



THE LONDON SCHOOL
OF ECONOMICS AND
POLITICAL SCIENCE ■

The Transformative Effect of Cloud on Firm Productivity and Performance

Defining the benefits and impact of cloud as a 21st Century digital enabler

Final report

Dr Alexander Grous ▪ March 2019



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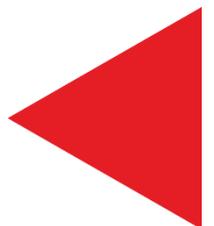


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Overview

Cloud can assist in the delivery of a 20% productivity enhancement when combined with best management practices. Cloud also facilitates accelerated time-to-market for products and releases, and is ushering a paradigm shift in how organisations implement technology: ‘heavy-lifting’ is increasingly being segmented to cloud providers, emancipating an enterprise to focus on developing differentiated offerings. As a result, technology is no longer a *critical path* item, with many digitally native ‘all-in’ cloud start-ups utilising the technology as the enabling mode for market entry.

This research ‘peels the organisational layers’ through primary engagement in cloud, ICT and management practices since 2009, including extensive interviews with CxOs, Technology, Operations, HR Directors and others internationally, including drawing on over 20,000 interviews in 35 countries, and international companies covering around one million employees.

Best-performing enterprises are integrating cloud at the core of their strategy, while other are adopting cloud to harness its transformative properties and transition into a ‘leaner’ technical organisation and aligning this with control structure and practices. This process can lower costs, increase agility, and deliver faster time-to-market, enhancing return on equity (ROI) and conferring competitive advantage in the process. For many organisations, including an increasing number of start-ups, cloud is no longer a consideration: it is the strategy.

Academic Lead



Dr Alexander Grous

Lecturer & Researcher - Department of Media and Communications, LSE

Dr Grous has been at the LSE since 2007 and is attached to the *Department of Media and Communications*, where he teaches at postgraduate level including on the MSc in Digital Media and Communications and other LSE Management and Executive Programmes in the UK, EU and other countries. The Department is ranked #1 in the UK and #4 globally in the 2019 QS World University Rankings, reflecting its teaching and research strength.

Dr Grous teaches in digital, management practices, technology and innovation, socioeconomic analysis and other areas. He undertakes research that has an applied focus, blending close industry engagement with complex quantitative modelling and qualitative analysis to produce reports and research in topical and emerging areas. Dr Grous' work has been utilised by Government and enterprises, with a particular interest in the socioeconomic modelling of technology use, and has received industry recognition including assisting global agency Ogilvy to win the best B2B campaign award at the International Content Marketing Awards in 2018 through multi-platform campaign designed around the global research study '[Sky High Economics](#)'.

Dr Grous has been researching cloud and disruptive and emerging technologies since 2007 alongside management practices and the impact on firm performance that best practice technology management can deliver. This includes participation in one of the first efforts to construct a dynamic model on the [impact of cloud computing in industrial and service sectors](#) in 2012, and ongoing research in cloud and technology across organisation types, size and sectors internationally, quantifying the impact on firm performance across the firm's areas. The enclosed research draws on considerable close engagement with firms and ongoing research internationally.

Dr Grous brings extensive international experience to the LSE including as Managing Director for Lockheed Martin's Infocom Division in EMEA, CEE/CIS and from CEO and COO roles in US\$250-500m technology companies engaged in digital, e-commerce, P2P and B2B activities. He has also worked in FMCG companies such as PepsiCo in strategic and marketing roles.

1. Key Messages: Optimising Technology, Cloud and Management Practices

“An entire digital environment can be set up in 10 minutes. Before, such tasks would take weeks or even months.”

- R. Heely, Head of Technology, Macquarie’s Banking and Financial Services Group

The organisation’s technology strategy is defined by its management practices. Good practices align the organisation and technology to maximise productivity and profitability.¹ This research extends primary research undertaken since 2007 by the LSE and its research partners on management practices and ICT use in Small and Medium Enterprises (SMEs), Micro and Small Enterprises (MSEs) and large enterprises, with over 20,000 interviews undertaken in 35 countries, covering multinational enterprises. Additional cloud, technology and productivity studies covering around one million employees have been undertaken. Key messages across cloud adoption and firm-practices include:²

- Technology is no longer a critical path item for incumbent organisations or start-ups.
- Costs for technology are being reduced, with multiplier effects into other organisation areas.
- Cloud has disintermediated technology and emancipated businesses from infrastructure, administrative, and other technical overheads, freeing up costs, resources and business models.
- Releases can be brought to market rapidly as code becomes the differentiator.
- Cloud has ‘turned upside down’ go-to-market speed and processes with organisations revising structures, resourcing requirements, facilities, and other elements.
- The use of cloud is spurring a new wave of nimble, younger entrepreneurs, who are migrating from ‘App Store development’ to an all-in cloud enabled business start-up.
- Incumbent firm competition in some sectors is now more likely to emerge from cloud-only SMEs.
- A factor limiting the rate of innovation and speed of cloud adoption is a lack of relevant skills in emerging areas including serverless, artificial intelligence (AI), machine learning (ML), security.
- Best-management practices coupled with cloud-enabled intensive technology use can yield productivity improvement of 20%.
- The ROI of cloud-enabled business can be significant as costs reduce coupled with an increase in revenue-generating products and features.
- The observed benefits are agnostic of firm-type, location, size or sector.

This research reviews a number of cloud areas in the 21st-Century, highlighting the central facilitative role that cloud is playing. This is increasingly becoming *strategic* with cloud often ‘being the strategy’.

¹ Bloom, N., et al. (2012). Americans Do IT Better: US Multinationals and the Productivity Miracle, *American Economic Review*. V(102)1; pp. 167-201.

² The key messages utilise multiple LSE Management Matters interviews; productivity and technology research and interviews including specific research with UK enterprise customers representing 0.3 million employees; AWS client interviews.

2. Methodology

This project utilises both primary and secondary research including significant technology-related investigative research since 2007 on cloud, productivity and technology. This encompasses participation in the academic team developing one of the first comprehensive models to estimate the impact of cloud computing in a number of major industrial and services sectors.³ This research also encompasses targeted work on cloud since 2016 that has been assessing:

- Technology strategy and best management practices to support productivity.
- Organisational transformation through cloud based adoption to maximise ROI.
- Defining self-assessment methodology to guide organisations in identifying organisational type and technology enhancing options.

Primary research has been utilised for this study drawn from diverse but complementary threads:

- Participation in the largest ever global ongoing international assessment of management practices since 2007, including operations, undertaken by the LSE in collaboration with McKinsey and Co in the establishment stage, with interviews with 20,000 firm managers in 35 countries. This includes leading a stream assessing the transformative role of technology for productivity in high-technology SMEs including detailed on-site engagement and technology analysis in major companies including *Airbus*, *Rolls Royce* and others at COO, CTO, Exec HR level.
- Assessing the ROI of technology including cloud with interviews with CxOs and other senior technology, operational and HR managers in major global enterprises in the UK, EU, Asia Pacific, India and the US, representing around one million employees across these regions.
- In situ research in companies in Banking, Finance, Media, and Air Transport, Manufacturing and other sectors including engagement with Technology and Operations Managers.
- Case-study analysis with a cross section of managers in identified cloud providers in the UK and EU to review cloud development, management practices, and other factors.
- Interviews and in-house engagement with Technology Directors and senior managers in leading global cloud providers.
- Interviews with CIOs and CTOs of cloud-enabled companies in the UK, US and Asia Pacific for case studies for this research.
- Visits to leading technology incubation centres in London including *Google's Campus London*, and engagement with the Campus' founding managers, to assess start-up enablement drivers and attributes.

Primary research has been complemented by secondary research in cloud, productivity and workforce transformation through relevant journals, white papers, and industry reports.

