Potentialities of the Internet of Things in the Health Area in Brazil

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Abstract. Brazil is the ninth economy and seventh-largest health market in the world, currently accounting for more than 9% of the Gross Domestic Product (GDP). In addition, the country ended 2019 with more than 400 startups working in the health area, demonstrating the maturity of the market and the ability to foster innovation. In this scenario, the Internet of Things (IoT) emerges as a technology with a revolutionary potential to bring significant progress to the health area in Brazil. The Brazilian national IoT plan includes health as one of its strategic areas and is promoting a solid structural base, through a set of centers of excellence and initiatives, supporting research, development, and innovations. However, encouraging and training of qualified professionals and facing challenges related to infrastructure and connectivity are decisive factors for Brazilian success in the IoT area.

Keywords: Healthcare · Brazil · Internet of Things

1 Introduction

Health Units are complex environments where information plays a fundamental role. It is crucial that professionals have access to information about patients, procedures performed, or complications. It is also necessary to know about stocks of medicines, supplies, and conditions of the equipment used. Ensuring adequate and optimized processes for collecting, storing and disseminating information to team members who need to access it, while preserving patient privacy and maintaining data quality, integrity and consistency are major challenges [1].

Tools such as electronic medical records and mobile solutions for patient's interaction with institutions already save time and resources, even if implementation in Brazil is limited in scope. However, the Internet of Things represents the potential to promote a revolution in the sector, precisely because this technology redefines these processes. It is possible, for example, to send information about the vital signs of the patient directly

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from the equipment that collects the information to the electronic medical record in real-time, without human interference.

Brazil understands the potential that IoT represents for several sectors, including health. In this article, we show how the country is preparing to foster the development of IoT solutions and how it is creating an environment favorable to entrepreneurship and innovation.

2 Brazil Overview

First, it is necessary to reveal some information about Brazil. It is a country with an extensive area, with a large and heterogeneous population of more than 211 million people, according to the Brazilian Institute of Geography and Statistics (IBGE) [2]. In addition, the country is the ninth-largest economy in the world (International Monetary Fund for 2018 and 2020 (estimates) and the leading economy in Latin America, with a Gross Domestic Product (GDP) of approximately USD 2 trillion, assuming regional leadership in the dissemination of new technologies and market trends [3]. Moreover, Brazil ended 2019 in the third place in the ranking of countries with the largest number of new unicorns, which are, according to the definition of Aillen Lee (2013), startups that reached a market value above USD 1 billion (Fig. 1), behind the USA and China, both

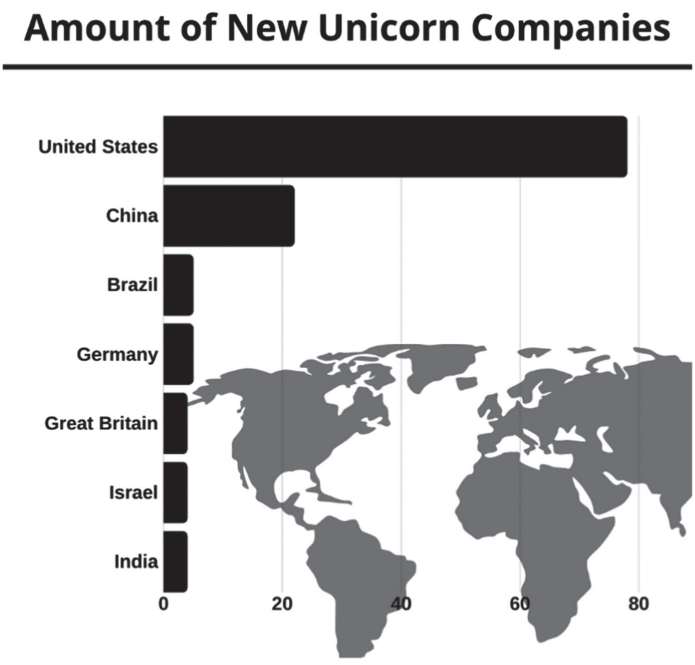

Fig. 1. Number of new unicorns by country for 2019 (extracted from Crunch Base. Available at https://news.crunchbase.com/news/the-new-unicorns-of-2019/)

showing more expressive numbers [4–6]. This ranking show that our innovation ecosystem is undergoing maturation, and opening space for technology-based entrepreneurship in most diverse areas.

