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Master Program in Statistics and Information Management

The impact of cloud computing on startups' success in Portugal: a quantitative study

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Dissertation presented as partial requirement for obtaining the Master's degree in Statistics and Information Management

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THE IMPACT OF CLOUD COMPUTING ON STARTUPS' SUCCESS IN PORTUGAL: A QUANTITATIVE STUDY

by

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Dissertation presented as partial requirement for obtaining the Master's degree in Statistics and Information Management, with a specialization in Information Management and Analysis

Advisor: Professor Nuno António

November 2021

DEDICATION

To my partner in life.

ACKNOWLEDGMENTS

To Professor Nuno António for not giving up on me and for not letting me give up on this adventure.

To my mum Anabela for her perseverance in providing the opportunities that brought me here.

To the family I chose, Luísa, Nuno, and Joana, for believing in me and always cheering me up.

To Tommy for putting a smile on my face when I needed it most.

To all my family, without whom I'd have finished this sooner, because of our never-ending lunches and FaceTime calls.

ABSTRACT

In opposition to traditional on-premises architectures, the consumption of cloud computing services has risen exponentially over the last decade, led by Amazon Web Services, Microsoft Azure, and Google Cloud. Simultaneously, Portugal has become an attractive hub for young entrepreneurs from all across the world, aiming to launch and grow their startups motivated by the high quality of education and the booming ecosystem of accelerators and incubators. This dissertation aims to understand the interaction between these phenomena, studying the impact of cloud computing on the business success of Portuguese startups through a quantitative analysis. Leveraging Intricately and Crunchbase as data sources, this study hopes to depict the relationship between cloud computing consumption and the success of a startup, based on its funding round status.

KEYWORDS

Cloud Computing; Startups; Business Success; Portugal

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LIST OF ABBREVIATIONS AND ACRONYMS

AWS	Amazon Web Services
CB	Crunchbase
CRM	Customer Relationship Management
CSR	Corporate Social Responsibility
ERP	Enterprise Resource Planning
GCP	Google Cloud Platform
IMF	International Monetary Fund
NIST	National Institute of Standards and Technology
OLS	Ordinary Least Squares
SCM	Supply Chain Management
VPN	Virtual Private Network

1. INTRODUCTION

Inspired by earlier successes and misfortunes in Silicon Valley, London, and Tel-Aviv, Portugal has become a fertile ground for startups to arise and thrive for some select few. The European Entrepreneurial Region award was given to the city of Lisbon in 2015, as investors from across the globe flock to the city due to its tempting living and infrastructure expenses, inexpensive but highly-skilled human resources, and enjoyable weather conditions (Parracho, 2017). The Portuguese business ecosystem, populated by many startups, incubators, and venture capitalists, has promoted a competitive landscape in which some startups have succeeded, despite the unattractive corporate fiscal policies and recent systemic crises (Peixoto, 2017).

Just as the Portuguese startup ecosystem was recovering from more than a decade of austerity, the 2020 events diverged it from the path of rehabilitation, being evidently and unmistakably marked by the COVID-19 pandemic. In April, the International Monetary Fund (IMF) warned that the global economy was about to suffer the worst downturn since the Great Depression, and consequences three times worse than those of the 2009 Great Recession (IMFBlog, 2020). While most countries in the developed world face health and financial challenges, some industries are being more affected than others.

In fact, the first quarter of 2020 saw a 37% increase in spending on cloud infrastructure services, compared to the homologous quarter in 2019, reaching the figure of USD 29 billion (Synergy, 2020) as predicted by Gartner in late 2019 (Gartner, 2019). Moreover, this research study aims to understand the impact of cloud computing on the success of startups in Portugal, as this is the fringe of companies with weaker foundations and more significant challenges to their business continuity.

1.1. BACKGROUND AND PROBLEM IDENTIFICATION

The second half of the twentieth century was one of significant technological development, which enhanced the popularization of computers and later internet usage. These changes paved the way for the data gathering techniques that we know today in the age of globalization and the dissemination of online platforms that have led to larger data sets. The amount of data that needs to be gathered, analyzed, and processed increased the need for bigger storage and more flexible processing units. Cloud computing was born out of this need. Initially seen as simple data centers, it is now known as computing power that works without direct management (Forbes, 2018).

Cloud computing is speculated to be highly beneficial to companies, and startups in particular, as it claims to provide unparalleled business agility through rapid elasticity and on-demand services, as well as cost efficiency by preferring pay-as-you-go models. Its scalability and resilience promise to give startups the foundations to thrive and the resources to innovate (Al-Ruithe et al., 2017).

Cloud computing as an industry can be divided into three main categories: public, private, and hybrid cloud. Although they are distinct, there is a certain leveling between them, namely in terms of maturity. Smaller companies tend to prefer the public cloud and move to private cloud as they grow.

However, others see the best results come from the merger of public and private, also known as the hybrid cloud. The public cloud is the one provided by other companies, which have an extensive service catalog, allowing contractors to minimize internal IT operations costs by having their resources highly automated.

Nonetheless, the public cloud can have low control and security issues that scare-off companies who have the means to have a private cloud (Changchit et al., 2016). On the other hand, the private cloud has high implementation and maintenance costs, requires operational cloud skills, and leaves the catalog evolution to the company instead of the cloud provider. The only benefits of the private cloud are the control of the environment and its security. As an alternative, companies who can afford it might prefer a hybrid cloud, trying to grasp the benefits of both public and private cloud. The hybrid cloud is characterized by its flexibility; however, this is something that only larger firms can make use of (Hsu et al., 2014).

The public cloud industry is led by three major companies, Amazon, Microsoft, and Google - their services, Amazon Web Services (AWS), Microsoft Azure, and Google Cloud Platform (GCP), respectively, are among Forbes' highest-grossing businesses. With AWS taking the first place in terms of revenue, with values higher than the sum of both Azure and GCP, it is not the one that prioritizes hybrid cloud (Fan et al., 2015). Although all are competing in the same industry, each has its strengths. AWS's focus on a vast toolset is unmatched by Azure, which prefers to enhance its interoperability between data centers, thus focusing on hybrid cloud. The latest trends in data science, artificial intelligence, machine learning, and data analytics are the core strength of GCP (Azeemi et al., 2015).

The concept of 'startup' is debatable, and while some authors define it based only on the age of a company, others consider more attributes. The same can be said for the concept of success and failure. Regarding the specific case of Portugal, Peixoto (2017) has concluded that Portuguese entrepreneurship has strong ties with culture rather than international scope. Therefore, we expect startups focusing on national business to be more common than those with worldwide ambitions.

