COVID-19 PANDEMIC IMPACT ON DIGITAL INDUSTRY

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Abstract: The goal of this study is to identify the impact (challenges and changes) of covid 19 Pandemics on the digital industry - from the economical, organizational but also from human resource point of view. The key objectives are (1) to highlight the main challenges that occurred in the IT industry, (2) to find how the IT companies cope with the challenges emerged, (3) to anticipate the impact of the COVID 19 pandemics on the IT companies in the foreseen future. To achieve these objectives, it had been used the literature review methodology and exploratory data analysis. It had been found that many IT companies struggled with an increased volume of work and with the pressure of solving problems in a short time while others had encountered losses or activity slow down, all these in the context of following new regulations and policies that affected all. However, the IT companies adapted fast to the new context, the remote working is already seen as an alternative, and they also demonstrate solidarity for sectors in need. This paper is meant to help companies that are still struggling to find an equilibrium and best practices to overcome this unwanted event, but also students and researchers to create new research hypotheses for new findings.

Keywords: COVID-19, software development, work from home, change, cloud processing

1   INTRODUCTION

According to the *Impacts of the COVID-19 pandemic on EU industries* (2021) study, digital industries have also been affected by the COVID-19 pandemic, even though this sector fared relatively well compared to others. The Organization for Economic Cooperation and Development (OECD) notices that the impact of confinement over the economics and individual's wellbeing is affected by the possibility of carrying out remote activities to perform job related tasks (2020). Dingel and Neiman (2020) from Becker Friedman Institute for Economics at the University of Chicago found in their study *"How Many Jobs Can Be Done at Home?"* that 37% of US jobs are included in this category. By consulting the list of jobs from the dataset of the research and considering the possible jobs that could exist into an IT company we estimate that almost 90% of jobs from this domain could accomplish their day-by-day job tasks from home. From this point

of view the IT industry can be indeed considered a fortunate case. However, many of the technology companies are producing for sectors of industry that had been strongly affected by the COVID-19 pandemic, so they had to find ways to remain sustainable in conditions of slow down or blockage of their customers field of activity but also to successfully cope with the wave of demands and challenges for those who develop for domains that have experienced in this period an expansion and increase in demand. For example, according to https://www.marketdata forecast.com/ Apple Inc. is estimated to have at list 10% fall in its shares due to the Covid-19 impact on China. At the opposite pole is the increased demand for software and social media platforms such as Google Hangouts, WhatsApp Video call, Zoom, and Microsoft Teams.

In this context, the paper aims to answer to three research questions:

RQ1: Which were the main challenges encountered by the IT industry?

RQ2: How did the IT companies managed the Covid pandemics challenges?

RQ3: What is the future impact of the COVID 19 pandemics over IT companies?

The method used is review of literature carried out on databases of Science Direct, Research Gate, Springer and IEEXplore using the following keywords: COVID 19, Pandemic, software development and impact. Additionally, an exploratory data analysis of the public opinions from news sites and the official blogs of some of the current top IT companies was conducted.

The opinions collected belonged to five of the top 10 software and IT companies according to https://www.value.today/.

The novelty of this paper consists in gathering lessons learned from previous research but also from the shared experiences of some of the biggest IT companies that chose to publicly express their opinion, beliefs and actions taken during the pandemic.

2   CHALLENGES AND CHANGES CAUSED BY COVID 19 PANDEMICS

Similarly to other undesirable events such as the second world war, which forced the engineers of that time to find alternative solutions to traditional raw materials necessary for building technological equipment and machines, also the current turbulent times are challenging the companies and employees as well to be creative and to adapt the best they and develop sustainable business.

At the beginning of 2020 many countries worldwide decided to ask companies and public institutions to move the recurrent office activity from physical office places into "telework" and "work from home (WFH)"; the request was to do this as soon as possible and as much as possible, and to limit in this way the human interaction and the quick spread of the COVID 19 disease.

2.1   Challenges and changes for IT companies

Alashhab et al (2020) identifies one of the most requested directions for which specialists in the field had to find solutions in a short time, namely cloud computing service. He draws attention to the overwhelming volume of users resulting from 129 countries affected by this virus, which generated hundreds of millions of users of online networks, moving basically to the online environment all direct communication activity in the field of education, medical, IT, but also other sectors that were able to carry out remote work. Luckly, creativity is considered to "be a way of coping with uncertainty by challenging old assumptions and trying new things" (Ford, 1996, apud Tønnessen Ø et al, 2021).

