The COVID-19 opportunity for Qure.ai

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Abstract
Qure.ai was a healthcare startup using deep learning, a subset of machine learning, in healthcare. One of their products was used to diagnose tuberculosis and other lung ailments. With the spread of COVID-19, they were able to repurpose their product to also detect early onset of COVID-19 in patients. They were in a position where they had to decide whether to focus on COVID-19 or on the opportunities related to other lung ailments.

Keywords
COVID-19, deep learning, healthcare, startup

Introduction
The COVID-19 pandemic had an enormous impact on lives, communities and the economy with about 170 million cases and about 3.5 million deaths reported worldwide, by April 2021 (WHO, 2021). The situation resulting from this crisis had impacted mobility, trade flows, consumption and lifestyle patterns. In addition to its impact on individuals, it had had a deep impact on several businesses. Although big multinationals had the resilience to weather the storm, COVID-19’s impact on small entrepreneurial firms had been particularly devastating (Syriopoulos, 2020). During a crisis, the problems startups face can be external like access to resources and finances (Mac an Bhaird et al., 2019) or internal, like when the pressures during a crisis situation can even hinder the cognitive processes involved in recognising and acting on opportunities (Pattinson, 2016). Promising startups in several sectors like travel and tourism, fashion, retail technology, sports, entertainment and others had to close operations.

It had been widely seen that crises give impetus to innovation and entrepreneurship (Levinthal and Murch, 1981). In a crisis such as COVID-19, a firm’s progress, or even survival, did not rest on the efficiency, but on the firm’s ability to respond to the new opportunities and challenges emerging from the crisis. Several studies had highlighted the important role entrepreneurs have played during the current COVID-19 pandemic, and the role entrepreneurship and entrepreneurial thinking were likely to continue to play in the post-COVID-19 times (Smith et al., 2020; Zahra, 2021).

Prior research assumes that businesses get extended periods of stability punctuated by occasional short periods of instability and crisis. The magnitude and perseverance of the COVID-19 pandemic signaled that there may be a higher frequency and magnitude of periods of crisis (Shepherd, 2020). Also, several behavioural and societal changes brought about by COVID-19 seemed unlikely to dissipate at the end of the pandemic but were likely to persist as part of the ‘new normal’.

As a response to COVID-19, several new ventures pivoted to new products and services (Li-Ying and Nell, 2020). The new businesses were more in tune with immediate requirements of the market. Several engineering firms got into the manufacture of ventilators, clothing firms started a line of face masks and taxi companies started ambulance services. For some, it was a new business line in addition to their existing ones and for others, it was a complete shift that involved closing down their previous line of work because they either did not see a return to the previous normal, or they just did not have the resources to stay in the previous business and also support the start of the new initiative.

Company background
Qure.ai was an India-based healthcare startup that used deep learning to address the need for accessible and affordable diagnostics. Deep learning is a subset of machine learning in Artificial Intelligence (AI) that renders networks...
capable of learning unsupervised from data that is both unstructured and unlabeled. It mimics the functioning of the human brain in processing data in detecting objects, recognizing patterns and making decisions.

Qure.ai was founded by Pooja Rao, a doctor, and Prashant Warrier, an AI professional who had previous entrepreneurial experience, in 2016. They were incubated at the corporate incubator of Fractal Analytics, one of the leading providers of AI and analytic services. Fractal had worked with several Fortune 500 companies in financial services, retail and consumer goods. The company had launched an ‘Ideas2Business’ program where entrepreneurs with promising ideas in AI were incubated at Fractal and given domain-specific guidance. Qure.ai was the first to graduate from their incubation and since then, other startups like Theremin.ai, Cuddle.ai and Eugene.ai had also emerged.

Microsoft, Apple, Google, IBM and other companies had played a big role in pushing AI into healthcare. We could see the evidence in consumer devices like the Apple Watch, anti-aging solutions from Google through investments in Verily and Calico, and in enterprise solutions created by IBM and Microsoft. The AI Market in medical imaging was expected to register a Compounded Annual Growth Rate (CAGR) of 30.4% over the next five years (Mordor Intelligence, 2021). The major players in this market included Siemens Healthineers AG, GE Healthcare, Nvidia Corporation, Philips Healthcare, Zebra Medical Vision Inc., IBM Watson Health, Samsung Electronics Co. Ltd, Medtronic Plc, Benevolent AI Limited, Enlitic Inc. and EchoNous, Inc. This was still a nascent market and most initiatives, even by big players, were not market ready. With rapid advances in the field of AI, this was expected to change soon.