³ Castro, D., Grous, A., Karrberg, P., Liebenau, J. (2012). LSE Research Report. Modelling the Cloud. Employment effects in two exemplary sectors in The United States, the United Kingdom, Germany and Italy. <http://eprints.lse.ac.uk/41763/1/LSE-Cloud-report.pdf>

3. Cloud Evolution

Cloud computing is transforming the digital ecosystem for businesses and consumers and has become integral to facilitating a paradigm shift in productivity and agility:⁴ around 80% of organisations that have implemented a digital transformation strategy have utilised cloud-based services.⁵ These are delivered through multiple service models including Software as a Service (SaaS), Platform as a Service (PaaS), Infrastructure as a Service (IaaS) and more recently, Container as a Service (CaaS), with three primary deployment models utilised: Public Cloud, Private Cloud and Hybrid Cloud.⁶ Cloud computing has a number of attributes that facilitate transformation: on-demand availability; self-service; incremental or rapid scaling; low-cost; breadth (of services).⁷ A key transformative attribute of cloud computing is the utilisation of a cloud vendor’s APIs or software solutions that can replace in-house company development providing rapid deployment capability and flexibility.⁸ This attribute can facilitate shorter innovation cycles and time-to-market, contributing to a competitive position.⁹ The adoption of cloud in isolation to the utilisation of other productivity-enhancing management practices can result in sub-optimal performance.¹⁰ Research indicates that the adoption of best management-practices in combination with technological solutions for the firm can result in an uplift in productivity of 20%, when blockers to enhancing performance are removed.¹¹

Changes in the mix of cloud service offerings have been observed since 2016 with this forecast to continue: cloud servers grew by 15% between 2015-2016 and are forecast to continue growing, while traditional servers are forecast to decline by 11% between 2016-2020. Table 1 depicts these trends.

Table 1: Cloud Computing Categories: 2016-2020¹²

	2016	2017	2018	2019	2020
Cloud Business Process Services (BPaaS)	40,12	43,772	47,556	51,652	56,176
Cloud Application Infrastructure Services (PaaS)	7,169	8,851	10,616	12,580	14,798
Cloud Application Services (SaaS)	38,567	46,331	55,143	64,870	75,734
Cloud Management and Security Services	7,150	8,768	10,427	12,159	14,004
Cloud System Infrastructure Services (IaaS)	25,290	34,603	45,559	57,897	71,552
Cloud Advertising	90,257	104,516	118,520	133,566	151,091
Total Market	209,244	246,841	287,820	332,723	383,355

⁴ <https://www.cloudindustryforum.org/content/cloud-fundamental-digital-transformation-strategies>

⁵ <https://www.cloudindustryforum.org/content/cloud-and-digital-imperative>

⁶ Wamuyu, P.K. (2017). Use of cloud computing services in micro and small enterprises: a fit perspective. *International Journal of Information Systems and Project Management*. V(5)2; pp: 59-81.

⁷ Ibid.

⁸ <https://business-reporter.co.uk/2016/05/29/cloud-key-enabler-digital-transformation/>

⁹ Ross. P. (2012) Cloud computing: the nexus of strategy and technology. *Journal of Business Strategy*, Vol. 34 Issue: 4, pp.39-47

¹⁰ Ibid.

¹¹ Ongoing LSE interviews with 20,000 firms in 35 countries since 2005: the largest ongoing study in this area globally.

¹² <https://www.gartner.com/en/newsroom/press-releases/2017-02-22-gartner-says-worldwide-public-cloud-services-market-to-grow-18-percent-in-2017>

Cloud will continue to grow both in revenue, traffic and in importance as a storage solution for consumers and enterprises, with almost 40% of US online adults utilising it.¹³ The evolution of the market is being driven by demand for storage by consumers and business, with all three areas of cloud computing growing: SaaS, PaaS, and IaaS. The total public cloud market is forecast to grow to US\$383 billion by 2020 from US\$246 billion in 2017, with SaaS accounting for the majority of non-advertising related market, followed by IaaS and Cloud Business Process Services (BPaaS).¹⁴ The growth opportunities presented by cloud, along with transformation changes include:

- Cloud computing services accounted for 75% of the total workload processed by data centers, forecast to reach 92% by 2020.¹⁵
- Average global annual growth expenditure for cloud computing was 43% between 2010-2016, and range from 29% in Latin America to 49% for Africa and the Middle East.¹⁶
- Per capita spending for cloud computing ranges from 1% of the US value for Egypt and India to over 200% for Australia, Sweden, and Canada with adoption lower for developing countries. Overall, cloud computing expenditure per capita for seven of 11 countries in Developing Asia is less than 10% of the US value, versus five of eight countries in Eastern Europe, and all seven Latin American countries.¹⁷

These demand drivers are facilitating changes within organisations and in their business models.¹⁸

¹³ <https://www.statista.com/statistics/710964/us-cloud-computing-consumer-usage/>

¹⁴ <https://www.gartner.com/newsroom/id/3616417>

¹⁵ <https://www.datacenterknowledge.com/archives/2016/11/11/2020-92-percent-data-center-traffic-will-cloud>

¹⁶ <https://softwarestrategiesblog.com/tag/iaas/>

¹⁷ <https://news.microsoft.com/uploads/2017/10/A-Cloud-for-Doing-Good-FINAL.pdf>

¹⁸ Mohammed, G.J. (2018). Factors Affecting the Adoption of Cloud-Based Enterprise Resource Planning (ERP) Systems in Small and Medium Sized Enterprises (SMEs): An Overview. *International Journal of Engineering & Technology*. V(7)3.15; pp:368-372.

4. 'Modern Cloud': From Virtual Servers to Serverless

Cloud has evolved from its inception as a 'storage' solution, to its current use by many organisations as a strategic tool that can confer competitive and operational advantages.¹⁹ Initial cloud use was predicated on the virtualisation of servers to cloud providers through *virtual private servers (VPS)*. This delivered lower cost, scale, flexibility and reliability.²⁰ This notion evolved with the advent of *containers*: servers could now run a 'container'. This is comprised of a narrower virtualisation that resides in the Linux operating system itself and runs in a single host operating system offering the benefits of faster start-up and reduced resources usage.²¹ Container-as-a-service (CaaS) has become relatively ubiquitous as it offers a key benefit through the rapid deployment of applications.²² This accelerated time-to-market enables the development and release of applications without the need to consider operational factors or many infrastructure components segmented to a cloud provider. This has resulted in the disintermediation of traditional PaaS and the portability of development effort that is agnostic of its environment.²³ Developers can relinquish environmental considerations to cloud providers and in turn, reduce the size of the code required, accelerating the time-to-market further.

A recent step-change of cloud is the emergence of *serverless*: containers are created for short-durations to execute a specific request.²⁴ Serverless offers a number of benefits: (i) lower cost (as idle time is not charged); (ii) no provisioning, and, (iii) simpler code.²⁵ Both containers and serverless reflect the evolution of cloud that has disaggregated the incumbent process of micro services. Greater cloud choice is available to organisations, including aligning this to development requirements such as if the entire application requires deployment, or if on-demand execution is required.²⁶ This is affecting how code is being delivered, the firm's structure, resource requirements and other requirements.²⁷ This research has highlighted a number of results that reflect the continued evolution of 'modern cloud':

- 90% of enterprise customers are utilising cloud for productivity gains, versus 55% in 2013.²⁸
- Over one-third of organisations are considering further cloud specialisation including the utilisation of serverless to generate additional time for application improvement.²⁹
- Cloud reduced the operating costs for almost 100% of companies adopting it.³⁰

¹⁹ Palos-Sanchez, P.R., et al (2017). Cloud Computing (SaaS) Adoption as a Strategic Technology: Results of an Empirical Study. *Mobile Information Systems*. Volume, Article ID 2536040; 20 pages.

²⁰ Ibid.

²¹ Sochat, V.V., et al. (2017) Enhancing reproducibility in scientific computing: Metrics and registry for Singularity containers. *PLoS ONE*; V12(11): e0188511. <https://doi.org/10.1371/journal.pone.0188511>

²² <https://blogs.cisco.com/cloud/the-next-evolution-of-paas>

²³ Herrera-Izquierdo, L., and Grob, M. (2017) A Performance evaluation between Docker container and Virtual Machines in cloud computing architectures. *Actas del V Congreso Ecuatoriano de Tecnologías de la Información y Comunicación - TIC.EC 2017*; V(8). <https://publicaciones.ucuenca.edu.ec/ojs/index.php/maskana/article/view/1457>

²⁴ Hoang, A. (2017) Analysis of micro services and serverless architecture for mobile application enablement. *ScholarWorks Open Access Repository*. <http://hdl.handle.net/10211.3/193100>

²⁵ Stigler, M. (2018). *Understanding Serverless Computing*. In: *Beginning Serverless Computing*. Apress, Berkeley, CA

²⁶ <https://containerjournal.com/2018/01/18/serverless-computing-trends-to-watch-in-2018/>

²⁷ LSE research, op cit, where not referenced in the benefits cited in the accompanying bullet points. Other benefits are referenced from source material.