Computer cloud environment (CCE) is defined by Alashhab et al as being "made up of a pool of computing resources that can be configured", which brings multiple benefits: not having to invest in hardware, network

infrastructure, low upfront cost, quick deployment, flexibility. It brings huge potential due to "plug and play" or "pay as you go" options. However, the CCE providers must invest in improving security, advantages awareness, prove of even more its benefits

In the same study, Alashhab et al (2020) mentioned the increased competition to gain new customers and customer satisfaction from the supplier point of view, but also the challenges faced from the user point of view.

They identified Cloud Services Providers (CSP) challenges as being the need to:

➢ to increase number of customers and customer satisfaction.

➢ to integrate bigger volumes and velocity in the context of large data flow at high speed are challenging, which makes it even more difficult to remain competitive.

➢ to change their ways of presenting services to customers, resulting in the concept of online service (application service).

Applications that are using big data generate new challenges for CSPs but also for their users. The latter are the ones to use and implement IOT technology, and in the context of our paper users of CSP are also the companies that are developing new programs based on cloud technology. Challenges identified by Alashhab from the user point of view with respects to CCE are:

➢ organizations must identify critical data source, structure, and architecture and to define the infrastructure that supports the big data analysis.

➢ using big data requires high levels of preparation in terms of application tools and resources selected.

➢ the companies must formulate new regulations and policies to ensure

security privacy, accuracy, quality, and control.

Knowledge Sharing (KS) is a critical success factor of knowledge management (Blankenship and Ruona, 2009 apud Tønnessen et al, 2021). In the context of a pandemic situation, when human interaction is limited to digital communication, the KS is also forced to convert into Digital Knowledge Sharing (DKS). Tønnessen and his colleagues consider in their research both internal and external DKS, which is equally important for the progress of the company. The internal DKS is expressed as key element for solving problems and generating new ideas, while the external DKS are equally important since the outside source of expertise is meant to fill the inside expertise gaps. The collaboration and communication is considered by Bezerra et al. (2020) to positively influence productivity. Their study suggests that teams are positively perceived as collaborative by 92.1% of the respondents. As far as the quality of communication is concerned, the study shows that only a very small percent considered the communication difficult or preferred not to comment, while the majority of 84.5% considers the communication with remote tools facile.

Brainstorming is a powerful tool for generating ideas and finding solutions to problems. Whiteboards are normally used for sketching and writing all these ideas in face-to-face meetings in which everybody is used to freely speak whenever an idea comes to mind. When it comes to remote work, existing tools are not a perfectly matched alternative because they are not fully adapted to this type of meeting. Many of these platforms are developed so that a single speaker can be heard at a time by the other attendees. Examples of these inconvenient have been pointed out by the audience members of an XP 2020 panel and had been emphasized by Mancl and Fraser (2020) in their study: "drawing isn't easy with a mouse or a touch screen" or "slack-based dialogs are generally less

effective than the conversations that co-workers would have face-to-face over lunch or in hallways, because text-based communication lacks body language cues and may be harder to interpret" (Mancl and Fraser, 2020, p. 313).

For the teams that are working with Agile methodologies, they had to adapt to multiple changes: digitalization of practices and artefacts such as analog Kanban boards; daily, weekly, or retrospective meetings that used to happen in rooms had to adapt to remote meetings. These changes have not been necessarily perceived as negative, for example the communication in the new approach is more efficient. Some of the teams had also proved to be creative and social meetings such as drinking a coffee or having lunch together turned into online meetings serving the same purpose. However, the online meeting seemed not to be as entertaining as they used to be in the face-to-face environment, so they were discontinued by some of the teams. Some Agile teams also perceived as a change an increased level of interventions from the product-owner (Neumann et al., 2021).

