

Analyzing the Impact of COVID-19 on the Top US Startups: A Close Look at their LinkedIn Profiles

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Summary

Nowadays, startups are growing massively, altering talent flows around the world and often, changing how we work and live. In recent years, there has been a growing interest from world-wide data scientists to analyze actions generated by LinkedIn members with an aim to understand practices related to startups. For example, in 2020, over 171 million LinkedIn profiles in the U.S. were analyzed to obtain the top 50 startups list. And in 2019, over 645 million LinkedIn profiles were analyzed. In this study, we analyze the top 50 US startups LinkedIn profiles in 2019 and 2020. Our results show that the technology startups are dominant during the two years. In particular, those related to cloud computing were found to be the most growing and widespread. Where the COVID-19 pandemic has not affected the growth of these startups but has made them more influential.

Keywords:

Social networks; LinkedIn networks; Entrepreneurship; Startups.

I. INTRODUCTION

Nowadays, actions carried out by social media users are considered among the most common internet activities. The number of social media users and the amount of available digital information continues to grow up day by day [1]. The explosive rise in the data on social media has its impact in different areas. These areas include recruitment, professional companies, and business strategies. One of the largest and most popular professional networks is LinkedIn. Because the organizations are increasingly dependent on professionally-oriented networks, LinkedIn contains more than 722+ million members in more than 200 countries and territories worldwide [2]. This network help members build business and professional connections while dealing with different companies. Also, LinkedIn is a valuable source of business network information.

LinkedIn members can be individuals or companies. A startup is a company in the first stages of operations that focuses on one service or product. Microsoft, Apple, and Facebook were startups but now they are one of the most successful companies. LinkedIn releases statistics every year regarding the Top 50 startups in different countries such as U.S, Australia, Canada, China, France, Germany, India, Japan, Brazil, Mexico, the U.K, and the Netherlands. To be considered as a startup, the company must adhere to the following criteria. First, it must be independent and privately owned. Second, it has 50 employees or more. In addition, LinkedIn evaluates the startups based on the following four

criteria: employment growth, member participation, job seekers' interest, and top talent attraction.

In December 2019, the new Coronavirus (COVID-19) has spread worldwide [3]. COVID-19 caused global concern, affecting the global economic and people's daily lives, leading to death in many cases [4].

The Contributions of this article is to analyze the top 50

U.S. startup companies in LinkedIn in 2019 before COVID-19 and the top 50 U.S. startup companies in 2020 after COVID-

19. Then, we compare them to find out what impact the pandemic has had on these startups. The analysis includes headcount, headquarters, year founded, most common skills, and largest job functions.

The remainder of this paper is organized as follows. Section II presents an overview of papers that analyzes LinkedIn data in the literature review. Section III describes the dataset used to develop our insights. Section IV provides detailed analysis and description of used algorithms. Section V, presents the discussion of results. Finally, section VI summarizes what has been done in this project and proposes future work.

II. LITERATURE REVIEW

Social media has a great impact on the business sector. This can be seen, at least partially, on LinkedIn, because it is the largest specialized network linking companies and individuals. This section is devoted to studies that analyze the data of LinkedIn or merge their data with other networks to help individuals or companies grow or develop.

In [5], the goal was to analyze the skills of data scientists. The authors collected 100 LinkedIn user profiles of the Philippines companies. Their work involves 4 phases: The first phase was to obtain the dataset from a search using the key term "data scientist" on LinkedIn. After collecting the data, they only select the location of profiles in Philippines. The third phase was to extract Self-reported featured skills from profiles. In the last phase, they adopted eight main categories. The results of the survey show that 53% of data scientists have a Bachelor's degree. Also from the

results, the authors concluded that the preferred language was Python.

