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BUSINESS PLAN FOR DIAGNOSTICO – ARTIFICIAL INTELLIGENCE COMPANY

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ABSTRACT

The artificial intelligence market is skyrocketing, impacting numerous industries such as the healthcare sector, which has been particularly affected by computer vision algorithms and cloud-computing. This sector has also experienced a great increase in demand due to population ageing in developed and some emerging countries.

The present work project comprises the development of a business plan, detailing how the business will operate, benefiting from artificial intelligence tools. The project consists of the External Environment, which is a key factor in the strategy formulation providing insights that support the business, Strategy Formulation that facilitates achievement of defined goals, and Action Plan, which is paramount for strategic planning and implementation plan.

Keywords: Artificial Intelligence, Business Plan, Innovation, Medicine, Medical Image

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1. INTRODUCTION

1.1 Topic

The digital technology can be perceived as a means of the knowledge distribution, both with the objective to promote scientific research and reduce the social inequality in the access to services, regardless of geographic location and social class. That digital tools have impacted the medical sector in several ways such as research development that has become more specialized, advancing the medical knowledge at an unprecedented pace. Conversely, the Association of American Medical Colleges (AAMC) study in 2015 suggested that "demand for physicians in 2025 will exceed supply by 46,100 to 90,400.". (MDedge 2015).

The 'artificial intelligence' term was coined during a conference in Dartmouth College by John McCarthy in 1956. The thinking machine study was the original study of artificial intelligence (AI) focused on developing machines able to simulate every aspect of human intelligence (Codementor 2018). AI could be an important tool to improve the medical diagnostic accuracy, proposing computational models that enable to describe human rationality.

The acquisition task in the development of an AI tool is key to successful product development, it refers to obtaining the source database in which the algorithm will be trained. The development of artificial intelligence products also depend on the system ability to update itself by acquiring new data.

Currently, artificial intelligence systems have started to help medical specialists to diagnose diseases based on probabilistic approaches. The use of these tools implies in a better quality of diagnostics due to a boost in the specialist confidence with an extra layer of intelligence and reduction of costs. The cost cut is associated with the support in the diagnostic process and decision-making process of the treatment plan, it can shorten the steps needed for

completing a diagnosis, which leads to an opportunity to attend more patients, reducing the shortage of doctors and decreasing the social gap in the access to health.

1.2 Relevance

Chest x-rays are the most common type of x-ray exams performed (Health Engine 2018). It is often the first step in the diagnosis of a heart or lung disease. That exam can also reveal many aspects of the patient's body including the condition of their lungs, heart-related lung problems, the size and shape of their heart, blood vessels and fractures.

In Brazil, diseases like pneumonia and chronic obstructive pulmonary disease (COPD), which can be diagnosed through a chest x-ray exam, are one of the main causes of death and hospitalization of elders in the country. Refer to Appendix I and II for the rank of causes of hospitalization and causes of death of elders in Brazil. COPD alone was responsible for over 40 thousand deaths in 2015 and affects around 7 million people in Brazil. Diagnosing in the early stage of the disease to control the symptoms and develop a treatment plan is of main importance to improve the patient's quality of life. (Boehringer Ingelheim 2015). Therefore, reducing the time between the exam and the treatment plan and increasing the accuracy of the diagnosis are key factors in the treatment of diseases.

2. LITERATURE REVIEW

2.1 Artificial Intelligence in the healthcare industry

Artificial intelligence is one of the new frontiers for science and technology. Turing, 1950, McCulloch and Pitts, 1943, Hopfield, 1982 and Hebb, 1949, works on AI were intertwined with neuroscience and psychology in the new computational advancements in the last decade and the growing processing power of computers brought AI and neuroscience even closer. (Hassabis et al. 2017).

Also, according to Hassabis, it is greatly beneficial to develop AI algorithms close to biological intelligence. Neuroscience is an important source of ideas for new algorithms, independent and complementary to the mathematical and logic-based approaches. For instance, if a new biological computation is discovered and reveals to support a cognitive function, it is then considered to be incorporated into an AI tool. Secondly, the existing valid AI techniques were validated by neuroscience, for example, if an algorithm is to be incorporated in the AI system, then that is considered to be an integral component of a general intelligence system.

2.2 Application of AI in the decision-making process

Organizations are frequently researching new technologies, methods, and tools to acquire a competitive advantage. AI is contemplated as one of the most powerful tools ever invented by humans that can significantly increase organizations productivity. Practical results of its application have increased in importance and number as the number of studies also grow. Some of the specific characteristics of artificial intelligence tools include the ability to learn with experience, apply the recent knowledge acquire in complex situations and solve complex problems even without all important pieces of information, performing better and quicker tasks than humans.

The growth of storage data by companies in the last decades has stimulated the need for new tools and techniques that allow data analysis in search for insights in a smartly and automatically way. Knowledge Discovery in Database (KDD) appeared as a field of research as the need for data science became stronger, this field uses concepts and techniques from artificial intelligence with the goal to find patterns, trends, probabilities, factors or other insight from the database.

2.3 Challenges and impact of artificial intelligence in medicine

The medical artificial intelligence (MAI) began as AI algorithms that perform medical diagnosis and recommend therapies. Nowadays, MAIs are able to monitor, retrieve information, process and recognize images, speeding results of exams. There are five areas related to medicine in which AI can be applied, encouraging innovation in the following medical fields.

First, care coordination is the field that provides personalized care and individualized treatment plans. Second, population management aims to identify risks and prevent hazardous events. Third, auto management of the patient, the patient's health is monitored in real-time. Next, system projects are the field for process optimization. Lastly, support decision-making is the field that aims to support doctors in the best treatment plan, diagnosis, and drug dosage.

It is often said that AI will take jobs from the people, but AI will not replace doctors, it will eliminate repetitive tasks and support medical decisions, allowing them to spend more time with their patient. Also, doctors will remain responsible for the final diagnostic interpretation and treatment plan.

A study performed by PWC in 2017 shows that most of the interviewees would accept receiving care from robots from diagnostics up to small surgeries. According to the research, people tend to adopt this technology if the diagnostic is more accurate and faster. Refer to Appendix III for further information on the PWC research.

3. METHODOLOGY

The business plan for Diagnostico will be split in three sections, namely External Environment, Strategy Formulation, and Business model and Action Plan. Firstly, the External Environment analysis exams the industrial environment, the macro-environment,

and the company's competitors, concisely the events beyond the control of the business, facilitating the evaluation of the external factors and the acquisition and sustain of competitive advantage.

Following the external environment analysis, 3C's model of Ohmae will be used. "In the development of business strategies, three key factors must be considered: the corporation itself, the customer, and the competition. (Ohmae 1982). The first C represents the Corporation that will be assessed through the PEST Analysis framework. The second C is Costumer that will be evaluated by carrying out market size, trend, and driver analysis. The last C is Competition, that will be assessed via a comprehensive study of the competitors.

Moving on to the second part of the report, Strategy Formulation consists of the Business Snapshot, it describes the 4Ps of Marketing Mix, i.e. Price, Product, Promotion and Place. Following that, the Vision and Mission statements elucidate the purpose of the company. The SWOT Analysis prepare the ground for the factors that set the company apart from its rivals, gathering insights from both external environment analysis and industry analysis. Lastly, the competitive advantage presents an overview of the factors that stand out the company among its competitors.