The volume and complexity of imaging data from x-rays, Magnetic Resonace Imaging (MRI), Computed Tomography (CT), etc. was steadily increasing. On the other hand, radiologist expertise was scarce and expensive, especially in developing countries like India. Qure.ai’s deep learning solutions helped doctors and radiology centers to be more efficient in processing data from images and to be accurate with their diagnosis, by reading and automatically interpreting medical images like x-rays, MRIs and CT Scans.

In deep learning, product development involved not just writing complex code, but also training the algorithm with lots of data to achieve accuracy comparable to that of humans. Sourcing the data needed a lot of time and investment. Qure.ai found it prudent, not to try for multiple solutions, but to focus on just two products.

**Product development**

Qure.ai developed qXR, a solution for x-ray abnormality detection. This solution focused on lung x-rays and it could identify 15 most common x-ray abnormalities. According to World Health Organization (WHO, 2018), chronic obstructive pulmonary disease and lower respiratory infections like pneumonia, each accounted for over three million deaths every year, while lung cancer and tuberculosis (TB) accounted for over a million deaths every year. There were several other lung-related diseases such as asthma, pulmonary embolism, pulmonary hypertension, and occupational lung disease, which were also of major concern across the world.

TB was a huge problem in India and the country accounted for the majority of TB cases in the world, hence, TB diagnosis became the focus of qXR. More than 10.4 million people were infected with TB in 2016 worldwide, and the same year an estimated 1.7 million people died as a result of TB-related complications, mainly in underdeveloped and developing countries.

Qure.ai sourced anonymous patient x-rays from 15 institutions across the country and built a library of millions of images. Then they had to carry out a lot of research and development to develop a pre-trained neural network model that would perform well in processing x-ray upwards of 16 million pixels in size, while operating on conventional computer hardware. The product development process was successful and in preliminary studies, qXR had proved to be 90% accurate in diagnosing TB. Although they had been working on using AI for interpreting chest x-rays and scans since 2016, qXR with its focus on TB, was launched in October 2017.

Their other product was for processing brain CT scans for emergency care. It identified hemorrhaging in the brain and bone fractures. A CT scan of the head was usually the first diagnostic test a patient undergoes when there is a head injury or there are symptoms suggesting a stroke. The problem patients often faced was that there may not have been a radiologist immediately available for reading and interpreting the CT scan. Time was of the essence for stroke patients as brain cells could be dying every minute that goes by. Their product, qER rapidly scanned scans in under 10 s to detect, localize and quantify abnormalities, as well as assess their severity. This led to proper patient prioritization and appropriate clinical intervention. qER was launched in April 2018.

**Market performance**

They made both solutions available in the market, but they faced several initial problems. Firstly, it was the reluctance to adopt new technology. To counter this, Qure.ai collaborated with physicians, researchers and universities to conduct studies and the results were published in leading journals and online distribution systems for medical research. To gain further credibility, they published the datasets they used from anonymized scans and x-rays. They were also proactive in getting international
certification. qER was US FDA 510(k) cleared and CE certified, while qXR was CE certified too. The international certifications not only provided credibility in the domestic markets but also paved the way for international expansion.

Although Qure.ai did not aim to replace doctors and radiologists, there was a fear among the professionals that the algorithm was taking the place of humans. In all their outreach for product deployment, Qure.ai stressed the advantages their products could bring to the doctors and hospitals. Overworked and tired doctors could rely on the diagnosis by deep learning algorithms to decrease errors and identify tough-to-spot cases. It was positioned as a radiology assistant, providing a draft report that could then be validated by a physician or a radiologist. Also, the products came with a technology that visualized the algorithm’s data, which made it easier for the physicians to understand what the algorithm saw.

Also, in a price sensitive market, medical centers and hospitals found it difficult to invest in new technology. To overcome this, their products were available either as a standalone solution or as an API that integrates with their current radiology workflow. Pricing of their products was kept largely as a variable cost to medical centers and physicians. Also, the cost was kept low considering the economic realities of operating in a developing country like India.

To increase the reach of qXR, Qure.ai partnered with government entities and Stop TB, an international non-profit. They had medical centers and mobile vans that had access to remote pockets of population. With the help of Qure.ai, they could now screen the population to identify if anyone has TB. To expand its international reach, it partnered with Teleradiology Solutions (TRS) and Telerad Tech. Through the partnership, qXR would be integrated with Telerad’s proprietary platform that TRS used to provide teleradiology services in over 20 countries.

