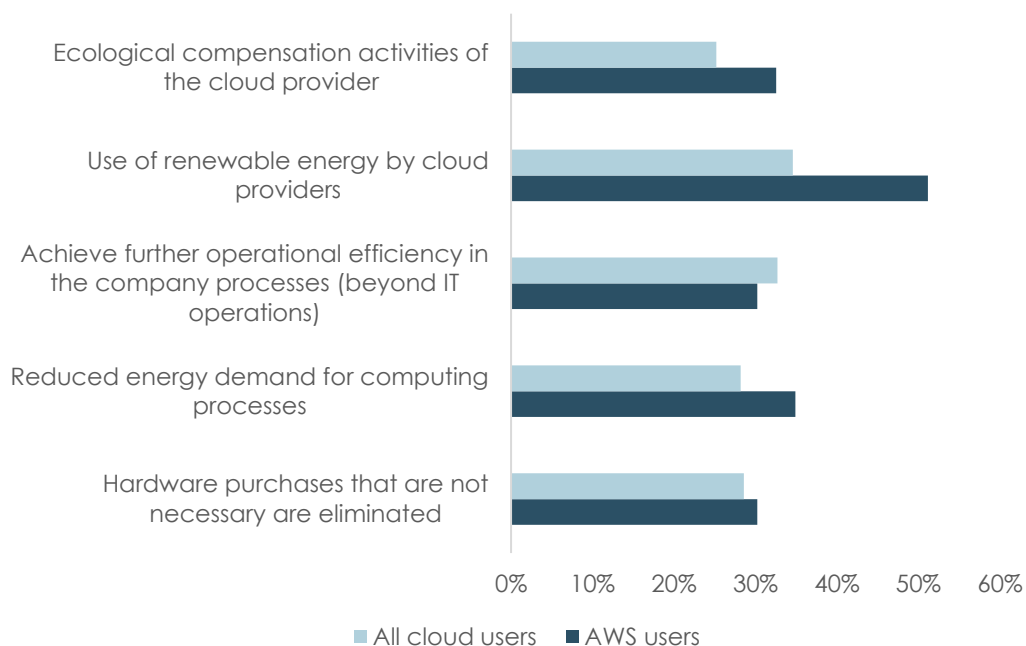
⁴¹ (451 Research, 2019)

- similarly, one third of AWS users acknowledges ecological compensation activities of their cloud providers, against only one fourth of overall cloud users;
- 30 of AWS users (29 percent of all cloud users) consider elimination of hardware purchases thanks to cloud as a way to reduce their carbon footprint;
- 35 percent of AWS users (against 28 percent in the all sample) also report reduced energy demand for computing processes as a relevant aspect of their sustainability profile.

Figure 16

How does cloud computing services help you reduce your environmental footprint?

Percentage of respondents



Source: Copenhagen Economics on survey data

6.2 USING CLOUD HELPS FIRMS TO IMPROVE OPERATIONAL EFFICIENCY AND DEVELOPING MORE SUSTAINABLE PROCESSES

Cloud users not only benefit from reduced carbon footprint of cloud infrastructure, but they can also capture more direct gains as cloud support them to improve operational efficiency and develop more sustainable processes. According to our survey, one third of businesses report that cloud computing support them to achieve further operational efficiency in the company processes beyond their IT operations.

Moreover, the use of cloud has supported the birth and expansion of new firms, green tech and sustainability start-ups, whose business model would have not been possible without the cloud.

Monta, a Danish startup operating in the Electric Vehicles (EV) charging industry, is one striking example of green business models enabled by cloud. Monta's mission towards the transition to electric mobility is powered by AWS. Thanks to cloud, Monta has experienced dramatic growth since its birth, three years ago (see Box 4).

Box 4 Case Study: Monta



About Monta

- Monta, headquartered in Copenhagen, provides integrated software platform solutions for EV charging stations and the entire EV ecosystem⁴².
- Monta was founded in 2020 and today counts more than 150 employees.

The challenge

- Monta wanted to enable the best EV charging experience to EV drivers, businesses and distributor of EV charging equipment, optimising price for charging while reducing CO2 emissions.
- Monta needed a scalable IT infrastructure that could support its ambitions for growth.
- Creating an automated, easy-to-scale-up and flexible infrastructure was key to manage large inflows of new users and charge points when entering a new market.
- Monta needed to get new features to market fast and to have the flexibility to automatically scale up and down according to clients' needs.