Concerning the Business Model and Action Plan, the Business Model Canvas was used to facilitate the development of a new business model and to structure the company by defining the "Why", which consists of the purpose or belief, the "How", represented by the elements that set the company apart from its rivals, the "What" that consists of the product itself, and the financial part that encompasses the cost structure and revenue stream. In parallel with the Customer Segment, Customer Relationship and the Channel of the Business Model Canvas, Segmentation was also included to identify brand positioning, these elements represent the Who of the company. The key partners, key activities and key resources with the SWOT

Analysis from the Strategy Formulation constitute the How, and the What is defined by analysing the 4Ps of Marketing Mix and the Value Proposition. Lastly, the cost structure and the revenue stream permit the Financial Forecast to be performed, estimating the not only revenues, expenses, and operating profits in the future, but also the financial needs, gross margin and return on investment.

4. EXECUTIVE SUMMARY

Diagnostico is a software as a medical device (SaMD) that provides an artificial intelligence solution integrated with radiologists at an affordable fee for the medical imaging industry, detecting a range of medical conditions and alerting relevant stakeholders.

It will exploit the blue ocean of the medical imaging industry in Brazil, taking advantage of trends such as the ageing population, the growing adoption of artificial intelligence, lack of doctors and constantly evolving processing power of computers.

The business target customers are hospitals, diagnostic clinics, and laboratories. Diagnostico's mission statement is "to develop practical and effective solutions for diagnosing x-ray, tomography and MR images in Brazil enabling a rapid and accurate medical decision for a treatment plan.".

The marketing mix strategies specified refers to all target customers. Regarding place, Diagnostico will have two distribution channels, the company's website in which the customer can purchase the product that will be distributed via Google Cloud and via third parties such as medical device companies. Concerning promotion, it will occur in two ways, content creation on social media to create awareness, and business-to-business marketing campaigns to promote the product via price sample products with a limited number of studies. The revenue stream consists of two pricing strategies, fee-per-study and subscription

models. The fee-per-study will be fixed at €1.8 per study and the subscription model price will depend on the number of studies projected in the year by the customer.

The financial forecast for Diagnostico was performed for the three intial years of operation, it requires an initial investment of around €29 thousand, the break-even is projected to be reached on the second operating year. The projection considers that by the end of the third year, the number of studies will be approximately 64 thousand, resulting in an operating profit of around €43 thousand, a return on investment of 46.3%, and a gross margin of 37.2%.

5. EXTERNAL ENVIRONMENT

5.1 Macro Environment – PEST Analysis

5.1.1 Political Analysis

Political factors are significantly important for the healthcare industry, those factors include tax legislation changes, customer protection, anti-trust laws, pricing regulations, insurance mandates, intellectual property protection, mandatory employee benefits, bureaucracy, and interference in the healthcare industry.

Brazil has undergone political instability recently, that has affected the external investment. That kind of investment has decreased along the past years in the country, pushing away foreign investment. That creates an unsafe environment for international funds to invest in the country. (Globo 2020)

5.1.2 Economic Analysis

Over the last decade, Brazil has faced an economic recession affecting all industries and resulting in an increase in the unemployment rate, which in November 2020 hit the peak of 14.6% (Globo 2020).

Another factor is inflation that reduces consumer power, increasing the number of people that will seek the public healthcare system. In September 2020, the inflation rate went up by 0.64% which was the highest growth rate for a month in 17 years. (Silva 2020).

The interest rate in Brazil in August 2020 achieved its lowest value since 1996, the central bank manipulated the interest rate in order to control inflation and stimulate the economy. (UOL Economia 2020).

Regarding the infrastructure of hospitals in the country, across OECD countries, the average rate of hospitals beds per a thousand people in 2017 was 4.7, while Brazil had 2.3 hospital beds per a thousand people. (OECD Health Statistics 2019)

Brazil currently invests 1,285USD purchasing power parity (PPP), while the OECD 36 average is 3,994 USD PPP. Along with Brazil, South Africa, Russia, Mexico, and Turkey are the lowest per capita spenders in the key emerging countries. (Health at a Glance 2019)

Taking the economic factors above into account, in order to improve the public health quality and raise the number of patients attended, the solution will be through increasing the efficiency of the public health service. As the inflation rate is at its peak and the interest rate is low, people are investing in business solutions, as traditional investments have low returns. Therefore, AI-solutions are attractive to both investors and healthcare providers, as it enables healthcare providers to be more efficient and serve a greater number of patients.

5.1.3 Socio-cultural Analysis

Not only the developed countries, but also Brazil has experienced a generational change that is projected to greatly impact the market. The millennials became decision-makers nowadays, as the Boomers retire that new generation accounts for 34% of the population in Brazil. Millennials are generally more open-minded to innovation and adopt new technologies more easily than Boomers. (Veja 2020)

A significant social factor in Brazil is the lack of doctors and equipment in public hospitals. The rate of doctors per a thousand inhabitants in Brazil is 2.1, whereas the average in OECD is 3.3 professionals per a thousand inhabitants. That rate in Brazil drops to lower than 1.0 in some states in the North and Northeast of the country. (Cambricoli and Felix 2020).

The growing elder population is another factor that has played a role in Brazil. “In 2010, there were 39 elderly persons for every 100 young people, while in 2040 there will be an estimated 153 elderly persons for every 100 young people”. (Brazilian Journal of Geriatrics and Gerontology 2016). That represents an increase of the elder population of about 3 times, considering part of this population individuals older than 60 years old. The Appendix IV represents the population pyramid of Brazil in 2020 and 2050, respectively.

5.1.4 Technological Analysis

Data protection is one important technological factor due to privacy and information safety issues, data from disease history is used to train AI, but there must be effective and reliable protection from cyber-attacks to prevent third parties accessing this data. Cyber attacks are currently a huge problem in many industries, but it can be especially dangerous in healthcare as they can literally cause deaths.

“Cloud computing delivers an unprecedented level of computing power, at relatively low cost”. (Google Cloud 2020). Machine learning and artificial intelligence can highly benefit from this computer power to solve complex problems. The medical image analysis industry requires a strong computer power to deal with the amount of data needed to train a machine learning algorithm, such processing power is provided by Google through Google Cloud AutoML and machine-learning APIs.

5.2 Industry Overview

5.2.1 Market Size

The market size of the medical analysis software is value in 2020 at 2.6 billion dollars and is expected to grow up to 4.5 billion dollars in 2027, resulting in a growth rate of 8.15% CAGR in that period. (Grand view research 2020).

The artificial intelligence (AI) in medical diagnosis market was evaluated at 3,639.02 million dollars in 2019 and is forecasted to achieve the value of 66,811.97 million dollars in 2027. The compound annual growth rate (CAGR) of this industry is projected to be 44% from 2020 to 2027. (Businesswire 2020).

The modality of the medical image analysis software with the highest share is tomography, followed by radiographic imaging, ultrasound imaging and combined modalities, as shown in the Appendix V.

The main factors driving the medical imaging market are the adoption of artificial intelligence in the identification of diseases, which has significantly increased in the past decade, and the growing investment of companies and funds in medical artificial intelligence. The artificial intelligence based medical image analysis software market is expected to reach 2 billion dollars in 2023. Refer to Appendix VI for the revenue forecast of the world market for AI-based medical image analysis software.

5.2.2 Market Trends

Artificial intelligence algorithms have revolutionized the medical imaging sector. AI solutions enhance the results, increasing the accuracy rate of diagnosis and reducing the time for a treatment decision. Currently, AI technology trends include digital breast tomosynthesis

(DBT), which is a technology that individually analyses tissue layers, and cardiac MRI scans that instantly separate heart scans in different layers.

Another trend is the adoption of artificial intelligence algorithms by universities, researchers, and government administrations in medical imaging analysis. The US food and drug administration (FDA) is elaborating regulations for artificial intelligence and machine learning base software as a medical device (SaMD). The FDA and manufacturers will be able to assess and monitor software solutions from its pre-sale development to post-sale performance. Those rules will enable FDA to supervise the enhancement of medical AI and ML products while ensuring the safety of the patient. The FDA forecasts that AI and ML solutions require pre- and post-commercialization review. (Food & Drug Administration 2020).