By 2019, the growth of the company had been steady but not spectacular. There had been good traction for qXR, with over 30 deployments in India across five different states. It included both urban and rural medical centers. All put together there were about 200 deployments across the world. Although there was lesser traction for qER, there had been good reception following the publication of a study in Lancet (Chilamkurthy et al., 2018), and the volume of queries and trials indicated that it would catch up with qXR quite soon.

Overall, there was interest, which translated into trials and deployments, but still the revenue was low. Qure.ai’s business model depended on usage, and not deployment, to bring in the revenues. Physicians and radiologists were still reluctant to use and there did not seem to be a significant intent to making it a habit to include it in their workflows. The physicians and radiologists still preferred doing the process manually and only occasionally resorted to using qXR as a confirmatory second opinion. In spite of the evidence, they did not trust AI to reliably interpret the chest images and to diagnose TB accurately. It probably needed a continuous effort to encourage the physicians to use qRX regularly and to have trust in the product. Unfortunately, Qure did not have the finances to invest in that scale of market outreach. So, not only were they hampered in growing to new markets and reaching new customers, they also had limited ability to promote adequate usage among their existing customers. In the year ending March, 2019, Qure.ai had revenue of $113,000. The organization had also grown to about 30 people. The initial funding of $2.7 million from Fractal was so far able to support their monthly burn but without additional funding or an increase in revenues, they were fast reaching the end of their runway. In February 2020, Qure.ai finalized a $16 million round of funding from Sequoia India and MassMutual Ventures Southeast Asia. This gave them an opportunity to effectively pursue existing leads as well as to explore new opportunities.

**COVID-10 pandemic**

Early in 2020, COVID-19 started spreading all over and by March there was a significant spurt of cases in India. Alarmed by the rapid rise in cases, the government imposed a total lockdown all over the country starting on 24 March 2020. Although it was initially supposed to be for 14 days, subsequent extensions brought the total to 61 days of complete lockdown, followed by gradual easing of restriction spread over several months.

As a result of the lockdown, all economic activity, other than essential services, had come to a halt. Healthcare was an essential service but in this too there were several restrictions. There was a drastic reduction in activity in the healthcare sector. Complete departments in major hospitals got shut down, elective surgeries were postponed, and doctors started attending to patients remotely through telecalling.

This was a time medical centers and hospitals were struggling to come to terms with their operational and financial challenges. None had the time to adopt or give attention to innovations such as qER and qXR. Though there was the buffer of a recent funding round, like many other entrepreneurial firms, Qure.ai was looking at very bleak prospects of business in the new scenario.

Meanwhile, the number of COVID-19 cases continued to climb. When India had gone into lockdown, there were less than 500 confirmed cases in the country but very quickly, there were thousands of cases being reported on a daily basis. The medical facilities in cities such as Mumbai and Delhi got overwhelmed by the sheer number of cases.

By April, there was an acute shortage of RT-PCR kits that were used to detect COVID-19. Doctors soon realized that in the absence of RT-PCR tests, chest x-rays could be used to identify and segregate patients with pneumonia-like
conditions, indicative of a severe COVID-19 infection. COVID-19 resulted in the blockage of arteries leading to lungs and caused damage to both sides of lungs. On x-rays, it looked different from TB or lung cancer. So theoretically, doctors could diagnose and begin treatment on the basis of x-rays, but the reality was that India had less than 20,000 radiologists for a population of 1.3 billion. Moreover, the radiologists were largely concentrated in the urban areas. The trained manpower required to interpret the x-rays was simply unavailable.

This presented an opportunity for Qure.ai to deploy qXR. The algorithm had already been trained to detect TB, lung cancer and other lung abnormalities and it could be repurposed to detect COVID-19-related lung abnormalities too. The team at Qure.ai had already been studying early literature on COVID-19 to figure out how COVID-19 might show up on an x-ray.

Qure.ai got access to a large number of anonymized x-rays of COVID-19 patients in Mumbai and used those to train the algorithm. They created a COVID-19 scoring method alongside the existing algorithm and rolled out the tool for use by doctors.

