Digital Health Challenges in Social Entrepreneurship: Insights and Best Practices

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Abstract: Ensuring dignified care for needy populations worldwide is a collective responsibility that transcends geographical and environmental conditions. Modern entrepreneurs and businesses should incorporate social responsibility into their core objectives and success plans, recognizing the influence of underprivileged communities on their operations. However, not all organizations possess the internal capacity to actively practice social responsibility due to factors such as business type or staff profile. Consequently, many companies support other institutions dedicated to social causes, viewing it as a business opportunity that can yield modest profits. This article presents a case study of Diagnext.com, a small company that has devoted 14 years to technological innovation in digital health and has made significant contributions to public healthcare. Their initiatives have had a remarkable impact on the Amazon Rainforest's remote populations, including indigenous communities and river dwellers, facilitating hundreds of thousands of medical consultations annually. The case study aims to understand the main factors that drove Diagnext.com's promoters to invest their knowledge in social innovation and how they are proactively building their future. Key aspects explored include the leadership profile of Diagnext.com, ethical and sustainability concerns, transparency, and social responsibility. By analyzing these factors, the article highlights the importance of integrating social responsibility into business practices and the positive outcomes that can be achieved through technological innovation in addressing the healthcare needs of underprivileged populations.

Keywords: Social responsibility, Social entrepreneurship, Digital health, Technological innovation, Ethical concerns, Leadership profile, Sustainability, Diagnext.com

1. Introduction

Providing dignified care to needy populations around the world is a commitment that must be assumed by all of society, regardless of where and in what conditions they are (Baehr, 2016; Freeman, 2022; Fukuyama, 2018; Tomuschat, 2014). It is crucial that modern businessmen and entrepreneurs include social responsibility in their businesses (Kickul & Lyons, 2020; Satalkina & Steiner, 2020) because they are also influenced by a representative part of the population in need of everything or almost everything (Martins et al., 2023).

However, not all public or private organizations have the conditions in their business to practice social responsibility. Although this practice is noble, some companies do not have the necessary internal capabilities due to the type of business they have or their staff profile. Many of them become sponsors of other institutions that have this vision as their central goal (Cajaiba-Santana, 2014). This can be translated as a business opportunity, which can be contextualized as a modest profit factor. This is what is called social entrepreneurship, which may or may not be involved with technological innovation (Gupta et al., 2020; Witkamp et al., 2011). With the ability to adapt to any industry, social responsibility encompasses the application of "digital health" to provide attention, relief, and medical care to those in need, regardless of their circumstances, including unconventional situations (Ibrahim et al., 2021).

The present study aims to understand the main factors that drove a small company, born in Brazil, to invest its knowledge in social innovation, ensuring that no one is left behind in the digital era regarding digital health. After conducting a literature review, a case study of Diagnext.com is presented. The study discusses the results, outlines the future of the company, and concludes with key findings.

2. Literature Review

Ensuring dignified care for global populations is a collective duty, irrespective of geographic or environmental challenges. Businesses, as key stakeholders, should embed social responsibility in their core objectives. However, constraints like business type or staff profile hinder some organizations. Many opt to support social causes, viewing it as an opportunity for both altruism and modest profits. Addressing corporate social responsibility requires attention to ethical obligations (Beji et al., 2021), stakeholder engagement (Calabrese et al., 2019; Waldman et al., 2019), sustainable practices (Sabokro et al., 2021), community development (Caiado et al., 2018; Gunawan et al., 2020), and transparency (Caputo et al., 2021). Implementation challenges include resource limitations, conflicting priorities, and the need to balance profitability with social impact. Overcoming these demands strategic planning, leadership commitment, and stakeholder collaboration (Stahl et al., 2020).

A sustainable business model hinges on a comprehensive integration of innovation, social responsibility, and eco-friendly practices. This approach not only addresses societal challenges but also cultivates economic prosperity (Ibrahim et al., 2021). However, the integration of social causes and modest profits can also be a choice in social entrepreneurship through employing market-oriented strategies to achieve social impact (De Lima, 2023). By leveraging their entrepreneurial activities, social entrepreneurs seek to address societal challenges and promote positive social change. One approach to achieve this is through sponsorship of institutions dedicated to social causes, which presents business opportunities aligned with the organization's mission and values (Barnett et al., 2020). This alignment allows companies to simultaneously seek financial sustainability and social impact, reinforcing their commitment to social responsibility.