The benefits of using AWS

Business growth and efficiency

- AWS enabled Monta to access the benefits of a scalable solutions which translates into more than 90,000 users use the Monta app and more than 4000 charge points are added monthly.
- Scalable solutions has also fuelled international expansion. Thanks to the cloud the business has been able to quickly expand into new markets. In 2020, it launched in Norway, Sweden, UK and Germany. More recently, Monta started operations in Ireland, Austria and France and have a few more markets in the pipeline for this year.
- The ability to scale up and down easily without minimal disruption is key to Monta's business model, which is highly subject to fluctuations in demand.
- Using AWS cloud services allowed Monta to cut costs related to maintenance of the physical hardware, servers set-up, etc. thus favouring competitiveness

"Running and maintaining physical data centres would require double IT staff"

"having access to everything that AWS provides in terms of manpower to manage the physical data centre means that we can compete with all the other big players in the market, including major car manufacturers" Head of Platform, Monta

Innovation

- The use of AWS facilitates the launch of additional services and features quickly and efficiently.
- The streamlined, fully automated process from getting the code through testing environments into production, enabled by AWS, allow Monta to save resources and time that can be invested in high value-added research and development activities.

"taking code from the test environment and manually moving it to the production environment [without cloud], then it would take, at least four times longer as it is today"

Head of Platform, Monta

Sustainability

- The platform allows users to obtain major energy efficiency gains, thanks to charging during off peak hours. Thanks to Monta more than 4 254 ton of CO2 have been saved.
- AWS' commitment towards sustainability aligns with Monta's mission.

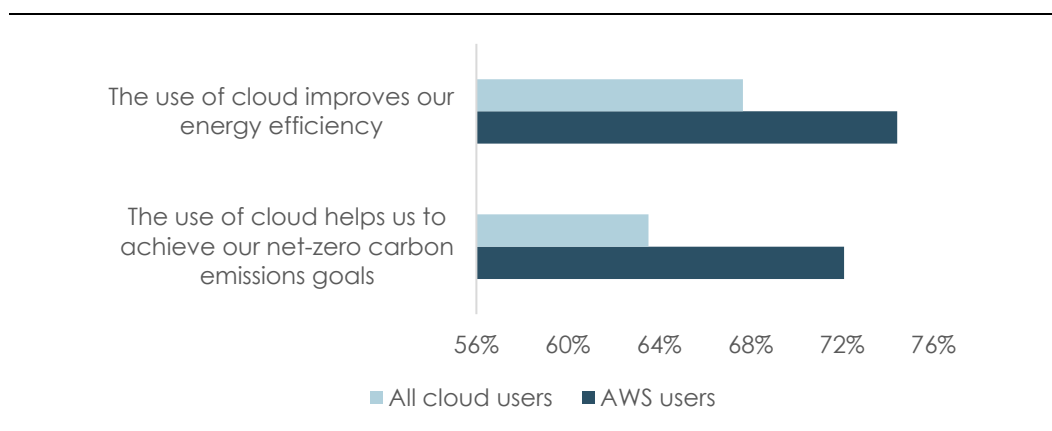
"AWS' plan on carbon neutrality is an important factor for us. Monta tries to eliminate as much CO2 as possible throughout our supply chain, and I also know that Amazon is actually working on insights into the carbon emissions from our entire cloud platform" Head of Platform, Monta

Simultaneously, cloud has been key to improve operational efficiency and achieve sustainability goals also to larger, more traditional organisations. For instance, AWS has enabled Factbird (see Box 5 in section 7.2) to develop its energy monitoring solution that helped multinational manufacturers like Danfoss (a Danish multinational manufacturer of hydraulic, temperature control, and power solutions) to improve energy efficiency, reduce energy costs, and move closer to meeting their sustainability goals. Thanks to AWS-enabled Factbird’s solutions, Danfoss could save up to 33% on production energy costs.

Additionally, the use of cloud might increase companies’ efficiency, while reducing their emissions, by facilitating information sharing and collaboration across different locations and teams (as put forward in section 4.3). This allows to reduce travel costs and associated emissions.

In sum, our survey reveals cloud users are aware of the role cloud can play in their path towards achieving greater sustainability. We find that 64 per cent of businesses agree that the use of cloud help them to achieve their net-zero carbon emissions goals and 68 per cent of businesses report that the use of cloud improves their energy efficiency. AWS have a higher perception of the role of cloud, with agreement to the above statements up to 72 and 74 percent, respectively (see Figure 17).