Soon, doctors started to use qXR to detect COVID-19. RT-PCR tests remained the primary and most accurate means of testing for COVID-19 but qXR proved to be an important part of the process. In several hospitals in Mumbai, the digital chest x-ray was the first point of diagnosis for any patient suspected of having COVID-19. Detection of COVID-19 by qXR led to the segregation of patients even before there was confirmation by a RT-PCR test. Later those patients could undergo an RT-PCR test to back up the x-ray results. Even if the RT-PCR test came back negative, but the x-ray score was high, the patient would be treated as a COVID-19 patient.

qXR seemed particularly effective in detecting COVID-19 early. It was able to detect COVID-19 in a large number of cases that did not show any symptoms. This, coupled with the fact that an x-ray was far less invasive than a throat and nose swab needed for an RT-PCR test, led to qXR being used as a frontline tool to stem the rise of COVID-19 cases. All over the age of 55, who had comorbidities like high blood pressure or diabetes, but showed no symptoms of COVID-19 were subjected to an x-ray. Anyone who threw up a high score was immediately isolated.

Although qXR was certainly a big help in fighting the pandemic in Mumbai, it had an even greater contribution in battling the disease in the rural areas. In some places, throat and nose swabs had to be transported for three hours for RT-PCR testing. The doctors manning the rural medical centers were general physicians and had limited expertise in reading x-rays. qXR was able to bridge the gap for them. They could now use x-rays and qXR to identify COVID-19 patients and segregate them, without having to wait for the results from the RT-PCR tests.

There were some questions raised over the accuracy of qXR. Results from India indicated that the accuracy was around 90%, and given India’s needs and ground conditions, this was acceptable. The spread of COVID-19 had been particularly bad for Europe, and Qure.ai was eyeing the possibility of deploying it in Europe. In a study in Italy (Mushtaq et al., 2021), qXR analyzed x-rays of 697 COVID-19 patients and was able to identify 79.6% of the cases. The success rates of doctors who analyzed the x-rays manually were higher at 86.95%. As Europe too was reeling under the onslaught of COVID-19 cases, this level of accuracy seemed sufficient to warrant deployment of qXR at San Raffaele Hospital in Italy and Medica, a radiology company that worked with National Health Services in United Kingdom. They also ran COVID-19 pilot programs with the Oman government, vRad in United States and others in Vietnam, Turkey, France and Egypt.

This was significant from a revenue angle as the international deployments were all paid for, while their initiatives with the Indian government were largely pro bono. The growing worldwide demand for their product was good news for the company, but it placed a huge demand on the resources of the company. Responding to leads from all over the world, attending to queries of varied prospects, prolonged product demos and servicing widespread customers was taking a toll on the already stretched resources of the company. Also, it was taking their attention away from qXR and qER and it was possible that the market performance of these newly introduced products would be compromised.

By December 2020, the number of COVID-19 cases in India had come down significantly, but the second wave had started in Europe and North America. The need for qXR as a COVID-19 diagnostic tool continued but there was a slowdown in its growth as RT-PCR test kits were now readily available all over. From the usage figures, it did seem that the doctors and radiologists who used qXR for COVID-19 diagnosis were not using it as much for detection of lung cancer or TB.

Other businesses

Other lines of business had started picking up. Astra Zeneca and Qure.ai announced a partnership aimed at using qXR for early detection of lung cancer in patients across its emerging markets regions in Asia, Africa and Latin America. This was aimed at increasing lung cancer detection at an earlier stage and ultimately reducing lung cancer mortality rates.

There was interest from manufacturers of digital x-ray machines such as GE, Siemens, Fuji and Phillips. All manufacturers had tried their hand at bundling software with their medical hardware. They were exploring the possibility of embedding qXR inside their machines. This would need Qure.ai to go with a different business model. They could
charge a one-time fee for installing the software and then an annual fee for maintenance and updating the software. This would be a departure from their pay per use model but would result in steadier cash flows. Also, many of the manufacturers themselves had teams working on AI but Qure.ai had an advantage of being one of the early entrants. A partnership with a manufacturer would seem to be a good way to seal the advantage.

Their TB deployments in India and Philippines were already revenue positive. In its annual TB screening guidelines, the World Health Organisation (WHO) introduced qXR as one of three AI platforms that can be used to replace human specialists. With official recognition, there was bound to be some growth in this segment for Qure.ai.

The negative fallout of all the attention to COVID-19 and qXR was that Qure.ai could not focus on market deployment of qER. It was a fully developed product that had all necessary certifications and clearances, but adoption was slow.

