Chapter

Science-Based Technological Transfer as a Key Tool in Public Health

Alonso Ureta Dumont and Jovanka Trebotich Zúñiga

Abstract

Only a small portion of all the projects that are funded with public grants reaches the market, due to a gap known as "Death Valley" between the public and private source of resources. Know Hub Chile (KH) is a non-profit organization founded to transform scientific research results into goods and services available to the market and for the benefit of society. When the Covid-19 emergency reached Chile, the organization launched the "KH Bridge" a program of proof-of-concept and selected three technologies able to support hospitals in solving their needs. The first one was a smart shift planning platform of medical staff for reducing the virus spreading probability; the second solution aimed to assess the use of masks, and counting capacity and physical distance of patients by using video camera analytic technology in real-time; and the third project selected was an innovative design of personal protection equipment made with copper nanoparticles. All these solutions were piloted and validated into public hospitals for three months with a USD 25.000 budget. The KH Bridge experience has shown that the pandemic scenario has been an opportunity to validate university technologies in real environments and in shorter time frames, contributing to public health operations.

Keywords: Covid-19, Pandemic, Know Hub Chile, Proof of concept program, Know Hub Bridge, OpenBridge Covid-19

1. Introduction

Innovation and technology transfer are a fundamental part of society sustainable growth. In terms of Research and Development (R&D) investment, Chile is still far from OECD countries, being only 0.36% of the Gross Domestic Product (GDP), against an average of 2.4% GDP. Currently, universities are the largest precursor of innovation and technology transferring, capturing 45% of the total investment in research, equivalent to USD 452 million at 2017. Despite this, only 49% of this investment is dedicated to applied R&D activities, with a focus on technology transfer [1].

Between 2015 and 2018, 11 news Transfer and Licensing Offices (TLOs or university technology transfer offices or TTOs) were founded into the universities, which move from 18 to a total of 29. However, the magnitude of this increase on the TLOs was not observed on the transfer indicators, which present a slight increasing (**Figure 1**). This issue could be reelevated to the lack of capabilities on technology transfer and

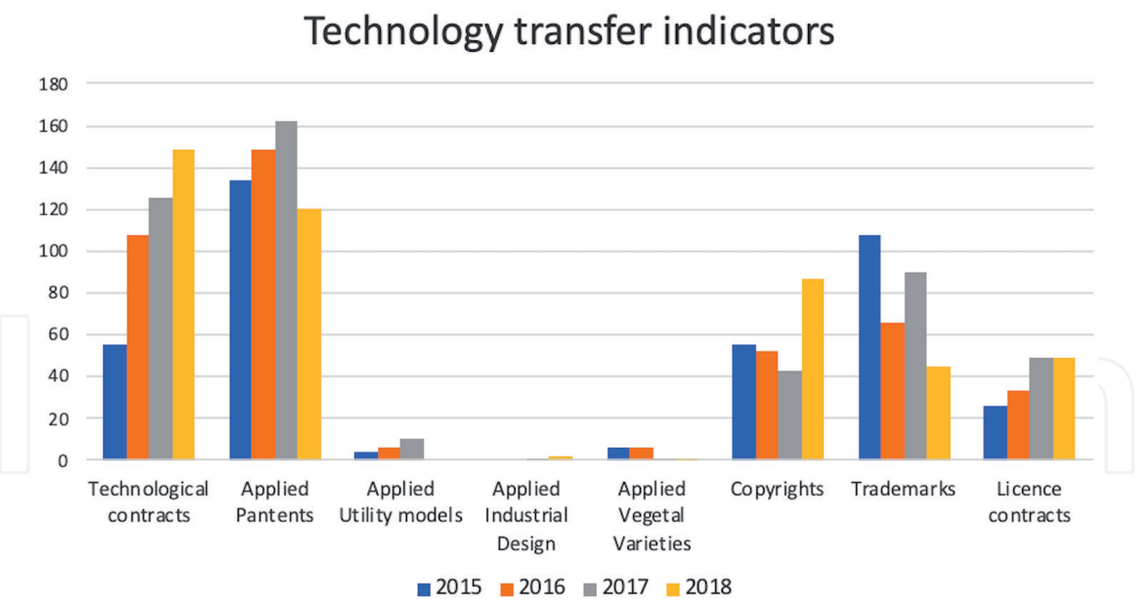

Figure 1.
Technology transfer indicators between 2015-2018.

commercialization inside the TLOs. It is still insufficient open new OTLs, without an additional support on technology transfer and commercialization [2].

In 2009, the World Bank published "Promoting Technology Transfer and Commercialization: Chile" [3] report, pointing out the need to update the national regulatory framework for technology transfer, since it does not achieve international standards. The following needs of the Chilean ecosystem stand out from this report:

- To improve institutions, regulations and practices for an efficient and dynamic intellectual property management system.
- To develop strategic partnerships for science-oriented, science-enhancing Public Technological Institutes.
- To accelerate the creation of technology companies.
- To develop skills and competencies to support these companies.
- To stimulate the universities "third mission": contributing to economic growth.
- To trigger demand for technology and innovation.
- To promote a culture of entrepreneurship and innovation.

In response to these points, various public policies were generated between 2011 and 2015 to develop trained human capital, and to promote technology commercialization or "go to market", in addition to the creation of institutions devoted to facilitate technology transfer processes, and TLOs in universities and research centers.