2.2   Challenges and changes for IT companies' employees

Considering the COVID-19 pandemic a highly disruptive and extraordinary event, its overall duration and other relevant attributes can classify this event as a career shock for many employees and the consequences should be evaluated for both short term and long term (Akkermans et al., 2020). Acknowledging this, if we are looking to the IT domain, we could consider a short-term consequence the limited interaction between the new employees and the groups of existing employees who already have an advanced level of familiarity, not to mention the longer time necessary to get familiar with the processes and knowledge sharing. The new employee might fill unsecure a longer time than in "normal" conditions, but this remains a short-term consequence. The difficult times regarding

the onboarding process during pandemics is researched by Rodeghero et al (2021). The new employees are having difficulties in asking for help, they complain about poor communication and almost no visual interaction and they also find difficulties in bounding with the teams. At the same time Akkermans et al (2020) mention the fact that elements that are negatively perceived on short term, on log term might turn into positive ones (in the case of new employees, the effort made will pay off as new abilities will make them more independent, creative or communicative).

On-boarding is considered by Rachel Reinitz - CTO and Founder of the IBM Garage to be challenging for both the person who must join the new team and for the persons who must assimilate the new members because the new one must learn in remote conditions and the others must teach them in the same conditions which means a lot of "screen-time" hours for both. She also mentions the fact that people are learning by seeing the others in the process of work, and that is something that cannot happen almost at all in remote working (Mancl and Fraser, 2020). The difficulty of training the new employees is also mentioned by Neumann et al. (2021) in their multiple case study.

The first change noticed was for sure the communication activity, which until this event had taken place directly. Communication is mainly needed for knowledge and information sharing. According to Tønnessen et al. (2021} internal DKS has a weak positive correlation with stress but a positive correlation with motivation and use of digital platforms which can lead to increased creative performance and to increased employee well-being.

As far as the WFH activity is concerned, it is generally perceived as positive "with a better work-life balance, increased creativity, positive affect, higher productivity, reduced stress, and fewer carbon emissions because remote workers commute less" (Russo et al., 2020, p.5). Tønnessen et al. (2021) considers that there is

not yet enough information, but according to the recent studies this type of activity along with DKS might become common in the future. However, there are also challenges regarding the remote working identified by Russo et al. (2020). These are: "collaboration and communication (named by 20%), loneliness (20%), not being able to unplug after work (18%), distractions at home (12%), and staying motivated (7%)" (Russo et al., 2020, p.5). There are also cases when the persons who WFH do not have a dedicated space for developing their work activities, and in those cases the work can be affected by the members of the family with whom they are cohabiting. Bezerra et al. (2020) found in their research group, that out of 58 participants only 67,2% have a dedicate space, while 56,9% are not living with family members.

Two major preoccupations had been identified in the researcher's studies: the wellbeing of the people developing activities in the IT industry and how their productivity had been influenced by the current context. The wellbeing is defined by Diener (2009) as "the fact that the person subjectively believes his or her life is desirable, pleasant, and good" (Diener, 2009, p1). He calls this "phenomenon as subjective well-being" (Diener, 2009, p1). The individual wellbeing is directly influenced by emotional stability. A good emotional stability provides autonomy and increased wellbeing while WFH (Ralph et al., 2020). The productivity is defined by Ralph as being "the amount of work done per unit of time" (Ralph et al., 2020, p. 4931). It is affected by: team size, used technologies, job satisfaction, emotional state, and others by external interruptions, environment adaption, emotional issues, discipline, awareness, collaboration (Neumann et al., 2021).

Public institutions from the affected countries also had and still must adapt to the new context, and many of the activities once developed directly with the public have now currently moved to online environment. This change determines a growth of IT positions in public institutions. One such situation is described by Koh et al. (2021), in their research in Germany. Findings from their research reveals that the new positions are demanding highly skilled IT professionals, and it seems that there will be more pressure on these professionals to resolve inefficiencies of existing processes.

3 CHALLENGES AND CHANGES CAUSED BY COVID 19 PANDEMICS

In order to be able to share information on daily bases companies adopted immediately communication instruments such as Zoom, Skype, Google Meet, Teams, enterprise social media (e.g., Slack, Workplace), and file-sharing tools (e.g., SharePoint, Dropbox, Google Drive).

The companies researched best practices in terms of adapting the office work in case of disasters, promoted new regulations and provided employees with needed equipment and the time to set up the new office environment in their homes. This finding is based on public statements made by large companies through public information channels but also found in academic articles. The Camara et al. (2020) study describes this approach taken by a startup company from Brazil, where they describe 23 measures taken.