²⁸ LSE productivity and technology research and interviews with UK enterprise customers

https://www.yourreadybusiness.co.uk/wp-content/uploads/2017/08/J198-Vodafone-LSE_productivity_paper-Final.pdf

²⁹ LSE interviews with Technology Managers engaged in cloud deployments and applications covering over 0.25million customers per annum and deployments in multiples of this.

³⁰ Ibid

- Almost two-thirds of SMEs indicated that their cloud spending is likely to grow by at least 25% as they migrate more applications and services and re-align their IT and work practices as a result.
- 80% of enterprise customers are including the *lack of vendor lock-in* as a key procurement selection criteria for cloud provider selection.³¹
- One third of organisations have deployed serverless cloud, with the remainder assessing this mode.
- Security remains a concern for all organisations but confidence exists by the majority of organisations in the adequacy of security arrangements by cloud providers.
- 75% of managers are currently assessing the migration of a greater amount of data to the Cloud.
- 80% of Technology Managers are now engaged directly with Product Development from the concept stage to rapidly develop code and a faster time-to-market strategy.
- 5% of SMEs and start-ups utilised multi-cloud with single providers suited to their size and early-stage market entry.
- 70% of Enterprise managers are assessing AI and ML strategies for data-related applications and services due to cloud adoption.

³¹ LSE CxO interview, 2016-2017 covering 20 multinationals and large enterprises encompassing approx., 1m employees.

5. Removing Barriers to Entry

This research highlights rapid market *entry* as another key tenet of cloud:³²

Cloud has removed barriers to market-entry, enabling a new generation of organisations to mobilise, while transforming the operations of incumbent businesses.

Ninety-five per cent of organisations today utilise cloud, with forecasts that by 2021, over half of all businesses will be ‘all in’ for cloud: companies will build, re-factor and make cloud the default platform.³³ Global and major enterprises such as *Netflix*, *Airbnb*, *Fortnite*, *JustEat* and *Deliveroo* reflect companies that have migrated operations to cloud and cited accruing benefits that include cost-savings through a reduction in technical and operations roles;³⁴ agility and scalability,³⁵ and automation that has enhance productivity in Customer Care and DevOps functions amongst others.³⁶ *Just Eat* represents a major cloud migration, with 95% of the Company’s e-commerce platform and its associated applications hosted on cloud, in addition to its testing and developmental toolsets and mobile applications.³⁷ The Company has realised benefits, with its CTO highlighting; *“If you take into account the true value, the improved IT availability, the time saved on not running backups or patching operating systems and instead focusing on more strategic IT, cloud has definitely given us more return on investment.”*³⁸ Research indicates that almost 90% of SME and MSE start-ups today would not consider market entry if a traditional model of IT was utilised, with a number of prohibitive factors cited: technical and infrastructure costs; skills required to manage technology; additional resources required; scaling issues and costs.³⁹ In addition, around two-thirds of SMEs cite the availability of low-cost collaborative entrepreneur facilities as aiding their technology strategy, such as *Google Campus* in locations around the world, *Nasdaq Entrepreneurial Center* in San Francisco, and others.⁴⁰

SMEs often lead enterprise firms in the adoption of cloud to spur rapid decision making between technology areas and agile delivery.⁴¹ Cloud’s lower operational costs and commoditised transferable elements can result in reduced organisational hierarchies: fewer individuals are required to approve traditional legacy and infrastructure decisions, with these elements devolved to cloud providers. This facilitates lower requirements for technical ‘expertise’ within SMEs and MSEs in particular, further resulting in a flattening of structures and reducing some skill types.⁴² ‘Entrepreneur campuses’ are increasingly becoming populated by entrepreneurs who are migrating from developing online apps from their homes, to launching a technology-business by utilising cloud providers to obtain technology infrastructure, releasing them to focus on business development, code-writing, and growth. The offering of ‘payment holidays’ by cloud providers has been

³² Pethuru, R., et al. (2013). Envisioning the Cloud-Induced Transformations in the Software Engineering Discipline. In: Mahmood Z., Saeed S. (eds) Software Engineering Frameworks for the Cloud Computing Paradigm. Computer Communications and Networks. Springer, London

³³ <http://www.gartner.com/imagesrv/media-products/pdf/hcl/HCL-1-3MER9PC.pdf>

³⁴ <https://aws.amazon.com/solutions/case-studies/airbnb/>

³⁵ <https://diginomica.com/2015/05/29/the-cloud-takes-away-the-infrastructure-strain-at-just-eat/>

³⁶ <https://www.computerworlduk.com/devops/how-justeat-runs-devops-at-scale-3679792/>

³⁷ Ibid.

³⁸ C. Morgado, CTO, Ibid.

³⁹ LSE interviews including in-situ Google Campus London attendance and interviews with founder and VCs engaged with start-up funding; additional interviews with KPMG, AWS, Sapient, Technology leads.

⁴⁰ Ibid.

⁴¹ LSE interviews with SMEs for Management Matters, 20,000 firms; ICT interviews with SMEs 2016-2017.

⁴² Ibid.

observed to be a key catalyst in spurring entrepreneurial activity and cited by these individuals as a ‘must have’ in spurring their market entry.⁴³ Cloud providers facilitate this by offering services and source code that can be integrated without the need to develop these elements in-house. This area has shown particular proliferation by cloud providers as they expand their catalogue of applications and in the process, accelerate the time-to-market capability of organisations by removing overhead functions and related requirements.⁴⁴ Case study analysis highlights the transformative benefits that cloud can bring.

Case Study: Vidsy (www.vidsy.co)

"In the early days of Vidsy, we were building multiple products with a skeleton engineering team. With that level of resource available there was no question but to go with cloud, due to the managed aspect of the service and the quality that is delivered."

- C. Revett, CTO

Vidsy reflects how technology start-ups are adopting cloud for its transformative benefits. The Company utilises cloud for cost-effective virtual storage and in facilitating rapid deployment capability in an agile manner. Vidsy's business model connects a global network of creator talent with brands, to produce mobile-first advertising. The Company utilises crowd-sourced micro digital content that is stored in the Cloud and rapidly accessed by brands. This provides brands with access to a video-production platform that is bereft of administrative effort and cost.

Vidsy has adopted a micro service architecture with around 40 services in production at any one time, reflecting a strategy of single role-responsibility. The Company has utilised containers from the outset with cloud employed as the enabling transformative model for market entry, with multiple benefits cited: (i) low-cost of operations and storage; (ii) the utilisation of a smaller team than otherwise would have occurred due to cloud providing key IT and related infrastructure and its administration; (iii) rapid scalability, as the Company's storage continues to grow rapidly; (iv) maximising resource budget through the delivery of the adopted technical model with a smaller number of 10 technology/development resources, and; (v); an accessible scalable platform without performance constraints. Cloud is the primary enabler underpinning Vidsy's business model, facilitating the delivery of its core services while its cloud provider undertakes the provision of infrastructure and related functions. This is congruent with the results of this research across start-ups and SMEs where cloud has provided market entry, growth and differentiation that previously were not possible to the same degree.⁴⁵

⁴³ Ibid.

⁴⁴ LSE research

⁴⁵ LSE research, op cit.

6. Time to Market

“ We improved time to launch for a digital marketing campaign from two weeks to an average of two days. That’s more than seven times faster than our traditional environment. If a brand manager has an idea, he or she can implement it before the competition.”⁴⁶

- S. Yalamanchili, Digital Marketing Services Global Technical Manager, Unilever

One of the most cited benefits of cloud is the facilitation of rapid time-to-market through the delivery of new code; functionality; updates; major and minor releases; scaling, and experimentation. This highlights a further cloud tenet:

Cloud enables rapid time-to-market for the release of code, functionality, experimentation and other elements versus traditional technology modes.