Arora et al. [6] used machine learning techniques to

analyze promoted posts in social media to explore competitors' pro-

TABLE I. DATASET SAMPLE OF 2020

Company Name	type	headcount	headquarters	year founded	Most common skills	Largest job functions	What you should know
Better.com	Financial Services	4000	New York City	2016	Customer Experience, Loans, Data Analysis	Finance, Support, Operations	While the U.S. economy quickly sank into a recession at the start of the pandemic, one of its engines has been roaring: housing. Digital mortgage lender Better.com has been inundated with refinancing applications and new loan demand as a result of falling interest rates (thanks to the Federal Reserve) and a growing desire for space (thanks to work-from-home policies). To keep up, the four-year-old company is hiring at a staggering rate, onboarding more than 1,500 employees since March and planning to bring on 7,000 more in the next 12 months.
DoorDash	Internet	3500	San Francisco	2013	SQL, Data Analysis, Salesforce.com	Sales, Engineering, Operations	Having filed to go public in February, the on-demand food delivery service was already embarking on a big year. The pandemic introduced quarantines, and delivery demand skyrocketed. While DoorDash continues to clash with California regulators over whether its "dashers" must be classified as employees, its ambitions have only grown. It expanded its delivery service into pharmacy and grocery offerings. And after nearly doubling its employee base for the second time in two years, DoorDash has revamped its hiring process to focus on what it calls "engineering values" rather than culture fit.
Robinhood	Financial Services	1042	Menlo Park, Calif.	2013	Python, Data Analysis, Java	Engineering, Finance, Support	Robinhood, which bills itself as "Investing for everyone," has sought to democratize stock market investing via its app by making trades affordable and easy to execute. It recently raised 200million new funding, making it worth 11.2billion. It's now on a hiring spree to keep up with its growth and respond to growing regulatory concerns, bringing on hundreds of registered financial service representatives in Southlake, Texas, and Tempe, Arizona.

motional strategies and posting behaviors. They obtained the following results when using classification via logistic regression model to detect promoted post in social media: 97% precision, 95% accuracy, 96.5% Recall and 97% F1 score.

In [7], the authors focus on entrepreneurs and startup ventures, testing whether benefits translate into tangible financial outcomes for a startup. They integrate two extensive datasets. The first dataset is Crunchbase.com which is the leading platform for professionals to discover innovative companies and the people behind them. Also, it provides financial success stories of startups. There are over 55 million professionals on this platform. The second dataset is LinkedIn which provides social network information of founders. It has more than 750 million users. The result of this merger has formed a link between social networks and entrepreneurial success. It showed a positive correlation between many variables in LinkedIn profiles and the number of funds raised by the startup. For example, the average number of company founders' followers had according to their LinkedIn profile was the strongest predictor of the number of funds raised by companies.

Drakopoulos et al. [8] aimed to develop innovative products and services. One of the prime obstacles to doing this is the need to discover employees and business partners with a specific background. LinkedIn is the most common platform where their professionals' endorsements, milestones, recommendations, and skills are posted. Researchers have suggested a graph search

algorithm with a Breadth-first search (BFS) and a Depth-first search (DFS) strategy to find the trusted candidates' accounts on LinkedIn. Both strategies depend on a metric for evaluating the trustworthiness of an account according to LinkedIn attributes. LinkedIn profiles contain a huge amount of information such as skills, background, professional career milestones, and previous positions. This data helps to Build the Skills Map. So, vertices represented the startup page (vs) and candidate profiles (vc) and edges between vertices represented the actual LinkedIn connections (u). Then determine the most frequent technologies in startups as shown in Table II. The result of this paper is discovering trusted candidates for startups in the LinkedIn graph with a BFS and a DFS strategy.

In the present study we analyze the data from LinkedIn to know the impact of a covid-19 pandemic on startups. Also, to give the advice to exit with the least possible damage and to avoid the damage next time.

III. DATASET

The primary dataset used in this study contains LinkedIn profiles of startup companies. We scraped the top 50 startups

TABLE II. FREQUENT STARTUP TECHNOLOGIES [8]

Technology	Startups
Data mining	36
Blockchain	22
NoSQL databases	16
Relational databases	16
Social media	14
Android	11
IoT	11
GPU computing	7
NLP	7
GIS	2

data from LinkedIn using LinkedIn helper tools. This dataset contains the top 50 US startups of 2019 [9] and 2020 [10] on LinkedIn. We gather the following data for each company as company Name, type, headcount, headquarters, year founded, most common skills, largest job functions, what you should know. Table I shows a sample of startups dataset in 2020.

IV. DATA ANALYSIS

This paper examines the top 50 startups through the years 2019 and 2020. The year 2019 referred to as before COVID- 19, and the year 2020, referred to as COVID-19 year. Throughour dataset, we will discuss the impact of COVID-19 on the top 50 startups in the U.S., in particular, the startup’s activity, employee growth, common skills and job functions.