In April 2021, Fujifilm finalized a partnership with Qure.ai. Fujifilm’s portable X-ray machines would be equipped with a new image processing box enabled to connect with qXR software. It would assist doctors and technicians by flagging abnormal findings at the point of care.

At the same time, the number of COVID-19 case was rising rapidly in India. The virulence and numbers far surpassed the earlier wave of COVID-19 cases, and the Indian healthcare system was caught unawares. Again, there was widespread shortage of RT-PCR kits leading to a shift in focus to x-rays as the preliminary diagnostic tool. Qure.ai partnered with Molbio, a diagnostic test company, to come out with integrated testing solutions. It also partnered with the international non-profit, PATH, which worked to make qXR available to physicians through the Telegram app.

Summary of the situation

There was a decision problem facing the company. A young startup like Qure.ai did not have the bandwidth to pursue COVID-19-related opportunities and its other international initiatives at the same time, and it would need to take decision on which one to prioritize.

Summary of the issues

Qure.ai’s focus on COVID-19 had been very good for growth. Within two years the revenues had grown 18-fold to $2 million for the year ending 2021. Although hospitals and physicians were reluctant to adopt qXR for lung cancer or other lung abnormalities diagnosis, the sheer volume of COVID-19 cases made it easier for Qure.ai to push for deployment of qXR. The number of COVID-19 cases was still high and there were even talks of further mutations and a third wave, but there were several vaccines already out in the market and healthcare providers were also learning from their past experiences to be better prepared for new outbreaks.

On the other hand, there was a significant investment of time and effort in forging partnerships and following through with Fujifilm, Astra Zeneca and several other initiatives in the works that were aimed at increasing their international reach.

Questions

1. When Qure.ai launched qXR and qER, why were radiologists and physicians reluctant to adopt the product?
2. Describe the opportunity that emerged for Qure.ai due to COVID-19.
3. What did Qure.ai do to harness that opportunity? Do you agree with their strategy?
4. Should Qure.ai continue to pursue COVID-19-related opportunities or should it concentrate on opportunities related to TB and other lung ailments?

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References

Chilamkurthy S, Ghosh R, Tanamala S, et al. (2018) Deep learning algorithms for detection of critical findings in head CT scans: A retrospective study. The Lancet 392(10162): 2388–2396.

Levinthal D and March JG (1981) A model of adaptive organizational search. Journal of Economic Behavior and Organization 2(4): 307–333.

Li-Ying J and Nell P (2020) Navigating opportunities for innovation and entrepreneurship under COVID-19. California Management Review. Available at: https://cmr.berkeley.edu/2020/06/innovation-entrepreneurship/

Mac an Bhaird C, Owen R and Freel M (2019) The evolution of entrepreneurial finance–10 years after the global financial crisis. The International Journal of Entrepreneurship and Innovation 20(4): 235–238.

Mordor Intelligence (2021) AI in Medical Imaging Market Technology Innovations in Medical Sectors 2021–2026.
Mushtaq J, Pennella R, Lavalle S, et al. (2021) Initial chest radiographs and artificial intelligence (AI) predict clinical outcomes in COVID-19 patients: Analysis of 697 Italian patients. *European Radiology* 31(3): 1770–1779.

Pattinson S (2016) Strategic thinking: Intelligent opportunism and emergent strategy—the case of strategic engineering services. *The International Journal of Entrepreneurship and Innovation* 17(1): 65–70.

Shepherd DA (2020) COVID 19 and entrepreneurship: Time to pivot? *Journal of Management Studies* 57(8): 1750–1753.

Smith AM, Duncan P, Edgar D, McColl J. (2021) Responsible and sustainable farm business: Contextual duality as the moderating influence on entrepreneurial orientation. *The International Journal of Entrepreneurship and Innovation* 22(2): 88-99.

Syriopoulos K (2020) The impact of COVID-19 on entrepreneurship and SMEs. *Journal of the International Academy for Case Studies* 26(2): 1–2.

World Health Organization (2018) World Health Statistics 2018. Available at: https://www.who.int/docs/default-source/gho-documents/world-health-statistic-reports/6-june-18108-world-health-statistics-2018.pdf

World Health Organization (2021) Rolling updates on Coronavirus disease (COVID-19). Available at: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/events-as-they-happen (accessed 23 April 2021).

Zahra SA (2021) International entrepreneurship in the post Covid world. *Journal of World Business* 56(1): 101143.