Figure 17
Cloud enables firms to improve efficiency and achieve sustainability goals
Percentage of respondents saying they strongly agree or somewhat agree



Source: Copenhagen Economics on survey data

⁴²See: <https://monta.com/>

CHAPTER 7

CLOUD ENSURES BUSINESS SECURITY**Key findings**

- Security related features of cloud are indicated by users as some of the most relevant benefits.
- 69 percent of cloud business users considered cloud infrastructure as more secure than traditional IT.
- More than 60 percent of cloud business users surveyed for this study (the share increases for AWS users) agree cloud increases security and helps fighting cyberthreats.
- Cloud service providers help increase security by enabling teams to automate basic security tasks and focus their time on the most complex threats, increase early detection, reduce probability of errors, and provide professional support.
- Enhanced security enable start-ups like Factbird to compete with larger companies.

7.1 DATA SECURITY AND PRIVACY ARE INCREASINGLY A CONCERN FOR BUSINESS CUSTOMERS AND END-USERS

The volume of data that businesses collect, create, manipulate, and store is growing, thus requiring an increasing attention on how data is governed and secured. The Assessment on the Status of CyberSecurity in Denmark (ASCD)⁴³ highlighted how the increased level of digitalization in Danish businesses and society at large has made security and privacy measures more salient and relevant to companies' growth.

In 2022, more than a quarter (26.4 percent) of Danish businesses reported having experienced an ICT related security incident leading to some consequences (e.g., unavailability of ICT services, destruction or corruption of data, disclosure of confidential data)⁴⁴. Data is at the core of digital business models and digitized society and effective data protection has therefore become a key element of corporate strategy.

Increased awareness of the importance of data security is also signalled by the high and growing share of enterprises having insurance against ICT security incidents: according to Eurostat⁴⁵ this share went up from 55.7 percent in 2019 to 70.6 percent in 2022 (the EU 27 average records only 25 percent of businesses insured in 2022).

⁴³ The Assessment on the Status of CyberSecurity in Denmark (ASCD) is a research project conducted by the IT University of Copenhagen and the University of Southern Denmark and funded by the Danish Centre for CyberSecurity. The project aims to study and report on the existing cybersecurity and privacy protection practices used in large Danish companies and SMEs, identifying the most important challenges the developers in Denmark face in developing secure and privacy-preserving solutions, and providing guidelines for securing critical infrastructures.

⁴⁴ (Eurostat, 2022)

⁴⁵ (Eurostat, 2023)

7.2 CLOUD SOLUTIONS PROVIDE HIGH SECURITY FOR THE STORAGE AND HANDLING OF BUSINESSES DATA

By providing technical, operational, and contractual measures for data protection, cloud solutions support companies in managing all aspects of data protection:

- data controls and residency (or storage), related to how data is stored, secured and how access to data is managed.
- data privacy, related to advanced access, encryption, and logging features.
- data sovereignty, related to the laws and governance structure of the nation where data is collected, and,
- data security, related to practice of protecting digital information from cyberthreats and enforcing real-time controls.

As shown in Chapter 1, security related features of cloud are indicated by users as one of the most relevant benefits. These include increased reliability and security, better data management and disaster recovery. Given the increasing importance that data have assumed on business performance and profitability, loss of a key asset such as data is a critical business risk, thus making disaster recovery essential for business continuity.

In general, in our survey we find that:

- 69 percent of cloud business users considered cloud infrastructure as more secure than traditional IT
- more than two thirds of cloud business users report that the use of cloud increased their ability to cope with cyber threats.