Unilever reflects a global cloud implementation. The Company is the 100th largest business in the world in terms of market value, and generates US\$62 billion in revenues.⁴⁷ The adoption of cloud has been cited by the Company’s management as resulting in: *“A reduction in time to launch a project by about 75 percent. What used to take four days now only takes one day.”⁴⁸* In addition, the Company has utilised cloud for digital engagement and a further key benefit cited by numerous organisations-*experimentation: “We improved time to launch for a digital marketing campaign from two weeks to an average of two days. That’s more than seven times faster than our traditional environment. If a brand manager has an idea, he or she can implement it before the competition.”⁴⁹* Primary research highlights how cloud is underpinning and promoting rapid time-to-market delivery:⁵⁰

- 77% of organisations indicate that cloud had enabled more rapid code release.
- 95% of start-ups would be prohibited in entering the market if a traditional IT model was utilised versus cloud.
- Continuous delivery is one of the key drivers for cloud adoption amongst SMEs: 90% of managers place this attribute second only to cost in creating a key advantage for the adoption of cloud.
- 85% of small and micro firm managers indicate that rapid-market entry is a key technology-enabling requirement, versus 33% in 2013.
- In 95% of cases, cloud has reduced the need to collate metrics, with data provided in real-time in most cases by cloud providers.
- 95% of start-ups and 80% of enterprise customers are hiring developers only with a reduction in infrastructure, administrative and some support resources, accelerating the ability to test and deliver code rapidly.
- Enterprise customers are structuring their technology functions to incorporate and build-out development resource capability in particular around cloud.

⁴⁶ <https://aws.amazon.com/solutions/case-studies/unilever/>

⁴⁷ <https://www.unilever.co.uk/about/who-we-are/introduction-to-unilever/>

⁴⁸ N .Morgan, Enterprise Architect, Digital Marketing, ibid.

⁴⁹ S. Yalamanchili, Unilever, op cit.

⁵⁰ LSE Management Matters interviews with 20,000 firm managers in 35 countries; Productivity and technology research and interviews with UK enterprise customers https://www.yourreadybusiness.co.uk/wp-content/uploads/2017/08/J198-Vodafone-LSE_productivity_paper-Final.pdf; AWS Client interviews.

These attributes are reflected by numerous case-studies with large international organisations.

Case Study: KPMG (www.kpmg.co.uk)

"One of the biggest reasons by far for the implementation of cloud by customers today is agility. Of course cost provides the compelling business case but customers tell us they want servers in minutes, not weeks or even days and to be able to scale and launch quickly."

- C. Astley, Director, Cloud Practice Lead, KPMG UK

KPMG's Technology Practice in the UK provides services to a customer base that spans SMEs to global enterprises nationally and internationally. Case-study engagement highlights that the increased adoption of cloud resulted in a number of benefits to the Organisation: (1) reduced time-to-market for the delivery of solutions; (2) the disintermediation of IT administration, overhead and other components, with cloud providers undertaking the management of these; (3) a change in the skill base engaged in technology; (4) changes to organisational structures and governance; (5) lower existing technology costs and other operational costs by 20%-80% with an average observed reduction of 55%. The Company cited that cloud enabled *productivity enhancement* to occur for clients who faced similar challenges, with these following the initial more expedient benefits that accrue from lower costs.

Engagement indicated that sectors such as Banking, Finance, Insurance, and Retail are leading the large-scale adoption of cloud for productivity-enhancement, with organisations increasing their ROI on cloud investment through: (i) the reduction of technology/infrastructure costs and technology resource costs along with a greater throughout of effort; (ii) increasing the number of releases and updates in a defined time period with a lower cost base; (iii) utilising 'agility' to monetise a greater number of concepts from 'design-to-release' in days, versus weeks or months. Interviews highlight that technology providers are evolving their service and product offerings to meet demand for agility, rapid speed-to-market, lower IT, storage, application and access costs that cloud delivers. In the process, this is transforming the engagement model for technology providers. The delivery of services by major technology providers such as KPMG is customer-driven and reflects general trends in the utilisation of cloud: *"We know that we can provide the environment to provide lower cost, agility and other benefits; the key is having the people on the ground who can make this happen."*

7. Driving Productivity

“With greater automation and the tools to efficiently deliver software, our engineers are spending less time on repeated, mundane activities and focusing on creating innovative solutions. We can focus on building assets that really differentiate us.”

- R. Rai, Head of Digital Engineering, Macquarie Bank

Combined with best practices, cloud has removed ‘the tyranny of distance, cost, and infrastructure’. The use of cloud has rapidly proliferated from use by large enterprises to SMEs and MSEs.⁵¹ Today’s cloud has created a paradigm shift in business operations to enhance agility and productivity.⁵² This research highlights a further cloud tenet:

Cloud can enhance agility and productivity, particularly when combined with best management practices.

Cloud can result in revenue transformation through reduced infrastructure and organisational costs and the use of cloud infrastructure to generate additional revenue at a lower cost.⁵³ The ROI of cloud varies significantly and is influenced by many factors. Primary research indicates that organisations are obtaining an ROI from cloud investment ranging from 50%-500%⁵⁴ and that ROI improves over time as organisations embed cloud and adjust their practices.⁵⁵ Some organisations are reporting an ROI of over 600% seven years after cloud implementation.⁵⁶ Higher ROI is a function of best management practices and technology utilisation. The reduction of technology costs contributes to the maximisation of ROI: *“An entire digital environment can be set up in 10 minutes. Before, such tasks would take weeks or even months,”* (R. Heely, Head of technology, Macquarie’s Banking and Financial Services Group).⁵⁷ When aligned, these can enhance the organisation’s performance:

- Organisations innovating in the cloud are more productive, more inventive and are focusing on their business differentiators: 90% of enterprise customers are utilising the cloud to make productivity gain in 2018, versus 55% in 2013.⁵⁸
- In Media and Entertainment, FMCG, Telecommunications, and the Retail Sector, around 66% of firm managers in incumbent firms perceive their largest competitive threat is from digitally-enabled cloud start-ups, citing advantages they possess: rapid innovation; a high degree of agility; an all-digital culture; an environment of risk-taking and experimentation; the drive, determination and good practices of company leaders.⁵⁹

⁵¹ LSE research, and ITU: https://www.itu.int/en/ITU-D/Regional-Presence/AsiaPacific/Documents/Events/2015/July-Could-Computing/S8_Ismail_Shah.pdf

⁵² Attaran, M. (2017). Cloud Computing Technology: Leveraging the Power of the Internet to Improve Business Performance. Journal of International Technology and Information Management: V(26)1; Article 6; pp: 112-137. <https://scholarworks.lib.csusb.edu/jitim/vol26/iss1/6>

⁵³ <https://pdfs.semanticscholar.org/924e/c0f54403af000a00ba22216abebfd997ea0d.pdf>

⁵⁴ LSE research, of Enterprise firms

⁵⁵ <https://www.trackvia.com/blog/cloud-computing/the-amazing-roi-of-cloud-computing/>

⁵⁶ Ibid.

⁵⁷ <https://www.redhat.com/cms/managed-files/rh-macquarie-banking-digital-cloud-application-development-openshift-container-platform-case-study-f6460kc-v2-201704-en.pdf>

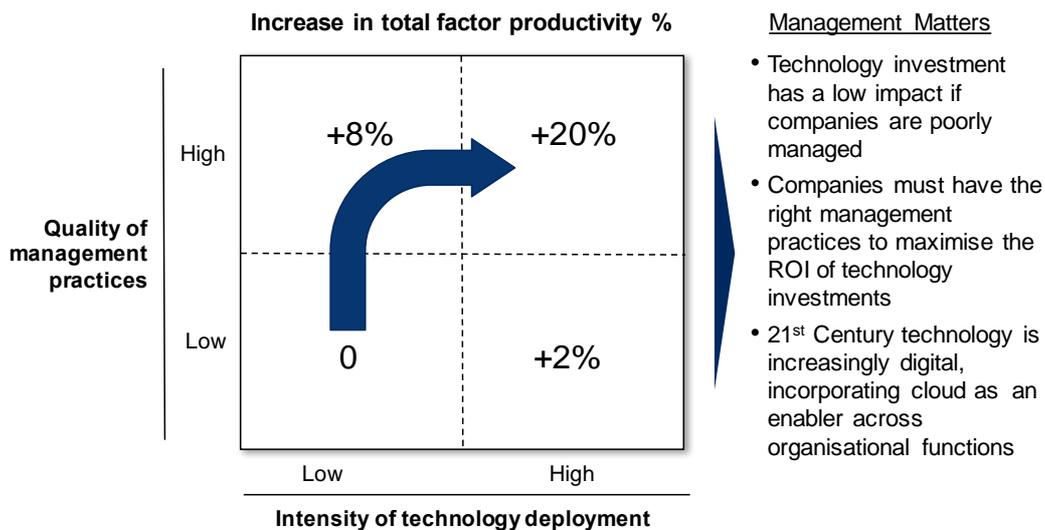
⁵⁸ LSE productivity and technology research and interviews with UK enterprise managers, 2015-2016.