The FDA notes 4 main elements to evaluate the product and organizational quality of SaMD solutions. The first key is to set up a definition of best practices of machine learning and quality systems, the second element is to determine safety measures, reviewing SaMD products and manage risks for the patient throughout the product life cycle. The third factor is for manufacturers to monitor AI/ML components in the development stages. The last component is to increase post-sale report transparency.

5.2.3 Market Drivers

The growing number of patients with respiratory diseases and illness due to air pollution and recently due to the Coronavirus pandemic the overall number of patients skyrocketed.

5.2.4 Segment Analysis

The AI in the medical imaging market can be segmented in terms of geography, application, AI technology, image technology and customer. Concerning the geographic segmentation,

the market is divided in the Asia Pacific, Middle East & Africa, Europe, North America, and South America.

In regards of application, AI products in medical imaging can be applied to a number of medical field such as dermatology, ophthalmology, cardiology, pulmonology, neurology, and oncology. The AI technology used for medical imaging analysis is generally deep learning, machine learning, and computer vision.

Regarding the kind of medical imaging method, the possible procedures are X-ray, computed tomography , ultrasound imaging, magnetic resonance imaging, molecular imaging and traditional photos.. Finally, concerning the final customer, there are three main segments, hospitals, R&D centres and Laboratories & Diagnostic centres.

5.3 Competition

The competition in the market can be assessed in terms of the size of the players and quantity. The main players in the AI in the healthcare industry are GE Healthcare, IBM Corporation, Medtronic, Hitachi, Siemens Healthineers AG, Samsung, Intel, Nvidia and Zebra Medical Vision, these players are located in Europe, Japan, and the United States.

Large corporations have invested in AI-medical imaging solutions by acquiring or partnering with start-ups or creating their own products. For example, Philips acquired Carestream Health that was able to identify patients with diseases such as coronary calcification, and lung emphysema.

Tech companies such as Google and IBM work as a platform for other AI solutions, with products like Google Cloud and IBM Watson Health, both products are machine learning platforms that also serves as a data storage. Although those companies currently invest in AI solutions and offer platforms for their development, they can easily develop their own solutions and become key players in the market.

As aforementioned, the big players are not in the Brazilian market yet, the only company that offers the service of analysing medical exams is called “Portal Telemedicina”. Their product works via telemedicine, hospitals and laboratories send x-ray images to them through the Cloud and a medical team remotely diagnose the image and return the medical certificate and they also store the medical image and the results in their cloud storage.

6. STRATEGY FORMULATION

The strategy plan to be implemented is the outcome of the strategy formulation process that determines the steps for the optimal strategy or solution. (Ulwick 1999).

6.1 Business Snapshot

The brand’s name will be Diagnostico, which instantly reminds of medical certs and exams in Portuguese.

6.2 Product

The product has to provide a reasonable performance, or else place, promotion and price from the marketing mix will have no effect. (The Economic Times 2015).

Diagnostico’s product is an AI cloud-based solution for the medical imaging market. The first product will be an algorithm to help doctors to diagnose thorax and heart-related problem with x-ray scans, this tool will be accessed to the end-customer via the Google Cloud Platform, which is ideally connected to the x-ray machine, therefore, as soon as the image is captured, it will be processed by the AI software and returned to the specialist and a copy of the image will be sent to their doctor.

As a result of the process, the AI application will return a radiology report describing the findings of the analysis, a heat map showing the exact location where the AI identified a disease, which is as an uncommon pattern for health bodies. Refer to the Appendix VII for

findings of the study, the warmer colours represent patterns identified by the AI as diseases, as described in the findings in the report. Some of the possible findings are effusion, infiltration, atelectasis, cardiomegaly, nodule, pneumothorax, consolidation, and oedema.

6.3 Price

Pricing strategy reflects the positioning of the product in the market and it should be enough to cover the cost per item and the profit margin. (David 2011)

Diagnostico will use the penetration pricing strategy, initially setting a low price to increase adoption, sales and market share. Afterwards, when it creates brand awareness and become established in the market, the company will gradually increase the price of its product.

In order to define the price, a cost breakdown analysis made available by PUC Minas was assessed. The study does not inform the costs breakdown for a chest x-ray exam; however, it was assumed to be similar to the back x-ray exam as the retail prices and the material used for both is the same size. The cost of the procedure is €4.90 and considering that the radiologist will take as long as the exam to analyse the image, the total cost of the exam goes to €13.68. Aiming a reduction in the exam cost and turning Diagnostico's business into a profitable company, a fee-per-study of €1.8 was obtained after financial analysis. Refer to Appendix VIII for the cost breakdown table, procedures and time spent on exams.

6.4 Promotion

Promotion includes activities that create interest in the company's product or service and persuade the customer to buy it. The company's marketing strategy is aligned with the distribution channels, so it will target both online ads and business-to-business (B2B) marketing campaigns.

Diagnostico's online promotion will be through content creation on social media, namely Instagram, YouTube and Facebook, platforms to develop awareness in relation to our product. search engine optimization (SEO) is paramount for an online business, as our business will appear at the top of the search engines like Google and Bing, to achieve that Diagnostico will frequently create online content, as well as work with tags and words that are searched online.

On the other hand, the B2B marketing campaigns will promote via price reductions to be more attractive to the end-customer and convert them to sales, another promotion method is sample products, as that is a new product in the healthcare market, sending free samples with a limited number of studies will allow the customer to try the product, make a purchase decision and give feedback. If the customer decides to buy the product, it can have long-term implications, becoming a loyal customer.

6.5 Place

Place defines the strategy used to distribute the product to the end customer at the right time and place. Diagnostico will have two distribution channels to the end-user. The company's website in which the customer can purchase the product that will be distributed via Google Cloud. The second distribution channel is via third parties such as medical device companies that already have an established partnership with our end-customers and can cross-sell their products with the AI solution access.

6.6 Vision & Mission

A Mission Statement determines the company's objectives and what approach will be used in order to reach them. A Vision Statement describes the future position in the market desired by the business. (Bain & Company 2018)

6.6.1 Vision Statement

Our vision is to create artificial intelligence solutions to clinically diagnose cases obtaining information from an extensive database to develop a clinical decision support tool through the use of machine learning and deep learning algorithms.

6.6.2 Mission Statement

Our mission is to develop practical and effective solutions for diagnosing x-ray, tomography and MR images in Brazil enabling a rapid and accurate medical decision for a treatment plan.

6.7 SWOT Analysis

SWOT Analysis is a structure to establish strategic planning and assess the company position in the market in relation to its competitors. Some of the strengths identified in the analysis are incubators, partnership with universities and research centres, and high expenditure on medical technologies. Regarding weaknesses, some of the factors are lack of brand awareness, low budget in comparison to big companies and high cost of development of AI cloud-based solutions. A few of the opportunity factors are regulatory support for early innovators, large community of scientific AI experts, and growing demand for medical devices. Lastly, threat factors include adequate funding, strict government laws in the healthcare industry, and world economic recession. Refer to Appendix IX for a more in-depth SWOT analysis.

6.8 Competitive Advantage

Competitive advantage is an advantage over its rivals that enable the business to offer better or cheaper products and services than its competitors. Competitive advantage grows fundamentally out of value a firm is able to create for its buyers that exceed the firm's cost of

creating it. Competitive advantage can be obtained through two main ways cost leadership and differentiation. (Porter 1985)

Diagnostico can take advantage of technological innovation to create a competitive advantage through several different manners. Partnerships are paramount for this industry, tech companies such as Google has partnered with AI start-ups, easing the development of machine learning algorithms and cloud computing. Other key partners are hospitals, laboratories, diagnostic centres and academic institutions that in collaboration with AI start-ups develop new solutions and having a vast, labelled and reliable database is key for achieving accurate results with the machine learning tool, obtaining a competitive advantage.