Like case studies in other countries, the Portuguese scenario is expected to have its specifications, namely economic aspects. Somewhat inspired by the work of Ferri et al. (2017), this work aims to understand the major attributes of a startup in the analysis of its success and its correlation with the world of cloud computing.

1.2. Study Objectives

The purpose of this study is to understand the impact of cloud computing usage in Portuguese startups. The main research question is if cloud utilization is related to the level of success of startups in Portugal.

This relation will be proven through the analysis of several variables with the help of an econometric method. Concerning the specific objectives, this study aims to understand the struggles behind startups' survival and how cloud providers can better equip them for that.

1.3. Study relevance

Despite the widely recognizable notion that startup firms are stimulating forces of economic prosperity, fostering employment and innovation, the overwhelming majority of them tend to fail within their first years of existence (Krishna, Agrawal, and Choudhary, 2016). Many authors have tried to understand the reasons behind this, almost always through case study analyses. Additionally, we observe a lack of consensus about the success/failure factors of startups, both worldwide as well as in Portugal.

Simultaneously, new ground-breaking technologies, such as cloud computing, artificial intelligence, machine learning, and blockchain, are becoming paramount to the way startups operate today, both when it comes to their products per se as well as the way they engage with their customers. However, very little research has been performed to understand the correlation between these two simultaneous phenomena.

Some studies resemble the research proposed here. However, none is specific to the Portuguese scenario on cloud computing. Therefore, while considering the works of Ferri et al. (2017, 2019) and Adane (2018), this dissertation retrieves some of the actions taken by these authors while updating the variables under study. This study also creates a quantitative overview for the Portuguese case rather than following a case-study approach.

2. LITERATURE REVIEW

2.1. CLOUD COMPUTING

Although it is not an entirely new concept, authors have struggled to agree on a universal or standard definition of cloud computing. Having evolved through late developments in hardware, virtualization technology, distributed computing, and service delivery over the internet, cloud computing has been defined by different authors and institutions, both from a business, technical, and academic perspective (Oliveira et al., 2014; Adane, 2018).

Despite the considerable offering of definitions of cloud computing, most are based on the definition provided by the National Institute of Standards and Technology (NIST) of the United States of America, which characterizes it as a 'model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources that can be rapidly provisioned and released with minimal management effort or service provider interaction' (Caldarelli et al., 2016; Changchit et al., 2016; Hsu et al., 2014; Carcary et al., 2014; Adane, 2018; Fortes et al., 2016). This definition was designed to facilitate comprehensive analyses between cloud services and deployment strategies and constitute a starting point for debate on cloud computing and its global utilization. Furthermore, the NIST definition comprises five fundamental characteristics of cloud computing: "on-demand self-service, broad network access, resource pooling, rapid elasticity or expansion, and measured service" (Caldarelli et al., 2016).

Even though NIST's definition is the most widely adopted, some authors have broken down the concept of cloud computing further in an attempt to complement NIST's more conceptual definition. Cloud computing has been defined as a bundle of virtualized services flexibly offered by a firm/provider to potential users who outsource some or all functions of their technology infrastructure in exchange for various benefits. These services include basic computer functions, such as network management and data storage, as well as more complex tasks, like the processing of sensitive data, machine learning algorithms, and application services (Caldarelli et al., 2016; Fortes et al., 2016).

Cloud computing has come to revolutionize the tech industry by introducing pay-as-you-go pricing, where consumers are billed by actual consumption, similarly to domestic electricity billing, which they can scale up or down as they please (Low et al., 2011). The fact that these disembodied IT capabilities (delivered as a service) are all demanded, supplied, and consumed over the internet in real-time has contributed to the democratization of the tech industry (Sultan, 2010).

The concept behind this is that traditional IT services, such as hardware or software, are rented out to multiple simultaneous end-users (individuals, institutions, or businesses) who pay for the amount and time that the services are used and can adjust them to match their ideal utilization levels (Adane, 2018; Carcary et al., 2014; Fortes et al., 2016).

The "cloud" metaphor refers to the fact that virtually any company, regardless of its size or location, can access the cloud and its benefits, with the only prerequisite being an internet connection. This now popular and commonly adopted term is associated with the global utilization of a network of IT services, which are interconnected to an enormous number of physical or virtual servers denominated as the "cloud" (Low et al., 2011; Fortes et al., 2016).

2.1.1. Service models

In its definition, NIST also puts forward three service models that can be employed to implement cloud computing – Infrastructure as a Service (IaaS), Platform as a Service (PaaS), Software as a Service (SaaS) – and that vary depending on the degree of outsourcing and abstraction. The latter impacts the level of efficiency in terms of cost reduction but also the control over data (Adane, 2018; Caldarelli et al., 2016; Oliveira et al., 2014). However, cloud computing itself is an intricate aggregation of the different service models, and users can choose various combinations of these models in their adoption journey (Hsu et al., 2014).

IaaS refers to the tangible physical devices, such as servers and network cables, which are physically located in a data center but that can be accessed by anyone, anywhere, through the internet using login authentication systems. Higher levels of control characterize this architecture as most IT functions remain internal, and the end-customer retains the responsibility for data security (Caldarelli et al., 2016; Gupta et al., 2013). Commercial vendors of this service model include AWS' Amazon Elastic Compute Cloud (EC2) and Amazon Simple Storage Solution (S3).

In PaaS architectures, cloud vendors provide a range of computer, database, and storage functions within a virtualized platform over the internet (Low et al., 2011). Although they do not purchase software licenses directly, end-users can focus on developing applications without the need to provision and manage the underlying server infrastructure that sustains those applications (Adane, 2018). Commercial vendors of this service model include Salesforce.com and Amazon Relational Database Service (RDS).

Expanding the functionalities of the PaaS model, SaaS users can access various application services from any device by paying a fee, but not owning these applications. This can be an efficient way for businesses to outsource multiple applications and functions, such as customer relationship management (CRM) and enterprise resource planning (ERP), despite reducing the room for customization (Caldarelli et al, 2016).

2.1.2. Deployment models

To fully leverage cloud computing services, one must ensure successful deployment processes. While some authors only recognize two different deployment models, namely public and private cloud, the majority of research follows NIST's denomination of four different deployment models: public, private, hybrid, and community cloud (Gupta et al., 2013; Adane, 2018; Fortes et al., 2016; Lee, 2017; Low et al., 2011; Hsu et al., 2014).