The companies focused on stimulating creativity and so the development teams came up quickly with solutions to emergent problems caused by COVID 19 pandemic. The creative performance in turbulent times is highlighted in their article by Dahlke et al. (2021). Based on their research 707 innovation projects were triggered by the human needs in the context of pandemics, and the IT is one of the domains for which the innovations had been directed.

Almost all these companies showed solidarity for sectors in need and offered active support to the most affected ones: primarily health, followed by the academic sectors but also their partners and customers that develop their

activities into sectors which are less privileged when it comes about the possibility to develop activities remotely.

One of the top priorities declared during this period has been the safety and wellbeing of the employee. The companies created new sanitary rules to be followed inside the companies and facilitated the quick access to vaccines for their employees (see Table 1 from this article).

From the economic point of view, they found solutions to remain sustainable. Some of them changed their ways of presenting services to customers by shifting from license programs to programs as service, or by also offering this alternative solution (Alashhab et al., 2020).

Table 1: Qualitative data collected from IT Companies' public statements with regards to COVID 19 Pandemics impact and the possible perceived effect

Company	Variable type:	Declaration (quoted)	Perceived effect
Apple	Economic	An uptick in coronavirus cases in Vietnam is forcing supply chain manufacturers for Apple and others to operate well below capacity as a mitigation effort.	Economic decline
	Economic	Apple is having supplier labor manning issues across the globe.	Economic decline
	Organizational	We are all adapting and responding in our own way.	Change
	Organizational	We are committed to providing exceptional service to our customers. Our online stores are open at www.apple.com.	Change
	Organizational	In all of our offices, we are moving to flexible work arrangements worldwide outside of Greater China.	Change
	Employee well-being	That means team members should work remotely if their job allows, and those whose work requires them to be on site should follow guidance to maximize interpersonal space.	Change
	Organizational	Extensive, deep cleaning will continue at all sites. In all our offices, we are rolling out new health screenings and temperature checks.	Increased costs
	Economic	All of our hourly workers will continue to receive pay in alignment with business-as-usual operations.	Normal state
	Employee well being	We have expanded our leave policies to accommodate personal or family health circumstances created by COVID-19 —	Economic strength

Company	Variable type:	Declaration (quoted)	Perceived effect
		including recovering from an illness, caring for a sick loved one, mandatory quarantining, or childcare challenges due to school closures.	
	Future	We do not yet know with certainty when the greatest risk will be behind us. "As our case is new, so we must think anew, and act anew."	Uncertain
	Philanthropic	Apple's committed donations to the global COVID-19 response — both to help treat those who are sick and to help lessen the economic and community impacts of the pandemic — today reached $15 million worldwide.	Economic strength
	Community well-being	We're also announcing that we are matching our employee donations two-to-one to support COVID-19 response efforts locally, nationally and internationally.	Economic strength
Microsoft Corporation	Economic	The supply chain in China returned to more normal operations at a faster pace than we had anticipated.	Normal state
	Economic	we saw increased demand from work, play, and learn from home scenarios, benefitting Windows OEM, Surface, Office consumer, and Gaming.	Economic growth
	Economic	significant reduction in advertising spend, which impacted our Search and LinkedIn businesses.	Economic decline
	Economic	In our commercial business in March, we saw healthy Azure consumption and increased usage across Windows Virtual Desktop, Power Platform, and Microsoft 365, particularly in Teams and our advanced security solutions.	Economic growth
	Economic	we also saw some changes to our sales dynamics particularly in the industries and segments most impacted by COVID-19.	Economic decline
	Economic	Microsoft has been on a transformation to become a cloud company but more personal computing.	Change