Diagnostico will make use of funding to further enhance its AI algorithm, commercialize the product and integrate Diagnostico's solution with the existing customer system. That is critical to achieving the company's goal and gaining a sustainable competitive advantage.

Lastly, the company aims to start its operation within one year, being a first mover in the Brazilian healthcare industry. Diagnostico will gain a competitive advantage by entering first in the market, establishing customer loyalty and strong brand recognition.

7. BUSINESS MODEL AND ACTION PLAN

The business model frameworks structurally determines how a business creates, distributes, and captures value. (Osterwalder et al. 2010, 14-15)

7.1 Key Partners

Aiming to ensure the product feasibility and implementation, partnerships will be established with hospitals, laboratories, diagnostic centres and medical image sharing platforms to continuously enlarge the image database. Google Cloud is a strategic partner which provides a scalable, relevant, and cost-effective data infrastructure and allows to train neural networks on a Cloud Machine Learning Engine. The partnership with medical advisors will ensure that

the results generated by artificial intelligence are accurate, and the investors will facilitate the expansion and scalability of the business.

7.2 Key Activities

The key activities can be split into two groups, software-related activities, and business-related activities. The first group consists of cloud architecture, software development, product development, IT maintenance, R&D, and data acquisition, aggregation, preparation, processing, and analysis, which are part of the data science life cycle. The second group of activities are sales, customer support, project management, public relations, and marketing.

7.3 Key Resources

The Resource-based view (RBV) defines three different areas of resources within company, namely physical, human, and organizational resources. (David 2011). Despite the company has not yet started its operations, the key resources above mentioned are essential for the business success.

The company's assets to support the business are the following: medical imaging insight platform, medical data, machine learning and deep learning algorithms, computer vision tools and copyrights are part of the organizational resources needed. The human resources encompass data scientists, engineers, radiologists, pathologists, artificial intelligence experts, effective sales force, and marketing teams. The physical resources include raising capital for initial investments, performance computers and strategic partnerships with research centres, universities, hospitals, medical imaging platforms.

7.4 Value Propositions

The purpose of the business is to deliver three values for its end-customer. First, an increase of operation efficiency, reducing time for a high-quality diagnose. The AI solution has a

faster detection rate than a radiologist and precise findings of about 90%. Second, it works as a safety net for the specialist, it boosts confidence in the diagnosis as it adds an extra layer of intelligence. Lastly, it is efficient in reporting, reducing context switching and time on writing the medical certificate.

For the patient, the value-added is a scalable diagnostic to both the lower and middle class, high accuracy of results in a fraction of the time a radiologist typically takes to analyse.

As a result, the queue for medical exams is expected to reduce significantly, giving access to healthcare to people who needs the most, reducing the treatment planning time leading to a healthier and less risky recovery and increasing healthcare providers profitability.

7.5 Customer Relationship

A close relationship with the clients will be established via efficient communication based on customer support for inquiries, product maintenance and updates, and an automated service which gives information regarding image analysis.

7.6 Channels

The customers will be reached by the medical imaging analysis software via web, blogs, social media, and word-of-mouth. The selling and distribution of the product will occur through Google Cloud AI Initiative and the company's website.

7.7 Customer Segments

The business model of the product is business-to-business (B2B), its customer segments consists of laboratories, hospitals and diagnostic centres.

7.8 Cost Structure

The expenditure sources can be related to the software or business operation. The software-associated costs include IT infrastructure, cloud computing systems, deep learning, machine learning, and software development, research & development, and cost of data acquisition and processing. Regarding the business operation, the expenses comprise marketing campaigns, advertisements, sales team, customer support centre, and administrative costs.

7.9 Revenue Streams

The revenue business model is based on access to the cloud-based AI solution. In order to be attractive to both large customers and small customers, the product will be offered through both subscription and fee-per-study models. Customers are expected to start with the fee-per-study model and switch to a subscription model as usage increases.

The subscription model targets large customers, as it is more affordable with a predictable payment schedule, low barrier to entry for our products, flexibility in terms of adding and removing users, cheaper than fee-per-study for high volumes. The fee-per-study model targets small customers, it charges customers based on software usage, it gives customers maximum flexibility, the lowest entry cost and low-risk investment. That model is harder to budget as the customer should predict scan volumes for their pricing, it is more cost-effective for low scan volumes.

7.10 Positioning

The number of articles in the medical field has rapidly increased, which led physicians to read literature reviews and summarized publishes, hampering them to keep up to date. Artificial intelligence algorithms that use this vast medical knowledge and use in a structured way can assist physicians' decisions on the best treatment plan, increasing productivity.

Regarding the diagnostics system using artificial intelligence, there are two ways of positioning the AI solution. The more radical position is that AI replaces traditional doctors in medical imaging diagnosis. The second manner is that AI helps doctors to diagnose more quickly and precisely, working as a tool.

The business will be positioned as a tool, keeping the responsibility of interpreting results with the specialist. As mentioned by Dr Eyal Zimlichman, AI needs to serve as a decision-support tool. In the end, it is the decision of a doctor. (Zimlichman 2020).

7.11 Financial Forecasts

The financial forecast allows future events and expenses to be estimated, it assesses the necessary investment and the return on investment, leading the business to profitability. Diagnostico is a tech-startup in nature, thereby, it is characterized by its scalability. The period set for the financial forecast is 3 years. A number of assumptions were considered in order to develop this assessment as noted below.

The customer penetration rate for a business product is between 10 and 40 per cent (Jensen 2001). Moreover, assuming that it follows the Diffusion of Innovation theory (Rogers 2003), the market penetration rate of the first year will consist of the innovators and early adopters that account for 2.5% and 13.5% respectively. Summing up 16% of market penetration in the first year. It is assumed that the business will take two years after the first operating year to be adopted by the early majority, which accounts in total for 34% of the population. Thus, the second-year penetration rate is 35% and 50% for the third year.

Regarding the revenue and expenses, as mentioned in the price section of the business snapshot, the fee-per-study was set at €1.8, which was used to calculate the revenue, the calculation of the expenses includes employees' salary, fixed costs and marketing costs. Refer to Appendix X for further information.

The business will turn into a profitable company in the second year of operations, rapidly growing as the number of medical images performed increases. Regarding the return on investment (ROI), it increases as the operating profit raises. Although the company has an operating loss in the first year, it becomes positive from the second year onwards. Thus, despite the investment of approximately €29 thousand, the company scales in the second and third year turning into a highly profitable business, as shown by the ROI of around 46%. Refer to Appendix XI for further information on the financial forecast.