https://www.yourreadybusiness.co.uk/wp-content/uploads/2017/08/J198-Vodafone-LSE_productivity_paper-Final.pdf

⁵⁹ LSE interviews 2016-ongoing with global CxOs and UK Enterprise Managers, extending IMD and Cisco’s interviews of 1,000 Executives in 15 industries: <https://www.imd.org/publications/articles/the-battle-for-digital-disruption-startups-vs-incumbents/>

- Organisations utilising best-management practices for production and operations (including lean, agile, just-in-time); workforce-enablement; talent-management, and technology and production, display a statistically significant correlation with performance: better management directly translates to improved productivity, profitability and sales growth.⁶⁰ Figure 1 summarises the returns that can accrue when best-management practices are utilised with intensive technology use.

Figure 1: Research results on increasing firm-level productivity



Organisations utilising technology without best management practices obtain on average 2% productivity gains; 8% productivity gains when only best practices are used, and 20% when best management practices are combined with leading technology utilisation. Examples of best management practices include:⁶¹

- ‘Lean’: Adopting basic principles across the organisation in addition to production and technology-tackling problems immediately when they occur; utilising teams to address root cause; exposing problems in a structured way; tracking performance in a continuously and communicating it to the relevant teams and wider; continuously monitoring performance to optimise it; undertaking regular performance reviews focusing on problem solving, and other areas.
- ‘Target Setting’: Goals are a balance between financial and non-financial; they are clearly set and cascaded to enable teams to deliver against them; goals are interconnected to provide context; performance measures are well defined, and others.
- Technology:⁶² There is a clear link between strategy, goals and targets and the technology deployed; technology has the required ‘flex’ to scale and support rapid growth or contraction; undifferentiated technology is delivered in the most cost-effective manner possible; technology permits flexible and collaborative engagement between resources without penalties for distance or location, and others.

⁶⁰ LSE Management Matters productivity research from 2007-ongoing with McKinsey and Co, covering 20,000 interviews in 35 countries. The largest management and company review study in the world.

⁶¹ Reflecting the LSE and McKinsey and Co’s Management Matters management practices utilised for 20,000 interviews to date in 35 countries with best practices from these correlating to enhanced productivity, sales growth and profitability.

⁶² The practice of ‘Technology’ has been widened by the Project Team to date, including from work commencing in 2007 to assess the link between ICT as an element of management practices.

- Talent Management: A high performance mindset is instilled and maintained; poor performers are moved on if negatively affecting performance; talent is actively developed and supported; a unique value proposition is created to encourage talented people to join, and to stay, and others.

Productivity can be enhanced through the utilisation of ‘heavy lifting’ by the cloud provider, with resources focused on differentiated effort; *“Our cloud provider takes care of undifferentiated heavy lifting, and that helps us focus on developing innovative features and delivering great value to our customers,”* (A. Kesavan, Software Engineering and DevOps Director, Xilinx).⁶³

A sector undergoing major digital transformation and enhancing productivity with cloud is Air Transport.⁶⁴ *“Connectivity and cloud are transforming air transport. The ability to undertake analytics and processing off-the-plane via cloud opens up powerful opportunities for safety, efficiency, and to monetise savings such as reducing unplanned maintenance that costs the industry billions every year. These will transform how operations are undertaken and could save a potential \$15bn annually globally by 2035,”* (A. Spouncer, Senior Director, Safety and Operational Services, Inmarsat). Enhanced bandwidth to-and-from aircraft from next generation satellites, concomitant to the use of cloud, offers significant productivity savings including the real-time use of data, performance metrics, weather information, and other information that can be streamed and processed via cloud-based networks.⁶⁵ Benefits include:

- Contributing to annual savings of US\$15 billion by 2035 through reductions in delays; lower fuel use with optimised route planning utilising enhanced data, weather and trajectory management;
- Airbus and Boeing positioning cloud as a core element of their services to drive efficiencies across their customer base. Airbus’ *Skywise Core* is a cloud based platform that integrates airlines’ operational, maintenance, and aircraft data into the cloud for access and analysis along with selected Airbus data to optimise operations without the need for additional infrastructure investments. This facilitates capturing 100% of the available data from aircraft with forecasts of 25% time savings and 2-5% fuel savings that could yield savings of US\$2.6-US\$6.5 billion per annum.⁶⁶
- Rapid supplier integration through cloud and enhanced analytics: for inventory can reduce airline fuel costs by around US\$1 billion annually by 2035 with a further potential US\$1.76 billion reduction annually for inventory.

The utilisation of cloud, technology and best management practices can deliver productivity and related transformative benefits encompassing *governance, time-to-market and development*:⁶⁷

- Time-to-market and corresponding governance have reduced for many enterprise customers by 500%-2000% through the use of cloud: *“We have seen internal governance processes and corresponding time to market drop from 9 months to 10 days: technology is no longer on the critical path,”* (C. Astley, Director- Cloud Practice, KPMG).

⁶³ <https://aws.amazon.com/solutions/case-studies/xilinx/>

⁶⁴ LSE research 2015-to date with airline managers in Operations, Technology, Flight Ops internationally.

⁶⁵ LSE. (2018). Sky High Economics. Chapter 2: Evaluating the Economic Benefits of Connected Airline Operations. <http://www.lse.ac.uk/business-and-consultancy/consulting/assets/documents/sky-high-economics-chapter-two.pdf>

⁶⁶ Data is key to airline efficiency. The Airbus A350 can transmit 400,000 parameters per flight, 60% more than the A380. The A320 model transmits 400 parameters per flight and the A330 around 1,500. <https://www.flightglobal.com/news/articles/big-data-capabilities-boost-manufacturer-aftermar-443055/>

⁶⁷ LSE Management Matters interviews with 20,000 firm managers in 35 countries; Productivity and technology research and interviews with UK enterprise customers https://www.yourreadybusiness.co.uk/wp-content/uploads/2017/08/J198-Vodafone-LSE_productivity_paper-Final.pdf; AWS Client interviews.

- Reducing average time to market for enterprises and SMEs by 70-90%; *“For impression tracking, we have decreased time to market by at least 70 percent, because what used to be an extra-large project in terms of IT has been reduced to nothing”*, (S. Keren-Haselkorn, Director of R&D, Kenshoo).⁶⁸
- Increasing development productivity by a factor of five compared to pre-cloud; *“Development, testing, and deployment all showed productivity gains in the neighborhood of 500%... A 500% improvement in inefficiency means that developers could perform tasks five times faster with cloud than with other in-house alternatives.”*⁶⁹

Case study analysis highlights these benefits.

Case Study: Monzo (www.monzo.com)

“From the start, the Company founders had a clear vision of the scale of the business and requirements. Anything but a public cloud strategy doesn’t seem to make sense. Also, for us it was about familiarity: it’s a relatively young workforce here who are digitally savvy and not familiar with the ‘old days’ of procuring hardware, so having a virtual server and an API call away is the norm.”

- C. Evans, Platform Team Lead, Monzo

Digital transformation is a continuous process in the Banking and Finance Sector.⁷⁰ Cloud adoption concomitant to legislation such as Open Banking, PSD2, and GDPR are continuing to foster a new bank climate encouraging new entrants and an API-driven paradigm in which agility and on-demand-access to infrastructure, tools and applications is the norm. This is resulting in FinTech start-ups rapidly coming-to-market.⁷¹ Cloud is increasingly being adopted to facilitate agility in this sector.