A. Joint startups

We noted 12 startups pertaining within the top 50 startups in 2019 and 2020, we called that joint startup. Those startups, six of them in computer science startups, three in internet field, two in financial services and the last one in information technology and services field. We conclude from this that startups in the field of technology have a great turnout in 2019 and are still in top 50 in 2020. Regarding the growth of employees in the joint startups, the number of employees was increasing, and figure 1 shows the increase in the number of employees in all joint startups. Table III, shows how frequently each common skill occurs in year of 2019 and 2020 in joint startups. Moreover, TableIV shows how frequently each largest job occurs in years of 2019 and 2020 in joint startups.

B. Startups’ activity

In this section, we analyze the activity of the startup, which type is growing and which is not. As shown in Table V, Computer software Startup is registering an increase, as in 2019 it was equal to 26% of the activities of the top 50 Startup in the U.S, while in 2020 it represented 32%, as shown in Figure 2. While internet startup recorded a decrease, it was 16% in 2019, which is equivalent to 8 of the top 50 startup. In 2020, their percentage was 12%, equivalent to 6 companies, as shown in Figure 2.

TABLE III. HOW FREQUENTLY EACH COMMON SKILL OCCURS IN YEARS OF 2019 AND 2020 IN JOINT STARTUPS

Common skills	number of repeat
Cloud Computing	12
Sales force	7
Sales Management	5
Python	5
Social Media Marketing	4
Data Analysis	4
Analytic	4
Software Development	4
Java	4
SQL	3
Digital Marketing	3
C++	2
Machine learning	2
Data Mining	2
Virtualization	2
Enterprise Software	2

TABLE IV. HOW FREQUENTLY EACH LARGEST JOB OCCURS IN YEARS OF 2019 AND 2020 IN JOINT STARTUPS

Largest job	Frequency
Engineering	24
Sales	19
Human Resources	10
Information Technology	7
Operations	4
Support	4
Finance	2
Business Development	2

TABLE V. TYPE OF COMPANIES

Types of companies	2019	2020
Computer software	13	16
Internet	8	6
Financial Services	4	3
Information Technology and Services	3	3
E-learning	1	3
Marketing and Advertising	1	3
Health, Wellness and Fitness	2	1
Sports	2	-
Hospitality	2	-
Automotive	2	-
Apparel & Fashion	2	-
Transportation/Trucking/Railroad	2	-
Consumer Goods	2	-
Retail	1	2
Hospital & health care	-	2
Real Estate	1	1
Medical practice	-	1
Insurance	-	1
Entertainment	-	1
Biotechnology	-	1
Education management	-	1
Professional Training & Coaching	-	1
Consumer services	-	1
Cosmetics	-	1
Semiconductors	-	1
Mental health care	-	1
Computer Networking	1	-
Logistics and Supply Chain	1	-
Food Production	1	-
Food & Beverages	1	-

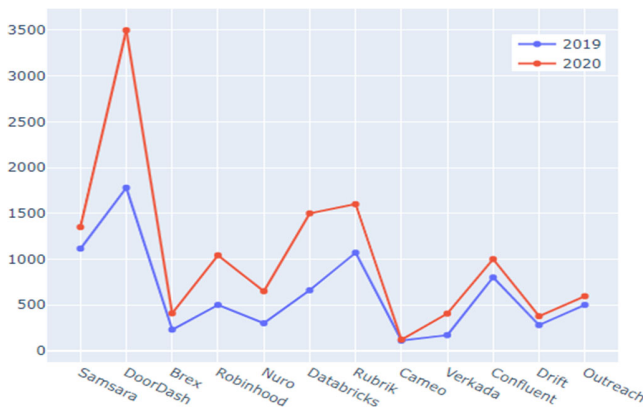


Fig. 1. Employees growing in joint startups

C. Skills

In this section, we will discuss the most common skills in Startups. We noted that Computer Software skills were at the top of skills in both 2019 and 2020, especially cloud computing, as shown in Table VI. We have also noticed an increase in the demand for the skills of software developers, as in 2019 there were three startups requesting this skill. In 2020, there are 7 startups requesting this skill.