Company	Variable type:	Declaration (quoted)	Perceived effect
	Philanthropic	We have donated $1 million to help launch the Seattle Foundation's COVID-19 Response Fund to support nonprofits and community organizations in the Puget Sound region. To date, the fund has raised over $15 million, helping around 130 community-based organizations.	Economic strength
	Philanthropic	Our senior leadership team has made individual donations, totaling more than $1 million, to the All In Seattle rapid response fund. And our employees are also supporting local fundraising campaigns: Together with our company donation matching initiative, they have given over $1.54 million to the end of March.	Economic strength
	Philanthropic	Microsoft commits more than $110M in additional support for nonprofits, workers and schools in Washington state.	Economic strength
	Community well-being	Making Virtual Classroom and Teams available on a free trial license basis to districts. Using existing training systems to quickly get teachers and other district personnel up to speed on Teams and other tools	Economic strength
Alphabet (Google parent company)	Community well-being	We're partnering with the U.S. government in developing a website dedicated to COVID-19 education, prevention, and local resources nationwide.	Economic strength
	Community well-being	As more employers have asked workers to stay at home to help slow the spread of COVID-19, we're seeing more people using the premium features of Meet, our video conferencing app, which we made available to all G Suite customers at no cost until July 1, 2020. We've also shared tips and resources for remote workers of all kinds.	Economic strength
	Community well-being	For educators around the globe, we've created new distance learning resources.	Economic strength
	Philanthropic	Through our philanthropic arm Google.org, we are committing $50 million to the global COVID-19 response, focusing on health and	Economic strength

Company	Variable type:	Declaration (quoted)	Perceived effect
		science, access to educational resources and small business support.	
	Philanthropic	We have been working in close collaboration directly with the WHO. As part of that collaboration, on Friday we announced we'll be matching up to $5 million in donations to the COVID-19 Solidarity Response Fund for the World Health Organization (through the UN Foundation). The fund will help the WHO track and understand the spread of the virus and help frontline workers with essential supplies and information. We also made a $500,000 grant to a team of researchers, epidemiologists and software developers at Boston Children's Hospital working on HealthMap, a website that provides up-to-date trends of emerging public health threats and outbreaks.	Economic strength
Amazon.com	Employee well-being	We're helping to ensure that our employees and their communities have access to COVID-19 vaccinations and testing.	Economic strength
	Employee well-being	Amazon is also heavily invested in supporting employees, ... in increasing paid time-off.	Economic strength
	Philanthropic	We established a $25 million relief fund for partners, such as delivery drivers, and seasonal associates facing financial hardship or quarantine.	Economic strength
	Future	Our plan is to return to an office-centric culture as our baseline. We believe it enables us to invent, collaborate, and learn together most effectively.	Predictability &Control
	Future	The timelines for returning to the office will vary by country, depending on the infection and vaccination rates, and we expect our return to the office to be gradual ... we expect more people will start coming into the office through the summer, with most back in the office by early fall.	Predictability &Control

Company	Variable type:	Declaration (quoted)	Perceived effect
	Community well-being	Amazon WorkSpaces is reintroducing its free Work from Home offer to help businesses and employees set up virtual desktops at home during the COVID-19 pandemic.	Economic strength
	Philanthropic	Amazon supports Washington D.C. public school students with donation.	Economic strength
	Employee well-being	We've invested in new processes, personal protective equipment, technology, time off benefits, and intensified cleaning methods to keep people safe.	Economic strength
Facebook	Community well-being	An Update on Our Work to Keep People Informed and Limit Misinformation About COVID-19.	
	Philanthropic	Matching $20 million in donations to support COVID-19 relief efforts and donating $25 million to support healthcare workers on the front line.	Economic strength
	Philanthropic	Investing $100 million in small businesses and making it easier for people to support their local businesses.	Economic strength
	Employee well-being	We have taken precautions to protect our workers by cutting down the number of people in any given office, implementing recommended work from home globally, physically spreading people out at any given office and doing additional cleaning.	Economic strength
	Economic	With fewer people available for human review we'll continue to prioritize imminent harm and increase our reliance on proactive detection in other areas to remove violating content… That being said, there may be some limitations to this approach, and we may see some longer response times and make more mistakes as a result.	Economic decline

The other five of the top 10 companies are Alibaba Group Holding, Tencent, Visa, Intel Corporation, and Cisco Systems. Each of these giants from IT industry shared publicly their activities, actions, and experiences with regards to combating and mitigating the negative effects of the covid pandemic. Some of them (Amazon.com) made very detailed almost daily reports, other had been more synthesized in declaration.

They help the health system by supporting the vaccination programs and facilitate employee's vaccination. They offered support to the employees in accommodating the work from home by endowing it with the necessary equipment but also by extending the medical insurance contracts so that they cover the eventual health problems caused by Covid 19. As far as the leading companies in the IT industry are concerned, their economic strength clearly results from their public declarations, but more important by far is the fact that they show care, concern and support for local and global communities affected by COVID 19 pandemic. Even though they are very strong economically many of them are transparent and publicly declare both the growth generated by the WFH which in turn generates the need of DKS and CCE but also the way in which the COVID 19 negatively impacted them. The business in this sector had not been affected directly by the pandemic, but indirectly, through the effect of pandemic over the industries on which it depends.