3 The IoT Plan in Brazil

The National Internet of Things Plan is a broad initiative that mobilizes members of the public, private sectors and the academy, provides investments in infrastructure and the promotion of entrepreneurship [7], whose main objectives are [8]:

- improve the quality of life of the Brazilian population through efficiency gain in the services offered;
- promote professional qualification and generate new jobs for a growing up IoT market;
- increase the productivity and competitiveness of companies developing IoT solutions in Brazil;
- establish partnerships between the public and private sectors;
- improve the country's integration in the international scenario.

The national plan started in 2017, and the first step involved a survey on diagnosis and aspirations. In other words, what would be the potential of Brazil to be a regional reference, the objectives to reach, the position Brazil intended to occupy in the international scenario, and the internal problems it could solve with this technology. Therefore, based on the conclusions built during the stage of diagnosis and aspirations, four verticals were listed: cities, health, agribusiness, and industry. Also, Ministry of Science, Technology, Innovation and Communications (MCTIC) recently announced the creation of eight Artificial Intelligence laboratories in Brazil. The laboratories will operate as a network, and four of them will be focused on IoT [7, 9].

4 The Healthcare Market in Brazil

According to the World Health Organization (WHO), Brazil is the seventh-largest health market in the world, with health expenses representing about 9% of GDP, including public investments and private spending, which means a total amount per year exceeding USD 160 billion and per capita spending per year of USD 929.00 [10]. The public system serves free of charge 75% of the population, while 25% of Brazilians use private health [11]. The country has 6,702 hospitals, of which 4,267 are private [12]. The Healthcare Information and Management Systems Society (HIMSS) offers certification according to the degree of hospital digitalization, with 7 being the highest score. Brazil has only nineteen institutions certified at level 6 and seven institutions at level 7, which suggests that most hospitals in the country are still behind in the digital transformation process [13]. Although the technologies are not present in hospitals as they should, organizations show an active interest in modernizing and overcoming this delay. It should be emphasized that the country currently has more than 400 startups seeking to offer innovative solutions for the health market [14].

5 The Internet of Things and the Health Context in Brazil

According to a recent survey, only 8% of hospitals adopt an Internet of Things (IoT) solution in their operation, and 70% of the Chief Information Officers (CIO's) report the intention to implement IoT solutions in their institutions in the next two years [15]. The research also mentions that the intention is to adopt IoT, in the first moment, to solve problems or improve operational efficiency, but they do not intend to put the technology in direct contact with the patient. However, there is openness for mobile solutions for patients, inside and outside the hospital environment. Costs, mainly with integration, were mentioned as the main entry barrier to be overcome [15]. It is a vast market, which will actively seek IoT solutions in the coming years.

The National Bank for Economic and Social Development (BNDES), in partnership with the MCTIC, estimates that gains from the Internet of Things in the Brazilian health market by 2025 may reach USD 39 billion [7]. In a survey carried out in 2017, about 50 companies in the state of São Paulo and a few in the states of Minas Gerais, Rio de Janeiro, and Rio Grande do Sul, declared themselves ready to offer IoT solutions for the health area. Therefore, on the one hand, we have a demand that will undergo a sharp growth in the next two years, and on the other hand, we still have a small number of institutions able to absorb this demand across the country, concentrated in the Southeast and South regions [7].

Several institutions are mobilizing around a series of actions to be taken so that opportunities are not lost, and the potential of IoT in Brazil is realized. Today, Brazil counts on the Brazilian Association of Internet of Things (ABINC - Associação Brasileira de Internet das Coisas), which is a non-profit organization and, according to its creators, arose from the "need to create an entity that was legitimate and representative, nationwide, and that would act on different fronts of the Internet of Things sector." According to the entity's website, its main objectives are: to disseminate relevant information about new technologies and the Brazilian market; promote commercial activities among members; promote research and development activities; act with government authorities and regulatory bodies and seek international partnerships [16].

In addition, Brazil also presents relevant research and development initiatives. It is valid to highlight the Integrated Systems Laboratory (LSI - Laboratório de Sistemas Integráveis) and the Interdisciplinary Center for Interactive Technologies (CITI - Centro Interdisciplinar de Tecnologias Interativas). Both are at the University of São Paulo, which is among the most important institutions in Latin America [17, 18].

LSI works on applied research and cutting-edge technology to offer innovative solutions that prioritize public interest, as well as the country's development. The laboratory was founded in 1975, has seven research groups, and a Digital Health and Assistive and Rehabilitation Technologies among its subjects of expertise. In addition, the LSI objectives are aligned with Brazilian ambitions in the field of IoT, as the laboratory has one among its objectives to work in technology transfer to the national industry [17].