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9. APPENDICES

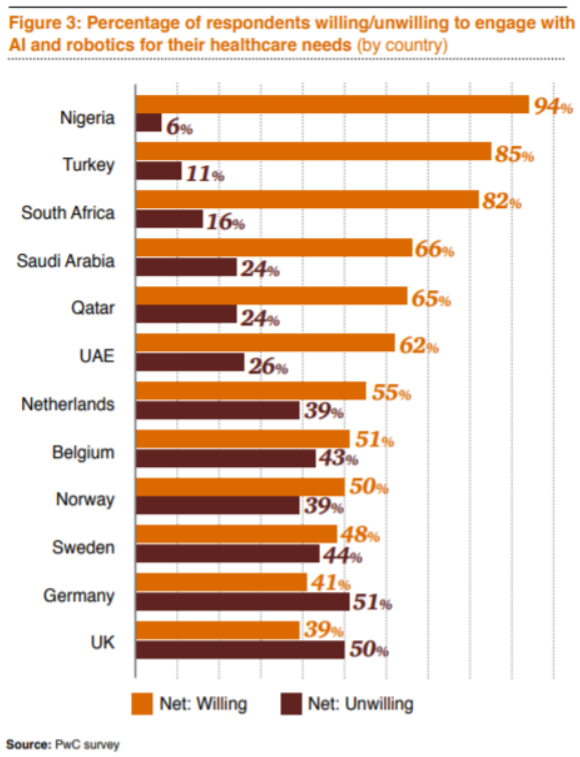
APPENDIX I – RANK OF CAUSES OF HOSPITALIZATION IN BRAZIL

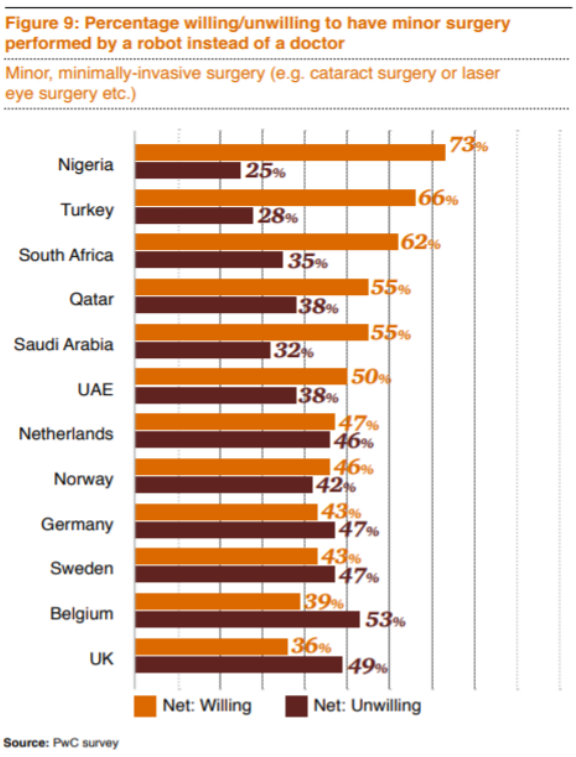
Causas de Internação	2005		2015		
	Ranking	N (%)	Ranking	N (%)	V (%)
Insuficiência Cardíaca	**1º**	**219.238 (9,5)**	**2º**	**157.712 (5,5)**	**-42**
Feminino	1º	110.495 (9,5)	2º	79.549 (5,6)	-41
Masculino	1º	108.743 (9,4)	2º	78.163 (5,4)	-42
60-79 anos	1º	160.064 (8,8)	1º	110.100 (5)	-43
≥80 anos	1º	59.174 (12)	2º	47.612 (7,1)	-40
DPOC	2º	125.063 (5,4)	4º	73.834 (2,6)	-51
Feminino	2º	53.851 (5)	4º	33.988 (2,4)	-52
Masculino	2º	71.212 (6,1)	5º	39.846 (2,7)	-55
60-79 anos	2º	94.756 (5,2)	5º	51.921 (2,3)	-55
≥80 anos	2º	30.307 (6,1)	6º	21.913 (3,2)	-47
AVC/NE	3º	87.987 (3,8)	3º	104. 736 (3,7)	-2.6
Feminino	3º	43.525 (4)	3º	50.757 (3,5)	-12
Masculino	3º	44.462 (3,8)	3º	53.979 (3,7)	-3
60-79 anos	3º	64.132 (3,5)	3º	74.290 (3,4)	-2
≥80 anos	4º	23.855 (4,8)	3º	30.446 (4,5)	-6
Pneumonia	4º	74.268 (3,2)	1º	169.791 (5,9)	84
Feminino	4º	37.160 (3)	1º	86.886 (6)	100
Masculino	4º	37.108 (3,2)	1º	82.905 (5,7)	78
60-79 anos	5º	48.827 (2,6)	2º	99.127 (4,5)	73
≥80 anos	3º	25.441 (5,1)	1º	70.664 (10,5)	105
Hipertensão	5º	61.235(2,6)	11º	40.603 (1,4)	-46
Feminino	5º	36.832 (3)	11º	23.634 (1,6)	-46
Masculino	7º	24.403 (2,1)	16º	16.969 (1,1)	-47
60-79 anos	4º	49.381 (2,7)	13º	30.412 (1,3)	-51
≥80 anos	6º	11.854 (2,4)	11º	10.191 (1,5)	-37
Angina Pectoris	6º	40.287 (2,2)	5º	71.713 (2,5)	13.6
Feminino	6º	24.433 (2,1)	7º	30.738 (2,1)	0
Masculino	6º	25.854 (2,2)	4º	40.975 (2,8)	27
60-79 anos	6º	43.776 (2,4)	4º	62.965 (2,8)	16
≥80 anos	13º	6.511 (1,3)	13º	8.748 (1,3)	0