In public cloud models, computational resources are delivered to the general public through the internet and are owned and operated by third-party cloud providers, such as AWS, Microsoft Azure, and GCP (Gupta et al., 2013; Adane, 2018; Changchit et al., 2016; Fortes et al., 2016). Although this solution generally implies lower costs for users, therefore being the most commonly used, it showcases increased risks, which will be explored later in this paper (Caldarelli et al., 2016).

Most suitable to large enterprises rather than startups, with the private cloud deployment model, customers own and maintain the computing environment exclusively for themselves, therefore retaining more control over the infrastructure (Gupta, 2013). This type of deployment model requires increased capital expenditure and well-versed IT teams (Caldarelli et al., 2016).

Community cloud is usually formed by a group of organizations with shared interests and goals, which share and control a single infrastructure. An example of this use is governmental institutions because of the reliance on shared data (Fortes et al., 2016; Gupta et al., 2013; Adane, 2018).

As the name indicates, the hybrid deployment model combines both public and private clouds. An organization that opts for the hybrid cloud will aim to make the most out of the benefits of each deployment model. This model allows for data and application sharing while remaining physically detached (Caldarelli et al., 2016; Fortes et al., 2016; Gupta et al., 2013).

2.1.3. Perceived benefits

Literature has inconsistently numbered the benefits of cloud computing; therefore, this paper will examine the most common pros associated with cloud computing. It is still unclear which may be the main driver for firms to adopt cloud. Thus no particular order was followed in naming the benefits (Carcary et al., 2014; Caldarelli et al., 2016). It is increasingly evident that cloud computing provides a favorable scenario for companies to succeed in their market. Still, as different authors focus on different benefits, one must inevitably assume that there are gains in each of these characteristics.

Cost reduction is by far one of the most cited benefits of cloud computing. Because of the payment scheme (pay-as-you-go model), companies can explore novel products or extend their offer of business, as financial requirements are drastically reduced. In the case of startups, the matter of cost reduction is even more paramount considering the initial investments can be lower – even in a typically risky panorama, as these companies are usually associated with innovation – allowing capital to be directed towards research and development (Ferri, 2017; 2019). Cost reduction is more thoroughly enabled in expenses such as the purchase of hardware that is no longer needed. Resources such as these are available without upfront investments, allowing a faster time for companies to enter the market. Companies that can be labeled as cloud-native (that have used cloud computing since their inception) benefit from numerous advantages at affordable prices, namely access to business analytics which needs plenty of computing power, as well as access to applications like CRM, ERP, SCM, and Salesforce.com, thanks to the per-user revenue model. In these situations, IT resources become an operational expense rather than a capital expense. (Fortes, 2016; Carcary, 2014; Gupta, 2013; Oliveira, 2014). Cost reduction thereupon demolishes the barriers of entry to innovation and competitiveness (Adane, 2018).

Along with cost reduction, scalability is one of the most mentioned benefits of the cloud. Scalability is related to the rapid and automatic resource provisioning allowed by cloud providers. Businesses working with the cloud can determine if they want to expand the quantity of service they're purchasing to endure critical moments, this means that computing loads can be balanced considering how many users are benefiting from that service, enjoying the perks of economies of scale (Ferri, 2017, 2019; Changchit, 2016). This increased flexibility allows for upgrades to be made, so business processes can be sped up as needed (Caldarelli, 2016; Low, 2011). Thanks to this feature, firms can be more flexible, agile, and adaptable, always making the most of what the market allows for.

Regarding convenience and ease of use, it is indisputable that companies have benefited from cloud computing during the COVID-19 pandemic like never before. Firms are now working outside of the office all the more, which itself presents a need for services such as the cloud, for its easy access to their platforms and data, without losing the computing power they would have when working on-premises (Gupta, 2013; Fortes, 2016). This new way of work also allows for increased global collaboration and mobility, as employees can stay connected despite their geographical location. This matter is particularly important for startups as opportunities to join networks are much incentivized and allow for growth without significant investments in development (Ferri, 2017, 2019). Businesses can now store, share and retrieve information and data at the distance of a click, granting portability and interconnection between their collaborators, fostering opportunities for growth and improvement (Fortes, 2016; Gupta, 2013; Carcary, 2014).

Because cloud computing services are available worldwide, there is easier access to the global market, facilitating businesses' access to international markets, which is usually preeminent to startups (Ferri, 2017). The delocalized nature of the cloud incentivizes the approach to international venture capital, which is decisive in startups' persistence in time (Ferri, 2019).

While using cloud computing services, companies can benefit from reduced time devoted to systems maintenance and IT. This benefit means that this service provides higher reliability than other models while at the same time freeing up internal resources, such as staff and infrastructure utilization. Cloud providers have as their primary goal the selling and improvement of the cloud, which makes their product better than any in-house service companies may pay for. This product quality means that cloud computing services have higher performance, are less faulty, have fewer interruptions of service provisioning, have higher redundancy levels, and can provide disaster recovery backups, hence increasing their reliability and their customer trust (Gupta, 2013; Fortes, 2016; Changchit, 2016).

These capabilities are always available thanks to disaster recovery processes, allowing for business continuity. The cloud provider's responsibility of maintaining services lets companies focus on their core strengths rather than worrying about threats of any kind, such as natural disasters (Changchit, 2016; Carcary, 2014; Fortes, 2016).

In a world where climate matters are more important than ever, cloud computing also presents itself as an eco-friendly IT solution since it decreases energy consumption, impacting carbon emissions and reducing the ecological footprint of businesses – this is mainly done through the scalability feature, which lets resources be used only when they are needed (Fortes, 2016; Oliveira, 2014).

Security and privacy are benefits of the cloud, which are more often than not perceived as risks. Firms which acknowledge security as an issue within the cloud are usually worried about having their own control rather than having their data safe (Gupta, 2013). Cloud providers have developed all sorts of mechanisms to reduce security risks to a minimum, insisting on multi-factor authentication and encryption. Still, it is the companies' choice to adhere to these mechanisms, hence improving the safety net in which they work. Studies have shown that the loss of USB drives is significantly high, which automatically makes the cloud a better option (Sultan, 2011).