CITI is a platform for multidisciplinary projects available to the scientific community. In this center, the "Caninos Loucos" project is underway, aiming to form a community of IoT developers in Brazil and, in addition, develops Single Board Computers with national technology and open structure, including hardware and software. The center also has a digital health center and works with the concepts of Think-tank and FabLab

(Factory-Laboratory) to enable projects that have an impact on human problems, such as health and accessibility [18, 19].

6 Challenges and Opportunities for IoT in the Health Area in Brazil

According to the National IoT Plan, Brazil has three main health challenges that can be overcome with solutions involving IoT [7]:

Improvement of the general health of the population: Eating habits are bad, and people are less active. These two factors have a negative impact on the health system.

Improve patient care: Only 25% of patients trust the health system and, among health professionals, only 35% trust the system. There are reasons to believe that the lack of confidence is related to the long waiting times for care. A problem that has the potential to be mitigated through efficiency gains that technology brings.

Financial sustainability of the system: There are two main factors adding pressure to the system: population aging and growing medical inflation, that is, the increase in health costs related to new treatments or procedures that are available to the population [20]. Both issues are not restricted to Brazil and have been discussed globally. Brazil's population is aging at an impressive rate. In 2030, we will see a reduction in all age groups below 40 years and accelerated growth in groups above that age. And this growth is more pronounced at the top of the age pyramid. Estimates indicate that, in 2030, the age group over 60 years old will be 3 times larger than it is today (Fig. 2) [2]. According to the "Instituto Coalizão Saúde," [21] it is estimated that only 10% of the elderly population will have access to private health services, that is, 90% will depend on the public system. Thus, an urgency to develop plans to meet the needs of this growing part of the population is enormous.

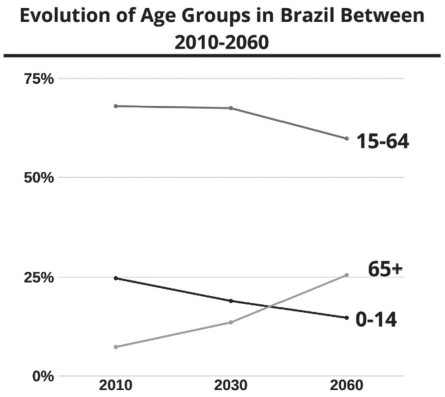

Fig. 2. Projection of the evolution of different age groups in Brazil until 2060 (extracted from IBGE - Brazilian Institute of Geography and Statistics: Projections and estimates of the population of Brazil and of the Federation Units. Rio de Janeiro: 2010 available at https://www.ibge.gov.br/apps/populacao/projecao/).

In addition to the three challenges that receive special attention, solutions to improve the use of resources, facilities, professionals, and pieces of equipment will similarly be well accepted. Innovations related to schedule control, stocks, and availability of hospital beds. Confronting epidemics, as the country has faced severe problems with dengue, zika virus, and chikungunya. Finally, it is also worth highlighting the management of patient data because a large amount of information is still on paper, and this is a limiting factor when we think about using this data as a planning tool.

For Brazil to take full advantage of the expansion of IoT solutions, it is essential that efforts be allocated to overcome challenges, such as regulatory issues. The draft General Data Protection Law already exists, so this issue should be mitigated soon [22].

Furthermore, Brazil is a country of continental proportions and very heterogeneous. In this scenario, connectivity is quite challenging, which is why investments in infrastructure and training of human resources are part of the National Internet of Things Plan. Brazil has 0.9% of its workforce in telecommunications, and for the European Union, this number is close to 4%, which reinforces the indication that it is essential to invest in the training of these professionals [23].

7 Conclusion

As discussed above, we can conclude that Brazil government understands the strategic role of IoT in the health area, enabling technologies with revolutionary potential and capability to bring significant progress to the Brazilian health market and health benefits for the population. Precisely for this reason, Brazil actively seeks to create strategies to develop its own solutions and achieve a higher degree of autonomy and a guiding role. Several efforts are taken in public investments and partnerships with the academy and the private sector. It is, therefore, a window of opportunity to leverage research, developments, projects, initiatives, and startups interested in innovation in the health area.