Innovations enable the development of sustainable practices and solutions (Sivam et al., 2019). Technological innovation, particularly in digital health, focuses on providing necessary care to underserved populations. This encompasses advanced diagnostics and medical consultations. The evolving landscape includes telemedicine, protocol-driven care, and enhanced access to healthcare resources. However, challenges related to data privacy, control, and ethical boundaries persist (Mitchell & Kan, 2019). Entrepreneurs face a demanding workload, resource limitations, high uncertainty, and the need for creativity and innovation (Nikolaev et al., 2020; Stephan et al., 2023).

This journey may initially be isolating, lacking the support typically available to traditional employees. Nevertheless, it provides the freedom to cultivate meaningful relationships. Entrepreneurs bear significant emotional and financial investment and may even be personally liable for their ventures (Jenkins et al., 2014). Entrepreneurs with a high-risk tolerance often report greater satisfaction and reduced stress levels (Carree & Verheul, 2012). Personal values, such as valuing freedom and seeking challenges, are strong predictors of entrepreneurship (Nikolaev et al., 2020).

3. Diagnext.com: A Case Study

3.1 Research Design

The case study is based on a combination of primary and secondary research, including interviews, data analysis, and a review of relevant literature and documentation related to Diagnext.com and its initiatives. The research design for this case study is qualitative in nature, aiming to gain an in-depth understanding of Diagnext.com and its initiatives in public healthcare. Qualitative research focuses on exploring complex phenomena and understanding the underlying meanings and motivations behind them (Ormston et al., 2014; Qu & Dumay, 2011). It allows for the collection and analysis of rich, detailed data to provide a comprehensive view of the case (Moser & Korstjens, 2018).

3.2 Diagnext.com

3.2.1 Framework

The effort to extend healthcare to the farthest frontiers, facilitated by cutting-edge technology, emerged in the 20th century through the integration of innovative processes. Indeed, technological advances throughout history have aimed to overcome barriers and challenges in various domains, including healthcare. From the early use of landline telephones to assess heart rhythm to futuristic video conferencing systems that transmit videos of patients to healthcare professionals, to state-of-the-art CT and MRI systems, the aspiration to overcome obstacles such as distance, contagious diseases and crises resulting from wars and disasters has always been a driving force. These aspirations were fuelled by the technological capabilities available at the time, continually pushing the limits of what was considered possible.

During the Christmas celebration of 2001, two brothers and the visionary sister-in-law of one of them, including a radiologist, a telecommunications engineer with extensive computer knowledge and an innovative nutritionist, devised a company project focused on improving public health through the intensive use of digital technologies. Although telemedicine was already widespread, it was predominantly applicable only where it was not truly needed. However, if the goal was to respond to the population's demand where there is no human or technical structure, it would be pointless to study solutions where they are abundant. Motivated by this vision, the engineer began designing and developing systems, processes, technical structures, and ultimately, codes, as a hobby. These endeavours aimed to enable the digital transmission of data through the limited means of communication and processing available in resource-constrained regions. The team collectively engaged in international consultancies, gaining expertise in operating systems for large computational volumes,

information technology management, advanced statistics, and project management. This expertise contributed to the development of a sophisticated model that successfully facilitated digital health processes.

Also from the outset, the team sought that the environment studied had the potential to have a significant impact on medical care in the face of substantial patient volumes and technical implementation challenges. In this sense, the environment was built based on: i) free software, innovative processes and remote operation formats; ii) best practices, inspired by the rigorous, standardised and technically oriented approach observed in the renowned Brazilian financial sector and iii) vision of integration with existing medical technologies, aiming to motivate professionals to adopt the technologies developed by the team based solely on their exceptional effectiveness, rather than their explicit visibility.

In 2009, following benchmarking at a university hospital, comparing the technologies used in daily healthcare practice with those implemented in the laboratory, the team found a 25-fold increase in efficiency, as well as greater resilience and a 60% reduction in operating costs. Encouraged by these remarkable results, the team decided to create Diagnext.com, with the intention of exploiting their research and presenting a new approach to working in hospitals with significant patient volumes and operational complexities.