Nonetheless, security must be seen as something dealt with by both cloud provider and consumer, instead of relying solely on the cloud provider to make the associated patches needed to guarantee privacy and safety (Gupta, 2013). Security and privacy can be perceived as risks if the appropriate behavior is not adopted, namely the disregard for VPNs while working outside of the office or the poor organization of the users' access methods to the cloud (Sultan, 2011). For example, AWS incessantly insists that companies create groups of users for different departments or projects, with distinct authorizations to access certain documents or actions, to avoid freedom of choice that can culminate in data loss or leakage (AWS Whitepaper, 2021).

2.1.4. Perceived risks

Market reports have called our attention to perceived risks limiting cloud adoption. However, cloud providers have developed adequate mitigation strategies to deal with potential risks in the cloud environment. There needs to be a distinction between a perceived risk and a real risk, as authors have thoroughly analyzed (Caldarelli et al., 2016; Changchit et al., 2016; Hsu et al., 2014; Lee, 2017). There is some consensus about the existence of risks associated with the use of cloud computing, and this is mostly accepted because of the slow adoption rate of cloud solutions (Changchit, 2016). Reports have shown that several companies find cloud computing a risk to their business, thus hesitating on its adoption. However, this is sometimes due to a lack of knowledge and information of the characteristics and conditions of cloud services (Hsu, 2014; Lee, 2017).

Risks may present themselves on different levels depending on diverse variables, such as firm size, to a greater extent than benefits. While small and medium businesses and enterprises can face hurdles with the lack of interoperability among clouds because of the matches in software and hardware, the same cannot be said for cloud-native companies, especially startups, whose needs are met within the offer of services of the cloud provider. These situations are sometimes regarded as issues within multi-provider scenarios, where firms want to take advantage of different services offered by various providers but then lack the awareness of the need for interoperability (Khan, 2015). Another issue mentioned by the authors is the user risk, also known as the lack of cloud knowledge risk (Lee, 2017). The adoption of cloud solutions can present a challenge, particularly for companies whose IT competencies and staff are low or non-existent. This lack of competencies is especially true in integrating previously purchased applications that demand expertise not found within the firm. Research has found that with or without knowledge of how the cloud operates, workers often show resistance against the implementation of solutions such as these, either because it implicates adjustments to their behaviors and routines or because they may feel like jobs may be being put at stake (Lee, 2017). Non-collaborating employees may slow the implementation of cloud services as they are less amenable to overcoming difficulties and issues (Oliveira, 2014).

According to Gartner's research, technical requirements are one of the top reasons why businesses give up on cloud providers (Gartner, 2019). Situations in which technical requirements are not met incentivize businesses' reliance on the assistance of partners within or outside the scope of their cloud provider, which may consequently result in. the loss of their competitiveness and technical abilities (Lee, 2017). Some may perceive this as provoking an over-dependence of the cloud services, as companies can start to dispossess IT capabilities.

The lack of transparency of contract terms has also been stated as a cloud adoption risk. When businesses are not fully aware of the agreed conditions with cloud vendors, they show distress about adopting cloud solutions. The apprehension felt by companies of being ambushed in the weak clarity of contracts can push businesses back to their traditional forms of navigating the market (Khan, 2015).

Costs have also been pointed as a trigger for the slow adoption of the cloud. Concerns over the financial burden cloud services can represent may discourage businesses from enjoying the benefits mentioned above that cloud computing can provide. Nonetheless, nowadays, firms have more room to pick the best solutions from competitive and advantageous plans that stimulate frugality. This freedom is notably useful when companies' worries are the charges related to maintenance and system complications that they might not be able to solve on their own (Lee, 2017).

As tackled in the previous section, security and privacy are perceived as risks within the cloud. However, when adopting every measure proposed by the cloud provider to avoid issues of this nature, it is unclear whether the justifications for fear of security and privacy risks have grounds to accept as reasonable worries. Authors have mainly dealt with this matter as a concern rather than an actual risk (Lee, 2017). Firms consider security a risky matter when it comes to cloud adoption or migration for fear of the compromise of confidential data, as well as not achieving data availability (Changchit, 2016). It cannot be considered nonsense that companies regard data leakage and theft as important affairs, but cloud providers have developed the necessary tools to mitigate such situations (Lee, 2017). Not only do cloud vendors offer mechanisms that reduce the risk of unwanted access to their data, but they also provide instruments with which companies can track by whom and when their data was accessed (AWS Whitepaper, 2021). The issue of data privacy is also connected to regional requirements, such as that data cannot be made available worldwide or that certain information must be kept for strict periods – this is especially true in the European Union since the publication of the General Data Protection Regulation, which was officially implemented in 2018 (European Commission, 2018).

The use of cloud computing can take a severe toll on companies' organizational structure since using a novel technological service can disrupt routines previously thought to be efficient. Along with the organizational risk, there can be an implication in a firms' reputation. Cloud vulnerability is mainly associated with the fact that it is a recent phenomenon, perceived as a valuable tool in its infant stages, and adoption rates are thought to be low. Consequently, these perceptions allow workers and companies to access cloud computing as an unpredictable market. This unpredictability is especially true when using small cloud vendors who may not reach the levels of professionalism and reputation as the big three – Amazon Web Services, Microsoft's Azure, and Google Cloud Platform (Lee, 2017; Caldarelli, 2016).

Studies have also shown that fear of service interruption as a business continuity issue is seen as a detractor of cloud adoption (Ferri, 2017). This fear can impact the expectations of businesses of performance levels while working with the cloud. However, this can be halted when staff training and platform optimization are prioritized at the time of adoption (Lee, 2017). Nonetheless, these actions aimed at easing the migration can result in a time risk, as research for the best cloud vendor or product, purchase, and training of employees can slow down the process, hence enabling regret felt by businesses (Lee, 2017).

2.2. STARTUPS AND CLOUD COMPUTING

2.2.1. Startups in Portugal

Before an unfamiliar concept to most, startups have recently emerged to the spotlight within the Portuguese economic landscape and society overall, with the country receiving multiple European entrepreneurship awards and Lisbon hosting since 2016 what is considered the world's most influential tech event - the Web Summit.

Furthermore, startups and the entrepreneurial culture surrounding them have proven to be important catalysts for Portugal's economic recovery in the last years by regenerating the country's obsolete corporate grid, balancing gender diversity amongst leadership teams, and reducing the systemic issue of youth unemployment. (Peixoto, 2017).

2.2.2. Defining startups

Authors who have researched startups have rarely agreed upon the definition of a 'startup', except for agreeing on one thing: there is no widely accepted and all-encompassing definition of the concept. That being said, a variety of different criteria have been employed to define these particular types of companies, such as age, profitability, strategy, innovation, growth potential, or funding type (Santos da Silva et al., 2016).