APPENDIX II – RANK OF CAUSES OF DEATHS IN BRAZIL

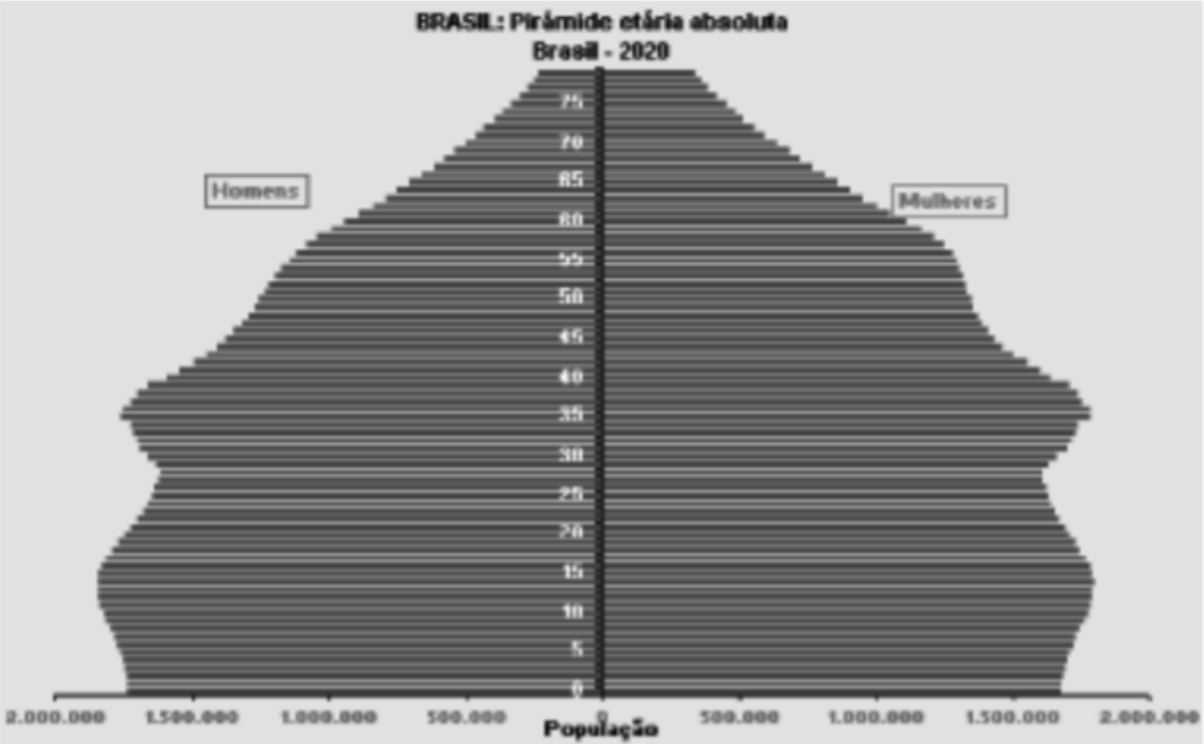
Causas de Óbitos	2005		2015		
	Ranking	N (%)	Ranking	N (%)	V (%)
IAM	**1º**	**45.825 (7,7)**	**1º**	**67.511 (8)**	**3,9**
Feminino	1º	20.644 (7,2)	2º	30.407 (7,3)	1,3
Masculino	1º	25.181 (8,2)	1º	37.104 (8,9)	8
60-79 anos	1º	32.002 (8,7)	1º	43.712 (9,3)	7
≥80 anos	2º	13.823 (6,1)	2º	23.799 (6,6)	8
AVC/NE	**2º**	34.518 (5,8)	**4º**	35.590 (4,3)	-25
Feminino	2º	17.603 (6,1)	4º	17.698 (4,3)	-29
Masculino	2º	16.915 (5,5)	4º	17.698 (4,2)	-23
60-79 anos	2º	19.915 (5,4)	5º	18.324 (3,9)	-27
≥80 anos	1º	14.603 (6,4)	3º	17.266 (4,7)	-26
DM	**3º**	28.405 (4,8)	**3º**	40.445 (4,8)	0
Feminino	3º	16.835 (5,8)	3º	23.070 (5,6)	-3
Masculino	4º	11.570 (3,8)	5º	17.375 (4,1)	7,8
60-79 anos	3º	19.504 (5,3)	2º	25.377 (5,4)	2
≥80 anos	6º	8.901 (3,9)	5º	15.068 (4,1)	5
DPOC	**4º**	25.694 (4,3)	**5º**	34.163 (4)	-6,9
Feminino	6º	10.099 (3,5)	5º	15.226 (3,7)	5,7
Masculino	3º	15.595 (5,1)	3º	18.937 (4,5)	-12
60-79 anos	4º	15.391 (4,2)	4º	18.405 (3,9)	-7
≥80 anos	5º	10.303 (4,5)	4º	15.758 (4,3)	-4
Pneumonia	**5º**	23.741 (4)	**2º**	57.210 (6,9)	72
Feminino	4º	12.680 (4,4)	1º	30.877 (7,5)	70
Masculino	5º	11.061 (3,6)	2º	26.333 (6,3)	75
60-79 anos	6º	10.346 (2,8)	3º	22.544 (4,8)	71
≥80 anos	3º	13.395 (5,9)	1º	34.666 (9,6)	62
Insuficiência Cardíaca	**6º**	22.212 (3,7)	**6º**	23.828 (2,8)	-24
Feminino	5º	11.935 (4,1)	6º	12.977 (3)	-26
Masculino	6º	10.277 (3,3)	8º	10.851 (2,6)	-21
60-79 anos	5º	11.397 (3,1)	7º	11.100 (2,3)	-25
≥80 anos	4º	10.815 (4,7)	7º	12.728 (3,5)	-25