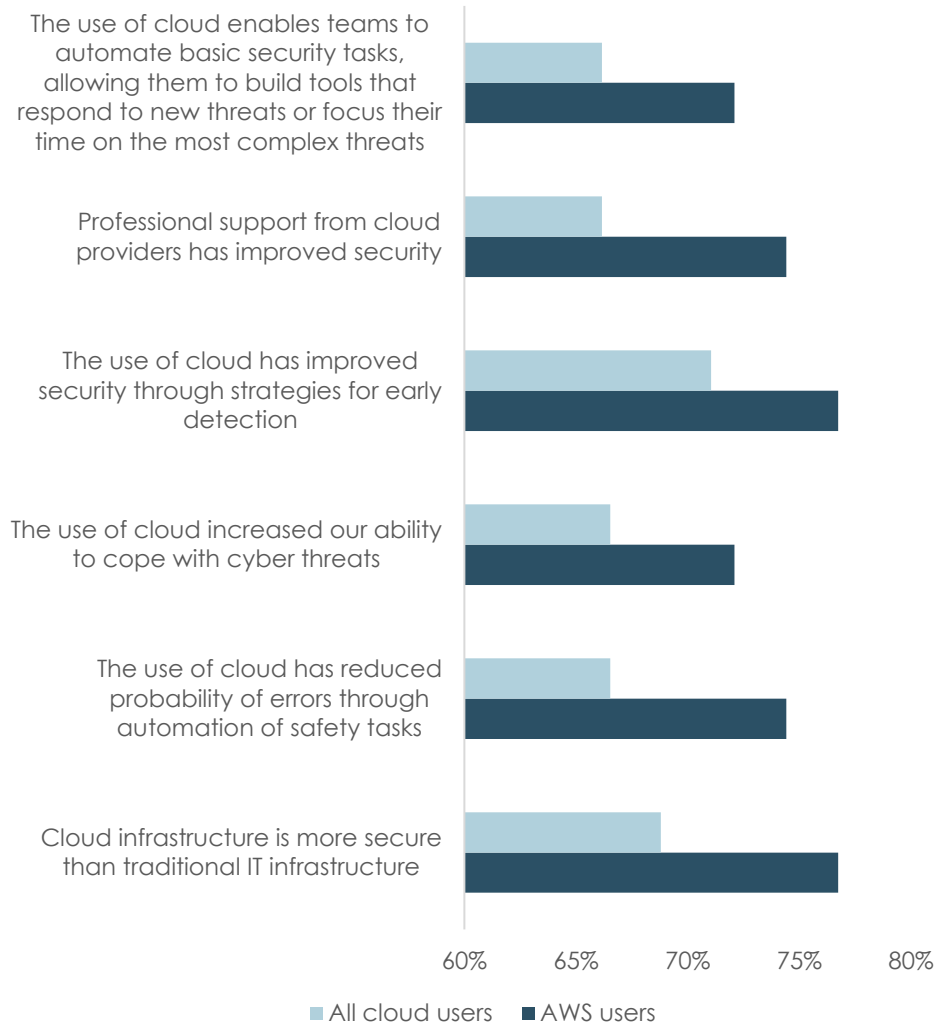
More specifically, more than 60 percent of cloud business users surveyed for this study (the share increases for AWS users) agree cloud increases security and helps fighting cyberthreats in several ways (see Figure 18):

- by enabling teams to automate basic security tasks and focus their time on the most complex threats,
- by using strategies for early detection,
- by reducing probability of errors,
- by providing professional support.

Figure 18

Cloud enhances security

Percentage of respondents saying they strongly agree or somewhat agree



Source: Copenhagen Economics on survey data

Enhanced security and reliability enabled by cloud can also be a competitive asset to win clients' trust and compete with larger firms. The success story of Factbird (see Box 5) confirms that relying on secure and reliable cloud infrastructure can support business growth.

Box 5 Case Study: Factbird

FACTBIRD

About Factbird

- Factbird is a comprehensive manufacturing intelligence solution designed to streamline data collection and analysis for manufacturers. This robust system comprises edge devices, sensors, and cameras for in-depth data acquisition, alongside a cloud-based application that captures, processes, and converts the data into actionable insights.

The challenge

- Factbird wanted to develop a solution that allowed to optimize production lines through data analysis and cloud processing.
- Factbird needed to scale up quickly while ensuring security and reliability, essential to win clients.

The benefits of using AWS

Business growth and efficiency

- By leveraging cloud technology, Factbird was able to harness the advantages of managed services, resulting in significant savings in server management, maintenance, resources, and time. This strategic move not only optimized cost efficiency but also facilitated rapid scalability for Factbird.

“We designed a complete new system that is 100% serverless. That means 100% managed services. So we don’t spend any time scaling up and down.” (CPO, Factbird)

Innovation

- Cloud enables the development of new features and facilitates product and process continuous improvement.

“Partnering with a cloud provider like AWS allows us to be at the forefront of technology change and innovation. The level of infrastructure and services provided surpasses what we could have achieved independently as a team of 15 developers. By leveraging AWS, we can focus our resources on product innovation while benefiting from the advanced capabilities and scalability offered by the cloud.” (CPO, Factbird)

Sustainability

- AWS enables Factbird to upload and analyze a large amount of production data and provide real-time analytics to help companies identify energy-intensive processes, improve equipment performance, and minimize waste.