Despite the varying definitions presented later, authors tend to agree that startups take a vital role in every country's economy by being engines of dynamicity, innovation, vivaciousness, and employment. Additionally, authors widely recognize that startups represent a medium for exceptional ideas to come to fruition and become financially viable. Moreover, most authors acknowledge that startups are organisms whose life cycles are spanned across multiple stages (Peixoto, 2017). Where consensus stops is precisely on the conception of those different stages. However, many agree that these stages can be defined as the different funding rounds that startups go through if they manage to survive. According to our data source Crunchbase, these funding rounds range from 'Pre-Seed', when startups go through a pre-institutional round of investment that either has no institutional investors or is of a very low amount, all the way to their 'Initial Public Offering (IPO)', when startups go public. Their shares are sold on the stock exchange market to any interested buyers. Between their early stages and the final IPO, which marks for many the end of their classification as a 'startup', surviving startups go through several funding rounds, with the most significant being the Series A and B (funding rounds where startups get investment ranging on average between $1M–$30M) and Series C (for later-stage and more established startups, which get an investment of at least $10M+ and often much more significant amounts).

When defining startups', Fonseca et al. describe them as ventures in their early stages of development, which seek a viable and long-lasting business model (Fonseca et al., 2001). Furthermore, Ries has creatively defined startups as human establishments built to launch new products or services under highly uncertain circumstances (Ries, 2011). Alternatively, Blank et al. (2012) have described startups as temporary organizations created to attain scalable and replicable business models. For these authors, when startup founding teams find such adequate business models, shifting from exploration to execution, they shall no longer be considered startups (Blank et al., 2012).

Taking into consideration the many perspectives in academia, and specifically the Portuguese context, in this research piece, a startup was considered to be a company established after the year 2006, when Amazon Web Services was launched, with no more than 250 employees and whose headquarters are within the Portuguese national territory. Because of the variables under analysis, only startups resorting to cloud solutions were taken into consideration.

2.2.3. Defining startups' success

Despite the extensive amount of research efforts on the topic, the influencing factors of startup success or failure remain a central question in research until today (Spiegel et al., 2015). However, authors have presented their attempts at the arduous tasks of both defining and predicting startups success, such as Weking's quantitative analysis that considers mere survival as the fundamental metric of startup success given the enormous failure rate (Weking et al., 2019).

Alternatively, Dellerman et al. (2017) have also attempted to provide an accurate prediction model of early-stage startups' success, bearing in mind the previously mentioned conditions of extreme uncertainty that the latter live under. In line with Baum and Silverman (2004) and Spiegel et al. (2015), this prediction model defines the success of startups as whether they have received 'Series A' funding, which we have described to be one of the most essential stages within startups' life cycle by its association to more significant amounts of investment (Dellerman et al., 2017). Using Series A funding as a minimum proxy for startups' success - meaning that subsequent funding types, such as Series B and C, are also considered as proxies for startup success - will also be the criterion employed in this research piece.

2.2.4. Startups and cloud computing

Although literature is not abundant regarding startups' use of cloud computing, one particular research team has comprehensively studied how the adoption of cloud services has impacted two Italian startups. Ferri et al. (2017, 2019) state that cloud computing provided a substantial degree of technological innovation and high-quality services for the analyzed startups. Furthermore, organizational advantages both in terms of product development and IT department flexibility are highlighted. The authors themselves signal the worthiness of expanding current research to analyze cloud adoption within startup firms. The current paper aims to perform such analysis from a quantitative perspective to understand whether the success verified by the startups in Ferri et al. (2017, 2019) are observed by the broader Portuguese startup ecosystem.

3. METHODOLOGY

3.1. RESEARCH FRAMEWORK AND HYPOTHESES

3.1.1. Framework

The goal of this study is to analyze the impact of cloud computing on startups' success. Therefore, it is imperative to start by defining startup success. Based on Carlos Díaz-Santamaría and Jacques Bulchand-Gidumal (2021), success is defined in this study based on a startup's financing status, ranging from Pre-Seed to Initial Public Offering (IPO). For the sake of this research, success will be defined as reaching at least a Series A funding type, with all types before that being considered not success.

To understand the factors behind this success (or lack of it), two sets of variables were taken into account: organizational matters, including the age of the startup and its number of employees; and technology spend, including the total estimated monthly spend on technology infrastructure, spending ability on technology infrastructure, and cloud hosting estimated monthly spend, as shown on Figure 1.

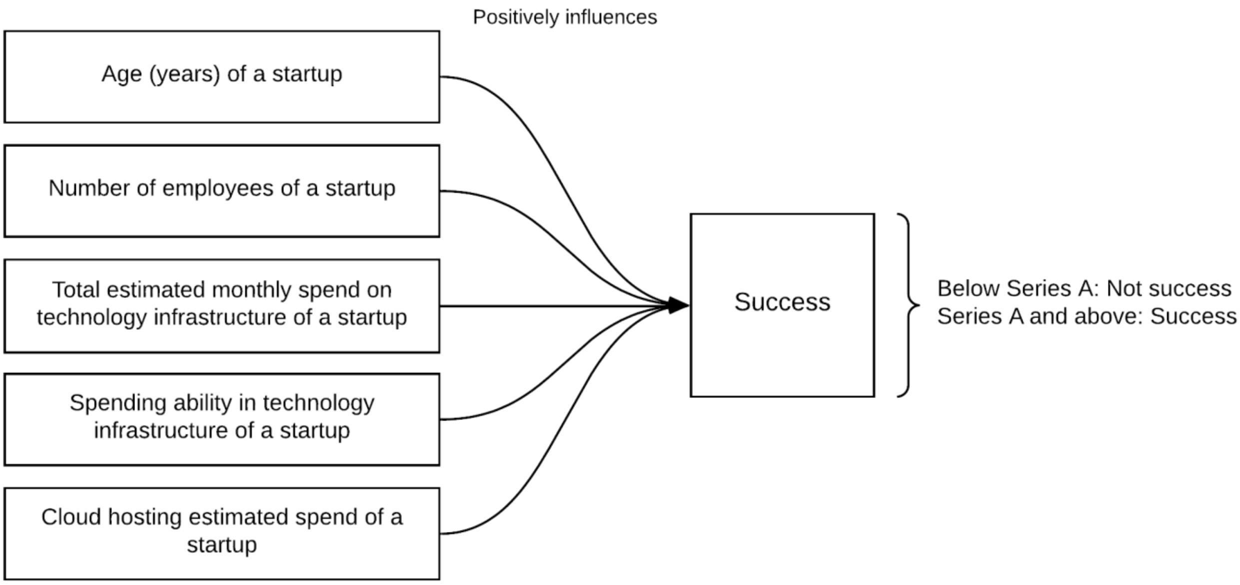

Figure 1 – Framework

3.1.2. Hypotheses

Based on the literature sources in Table 1, all variables are expected to positively influence success, hence generating the following hypotheses:

H1: The age of a startup positively influences its success.