References

1. Adamer, K., et al.: Developing a wearable assistant for hospital ward rounds: an experience report. In: Floerkemeier, C., Langheinrich, M., Fleisch, E., Mattern, F., Sarma, S.E. (eds.) IOT 2008. LNCS, vol. 4952, pp. 289–307. Springer, Heidelberg (2008). https://doi.org/10.1007/978-3-540-78731-0_19
2. Instituto Brasileiro de Geografia e Estatística: Projeções e estimativas da população do Brasil e das Unidades da Federação. https://www.ibge.gov.br/apps/populacao/projecao. Accessed 09 Feb 2020
3. International Monetary Fund: Gross Domestic Product. https://www.imf.org/external/datamapper/NGDPD@WEO/OEMDC/ADVEC/WEOWORLD. Accessed 09 Feb 2020
4. Fan, J.S.: Regulating unicorns: disclosure and the new private economy. Bost Coll Law Rev. **57**(2), 583–642 (2016)
5. Teare, G.: Crunch Base. https://news.crunchbase.com/news/the-new-unicorns-of-2019/. Accessed 09 Feb 2020
6. Lee, A.: Crunch Base. https://techcrunch.com/2013/11/02/welcome-to-the-unicorn-club/. Accessed 09 Feb 2020

7. Banco Nacional de Desenvolvimento Econômico e Social. Internet das Coisas: um plano de ação para o Brasil Produto 7B: Aprofundamento de Verticais – Saúde. https://www.bndes.gov.br/wps/wcm/connect/site/9e481a5b-a851-4895-ba7f-aa960f0b69a6/relatorio-aprofundamento-das-verticais-saude-produto-7B.pdf?MOD=AJPERES&CVID=m3mTltg. Accessed 09 Feb 2020
8. BRASIL. Constituição (2019). Decreto nº 9854, de 2019. Brasília, 2019. Disponível em: http://www.planalto.gov.br/ccivil_03/_Ato2019-2022/2019/Decreto/D9854.htm. Accessed 09 Feb 2020
9. Peduzzi, P.: Agência Brasil EBC. https://agenciabrasil.ebc.com.br/geral/noticia/2019-11/ministro-anuncia-criacao-de-8-laboratorios-de-inteligencia-artificial. Accessed 09 Feb 2020
10. World Health Organization: Global Health Expenditure Database. http://apps.who.int/nha/database/country_profile/Index/en. Accessed 09 Feb 2020
11. Agência Nacional de Saúde Suplementar: Mapa da Assistência Saúde Suplementar (2017). http://www.ans.gov.br/images/Mapa_Assistencial_2017.pdf. Accessed 09 Feb 2020
12. Ministério da Saúde: Datasus – Departamento de Informática do SUS. Cadastro Nacional de Estabelecimentos de Saúde (CNES). http://cnes2.datasus.gov.br/. Accessed 09 Feb 2020
13. Healthcare Information and Management Systems Society. https://www.himssanalytics.org/stage-6-7-achievement. Accessed 09 Feb 2020
14. Startup Base. https://startupbase.com.br/home/startups?q=&states=all&cities=all&segments=Sa%C3%BAde%20e%20Bem-estar&targets=all&phases=all&models=all&badges=all. Accessed 09 Feb 2020
15. Sartor, V.: Grupo Mídia. https://grupomidia.com/hcm/estudo-sobre-o-uso-da-tecnologia-nos-hospitais-brasileiros-pela-frost-sullivan-e-abcis-e-o-destaque-do-direto-da-redacao/. Accessed 09 Feb 2020
16. Associação Brasileira de Internet das Coisas. https://abinc.org.br/. Accessed 09 Feb 2020
17. Laboratório de Sistemas Integráveis. https://sites.usp.br/lsi/. Accessed 09 Feb 2020
18. Centro Interdisciplinar de Tecnologias Interativas. http://www.lsi.usp.br/citi/. Accessed 09 Feb 2020
19. Projeto Caninos Loucos. https://caninosloucos.org/pt/. Accessed 09 Feb 2020
20. Dhaene, J., Godecharle, E., Antonio, K., Denuit, M., Hanbali, H.: Lifelong health insurance covers with surrender value: updating mechanisms in the presence of medical inflation. ASTIN Bull. **47**, 803–836 (2017). https://doi.org/10.1017/asb.2017.13
21. Instituto Coalizão Saúde: Coalizão Saúde Brasil Uma agenda para transformar o sistema de saúde. http://icos.org.br/wp-content/uploads/2017/04/Relato%CC%81rioNet.pdf. Accessed 09 Feb 2020
22. BRASIL. Constituição (2018). Lei nº 13709, de 2018. Disponível em: http://www.planalto.gov.br/ccivil_03/_ato2015-2018/2018/lei/L13709.htm. Accessed 09 Feb 2020
23. Marques, F.: Brazil's Internet of Things. Revista Pesquisa FAPESP **259**, 18–23 (2018)