Security

- AWS' robust security processes and certifications provide Factbird and its clients with the assurance that data is securely stored and protected against cyberthreats.
- By leveraging AWS, Factbird ensures the reliability of its platform and services, enabling it to compete with larger industry players.

“The advanced security infrastructure offered by AWS allows us to build a product that offers enterprise-grade reliability and uptime guarantees to our customers. These factors carry significant weight in the purchasing decision, particularly for our enterprise customers.”
(CPO, Factbird)

CHAPTER 8

CLOUD CAN UNLOCK FURTHER OPPORTUNITIES**Key findings**

- Our survey shows that a general lack of knowledge and understanding of cloud technologies prevent non-users to adopt cloud technologies.
- 36 percent of non-users consider cloud computing services adoption as likely in the next five years citing as a way to increase competitiveness, lower IT costs, improve security and better data management and increased operational efficiency.
- Denmark can unlock value by a) increasing the share of sophisticated cloud users (only 20 percent of users employed cloud for more than five applications) and b) increasing adoption among small firms.
- Based on our extrapolation model, we estimate that an increase of just 10 percent in the cloud adoption rate of SME would translate into additional 1 DKK billion in economic value added for the Danish economy.

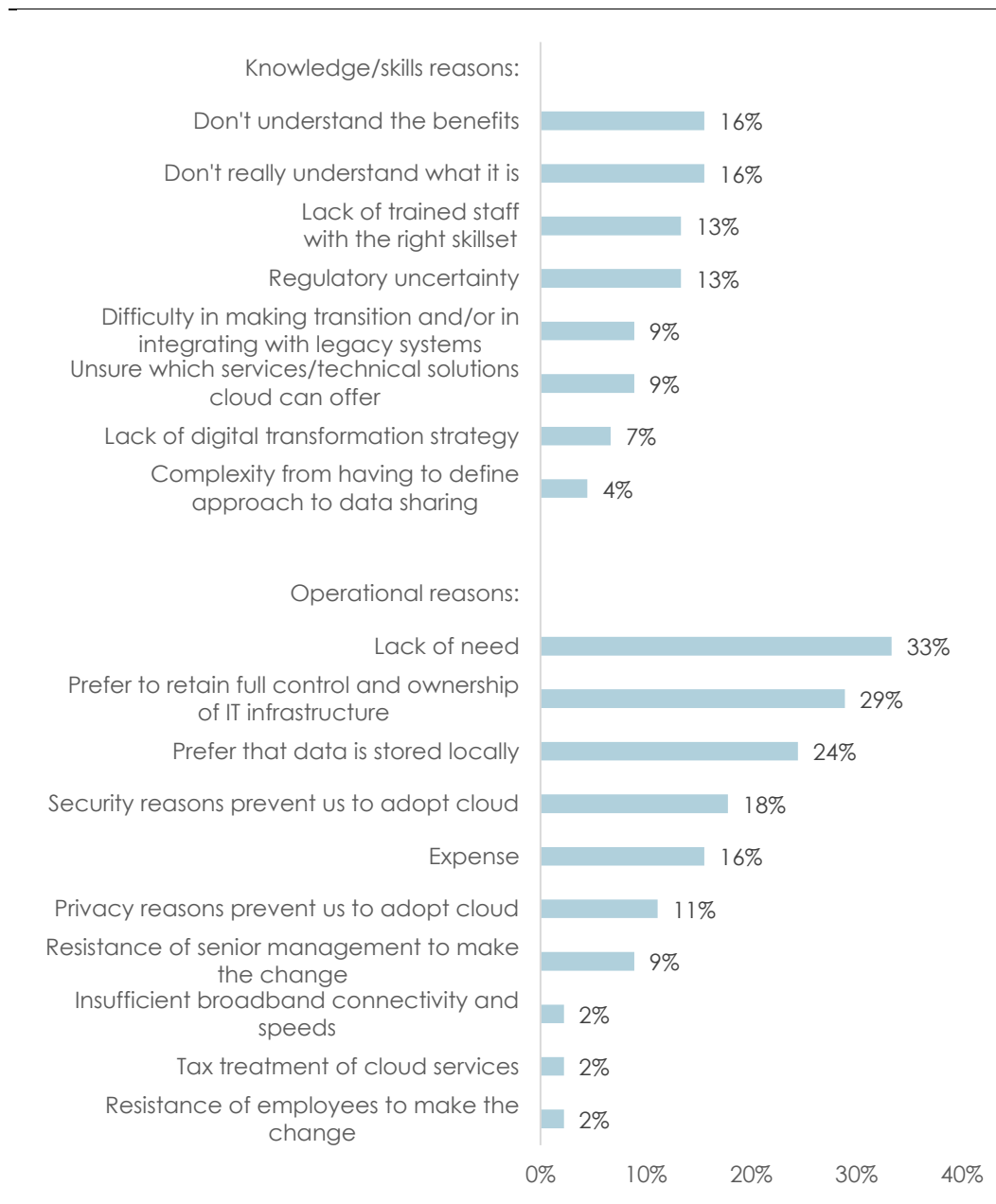
8.1 WHILE CLOUD CAN HELP SMALLER PLAYERS IN THEIR DIGITAL TRANSFORMATION, SEVERAL BARRIERS REMAIN TO INCREASE CLOUD UPTAKE