H2: Firm size positively influences the success of a startup.

H3: The estimated spend on technology infrastructure positively influences the success of a startup.

H4: The spending ability on technology infrastructure positively influences the success of a startup.

H5: The cloud hosting estimated spend positively influences the success of a startup.

Table 1 – Hypotheses sources

Variable	Expected impact on success (funding type)	Sources
Age (years)	Positive	Díaz-Santamaría et al. (2021)
Number of employees	Positive	Díaz-Santamaría et al. (2021)
Total estimated monthly spend on technology infrastructure	Positive	Ferri et al. (2017, 2019)
Spending ability (estimated budget for Cloud, Infrastructure or SaaS products)	Positive	Ferri et al. (2017, 2019)
Cloud hosting estimated monthly spend	Positive	Ferri et al. (2017, 2019)

3.2. Method

3.2.1. Data collection

For this research work, data was gathered through Intricately and Crunchbase. Intricately is a system that maps the Internet and analyses products and applications, mainly focused on cloud usage. This platform comprises over 7 million businesses and over 21 thousand digital products. A system such as this can give a thorough understanding of how cloud computing is being used nowadays, helping cloud providers and researchers to look out for trends. Using Intricately was crucial to fathom which products are more used by Portuguese startups, which ones are less used, and which providers Portuguese startups prefer. More importantly, Intricately provided data for cloud expenditure, the main topic under research.

On the other hand, Crunchbase is a platform aimed at professionals looking for data on startups. Besides containing essential data about startups, Crunchbase includes information regarding funding, company details such as acquisitions, investors, hires, among many others. A research project such as this one would not be viable without a data source such as Crunchbase, as the use of this platform built the path to the final output.

The use of two different sources helped to avoid preferential bias and allowed for comparisons in repeated categories. The data selection covered specific attributes in order to observe a pool of data points with some similarities, allowing for analysis within and between groups. Given that the original dataset had many startups that did not meet the criteria used in this study, a thorough data cleanse was necessary. Only startups with a founding date in 2006 or after were considered, which did not have more than 250 employees, and had their headquarters in national territory. Because of the nature of this research, only startups resorting to cloud solutions were taken into consideration. This thorough cleaning of the data meant that the final dataset to analyze was much smaller than the initial one obtained.

3.2.2. Reliability analysis

To evaluate the goodness-of-fit of the model, the Pearson coefficient (Sig. >0.05) was analyzed, confirming the adequate fitting of the data to the model (see Table 2), as well as likelihood ratio tests (Sig. <0.05), which also confirmed that further analysis could be performed (see Table 3).

Table 2 - Goodness-of-fit

	Chi-Square	df	Sig.
Pearson	173.681	171	0.428
Deviance	201.113	171	0.057

Table 3 – Model fitting

Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	282.437			
Final	244.603	37.835	16	0.004

3.2.3. Data analysis

Because of the nature of this dataset - two or more categorical independent variables but a dichotomous dependent variable - a multinomial logistic regression was performed. The choice of this method is based on the fact that the more common Ordinary Least Squares (OLS) cannot produce the Best Linear Unbiased Estimator (BLUE) when the dependent variable is dichotomous it cannot prevent bias and inefficiency, hence choosing a logistic method. The most significant advantages of choosing this method relate to it not needing to assume a normal distribution of the independent variables nor the homogeneity of the covariance matrix.

The use of secondary data in this research meant that variables concerning ideally covariate values, such as the variables related to spending, were, in fact, analyzed as categorical or factor variables since they were codified in ranges. For this reason, all independent variables were treated as categorical or factor, except for age (years), which was treated as a scale or covariate. The dependent variable startup success was treated as a dichotomous variable (success or not success), defined by a threshold on the funding round of the startup (Series A).

This analysis was done with the use of IBM SPSS Statistics, which only takes into account individuals (startups) without any missing values - for this reason, the sample used was smaller than the one gathered initially.

4. RESULTS AND DISCUSSION

A total of 302 startups were analyzed, with characteristics detailed in Table 4. Out of the 302 startups, 29.1% were considered successful and 70.9% not successful. The average startup age was 7.4 years old, while the mode was eight years old, and the median was seven years old. Regarding firm size, 60.6% of startups have between 1 and 10 employees, 33.8% have between 11 and 50 employees, and the remaining fit in ranges of up to 250 employees. The great majority of startups in this study have a total estimated monthly spend on technology infrastructure below $1000 (66.6%), a cloud hosting estimated monthly spend tier below $1000 (81.8%), and similarly, a spend ability below $1000 (95.0%).

Table 4 - Dataset characterization

		N	Marginal Percentage
Success by funding type	Not success	214	70.9%
	Success	88	29.1%
Total IT Estimated Monthly Spend Tier (total estimated monthly spend on technology infrastructure)	$100K-$500K	1	0.3%
	$10K-$50K	9	3.0%
	$5K-$10K	35	11.6%
	$1K-$5K	56	18.5%
	<$1K	201	66.6%
Cloud Hosting Estimated Monthly Spend Tier	$100K-$500K	1	0.3%
	$10K-$50K	5	1.7%
	$5K-$10K	36	11.9%
	$1K-$5K	13	4.3%
	<$1K	247	81.8%
Spend Ability (estimated budget for Cloud, Infrastructure, or SaaS products)	>$500K	2	0.7%
	$50LK-$100K	1	0.3%
	$10K-$50K	11	3.6%
	$1K-$5K	1	0.3%
	<$1K	287	95.0%
Number of employees	1 to 10	183	60.6%
	11 to 50	102	33.8%
	51 to 100	9	3.0%
	101 to 250	8	2.6%
Total		302	100.0%

Out of the five independent variables, only age and spending ability are statistically relevant, as shown in Table 5. This relevancy means that it was not statistically proven that firm size, the estimated spend on technology infrastructure, and the cloud hosting estimated spend to influence the success of a startup. Regarding the age of a startup, we are faced with a negative beta (-0.138), implicating that the younger the startup, the more chances it has of it being considered successful - this is likely associated with the fact that positive evaluations of the other variables are usually related to younger startups (see Table 6). The same happens with spending ability, with the sole range of between $10.000 and $50.000 being significant, having a negative beta (-2.00) (see Table 6). Further estimates can be checked in Table 8 (in the annex).