Sharing their experiences and actions is highly important for the IT industry because they are and should be inspiration for the other small and medium sized IT companies.

4   FORESEEING FUTURE

Working from home during the pandemic lockdown had proven to be stressful and challenging for the people working in the IT industry. Many of them also invested in adapting their home to work and started to see benefits out of it, and they would rather prefer to work from home then returning to office. "Corry explained that many offices in Denmark had reopened in May and June, but that "some people thrived so much on working from home" that they would prefer to remain virtual" (Mancl and Fraser, 2020, p.311). Some other reasons regarding for rejecting the return to physical offices have been mentioned by the keynote speakers to an XP 2020 panel: the increased risk of illness caused by a public crowded place, the preference for taking advantage of the new, hardly acquired skills and familiarization with the new tools for remote work, and not ultimately the joy of having more facetime with the dear ones that are around (Mancl and Fraser, 2020). The work from home might remain in the future as an alternative for the work from office activity, at least in a hybrid manner. There are also companies that consider the office work to be more productive and creative.

The changes that COVID 19 will generate in the future are still uncertain for this sector, like for almost all other. However, there are trends that can be outlined such as cloud computing, cloud applications, over license application or changes regarding the office flexibility with regards to workplace and tools. WFH along with all other effects of this approach is and remains one of the biggest challenges and most debated topics when it comes to the effects of the Pandemic impact on the IT technology. Some see the flexibility of WFH as positive, especially when it is not happening in turbulent times, while others consider that work in physical offices "enables to invent, collaborate, and learn together most effectively".

Digital knowledge sharing proved its benefits. The return to the offices will be gradual in some companies. Cloud processing and cloud services are expanding and seem to be the solution of the future due to their multiple advantages.

5   CONCLUSIONS

The findings of this research helped us find some responses to the questions addressed. To answer these questions we have consulted existing literature with regards to COVID 19 pandemic and its impact on the digital industry and we have researched public statements of the IT companies out of which we extracted relevant and detailed information.

The literature had been selected from 4 platforms, based on keywords search. We found 398 potentially relevant papers, and after applying inclusion and exclusion criteria we have selected 16 papers relevant for our research. Four of these papers have been based on surveys addressed to specialists from this domain, but after a deeper analysis we found that most of the respondents had been programmers and a very small number had other roles. Also, the surveys had been more focused on the employee wellbeing and productivity and less on the global impact of the pandemic over the industry. To have a more complete image we decided to include organizations' point of view expressed in public statements made by the IT companies on their blogs and press sites, by developing an exploratory data analysis.

We measured the impact in the number of changes and challenges that occurred in this domain. We have found that the IT industry is a domain in which almost 90% of involved jobs can be performed remotely. The IT industry has been affected directly by three major causes: the remote working and all the side effects generate by it, the slowdown from the other industries on which they rely on and by the effect of the pandemic on the people working in this domain.

For organizations there have been identified the following explicit challenges and changes: exceptionally increased use of cloud computing in a short time, change of regulations and policies of security in same short time, having to adapt working processes to remote working, deploying in a short time the necessary equipment for employee's home office, motivating and assuring the wellbeing of employees in turbulent times. For employees, the biggest challenge has been to adapt to the new home office and to find an equilibrium between job and family time. For the new employees it has been a hard time to accommodate to the new jobs, new teams, without direct or at list visual contact.

The IT companies adapted fast to the new context; they quickly adopted remote activities by implementing new working instruments, changed their ways of presenting services to customers. They supported communities by offering free use of programs, trainings, discounts, and special offers and provided financial support when needed.

The pandemic is not over, and it is important to learn from own experiences and the experiences of others to progress. The future is still uncertain, but the companies are already foreseeing future opportunities in remote working and cloud computing.

This paper aimed to help companies that are still struggling to find an equilibrium and best practices to overcome crisis; it can also be used by students and researchers to guide new research hypotheses.

The limitations of this study come from the fact that it relies only on statements originating from top-level IT companies. The perspective of medium and smaller companies through the eyes of their owners and leaders may be a useful next step.

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