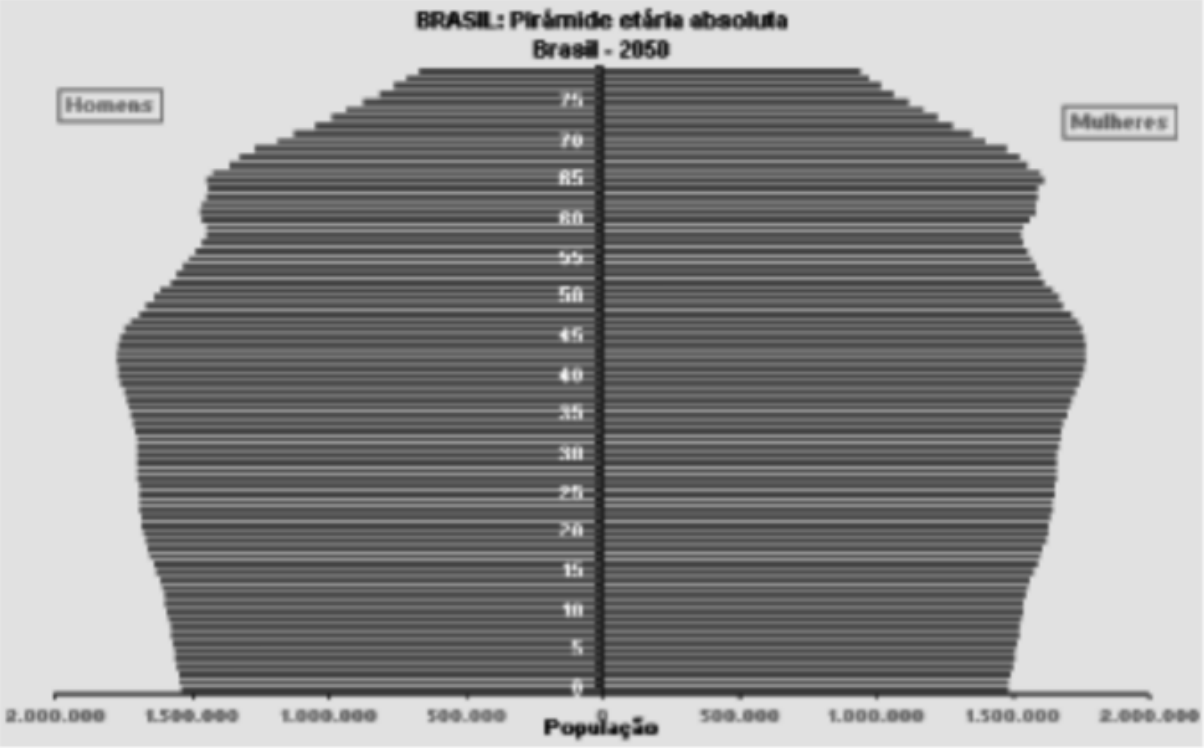
APPENDIX III – PWC RESEARCH



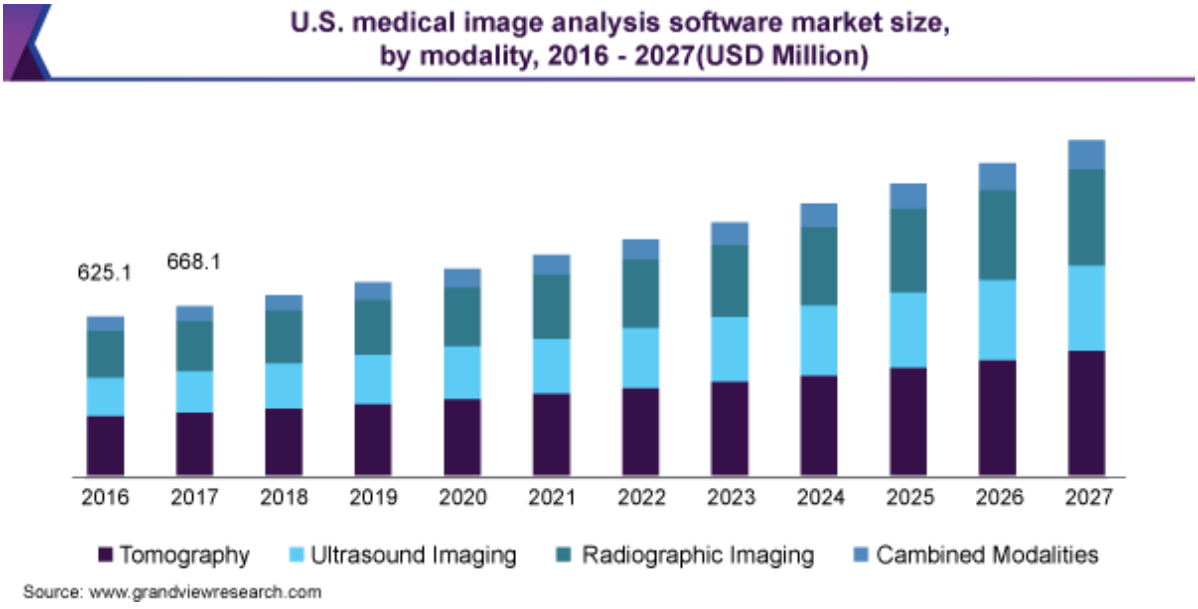


APPENDIX IV – POPULATION PYRAMID IN BRAZIL IN 2020 AND 2050

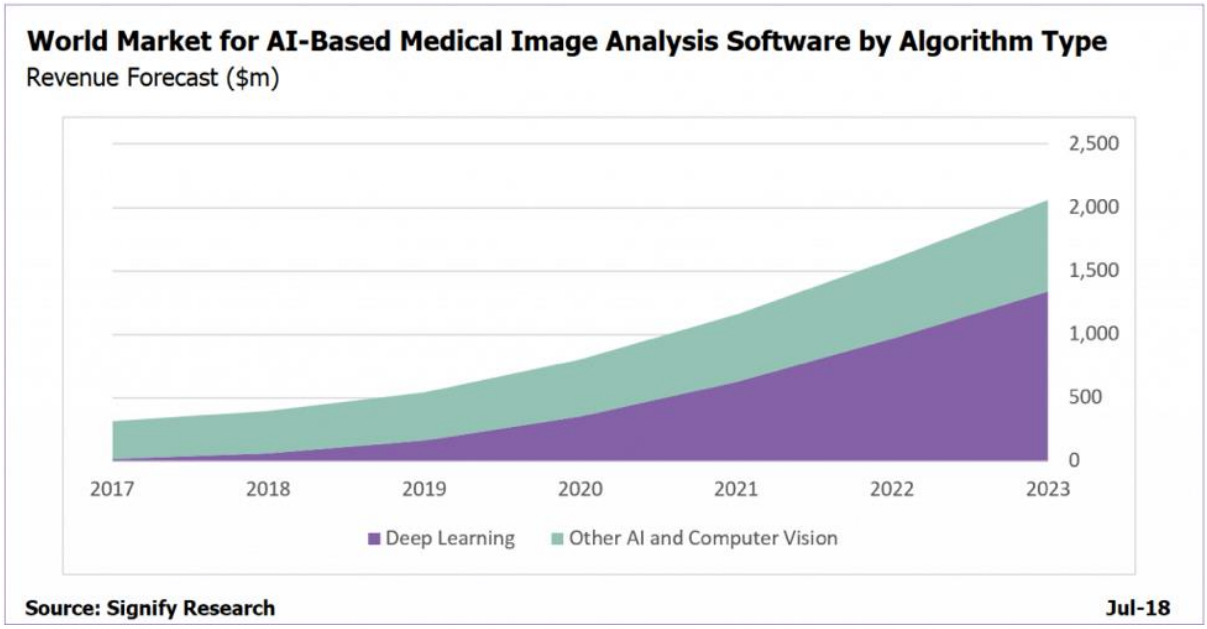




APPENDIX V – MEDICAL IMAGE ANALYSIS SOFTWARE MODALITIES

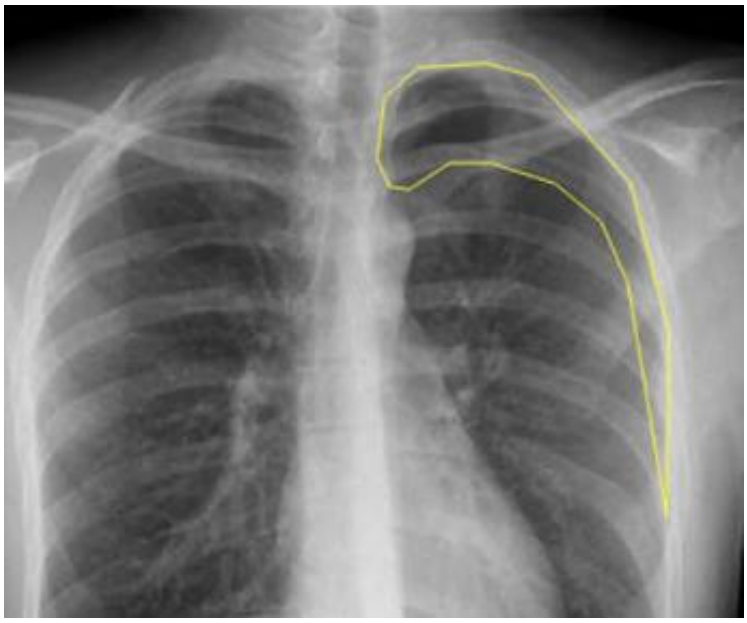


APPENDIX VI – AI-BASED MEDICAL IMAGE ANALYSIS SOFTWARE REVENUE FORECAST FOR THE WORLD MARKET

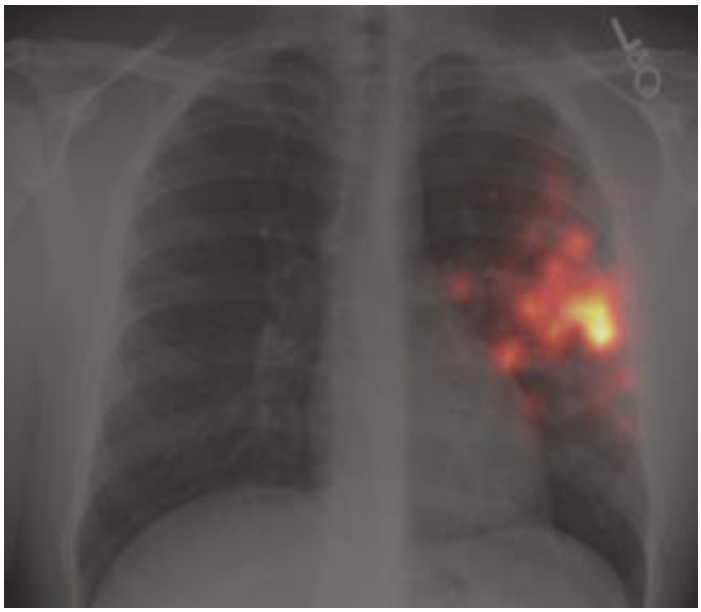


APPENDIX VII – AI SOLUTION PRODUCT RESULTS

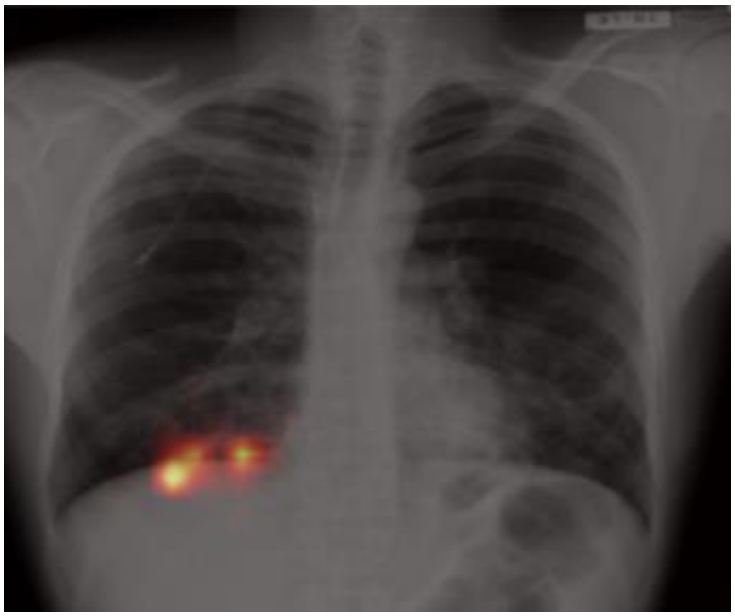
Findings: Pneumothorax



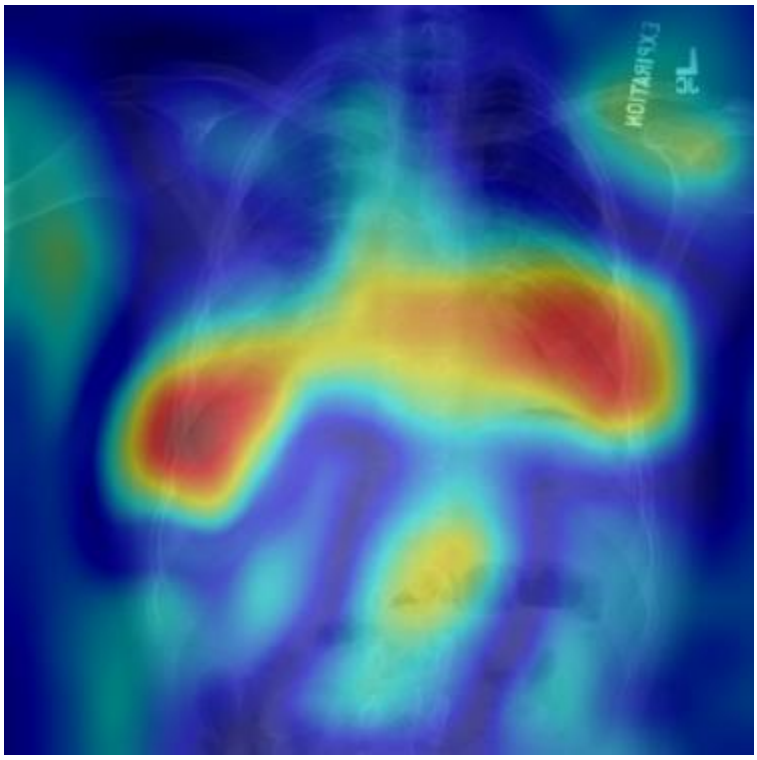
Findings: Consolidation



Findings: Pneumoperitoneum or Free air



Findings: Mass and Pneumothorax



APPENDIX VII – COST BREAKDOWN TABLE

PLANILHA DE ANALISE CUSTO - VENDA - LUCRATIVIDADE								
TABELA DE PREÇO DE VENDA								
ITEM	PROCEDIMENTO	CUSTO HORA	TEMPO HORA PROVAVEL	CUSTO DO PROCEDIMENTO			PREÇO VENDA	LUCRATIVIDADE
				SERVIÇO	MATERIAL	TOTAL		
1	RESSONANCIA DE CRANIO	75.34	0.30	22.60	75.00	97.60	450.00	352.40
2	RESSONANCIA DE CRANIOCOM CONTRASTE	75.34	0.40	30.14	285.00	315.14	630.00	314.86
3	RESSONANCIA JOELHO	75.34	0.25	18.84	75.00	93.84	450.00	356.17
4	RESSONANCIA JOELHO COM CONTRASTE	75.34	0.35	26.37	285.00	311.37	630.00	318.63
5	TOMOGRAFIA COLUNA LOMBAR	62.96	0.45	28.33	160.00	188.33	220.00	31.67
6	TOMOGRAFIA ABDOME TOTAL	62.96	2.00	125.92	220.00	345.92	440.00	94.08
7	TOMOGRAFIA BACIA	62.96	1.00	62.96	160.00	222.96	230.00	7.04
8	TOMOGRAFIA CRANIO	62.96	0.30	18.89	160.00	178.89	220.00	41.11
9	ULTRA SOM ABDOME SUPERIOR	27.89	0.15	4.18	10.00	14.18	80.00	65.82
10	ULTRA SOM OBSTETRICA	27.89	0.20	8.23	10.00	18.23	60.00	41.77
11	RAIO X MAOS E PUNHOS	36.32	0.10	3.63	10.00	13.63	30.00	16.37
12	RAIO X COLUNA TOTAL	36.32	0.30	10.90	20.00	30.90	60.00	29.10
13	RAIO X UROGRAFIA EXCRETORA	36.32	1.00	36.32	140.00	176.32	180.00	3.68
14	RAIO X MANDIBULA DUAS INCID.	36.32	0.20	7.26	10.00	17.26	30.00	12.74
15	MAMOGRAFIA	36.32	0.30	10.90	20.00	30.90	100.00	69.10

APPENDIX IX – SWOT ANALYSIS

Strengths	**Weaknesses**
- Science research parks. - Incubators. - High expenditure on medical technologies. - Existing Qualified AI and medical experts. - Partnership with universities and research centres. - Organizational structure.	- High cost of development of AI cloud-based solution - Lack of brand awareness - Low budget in comparison to multinational companies in the market - Low product differentiation. - Weak networking and communication with decision-makers in the government.