Monzo is an example of a company utilising cloud as a core strategic tool. The Company is a UK based start-up digital-only bank that provides current account services and a credit card. The Company has grown to over 300 employees and leverages a cloud-driven digital businesses to obtain a number of benefits: (i) a lower number of resources dedicated to managing overhead functions, with these functions undertaken by the Company’s cloud provider; (ii) technology teams focused on the development of code that drives functionality; (iii) open-source utilised wherever possible; (iv) container utilisation, with serverless under review for future applicability.

Monzo’s market entry and operational model is predicated on cloud adoption that will be utilised for further geographic expansion. The key benefits of cloud adoption include: agility, encompassing the rapid development and release of code for functionality, enhancements, and fixes; speed-to-market, and lower costs; *“Agility can be measured in minutes versus weeks when we go to market with anything.”* These reflect productivity enhancement that the Banking Sector in particular has been adopting in the release of an increasing portfolio of digital products and services with speed-to-market continuing to emerge as a key benefit for the Sector for the adoption of cloud.⁷² Challenger banks in particular may utilise cloud, including cloud-based core banking platforms, to reduce entry costs and time-to-market. These banks, along with smaller banks that have lower IT budgets and less in-house expertise, could arguably benefit from cloud the most.⁷³

⁶⁸ <https://aws.amazon.com/solutions/case-studies/kenshoo/>

⁶⁹ R. Perry, IDC at: https://media.amazonwebservices.com/IDC_Business_Value_of_AWS_Accelerates_Over_time.pdf

⁷⁰ Misra, S.C., and Doneria, K. (2018). Application of cloud computing in financial services: an agent-oriented modelling approach. *Journal of Modelling in Management*. V(13)4; pp.994-1006. <https://doi.org/10.1108/JM2-12-2017-0131>

⁷¹ Ibid.

⁷² Hon, W.K., and Millard, C. (2018). Banking in the cloud: Part 1 – banks’ use of cloud services. *Computer Law & Security Review*. V(34)1; pp: 4-24.

⁷³ Ibid

The productivity benefits of cloud for an organisation are observed across operations, technology and workforce-enablement:⁷⁴

- Release cycle times have reduced by 50-100% as major code releases occur in shorter frequency than pre-cloud.
- Development times for code have reduced by 60-80%.
- Technical team reductions in SMEs reflecting two average size teams that denote larger and smaller firms: (i) a reduction of 400% from an average of 8-10 resources to 2-3, and; (ii) a 100% reduction to 4-5.

Organisational productivity has been cited by leadership teams as a particular area of focus following cloud adoption: *“Once we are out of production, we must think about supporting that application. That, in addition to cloud has forced us to think differently about how we organise as a business, how we treat our engineers, and how we hire,”*⁷⁵ (G. Haus, SVP- Retail, Direct Bank Chief Information Officer, Capital One). The productivity benefits of cloud are observed across organisational areas:⁷⁶

- Server ‘spin-up’ reductions of over 1000%, reduced from 10+ weeks observed from in-house mobilisation to minutes once established with a cloud provider.
- Savings of 90% in infrastructure maintenance costs.
- A reduction in enterprise technology and related costs of 20-80% with an average of 55%.
- A reduction in firewall costs by 70-95%.
- Administrative costs reduced in enterprise customers by 10-20% through the adoption of integrated cloud across travel and expenses (T&E), HR, and other central functions.
- Reducing the cost of footprint by 50% for large scale data-centric enterprises through cloud-managed data protection and redundancy across multiple territories.

An increasingly key focus in enterprises is employee wellbeing, working practices and the retention of talent.⁷⁷ Cloud for Cloud can deliver productivity enhancement in a number of areas:

- Consolidated workforce productivity improvement of 25-50% through collaboration; workforce reduction; employee ‘well-being’; supplier-integration and common document ‘real-time’ virtual engagement’;
- An 20% productivity uplift through greater employee satisfaction with the use of ‘on demand’, ‘from anywhere’ access to information combined with greater collaboration agnostic of location.
- Mobile cloud optimisation has increased remote working productivity by 25% through a reduction in the use of alternative tools and options.
- Decision making turnaround times have been reduced by 50-70% with lower cost-decisions for many cloud functions localised without the need for additional approval.

⁷⁴ LSE Management Matters interviews with 20,000 firm managers in 35 countries; Productivity and technology research and interviews with UK enterprise customers https://www.yourreadybusiness.co.uk/wp-content/uploads/2017/08/J198-Vodafone-LSE_productivity_paper-Final.pdf; AWS Client interviews.

⁷⁵ G. Haus. Gill Haus, SVP- Retail, Direct Bank Chief Information Officer, Capital One: <https://www.forbes.com/sites/peterhigh/2018/02/26/a-capital-one-cios-take-on-blockchain-ai-innovation-labs-and-more/#27cfebb54c77>

⁷⁶ CIO interviews: 300 medium to large enterprises, <https://www.businesswire.com/news/home/20090901005446/en/Important-New-Research-Innovators-Beating-Recession-Pulling>; Interviews UK Enterprise and SME Managers on Technology ROI <https://www.information-age.com/enabled-best-practices-crucial-impron-123468580/>; LSE research, op cit.

⁷⁷ Grous, A. (2016). The Power of Productivity. An Assessment of UK Firms and Factors Contributing to Productivity Enhancement. LSE Report. http://eprints.lse.ac.uk/69181/1/Grous_The%20power%20of%20productivity_report-LSE_2016.pdf

- HR and employee-related digital tools increase of 50-80% as more services migrate to cloud and employee uptake increases including for T&E, HR, and other functions.
- A 25% lower total indirect costs per traveler through the use of cloud-based integrated end-to-end T&E solutions.
- HR personnel costs reduction of 10-20% with fewer resources required to manage some cloud-migrated services and more self-service occurs for employee engagement.

8. Reducing the Cost of Failure

Eighty-five per cent of organisations report that cloud has facilitated an enhanced ability to ‘test’ concepts and reduce the chance and cost of failure. This defines a further tenet of cloud:⁷⁸

In lowering the barriers to entry, cloud has also reduced the cost of failure, with a greater number of companies experimenting and exploring options not previously possible.

A number of high profile cloud-adopting organisations cite this as a key benefit of cloud:

Netflix: *"The other thing is that the cost model is really nice for us. You pay for what you use. That allows us to do a lot of experimentations...I can now spin up an entirely new set of machines in the tens, or hundreds or thousands in an afternoon and chunk through my data and see if we've done better, and I only pay for the portions I use. It allows us an amazing amount of freedom in experimentation."*⁷⁹

- D. Hahn, Netflix Senior Engineer

Ocado: *"We wanted greater agility for our engineers; to be able to experiment faster, to be able to deploy into production faster...our engineers wanted to be able to run experiments before we even knew if we wanted the infrastructure to stand it up long term. Our engineers can go from conceiving an idea to having it deployed in production in under an hour."*⁸⁰

- P. Clarke, CTO, Ocado

Capital One: *"The ability to provision on the fly is critical to our productivity and speed to market,"*⁸¹

- R. Alexander, CIO, Capital One

The rapid delivery of services and experimentation that cloud enables have been highlighted by case-study analysis of cloud-enabled organisations.

Case Study: A Cloud Guru (www.acloud.guru)

"We have zero ops staff. Our cloud provider manages infrastructure. We have only ever employed developers and we have a test-driven strategy that also sits on top of cloud. We can create, test and experiment fast in a manner that is not possible without cloud."

- S. Kroonenberg, Co-Founder

A Cloud Guru is a serverless cloud start-up that provides online cloud training with certification courses in public cloud for Amazon Web Services, Microsoft Azure, Google Cloud, and Linux. In-company analysis highlights that the Company has been cloud native from the outset, and utilises serverless cloud. A smaller number of organisations have embraced serverless cloud to date in comparison to the use of containers, but its use has grown 75% between 2017-2018, versus a 36% growth rate for containers over the same period, and is expected to be adopted by a larger number of organisations.⁸²

⁷⁸ LSE interviews: CxOs, 2016-2017, op cit.