Diagnext.com was formally constituted and quickly became an example of social entrepreneurship, even before the expression was used for this type of company. Its strategic objectives are presented through its "Vision, Mission and Values" declarations, namely:

- Vision: Take health to new frontiers and to those who need it, wherever they are.
- Mission: Make technological dreams in environments hostile to information technology come true.
- Values: i) Transparency: Be clear and transparent in your actions; ii) Sustainability: Develop techniques and processes that do not impact the environment where they are used; iii) Creativity: Maintain an innovative profile in all its operations. When in doubt, look at the new one; iv) Innovation: Focus, objective, and way of thinking of the institution; v) Ethics: Be completely ethical in your decisions, maintaining and influencing the market that surrounds you; vi) Social Responsibility: To be an institution that takes responsibility for its public, providing the best services and exceeding expectations.

3.2.2 Projects and awards

Since the beginning, the team made a deliberate decision to seek projects and clients in unconventional areas where few were willing to work. They embraced technical difficulties as constant challenges to their operations. One of the greatest and ongoing challenges has been the reluctance of healthcare professionals to recognize that technology can solve their problems through subtle or imperceptible modifications to established technical processes. At least in Latin America, there is great resistance to demonstrating that regional technology can provide great advantages to traditional processes.

In the early stages, the team embarked on major projects in the Brazilian states of Rio Grande do Sul and Mato Grosso do Sul, where the local telecommunications infrastructure was insufficient to support the demand. Existing convergent radio link structures were woefully inadequate for transmitting medical data from 21 hospitals. The challenges were immense, and the team set a significant milestone: to develop a system that utilized distributed processing techniques between local equipment and a more favourable technical environment—a data centre. The goal was to compress medical data without any loss and stabilize communication traffic. This milestone was achieved in 2010, resulting in a system that was approximately 65% more compact and 25 times faster than traditional methods. Other projects of various sizes emerged, focusing on integrating clinics with high patient volumes in regions plagued by violence in the state of Rio de Janeiro. The key milestones in these projects involved navigating complex operations due to the large number of people involved, employing low-cost equipment, adapting to unstable and precarious communication environments, implementing remote operations, and streamlining installation processes that differed greatly from conventional industry practices.

Leveraging their knowledge of the technology industry at the time, the team utilized recently commercialized Intel equipment featuring low-cost atom processors that offered sufficient processing power for their needs. This allowed them to overcome economic constraints while maintaining the required performance. Another innovative approach involved developing communication systems capable of handling media contingency, a concept commonly applied in conventional information technology but entirely novel in the healthcare segment at that time.

Meanwhile, during the 5th Brazilian Congress of Telemedicine and Telehealth, the company received an invitation from the Health Department of the State of Amazonas to explore technologies and test their models in that region. The goal was to establish an integrated telemedicine system capable of addressing the various challenges previously encountered.

Consequently, in 2011, an initial test was conducted for transmitting medical data from the interior of the state, particularly from the city of Itaocatiara, using an unstable and low-speed satellite connection. The results were promising, including:

- Transmission of 30 exams in less than 5 minutes: the traditional industry of the segment took more than 2 hours to transmit just one.
- The simplicity of installation: two computers of low cost, size and structure - commercially called thinclient - were used to carry out the entire technical operation.
- The local implantation was all carried out at a distance, through remote technicians, and the equipment was sent ready for use by the post office.

The results were thoroughly analyzed by both political and technical stakeholders, and they received full approval for successfully meeting the objectives of the project being developed: Telemedicine and telediagnosis in the remote areas of the State of Amazonas.

The achieved results, as requested by the State Government on a monthly basis, are outlined in Table 1, providing a comprehensive overview.

Table 1: Results obtained in the project until 2016 (own elaboration)

Goal	Reason	Results obtained
Time	Perform exam transmissions from environments as quickly as possible.	4.5 minutes
Compression	In clinical environments, it is essential to reduce information processing and how much it spends to store information	97%
Number of exams	Maximum and average volume of exams transmitted	The maximum overall volume of 9,000 exams/month, reaching an overall average of 7,077

The project garnered recognition and acclaim both within Brazil and on an international scale, receiving prestigious awards including HIMSS Latinamerica, being named among the "100 Most Innovative in Health," receiving the Transformational award from the Brazilian Association of the Health Technology Industry, and being recognized for Innovation by the Brazilian Association of the Medical Devices Industry. Furthermore, the project has been invited to present its outstanding results and methodologies at numerous conferences, including HIMSS Connected Health, IEEE Healthcom, WHO Healthcare Global Meeting, among others.