Despite very high take up rates in Denmark, many businesses (according to the most recent Eurostat data around 35 percent of companies with more than 10 employees⁴⁶) have not adopted cloud technologies yet. This is driven by a perceived lack of need for some firms but also a general lack of understanding of the technology.

In our survey, we grouped possible barriers to slow further uptake of cloud into two categories: a) barriers related to lack of certain knowledge/skills and b) operational barriers. We asked non-cloud users which barriers they perceived as more relevant for the lack of cloud adoption. Besides a perceived lack of need of cloud among one third of respondents, several respondents reported “don’t understand the benefits” and “don’t really understand what it is”, see Figure 19. This shows that a general lack of knowledge and understanding of cloud technologies prevent non-users to adopt cloud technologies.

⁴⁶ (Eurostat, 2023)

Figure 19
Several barriers hinder further cloud adoption
Percentage of respondents



Source: Copenhagen Economics on survey data

Despite the existence of operational and knowledge or skill-related barriers to cloud adoption, many non-users are aware of the disadvantages of not using cloud. For example, 13 percent of non-users reports that not using cloud services decreases their agility and limits their ability to innovate, while 11 percent state that not using cloud services limits their ability to flexibly adjust their IT capacity to meet their needs and, at times, results in excess IT capacity.

Finally, 36 percent of non-users consider cloud computing services adoption as likely in the next five years, citing as main reasons leading to adoption:

- increased competitiveness;
- lower IT costs;
- Security and better data management;
- And increased operational efficiency (producing high-quality services/products with less resources).

8.2 ENCOURAGING CLOUD TAKE UP COULD UNLOCK FURTHER GROWTH OPPORTUNITIES FOR DENMARK

8.2.1 Increasing cloud take up rate in Denmark would not only boost businesses performance and the level of innovation but also bring positive outcomes to overall economic growth

According to the International Data Corporation (IDC)'s Worldwide Software and Public Cloud Services Spending Guide⁴⁷, Cloud spending in Europe is expected to reach \$148 billion in 2023 and is projected to increase up to \$258 billion by 2026, growing at a 22% 5-year 2021-2026 CAGR. In terms of cloud adoption by enterprises, this translates into an increase of cloud uptake rate from 41percent up to 72percent⁴⁸. Ten years ago, in 2013, the total cloud market in the EU did not reach €10 billion⁴⁹.

The IaaS is expected to have the highest forecasted CAGR, explained by the increased demand to a reduced IT complexity and reducing deployment costs for data centres to drive the adoption of IaaS.

A recent study by Public First⁵⁰, found that the Digital Decade could unlock over €2.8 trillion in economic value in Europe— equivalent to 21 percent of the EU's current economy — via a 'sustained, collective focus' on digital transformation across the public and private sectors. In fact, Public First's study estimates that over half (55 percent) of the potential impact of the Digital Decade agenda relies solely on driving further adoption and use of cloud computing.

While Denmark displays high levels of cloud adoption looking at the extensive margins, there is still room for improvement in two main directions: a) intensity of adoption and b) inclusion of laggard firms and organisations (especially smaller firms).

Firstly, in terms of intensity of adoption, our survey revealed that only 20% of cloud users currently employ cloud technologies in more than five use cases. The vast majority of cloud users on our survey are not fully taking advantage of the potential benefits of cloud adoption. According to McKinsey⁵¹, more than 10 percent of the overall untapped potential of cloud is credited to growth from new and enhanced use cases. Harnessing cloud potential is indeed key to accelerate or enable innovation using technologies such as advanced analytics powered by ML and AI, IoT, and automation at scale.