⁷⁹ D. Hahn, Netflix Senior Engineer, in: <https://www.computerworlduk.com/cloud-computing/how-netflix-moved-cloud-become-global-internet-tv-network-3683479/>

⁸⁰ P. Clarke, CTO Ocado: https://youtu.be/Bp82g_TuYyg

⁸¹ R. Alexander, CIO Capital One: <https://youtu.be/OE90-ExySb8> and

⁸² Rightscale. (2018). State of the Cloud Report.™

https://www.suse.com/media/report/rightscale_2018_state_of_the_cloud_report.pdf

A Cloud Guru has a global footprint in 170 countries and employs 80 people to design and deliver its training courses. Cloud has been an enabler for market entry with a number of benefits cited: (i) accelerated time-to-market from business concept to go-live; (ii) low operational overhead; (iii) rapid scalability; (iv) no infrastructure to manage. The Company's cloud footprint includes 287 Lambda Functions and 19 micro-services, with daily usage of 6.49 million Lambda Invocations, 1.85 million API requests and 3.8+TB of data via CloudFront. No costs are incurred for the footprint or micro-services. The corresponding costs incurred for the Lambda Invocations and API requests are US\$579/month and US\$149/month respectively. The ability to access favourable cloud payment terms has been a further enabling factor for the Company, reflecting similar market feedback by other cloud-enabled start-ups, positioning this as a key aspect of market entry and growth: *"We also had a two-year payment holiday from our cloud provider letting us grow before we needed to fund anything, but even since we have seen payment reductions."*

The benefits conferred by cloud combined with a low-cost operational model were key to the Company's formation. Serverless cloud was selected as this was congruent with the strategic and operational requirements of the Company. This commenced with more highly coupled functions reading to-and-from the same database before a change was made to the development of micro services. Serverless has enabled the Company to be vendor-agnostic and architect across different cloud environments. The productivity-enhancing benefits of serverless cloud include: (i) greater ROI from the cost base through the faster delivery of revenue-generating courses from concept to upload; (ii) support of the applications directly by the development teams; (iii) hiring development resources versus IT Support and related functions to focus on code writing capability.

Management practices were optimised to complement the efficiency-enabling benefits of serverless cloud: best development practices were adopted; high-quality testing occurred; an *automation culture* was implemented, close and consistent communication occurred between teams. A major cited benefit of cloud was the ability for teams experiment, test and release code and features rapidly: *"Our business it to help people get certified for cloud. Through a cloud-native strategy, we are nimble and respond to market conditions adapting as required. We would not be here as we currently are today if we were limited to a traditional IT model."*

9. Workforce Enablement, Resources and Challenges

Cloud has transformed organisational structures, support, and workforce enablement for employees.⁸³ One of the major areas of concern amongst managers in cloud-enabled organisation is the ability to recruit adequately skilled cloud resources.⁸⁴ This is likely to be exacerbated as the adoption of emerging areas including serverless accelerate, with many organisations commencing cloud-skill recruitment earlier than occurs for other required technical areas. Where this is a persistent issue, some organisations are up-skilling existing technical resources.⁸⁵ Major challenges include:

- In 66% of cases, a lack of cloud skills has impacted revenue-generation or customer retention.
- 90% of managers have identified a lack of cloud AI and ML skills as a key barrier to developing these areas further.
- One-third of Enterprise and SME managers indicate that they have struggled to recruit the required cloud skills and this has impacted 10-15% of projects or product development.

The use of cloud has enabled workforce transformation in a number of areas:

- 90% of start-up and micro-firms do not utilise dedicated customer support in the initial growth phase, with developers monitoring solutions and directly providing support where required, with cloud cited as the enabler for this approach versus a traditional IT model.
- 90% of all organisations spend between 5-10% of development time on run-the-engine versus a significantly higher proportion in a non-cloud environment.
- 70% of managers see cloud security as a critical theme that requires attention by industry participants, to ensure that appropriate safeguards exist for the continued growth of cloud.

The use of cloud by large complex national enterprises highlights the requirement for accompanying best management practices. The transformation enabled by cloud can be significant when this occurs.

Case Study: NHS Business Services Authority (www.nhsbsa.nhs.uk)

"We have a cloud- first strategy. Our drivers for cloud adoption were flexibility and the speed that we could get applications out there and the cost-savings that we could make. We used to take 8 months to do a single deployment, such as for the European Health Card Service that we run, and we can now do this in 15 minutes. Time to market has dramatically improved."

- C. Suter, Lead Cloud Architect

The NHS has annual expenditure of £123 billion and employs around 1.5 million people in the UK including: 103,430 doctors, 285, 893 nurses, 21, 597 midwives, 132,673 therapeutic and technical staff, 19,722 ambulance staff, 21,139 managers, and 9,974 senior managers.⁸⁶ Over 1 million patients are treated every 36 hours, with 16.2 million hospital admissions occurring annually, and 89 million outpatient attendances.⁸⁷ The NHS Business Services Authority (NHSBSA) provides back-office support for activities for NHS employees, hospitals and some patient functions encompassing: (i) prescription

⁸³ LSE interviews with Technology Managers engaged in cloud deployments and applications covering over 0.25million customers per annum and deployments in multiples of this; LSE Management Matters interviews with 20,000 firm managers in 35 countries.

⁸⁴ Ibid.

⁸⁵ Ibid.

⁸⁶ <http://www.nhsconfed.org/resources/key-statistics-on-the-nhs>

⁸⁷ Ibid.

processing; (ii) scanning and digitising of patient records; (iii) pension payment administration including payments from hospitals to staff; (iv) payments for GPs and some other outgoing payments; (v) running the EU Health Card. The Organisation is adopting cloud to transform how it engages with the NHS's employees to provide services, and how GPs and other medical resources can optimise their engagement with the NHS to obtain both patient records and for other functions. This also encompasses dynamic changes that occur as a result of on-line activity: *"We often get spikes of traffic to our site from references in the media, but we utilise auto-scale and never have to worry about not being able to cope."*

The NHBSA employs around 20,000 people and migrated to a cloud environment in 2016. Company engagement highlights that cloud has delivered efficiencies across multiple areas: deployment times have decreased in some cases from 8 months to 15 mins; micro services are now routinely utilised; cost savings of over 80% are being reported in areas where greater self-service and automation is occurring through cloud enabled platforms and applications; contact centre build has occurred in 2 weeks with automated response by a bot accounting for over 40% of calls resolved, and new releases, with enhancements and other functionality released multiple times per week in an agile manner. The NHSBSA utilises containers with its cloud provider delivering the infrastructure, licenses, and other technical overheads required via a pay-as-you-go model: *"The impact of cloud is evident both on NHS employees and for the health practitioners that deal with it at many engagement points. The technology has made a difference on how they work, for the better."*

10. Self-Assessment for Aligning Technology and Management Practices

This research extends a management practices assessment methodology that quantifies the quality of practices across firm functions.⁸⁸ This research has defined a self-assessment matrix that provides encompasses four organisational areas: (1) Organisational Attributes; (2) Management Practices, Operations, Performance and Targets; (3) Talent Management; (4) Technology Practices. The enclosed template encompasses each of these areas and the inclusion of a number of practices defined within each. A scale ranging from 1-5 has been defined against poor to strong practices respectively. Self-assessment can occur through the assignment of a score against each practice e.g. for 'Location', a firm whose managers utilise a responsive strategy including multiple options, should be assigned a high score such as '5'. Mid-point scores reflect practices that are believed to reside between two strengths e.g. in the case of 'Location', a 4 represents practices that are believed to reside in between average and high quality (green and blue respectively).

At the completion of the self-assessment, the total score is divided by 18 (the total number of practices) to derive an average overall score for the organisation e.g. a total score of 50 yields an average of organisational score of 2.8, denoting a firm operating marginally below 'average practices', depicted by green.

⁸⁸ LSE and McKinsey and Co research on management practices, 2005-present. The author was part of the LSE team extending this into multiple sectors and undertaking both in-company and remote (telephone) interviews and in situ analysis of management practices, ICT and organisational functions.