3.2.3 Technological transfer to other activity sectors

The company was established with a strong focus on research and development, originating from diverse backgrounds. It has consistently emphasized innovation through processes that create a significant impact on the value chain, with a particular emphasis on the healthcare sector. However, as time passed, it became evident that the solutions they offered addressed needs beyond the healthcare domain. The technological challenges and requirements they aimed to resolve were present in various other sectors as well. Other industries began adopting their perspective and applying it to healthcare because no alternative or superior answers were available. These solutions originated from information technology in similar environments and were subsequently adapted for the healthcare market. Over time, it became apparent that there were gaps in meeting the operational demands that involved the transmission, storage, and processing of large volumes of data under critical, stringent, and sometimes resource-constrained conditions.

The patents developed by the company aimed to address two crucial challenges in the field of information technology, namely communication and archiving. In what concerns communication, these patents introduced valuable tools designed for environments facing significant obstacles in transmitting large volumes of data quickly and efficiently. They particularly catered to those on the fringes of developed society, where the existing communication channels exhibited imbalances between the volume of data to be transmitted and the quality

of the channel. These tools facilitated communication through satellites in challenging environments, optimized integration of diverse communication platforms, and mobile telephony in high-traffic areas, among other applications. In laboratory testing, the proposed communication techniques, management systems, and integration methods demonstrated up to 240 times greater efficiency compared to conventional approaches in critical environments. In what concerns archiving, the company also developed tools for specialized data compression. Initially, the focus was on compressing data before transmission. However, in 2017, this became a specialized service offered by the company, expanding beyond medical data. It encompassed video and audio files, digital documents, and other data formats, resulting in a drastic reduction in digital size (97% for digital images, 83% for video and audio, 65% for transcribed digital documents, etc.). These compression techniques provided significant benefits in terms of storage efficiency and data management.

Both areas of research offer technological advancements that extend beyond the realm of digital health, finding applications in various industries such as entertainment, education, museums, security, and public administration. The company was established on the foundation of its research and development division, stemming from diverse backgrounds. As a common *forum*, its primary focus has always been on innovative processes that create a tangible impact in the value chain, with a particular emphasis on enhancing the healthcare sector.

3.2.4 Scenarios for a sustainable future

Recognizing the rich history of Diagnext.com, its partners have come to understand that the company's most valuable strength lies in its ability to strategically plan and consistently deliver state-of-the-art innovations, irrespective of the industry or field it operates. As a result, several projects have been conceptualized recently, with the foresight that they hold great potential for the company's future. Some of these projects are shown in Table 2 and represent internal studies and proposals that have yet to be fully explored but exemplify the forward-thinking mindset of the company.

Table 2: Validated scenarios with proven experience (own elaboration)

Item	Name	Description	Potential locations
1	Expand activities in digital health and provide a framework capable of taking startup companies and new technologies to new frontiers	Integrate innovative tools from startups that needed infrastructure, knowledge, know-how, etc. in environments hostile to information technology. The intention is to make the constituted communication platform useful for other forthcoming technologies	Europe, Latin America, Africa, Middle East, Asia, etc
2	Experience in managing and operating complex company projects	Build in hostile environments essential services to local customers, such as integral schools and mobile telecommunications operators in dense forest environments, such as the one existing in the Amazon Forest and in the Brazilian semi-arid region	Latin America, Africa, US countryside, etc
3	Compression of databases and digital documents	Use information technology and artificial intelligence tools to compress large databases and collections to reduce your operating costs. The utility is great in reducing general costs of technological infrastructure (processing, communication and storage)	Public and private health, public administration, museums, useful data from the oil and gas segment, etc
4	Communication and operational management for critical environments	The techniques used, methods, processes and algorithms, can be used in environments with a high level of operational complexity, where the adversities of the environment make integration and communication impossible	Critical operation and control market, such as those found in the oil and gas, agribusiness, public safety, etc

4. Discussion of Results

The collected data presents several key factors that positively contribute to a successful and innovative company named Diagnext.com. Its mission is to make technological dreams in information technology-hostile environments come true. From its early stages, the company sought projects and clients in unconventional areas where few were willing to work. It embraced technical difficulties as constant challenges and developed solutions that addressed specific needs in resource-constrained regions. Its promoters have different backgrounds and utilize their expertise in operating systems, information technology management, advanced statistics, and project management to create efficient, cost-effective solutions and capable of operating in challenging environments.