D. Year Founding

In this section, we will measure the correlation between the headcount and the year of founding. We found in the data of 2019, the largest number of employees was 2300 and the date of the establishment of the company was in 2012, as shown in Figure 3 and the scope of the startup is Real Estate. But in the data of 2020, the largest number of employees was 4000 and the date of the establishment of the company was in 2016, as shown in Figure 4 and the scope of startup is financial services, which also shows an increase in the number of employees.

E. Job functions

In figure 5 shows the most popular job functions in 2019 and 2020. Note that the job function of engineering, sales and operations are the most common in the years 2019 and 2020. The job function of finance, business development and Human Resources fall down in 2020. Also, among job functions that grow in 2020 was marketing, art and design, support and information technology.

F. Startups Headquarters

We observe that the highest headquarters for startups is located in San Francisco, with a number of 15 startups in 2019 as shown in Table VII, and the number increased in 2020 to 16 startups as shown in Table VIII. We expect that the reason for the accumulation of these startups in the San Francisco area is Silicon Valley. We also noticed that some areas came out

TABLE VI. SKILLS IN COMPANIES

Type of companies	Skills	2019	2020
Computer Software	Cloud Computing	8	8
	Analytic	4	1
	Sales Management	2	5
	Python	3	2
	SQL	3	3
	Data Mining	1	1
	Virtualization	1	1
	Enterprise Software	1	1
	Software Development	2	6
	Data Analysis	2	1
Internet	java	2	2
	Social Media Marketing	3	3
	Data Analysis	2	4
	SQL	3	2
	Python	1	1
	SQL	3	3
	digital Marketing	2	2
	Customer Relationship Management(crm)	1	2
Financial Services	SQL	2	1
	Python	2	2
	Software Development	1	1
	java	1	1
Information Technology and Services	Cloud Computing	1	1
	Python	1	1
	C++	1	1
	Machine Learning	1	1

of the list, such as Atlanta, Incline Village, Nev., Brooklyn, Austin, Chicago, San Jose, California, and other states.