Opportunities	**Threats**
- Healthcare infrastructure investments in advanced technologies. - Grant funding from multiple sources and initiatives. - Regulatory support for early innovations. - Large community of scientific AI experts. - High expenditure on medical technologies. - Favourable demographics trend, Brazil is transitioning to an ageing population. - Growing demand for medical devices. - Huge market of 210million inhabitants. - Considerable export potential to other South American countries.	- Adequate funding. - Competition against big players. - Lack of awareness of the advantages of AI in medical images. - Strict government laws in the health industry, stringent legislation for applying scientific innovation to the industry practices. - Hospitals and diagnostic centres can refuse or be prevented from closing the partnership. - World economic recession and especially Brazil's economic stagnation. - High corruption levels

APPENDIX X – ASSUMPTIONS AND EXPENDITURE TABLES

ASSUMPTIONS	Year 0	Year 1	Year 2	Year 3
Population in the Great Vitoria	2,000,000	2,000,000	2,000,000	2,000,000
Rate of exams per 1.000 inhabitants	400	400	400	400
Percentage of Chest Xrays	16%	16%	16%	16%
Market Penetration	0%	16%	35%	50%
No. of Exams		20,480	44,800	64,000

SOFTWARE EXPENSES	(USD)	(EUR)
Data Storage per study	$ 0.0077	€ 0.0062
Requests per study	$ 0.0000	€ 0.0000
Notification	$ -	€ -
TOTAL	$ 0.0077	€ 0.0062

BUSINESS EXPENSES	Monthly	Annually
Employees' Salary	€ 500	€ 6,000
Fixed Costs	€ 500	€ 6,000
Marketing	€ 1,000	€ 12,000

APPENDIX XI – FINANCIAL FORECAST

Financial Overview				
	Year 0	Year 1	Year 2	Year 3
No. of Exams/ Studies		20,480	44,800	64,000
No. of Employees		5	7	9
Revenue	€ -	€ 36,864.00	€ 80,640.00	€ 115,200.00
Expenses	€ 18,000.00	€ 48,126.59	€ 60,276.91	€ 72,395.59
Operating Profit	-€ 18,000.00	-€ 11,262.59	€ 20,363.09	€ 42,804.41
Investment Needed	-€ 29,262.59			
Gross Marging (%)	-	-30.6%	25.3%	37.2%
ROI based on Operating Profit	-	-	-30.41%	46.28%

APPENDIX XII – DIAGNOSTICO'S LOGO

DIAGNOTISCO
IMAGENS MÉDICAS & IA