⁴⁷ (IDC, 2023)

⁴⁸ (European Commission, 2023)

⁴⁹ (European Commission, 2016)

⁵⁰ (PublicFirst, 2022)

⁵¹ (McKinsey, 2021)

The positive relation we find between number of cloud applications/use cases and growth in a) revenues, b) headcount and c) product and service portfolio (see Figure 6, Figure 7, Figure 10 showing that sophisticated users, defined as companies employing cloud services for five or more use cases, report consistently higher growth in revenue, headcount and product and service portfolio than less sophisticated cloud users and non-users) provides evidence of how increasing cloud adoption at the intensive margin could deliver growth.

Secondly, raising cloud adoption rates among micro, small and medium firms (0 to 249 employees) that now show lower take up rates, is also key to untap potential of cloud. Based on our extrapolation model, we estimate that an increase of just 10 percent in the cloud adoption rate of SMEs would translate into additional 1 DKK billion in economic value added for the Danish economy.

Therefore, encouraging higher and more intensive cloud adoption has the potential to accelerate growth even in a highly digitalised country such as Denmark.

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APPENDIX - METHODOLOGY

THE SURVEY

The empirical base of this study is a large-scale Pan-Nordic online survey conducted by a specialised market research firm (Savanta) on behalf of Copenhagen Economics. The survey was run in March 2023 and reached 918 firms across Denmark, Finland, and Norway. The sample captured firms of different sizes and different sectors of activity, thus providing a broad representation of the entire economies focused of the study.

In particular, the survey included firms fairly evenly distributed across the manufacturing and service sectors and across the following size classes:

- 0 to 9 employees
- 10 to 19 employees
- 20 to 49 employees
- 50 to 249 employees
- More than 250 employees.

Moreover, the survey targeted IT decision makers in the firms. This ensures that all collected information, especially on cloud spending, cost savings and additional revenues related to the adoption of cloud computing is provided by an informed respondent within the firm.

A short section of the survey addressed all respondents. However, most of the questions addressed cloud users only. The sample included a fairly high share of cloud users, slightly above the share recorded by Eurostat for each of the three countries under scrutiny. Nevertheless, some questions were also addressed to non-users to explore some of different characteristics between users and non-users and analyse potential barriers to the adoption of cloud computing technologies among these latter.

Overall, it is important to consider that the total number of responses varies per question, as respondents were given the possibility to answer “don’t know” to indicate that they do not know the answer to the question or skip the answer.

Finally, we should consider that all information retrieved in the survey is subjective, and correlation does not imply a cause-and-effect relationship between answers.

CALCULATION OF GROSS VALUE ADDED (GVA) CONTRIBUTION

In Chapter 2 of this study, we assess AWS’s contribution to the Danish economy in 2022 in terms of value added throughout the economy, i.e., the total amount of profits earned by businesses and their supply chains, thanks to the adoption of AWS cloud.

In order to estimate of AWS's economic impact, we followed similar methodological approach employed in PublicFirst and IW Consult studies.

First, we estimate for the average business in each size class the additional value added generated by cloud relative for the amount spent on cloud. To do so, we started by converting additional revenue generated by cloud in terms of economic value added⁵² and then we multiplied for the average country GVA multiplier⁵³ (taken from the latest input-output tables from the OECD) to account for the indirect impact of additional value upstream on the value chain. We then sum this with the additional cost savings thanks to cloud. Finally, we divide the amount by the estimated spending on the cloud (retrieved from the survey) to have a relative measure of additional value for one euro spent on cloud. The estimate economic impact of cloud for each business is thus expressed as:

$$\frac{\text{Estimate of additional revenue} \times \text{share of GVA} + \text{estimate of cost savings}}{\text{Estimated spending on the cloud}}$$

Second, we aggregate in order to obtain the overall AWS's economic impact on the national economy. Again, we mirrored the methodology employed by PublicFirst and IW Consult to aggregate the firm-specific estimates. Therefore, we multiplied size class averages by the country level estimate of number of businesses in each size class (retrieved from Eurostat) and the proportion of businesses in each size class using cloud, and of those, using AWS.