Table 5 - Likelihood Ratio Tests

Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	244.603[a]	0.000	0	
Age (years)	253.558	8.956	1	0.003
Total IT Estimated Monthly Spend Tier (total estimated monthly spend on technology infrastructure)	245.138	0.535	3	0.911
Cloud Hosting Estimated Monthly Spend Tier	248.013	3.410	3	0.333
Spend Ability (estimated budget for Cloud, Infrastructure, or SaaS products)	254.955	10.352	4	0.035
Number of employees	247.525	2.922	4	0.819
The chi-square statistic is the difference in -2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0.				
a. This reduced model is equivalent to the final model because omitting the effect does not increase the degrees of freedom.				

Table 6 - Parameter estimates

Success by funding type[a]		B	Std. Error	Wald	df	Sig.
Not success	Intercept	2.655	7141.39	0	1	1
	Age (years)	-0.138	0.047	8.718	1	0.003
	[Total IT Estimated Monthly Spend Tier (total estimated monthly spend on technology infrastructure)=2]	19.736	0		1	
	[Total IT Estimated Monthly Spend Tier (total estimated monthly spend on technology infrastructure)=4]	-0.088	1.518	0.003	1	0.954
	[Total IT Estimated Monthly Spend Tier (total estimated monthly spend on technology infrastructure)=5]	-0.353	1.306	0.073	1	0.787
	[Total IT Estimated Monthly Spend Tier (total estimated monthly spend on technology infrastructure)=6]	-0.265	0.388	0.467	1	0.495
	[Total IT Estimated Monthly Spend Tier (total estimated monthly spend on technology infrastructure)=7]	0[b]			0	
	[Cloud Hosting Estimated Monthly Spend Tier =2]	0[b]			0	
	[Cloud Hosting Estimated Monthly Spend Tier =4]	-0.293	1.787	0.027	1	0.87
	[Cloud Hosting Estimated Monthly Spend Tier =5]	0.076	1.332	0.003	1	0.955
	[Cloud Hosting Estimated Monthly Spend Tier =6]	1.712	1.107	2.392	1	0.122
	[Cloud Hosting Estimated Monthly Spend Tier =7]	0[b]			0	
	[Spend Ability (estimated budget for Cloud, Infrastructure, or SaaS products) =1]	-19.116	8746.384	0	1	0.998
	[Spend Ability (estimated budget for Cloud, Infrastructure, or SaaS products) =3]	-19.994	0		1	
	[Spend Ability (estimated budget for Cloud, Infrastructure, or SaaS products) =4]	-2.005	0.888	5.096	1	0.024
	[Spend Ability (estimated budget for Cloud, Infrastructure, or SaaS products) =6]	18.382	0		1	
	[Spend Ability (estimated budget for Cloud, Infrastructure, or SaaS products) =7]	0[b]			0	
	[Number of employees=1]	-0.756	7141.39	0	1	1
	[Number of employees=2]	-0.497	7141.39	0	1	1
	[Number of employees=3]	-0.632	7141.39	0	1	1
	[Number of employees=4]	-0.818	7141.39	0	1	1
a. The reference category is: Success.						
b. This parameter is set to zero because it is redundant.						

Against what was initially expected, none of the hypotheses were supported, as shown in Table 7, either because variables did not prove to be significant or because when they were significant, they portrayed a negative influence on the success of a startup, hence undermining the initial prospects.

Table 7 - Hypotheses validation

Variable	Expected impact on success (funding type)	Results
Age (years)	Positive	NOT confirmed but significant (Sig <0.05)
Number of employees	Positive	NOT confirmed
Total estimated monthly spend on technology infrastructure	Positive	NOT confirmed
Spending ability (estimated budget for Cloud, Infrastructure or SaaS products)	Positive	NOT confirmed but significant (Sig <0.05)
Cloud hosting estimated monthly spend	Positive	NOT confirmed

The sample analyzed included 285 startups, out of 302, with no more than 50 employees, corroborating other studies that show that Portugal has an excessive amount of micro-enterprises stemming from the growing entrepreneurial climate in the country's largest hubs. Data has shown that founders often work in silos and create new companies rather than joining efforts and avoiding the market saturation we observe today (Peixoto, 2017). Despite Portugal's acclaimed quality of foundational education on traditional technologies and engineering, it lacks formal education on recent technologies such as cloud computing, which are fundamental to the core of many startups today.

These results allow for a longer comment on the broader implications of the current startup scenario in Portugal. After this quantitative study, the question urging to be asked is if Portuguese startups have a generalized lack of ability to use the cloud. The growing number of learning resources, partner programs, and cloud certifications proves that the industry needs to help ramp up solutions by enabling employees to make the most out of the benefits cloud computing can provide.

Similarly, to what is observed in more traditional companies, the results of this study showcase that Portuguese startups are often unable to capitalize initial time and resource allocation beyond the short term. The typical hype period is observed at the time of launch but is not sustained across the medium to long-term. The data in this study indicate precisely that phenomenon. The negative correlation between startups' spending ability on technology infrastructure and their success shows that, as these companies begin to mature and have larger budgets, they may be unable to make savvy investment decisions that ultimately affect their progress across the funding journey. Data is overwhelming in showing very few examples of startups that make it through such funding journey from end to end: despite the substantial amount of micro-companies, the Portuguese startup ecosystem has only birthed five unicorns (startup companies that are valued at over USD 1 billion) - Farfetch, OutSystems, Talkdesk, Feedzai, and Remote.

We can, therefore, problematize that this generalized inability to survive in the long-term is exacerbated by the lack of best practices, structures, and processes, both in technology and managerial aspects, which forces us to think, as a society, of innovative ways to tackle these issues and skills gaps, as explored in the next section.

5. CONCLUSIONS

The data analysis efforts to answer the research question have brought about the inability to prove the correlation between cloud usage and startup success in Portugal. These have also highlighted startups' inability to survive across time, despite some initial hype.