By aiming to motivate professionals to adopt their technologies based on exceptional effectiveness rather than explicit visibility, they fostered the integration of their systems into established healthcare practices. This approach allowed for the seamless incorporation of their solutions, avoiding disruption or resistance from healthcare professionals. Also, by collecting and analyzing large volumes of healthcare data, the company gains insights that help optimize its solutions and enhance patient care, while continuously improving its algorithms, refining its diagnostic accuracy, and providing evidence-based recommendations. A culture of continuous learning and improvement is promoted, as it seems that the company actively seeks feedback from users, healthcare professionals, and stakeholders to identify areas for enhancement. Partnerships and Collaborations with other organizations, both within and outside the healthcare sector, enable Diagnext.com to expand its reach, access new markets, and accelerate the development and deployment of innovative healthcare solutions. The company has a work profile whose objective is to address serious health technology issues under critical and/or hostile conditions, developing patentable and sustainable technologies that really make a difference in medical care.

However, while its charitable mission holds significant social importance, it also needs to be financially sustainable. It is imperative to establish a strong presence in the market for its services to truly impact medical care in these unfortunately common environments. This entails establishing connections with partners or clients who recognize the value in terms of both financial returns and an enhanced reputation that it can offer and conducting a thorough assessment of the financial benefits that these strengths provide.

Several potential avenues have been identified to enhance the current model, including:

- Utilizing technologies developed in other markets that can be adapted. For instance, an advanced data compression system could be employed by governments to efficiently store data generated in interactions with their citizens, such as documents, contracts, reports, blueprints, etc. Document storage companies could benefit from these technologies to save technical and financial resources in digitally archiving documents. Additionally, the communication environments utilized by the company could prove highly valuable in public security sectors for monitoring high-risk areas and environments hazardous to human presence, particularly in the oil and gas industry.
- Collaborating with prominent brands with the aim of becoming a 'White Label' company, integrating their technologies with others that align with their expertise.
- Expanding the technical development model to other markets with similar needs, positioning themselves as a testing ground.
- Exploring potential partnerships with regional or local investors who share a degree of integration with the business model and objectives.
- Pursuing partnerships that bring additional benefits to the technology employed.

5. Conclusion

This study seeks to explore the key factors that have propelled a small Brazilian company to invest its expertise in social innovation, ensuring inclusivity in the digital era, particularly in the realm of digital health. In today's business landscape, innovative practices facilitate the development of sustainable solutions, while companies must also embrace their social responsibilities to promote societal well-being and environmental preservation. However, social entrepreneurship can present challenges, especially for organizations with limited resources or incompatible profiles. To gain a competitive advantage, collaboration and cooperation with relevant stakeholders, adaptability to changing circumstances, scalable and sustainable solution design, long-term ethical considerations, transparency, and social responsibility emerge as crucial factors. Nonetheless, Diagnext.com sets itself apart through its unique assets, team characteristics, and profile.

Diagnext.com prides itself on its diverse team of highly skilled professionals with extensive experience, all united by a vision to advance public health through the widespread adoption of digital technologies and always in continuous learning. Guided by values such as transparency, creativity, ethics, and social responsibility, the team demonstrates proactivity and an unwavering commitment to delivering exceptional services that consistently exceed expectations. The company's dedication to social impact and responsible business practices sets it apart as an innovative and socially conscious organization.The founders are dedicated to driving innovation and staying attuned to market trends, leveraging their expertise to assist sectors in need. They also prioritize the well-being of society, particularly in remote regions where establishing necessary physical infrastructure poses challenges. They recognize that not all regional problems can be solved with conventional tools available on the market, and thus, companies invested in technology development could draw inspiration from their adaptable approach.

Furthermore, the founders acknowledge that what may be considered definitive technology in one place may not always be easily implementable in other parts of the world due to varying factors like physical characteristics, population dynamics, and local profiles. Their approach is to develop solutions tailored to the specific environment rather than attempting to force technology where it may not be feasible. This approach, they believe, ensures optimal efficiency, preventing the end customer from receiving subpar or inadequate services.

This study aims to contribute to the promotion of best practices in social entrepreneurship. For future research endeavors, it is recommended to conduct interviews with the founders of Diagnext.com to gain deeper insights into their leadership style and strategies.

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