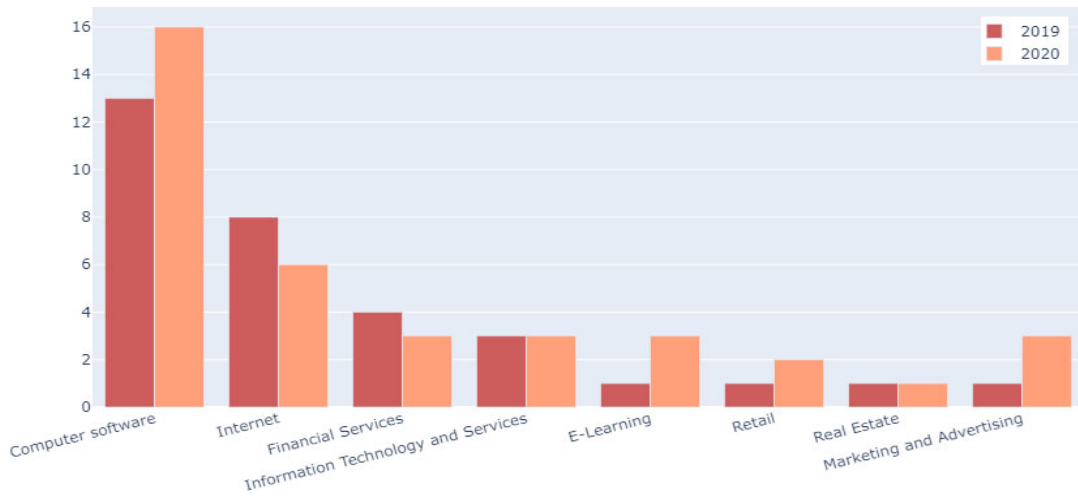


Fig. 2. Joint startups' activity

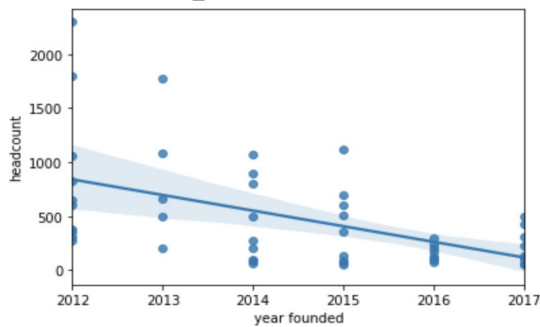


Fig. 3. The correlation between the headcount the year of founding 2019

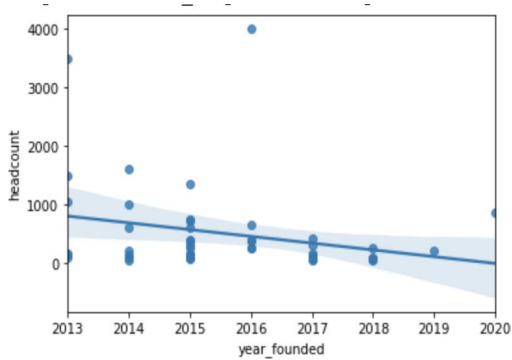


Fig. 4. The correlation between the headcount the year of founding 2020

TABLE VII. STARTUPS HEADQUARTERS IN 2019

Headquarters	Count
San Francisco	15
New York City	8
Palo Alto, Calif	5
Los Angeles	3
Mountain View, Calif	3
Seattle	3
San Mateo, Calif	2
Foster City, Calif	1
Austin, Texas	1
Culver City, Calif	1
Santa Monica, Calif	1
Boston	1
Los Angeles and New York	1
Stamford, Conn	1
Menlo Park, Calif.	1
Chicago	1
Sunnyvale, Calif.	1
Multiple	1

startups are growing in the field after Covid-19 but also big companies like Google, Microsoft and Amazon are turning into the cloud computing rental business. Also, small and medium-sized businesses (SMB) adopted and growing cloud computing in 2020 [11]. This is because all the work is shifting to remote working in the covid-19 pandemic which gives an unexpected spike in cloud computing uses. Company of different size needs to grow faster in the cloud computing scope to confirm the safety and reliability in remote working. Also, because of the economic recession in 2021 companies will change the hardware and maintenance spending to cloud solutions [12]. Because of this

V. DISCUSSION AND RESULTS

We've noticed in this study that software startups are growing in 2020, especially in the cloud computing space. Where there were 13 startups in 2019 and became 16 companies specialized in the field in 2020. As we found, not only the

pandemic, cloud computing not only uses in the company but also use in e-commerce, healthcare, education, and the supply chain industry. According to this trend expect 51% of serves moveto cloud computing

in 2021. The passive side of this increases the attack of cyber threats and data breaches on the servers.

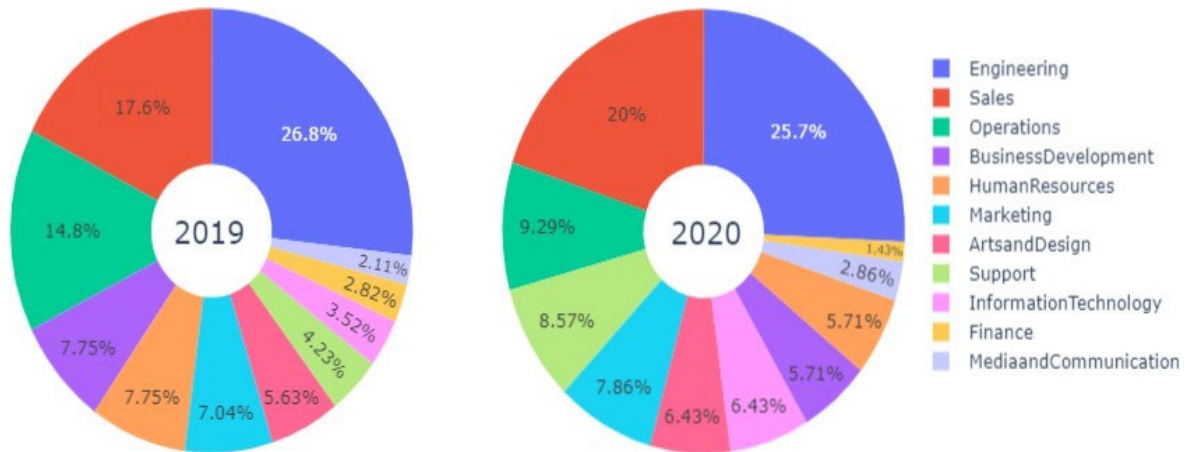


Fig. 5. The most popular job functions in 2019 and 2020

TABLE VIII. STARTUPS HEADQUARTERS IN 2020

Headquarters	Count
San Francisco	16
New York City	8
Los Angeles	4
Mountain View, Calif	3
Atlanta	2
Boston	2
Palo Alto, Calif	1
Incline Village, Nev	1
Brooklyn	1
Menlo Park, Calif	1
Seattle	1
Austin	1
Chicago / Remote	1
San Jose, Calif	1
Austin, Texas	1
Denver	1
Bend, Ore	1
Santa Clara, Calif	1
Columbus, Ohio	1
San Mateo, CA	1
Chicago	1

The remote work increases the possibility of attack not only through the server but also through the network breaches. This leads to the need to develop in security and cyber fields [13].