As anticipated above, in our survey, the share of firms using cloud resulted higher than the one recorded by official statistics. We adopted a conservative approach, and we employed in our calculations Eurostat's cloud uptake shares, for all class sizes except 0 to 9 employees. This latter is not included in Eurostat statistics, therefore, we employed results from the surveys (cloud adoption rates for this class size were considered credible as they were lower than those of the 10-19 employees class size). The share of businesses for each size class using AWS was retrieved from our survey.

We should finally highlight that the entire sample was cleaned and outliers were removed before calculating the overall impact. Specifically, we removed from the sample:

- Firms reporting a share of cloud spending on total turnover greater than 20 percent;
- Firms reporting a total turnover by employee higher than 5.2 DKK million.000;
- Firms in the 5% right-tail of the distribution of the ratio cost saving + additional revenue over cloud spending;
- Firms in the 5% right-tail of the distribution of cost savings per employee;
- Firms in the 5% right-tail of the distribution of additional revenue per employee.

These adjustments were carried out to remove potential outliers that overestimated the impact of cloud on additional revenues and cost savings and could lead to an overestimation of AWS's economic impact.

⁵² This considers only the direct effect, i.e. the direct contribution to GDP from the additional revenues generated, thus excluding costs related with e.g. intermediary necessary to produce the additional output.

⁵³ To obtain the national average GVA multiplier we use sectoral multipliers (obtained as the ratio between the sum of direct and indirect effect and the direct effects) and weight them by turnover per sector (retrieved from Eurostat).

SENSITIVITY ANALYSIS

As a main sensitivity test, we run the same model using estimated cloud spending data for Denmark from an established market research firm. This check ensures that our model does not overestimate the impact of cloud on the economy due to possible higher values reported on cloud spending from the survey – which in the main model are extrapolated to arrive at a total amount of cloud spending. The third-party estimate was higher than the estimated cloud spending we obtained from our model, suggesting our initial estimate was conservative.

Starting from the third-party comprehensive estimate of cloud spending in Denmark in 2022, we estimated cloud spending by size class using the same distribution retrieved in the main model. We then calculated cloud spending per firm per size class dividing the overall cloud spending per size class by number of firms in the same size class (Eurostat) and cloud adoption rate by size class (as above, we employed Eurostat cloud adoption rates per size class except for 0 to 9 employees, for which we adopted the rate retrieved from the survey).

We then estimated additional revenue and cost savings per size class assuming:

- the same ratio “extra revenue + cost savings / cloud spending” applied, and
- the same ratio “extra revenue: cost savings” applied.

These estimates then fed into the main model and resulted in an overall headline estimate of AWS cloud contribution to GDP of around 8.1 DKK billion, slightly higher than that retrieved using survey data.

We therefore conclude that our initial estimate was plausible and in line with third-party data, and we provided a conservative estimate of the overall contribution of AWS cloud to GDP.

As additional sensitive check, we note that similar impacts are found also for Finland and Norway, which have a similar level of cloud adoption and similar business environment. This gives further confidence on the overall estimations of the economic impact of cloud in Denmark.

Finally, our approach is conservative as it does not include induced effects that capture the spending capacity of employees, and tax contributions. We should also consider that this approach assumes fixed prices and wages.

CASE STUDIES

The empirical base of the study was complemented by case study interviews. We conducted interviews with company representatives selected with AWS who have gained experience with the use of AWS cloud services in the recent past.

In addition to the survey, case study interviews are aimed at collecting qualitative insights on the impact of the use of cloud on many aspects of firms performance. Case study interviews are indeed a useful tool to collect qualitative evidence and real stories on how AWS cloud services enable businesses to growth, innovate, become more sustainable, enhance security and so on.

The interviews followed a semi-structured approach, based on an interview guide designed and refined in advance. In drafting the interview guide and conducting the interviews, we adopted a top-down approach that included three main survey blocks:

- introduction and company profile;
- relevance of cloud for the business model: focusing on the challenges that the company was/is facing that required the use of cloud;
- benefits of cloud, in terms of:
 - o business growth and efficiency;
 - o innovation;
 - o sustainability;
 - o security.

The basic structure and the focus of the questions were shared with the interviewees in advance. Together with an overall perspective on the benefits of cloud, the interviews aimed at collecting concrete examples, quotes, and figures.

Participants were contacted by email and briefly introduced to the objectives, key points and content of the case study interviews in advance. The interviews were held online on Microsoft Teams, and lasted approximately 40 to 60 minutes. Two interviewers were present at each interviews.

Following the interviews, we collected notes and prepared a short summary of the case study that was sent to the interview participants to review and approve.