Self-Assessment to Identify the Firm's Profile to Align Management Practices and Technology

Self-Assessment: Attributes of Best-Practice Firms

Score	1	2	3	4	5	
1. Organisation Attributes	Location	Inflexible. Locked in. Little consideration of market dynamics or ability to be responsive.	Responds to the market but cautiously. Does not embrace all options but is seeking to maximise allocation strategy.	Flexible, with responsive strategy including adopting multiple options e.g. fixed and remote working		
	Technology Adoption	Slow cycle to adopt new technology. Long decision process. Often uses limited array of technical options.	Reviews and adopts some technology, but this is often limited to centrally defined option or narrower range.	Flexible, with responsive strategy that adopts the relevant technologies rapidly to develop the business.		
	Workforce Type	Workforce structure is rigid, with inflexible practices that allow additional skills and types of workers being utilised	Some flexibility exists in the workforce mix utilised. Barriers are eventually overcome.	Optimal workforce utilised with flexible responsive action taken to assemble required skills to support strategy		
	Decision Making	Slower decision making with multiple layers, or bottlenecks or single point. Less responsive and little delegation.	Decision making occurs with some responsiveness. Some feedback is sought and some delegation occurs..	Delegated decision making to multiple levels with no bottlenecks. Inputs actively sought and decisions made quickly.		
2. Management Practices: Operations, Performance and Targets	Operations Management	Few modern techniques have been introduced, or have been introduced in an ad-hoc manner because others were not using them. Workplace organisation is not optimised for the flow of products or services.	Some aspects of lean processes or best practices have been introduced to reduce costs, but the company has not adopted all best practice processes.	Business processes have been transformed to meet the needs of the business and its objectives including costs. The processes are best practice for the industry with all major aspects of modern/lean introduced in a formal way such as agile development and just-in-time. Leading practices such as automation, flexible resourcing, support systems, attitudes and behaviour exist.		
	Performance Monitoring	No process improvements are made when problems occur. Little standardisation and few protocols exist e.g. different staff have different approaches to the same issue).	Improvements are made in workshops involving staff to improve performance in their areas. Protocols have been created but are not commonly used because they are too complicated to monitor adequately	Exposing problems in a structured way is integral to individuals' responsibilities and resolution occurs as part of normal business processes rather than by extraordinary effort/teams. Employees know and utilise practices.		
	Performance Tracking and Review	Measures tracked do not indicate directly if overall business objectives are being met. Tracking is an ad-hoc process - certain processes aren't tracked at all. Performance is reviewed infrequently or in an un-meaningful way e.g. only success or failure is noted.	Most key performance indicators are tracked formally. Tracking is overseen by senior management. Performance is reviewed periodically with both successes and failures identified. Results are communicated to senior management. No clear follow-up plan is adopted.	Performance is continuously tracked and communicated, both formally and informally, to all staff using a range of visual management tools. Performance is continually reviewed, based on indicators tracked. All aspects are followed up ensure continuous improvement. Results are communicated to all staff		
	Types of targets	Goals are exclusively financial or operational. Management's main focus is on short term targets with either too easy or impossible to achieve. Managers' low-ball estimates to ensure easy goals.	Goals include non-financial targets, which form part of the performance appraisal to top management only - they are not enforced throughout the rest of the organisation. There are short and long term goals for all levels of the organisation and are set independently without necessarily linking to each other.	Goals are a balance of financial and non-financial targets. Senior managers believe the non-financial targets are often more inspiring and challenging than financials alone. Corporate goals focus on shareholder value and increase in specificity as they cascade within business units defining individual performance. Long term goals are translated into short term targets that act as the "staircase" to each long term goal. Goals are demanding for all divisions and grounded in solid economic rationale.		
	Achieving targets	Failure to achieve agreed objectives does not carry any consequences	Failure to achieve agreed results is tolerated for a period before action is taken.	A failure to achieve agreed targets drives retraining in areas of weakness or moving individuals where their skills are appropriate.		

Self-Assessment to Identify the Firm's Profile to Align Management Practices and Technology (cont'd)

Self-Assessment: Attributes of Best-Practice Firms

Score	1	2	3	4	5	
3. Management Practices Talent	Talent Priority	Senior management does not communicate that attracting, retaining and developing talent through out the organisation is a top priority.	Senior management believe and communicate that having top talent throughout the organisation is key way to win.	Senior managers are evaluated and held accountable on the strength of the talent pool they actively build. The company strives to outperform the competitors with ambitious stretch targets with clear performance accountability and rewards.		
	Employee Performance	Poor performers are rarely removed from their positions. People are rewarded equally irrespective of performance level.	The company has an evaluation system for the awarding of performance related reward. Suspected poor performers stay in their position for a few years before action is taken. People are promoted on the basis of performance.	Performers are moved out of the company to less critical roles soon as weaknesses identified. Top performers are identified, developed and promoted.		
4. Technology Practices	Technology culture	No review of technology applications, with low-cost often dictating options. Lower alignment between functionality and strategy.	Intermittent review of technology with some open discussions of options, aligning with strategy in some areas.	Regular review of technology and applications occurs, with rapid adoption of best-available. Alignment between technology and strategy.		
	Data Access and Use	Information is not readily accessible. When it is available, it is often not useable without further effort. Access to information is time consuming and requires permissions or workarounds to transform data.	Some information can be accessed from anywhere. Data can require further enhancement and lose face-to-face collaboration to improve.	Data access occurs from anywhere with information up to date, easily useable and without requiring considerable permissions.		
	Rapid changes in IT including policies	Scaling or changing IT and decommissioning new IT is a low process that requires hardware and software changes with procurement and/or other processes. Policy changes are low.	Scaling IT includes mix of low and fast processes. Capacity and software often follows longer approval processes with policies often posted internally.	IT can be configured, scaled and deployed rapidly. The processes are fast with cost-effective solutions available. Policies can be configured.		
	Security and data access	Files and information are stored locally on computers or intermittently. IT policies are not uniform or applied consistently. IT is low to be updated or reconfigured.	IT is generally deployed expediently. IT configuration occurs at moderate speed with security policies normally up to date.	IT can be configured, scaled and deployed rapidly. The processes are fast with cost-effective solutions used. Policies are configured quickly and security is best practices.		
	Business continuity	No disaster recovery in place. In the event of a disruption, employees may not be able to access files or information immediately, or some data may be lost. Recovery may be prolonged and the impact significant.	Disaster recovery is in place but the speed of access to information may vary. Recovery may take moderate time with some impact on near-term access and files.	Disaster recovery is in place and can be rapidly executed. Access to data is without interruption with employees knowledgeable in process, and information on DR in intranet/distributed.		
	IT maintenance	Licensing is based on individual renewals of solutions and involves multiple approvals. IT installs new programs and undertakes lengthy configuration settings for each business area.	IT maintenance occurs relatively quickly but involves some manual effort to manage and some automation. Licenses and other areas require approvals to do expansion.	Additional users, programmes, services and areas is a quick process with one-stop effort. As a result, resource acquisition and release can be dynamically and leverily managed.		
	Collaborative information	Information is not easily available or shared with little or no ability to access, update and version control documentation. Person-to-person sharing is the norm.	Information is shared relatively quickly but is not always accessible by everybody. Updating documents results in new versions. Collaboration is encouraged but not reinforced.	Employees can share files and documents quickly reducing applications or generation of multiple versions of the same document. Version control is visible and automatically managed.		

Conclusion

The adoption of cloud continues to transform organisations. Decision times, resources, infrastructure and costs have reduced while experimentation, innovation-rates, product-development and time-to-market have accelerated. Organisations adopting best management practices along with an intensive use of technology can obtain around a 20% improvement in productivity.

Digitally-native organisations and those that adopted an 'all-in' cloud strategy displayed the greatest agility, ROI, equilibrium between resources and roles and an innovation culture. For many start-ups in particular, an all-in cloud strategy was frequently the enabler for market entry, while larger incumbent firms are increasingly perceiving these firms as potential competitors and not reserving this for other peer firms: a recent shift in market dynamics.

The use of a self-assessment template can further assist firm managers to undertake an expedient high-level analysis of the firm's practices across major areas, including technology. The adoption of cloud can in many cases provide remediation for lower-scoring areas that require addressing and in the process, confer benefits to the organisation.

A key result from this research is that the benefits of cloud computing are maximised when combined with sound management practices: implementing or enhancing one without the other can suppress the potential enhancements to the organisation often from significant investment and effort.

Disclaimer

This research represents data and analysis undertaken through both primary and secondary investigation. The data are provided to illustrate the results from areas investigated. Any reliance on the information occurs at the risk and discretion of the user. No responsibility is taken for the use of information, with users encouraged to undertake their own analysis to validate any decisions.