With that being said, it is now crucial to understand both underlying systemic reasons for such disassociation and potential policies that could tackle this from an academic and managerial standpoint. Despite the proven advantages of cloud computing services elsewhere, the main underlying reason behind the lack of association between startup success and cloud usage is startup employees' inadequate enablement and skillset to enjoy such advantages.

Therefore, this study identifies a clear need to implement policies that incentivize technological innovation and adoption to enable companies to make the most out of emerging technologies that will prolong their life cycle and increase profitability. More concretely, policies towards cloud readiness both in academia, government, and private sector can bring unparalleled shifts in the way Portuguese startups modernize, and ultimately survive.

5.1. ACADEMIC IMPLICATIONS

This study has highlighted the need for academic institutions to employ quantitative methods in analyzing companies' success factors, such as their technological toolkit. That stems from the fact that most studies leverages either qualitative research methods or focuses on interview-/survey-based case-study analyses.

Furthermore, the educational system must ensure that emerging technologies that revolutionize the industry are present in study curriculums, as that does not happen nowadays. This situation forces interested parties to find learning alternatives, affecting startup founders' ability to make informed decisions about their technology investments.

5.2. MANAGERIAL IMPLICATIONS

5.2.1. For startups

On the other hand, startup founders must look to educate themselves before committing to technologies that they do not know well. They must also be able to discern beyond solid marketing campaigns, which often create unsustainable hype around emerging technologies whose value is not clear yet. Startup teams ought to choose technology products that are aligned with their individual business needs, specific use cases, industry, and size. Otherwise, they might be resorting to the right technology, but not at the right timing or not for the right purpose.

Startups and other enterprises need to close their skills gaps to expand their ability to enjoy the benefits of the cloud and other technologies instead of relying so heavily on (often expensive) implementation partners who blind their options and have skills gaps themselves.

5.2.2. For cloud providers

Finally, cloud providers need to ensure that their products are easy to understand and implement, regardless of the context of understaffed and under-budgeted startups. There is a significant need to optimize best practices for cloud adoption. Therefore, cloud providers should develop better support guidelines and cross-industry examples to showcase the feasibility of successful cloud journeys, be it migrating from on-premises or developing cloud-native infrastructures.

Additionally, cloud providers should collaborate more closely with startups at the new product and feature development stage to understand how these new products can best serve the specific needs and use cases of startups, tailoring these to their market and industry.

Ultimately, as cloud providers attain profits in the millions, they could seek creative ways to improve their Corporate Social Responsibility (CSR) policies and give back to the community that allows for such profits. These can include discounts and mentors for startups and create infrastructures locally that foster employment and innovation.

6. LIMITATIONS AND RECOMMENDATIONS FOR FUTURE WORKS

This study was conducted only within the Portuguese startup panorama and, therefore, may not represent the global startup scene. It was also based on the five variables provided by the data sources, influencing the depth of the analysis. This use of secondary data sources may be seen as a limitation, especially because it has missing values that undermine the statistical analysis. It also brings the disadvantage of not being a cross-time analysis, which would give a more thorough scrutiny of startups' paths within funding schemes and cloud usage. Additionally, this study was conducted during the Covid-19 pandemic, which caused an impediment to the usage of more recent data, which was not being collected. Hence, the data used does not take into account the impact of the current crisis.

This study is incapable of providing a quantitative guideline to define success and depends on the startup's funding round in the data source. An extra effort was made to include data from two different sources, but it was not enough to combat some bias in the sample, which is smaller than initially intended. Indeed, the use of two independent data sources attempted to avoid unwanted tendencies. Still, it is hard to prove that they are impartial in their data collection, as they are both settled enterprises with clear business intentions. It is also important to mention that these data sources are not Portuguese, which might have caused inaccuracies in the data collection.

Future research should consider the rapidly changing startup scenario in Portugal and the impact of growing efforts from the European Union to enhance technological development in the bloc. Ideally, such research should be done from a longitudinal perspective. Forthcoming studies may also pay attention to regionalisms to quantitatively prove whether or not the startup environment is susceptible to the economic tendencies of the centralization of power, be it in city capitals or centralized technological hubs.

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8. ANNEXES

Table 8 - Parameter estimates (cont.)

Success by funding type		Exp(B)	95% Confidence Interval for Exp(B)	
			Lower Bound	Upper Bound
Not success	Intercept			
	Age (years)	0.871	0.794	0.955
	[Total IT Estimated Monthly Spend Tier (total estimated monthly spend on technology infrastructure) =2]	372550729.874	372550729.874	372550729.874
	[Total IT Estimated Monthly Spend Tier (total estimated monthly spend on technology infrastructure) =4]	0.916	0.047	17.949
	[Total IT Estimated Monthly Spend Tier (total estimated monthly spend on technology infrastructure) =5]	0.702	0.054	9.089
	[Total IT Estimated Monthly Spend Tier (total estimated monthly spend on technology infrastructure) =6]	0.767	0.359	1.641
	[Total IT Estimated Monthly Spend Tier (total estimated monthly spend on technology infrastructure) =7]			
	[Cloud Hosting Estimated Monthly Spend Tier =2]			
	[Cloud Hosting Estimated Monthly Spend Tier =4]	0.746	0.022	24.778
	[Cloud Hosting Estimated Monthly Spend Tier =5]	1.079	0.079	14.671
	[Cloud Hosting Estimated Monthly Spend Tier =6]	5.542	0.633	48.544
	[Cloud Hosting Estimated Monthly Spend Tier =7]			
	[Spend Ability (estimated budget for Cloud, Infrastructure, or SaaS products) =1]	4.990E-09	0.000	.[c]
	[Spend Ability (estimated budget for Cloud, Infrastructure, or SaaS products) =3]	2.073E-09	2.073E-09	2.073E-09
	[Spend Ability (estimated budget for Cloud, Infrastructure, or SaaS products) =4]	0.135	0.024	0.768
	[Spend Ability (estimated budget for Cloud, Infrastructure, or SaaS products) =6]	96220007.412	96220007.412	96220007.412
	[Spend Ability (estimated budget for Cloud, Infrastructure, or SaaS products) =7]			
	[Number of employees=1]	0.470	0.000	.[c]
	[Number of employees=2]	0.608	0.000	.[c]
	[Number of employees=3]	0.531	0.000	.[c]
	[Number of employees=4]	0.441	0.000	.[c]
c. Floating point overflow occurred while computing this statistic. Its value is therefore set to system missing.