Also, the pandemic affected employment, and Silicon Valley was the most affected due to the overcrowding of companies in it. Where more than 69,000 startup employees have been laid off since March. On the positive side, this will disperse talent over the country if not across the globe. At least 25% to 30% of employees will be open to remote work. This will enable excellent products to be built anywhere and increases the size, and diversity of the talent at any size of the company. The pandemic will be a huge

catalyst for employment depend on the talent and skills instead of location or pedigree [14]. This explains what we got to him in this paper when comparing the number of employees in 2019 and 2020. When the total number of employees in the top 50 startups in the year 2019 and 2020, respectively, it is 22058 and 24608 so the difference between them is 2550. As the highest number of employees in 2019 is 2300 and in 2020 it is 4000. We observe that the startups in Silicon Valley keep growing through the covid-19 pandemic. This demonstrates Silicon Valley's power to cross the turbulent times very prosperously. This pandemic and new living conditions have made the focus more on electronic companies. Specifically, the focus is on six big companies in the field which is represented by the Internet economy, namely Amazon, Apple, Alphabet, Facebook, Netflix, and Microsoft, which have made them more influential [15]. We have 12 LinkedIn's startups preserve their place through 2019 and 2020 in the top startup list. All these startups are keeping growing in 2020. And the number of employees in these 12 startups has increased like DoorDash startup the number of employees in 2019 has 1780 and in 2020 arrived 3500. The activity of these startups was in technology such as Rubrik, Databricks, and Confluent. Also, in finance fields such as Brex, and Robinhood. And the skills that were required in these startups were cloud computing, salesforce, sales management, and Python. In terms of jobs, they were the most job functions demanded were engineering, sales, and human resource. In Figure 2, we have seen computer science startups are expanding in the years 2019 and 2020. Also, the startups of Marketing are keeping to grow. E-learning startups, also expanding in 2020 because education in schools and universities has become online.

Moreover, we noticed that the most popular programming languages in these startups are Python and SQL.

Python is a programming language, easy-to-learn, provides clean code with great structure. It is used in many fields such as games, web applications, and artificial intelligence. Python was developed in 1990s, No one expected that it would witness great growth and become one of the best programming languages. In 2020, the StackOverflow developer survey ranked Python as the second most popular programming language, at 73.1%. Python is the most requested programming language in the USA job market and the yearly salary of Python is 120K\$, which is the third place in the highest salaries in the USA job market, as stated in Indeed [16].

We observe the highest state that has startups in the U.S. is San Francisco, with a number of 15 startups in 2019, and 16 startups in 2020. We expect that the reason for the accumulation of these startups in the San Francisco area is Silicon Valley. Also, there are states that remained constant during the pandemic did not prove any progress or decline, such as New York City where the number of startups in the years 2019 and 2020 reached eight startups. And some states came out of the list, such as Atlanta, Incline Village, Nev., Brooklyn, Austin, Chicago, San Jose, Calif, and others. And some states have increased the number of startups, like Los Angeles, which had three startups in 2019 and in 2020 there were four startups. And vice versa, there are states where the number of startups decreased, such as Palo Alto, there were five startups in 2019 and only one startup in 2020. The scope of this startup is computer software particularly cloud computing services.

VI. CONCLUSION AND FUTURE WORK

In this paper, we compare the top 50 U.S. startup in 2019 and 2020. To measure the impact of covid-19 on the startup. We found the startups that are least affected by the pandemic are the startups in the field of computer software. Furthermore, these startups have been growing during this pandemic, especially those startups that adopt cloud computing skills. The covid-19 and remote work is the main reason to increase the need and more influence of cloud computing. As future work, we will develop a proactive model to identify startups' weak points in order to improve them.

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