Towards the end of 2015, a new public policy was designed, the "Technology Transfer Hubs" (three in total). Under this instrument, seven public universities and three research centers created Know Hub Chile in January 2018. Its main

objective is collaborating to transform scientific research results of its partners in products, services and start-ups companies for the society benefit. For reaching this objective, Know Hub developed a series of programs to accomplish specific challenges of the Chilean (and Latinoamerican) innovation ecosystem. For instance, Know Hub Bridge program was created at the end of 2019 to close gaps in the development of technologies generated with public funding, and to improve their chances of reaching the market [4].

In parallel, due to the Covid-19 pandemic, the Chilean system of health tried to be prepared to the emergency that already had begun in Europe. Thus, a series of measurements were initiated, such as the purchase of mechanical ventilators, medical supplies for personal protection, reagents for PCR sample analysis, among others. Given the high world demand, there was a shortage of some of these items. In addition, there was a growing need for more effective technological solutions to mitigate the virus spreading, which led to local technological capabilities to meet the needs of health institutions [5].

In this context, from the innovation ecosystem, innovation challenges focused on validating technologies that would help to fight against coronavirus, such as the "Covid-19 Challenge" (TransferenciAP) [6], "SiEmpre initiative" carried out by SOFOFA hub [7] and the "Innovation Challenges for diagnostic kits and personal protection elements", promoted by the Chilean Economic Development Agency (Corfo) and the Ministry of Science, Technology, Knowledge and Innovation (MinCTCi) [8, 9].

In parallel, Know Hub Chile launched its pilot program Know Hub Bridge, to accelerate the validation of technologies that helped Chilean public hospitals to combat Covid-19. The initiative was called OpenBridge Covid-19 and was carried out together with Open Beauchef (University of Chile) and Santander X [10].

In this chapter we will discuss how the Technology Transfer Hubs policy, and specifically how Know Hub Chile established itself in the innovation ecosystem, and how the implementation of the pilot program Know Hub Bridge, under the name of OpenBridge Covid-19, has allowed to closing gaps in Science and Technology Based Companies (STBCs) by transferring their technologies to public hospitals during pandemic times.

2. Technology transfer institutions in Latin America

For some years now, several countries in Latin America have begun to generate the necessary institutions to carry out technology transfer, understanding that these technologies have the potential to impact the quality of life of society. In this sense, LTOs have been the institutions with the greatest development in recent years in Latin America, mainly housed in universities and research centers. In some countries, such as Colombia, Regional Research Results Transfer Offices (OTRI in spanish) have been created, covering various regional demands of the country through five offices -Connect Bogota, Tennova UEE, OTRI Estratégica de Oriente, CienTech and Reddi- [11].

Along with the development of the LTOs and/or technology transfer units, other institutions have also emerged to support and complement the work of these offices or their similes. In this regard, Ecuador through the Secretary of Higher Education, Science, Technology and Innovation (SENESCYT) has generated the Innovation and Technology Transfer HUB (HUB iTT) project in 2018, to "promote the development of innovation, entrepreneurship and technology transfer activities carried out in the country's higher education institutions". Thus, six HUBs iTT have been created throughout Ecuador, grouped to meet regional needs (North, Quito, Central,

Cuenca, Guayaquil and Manabí) [12, 13]. Another country that has created a similar institutional framework is Chile, through the technology transfer HUBs, whose history and results are discussed in more detail in this chapter. It should be noted that this new institutional framework is still incipient in the region, so as success stories are generated with HUBS in Ecuador and Chile, it is highly probable that more countries will generate public policies that support the creation of these institutions.

3. Technology transfer hubs in Chile

3.1 Innovation ecosystem

In 2011, Corfo launched the first Program for the Creation and Strengthening of TLOs. This program was open to universities and technology centers. Eighteen projects were funded, with a budget of USD 7.14 million. Despite this significant investment, it was not enough to maintain the structure of the offices with a sustainable financial model.

In 2015, Corfo launched a second TLO program, which tried to consolidate and to position the offices, hoping to improve transfer indicators. Through this program, 15 TLOs were financed. In addition, in order to consolidate the existing TLOs and strengthen the new ones, a new stage in the specialization of technology transfer in Chile began with the "on campus-off campus" model.

3.2 "On campus - Off campus" model

The "on campus-off campus" model takes into consideration the need to strengthen commercialization and transfer capabilities within universities, considering that the specialization of competencies is the way to achieve successful commercialization with greater probability.

The "on campus" component corresponds to the role played by the TLOs in the identification, follow-up and compilation of research and development results within universities and research centers. The aim is to promote research focused on solving specific problems or needs of the productive sector and society. Similarly, the role of technological asset management is considered, according to the guidelines or capabilities of each institution.

The "off-campus" component is related to entities that have the capabilities and human capital highly specialized in scaling and transferring research and development results generated in universities and research centers. This work itself is oriented to the generation of global business in different industries, with access to support networks in internationalization of scientific and technological enterprises, which involves a decrease in the gap in the capabilities required by the TLOs, performing this activity through two ways: using their own work, or coordinating and intermediating external services (**Figure 2**).

Along with the implementation of the model, the Technology Transfer Hubs were born with the objective of strengthening the transfer capabilities of universities and associated research centers, through the "on campus and off campus" model, focusing on improving the processes of intellectual property, technological development and commercialization, in a joint work with the TLOs [14].

3.3 Origin of technology transfer HUBs in Chile

Technology transfer hubs were created by Corfo as a public policy that sought to close the gap between the generation of technologies in universities and research

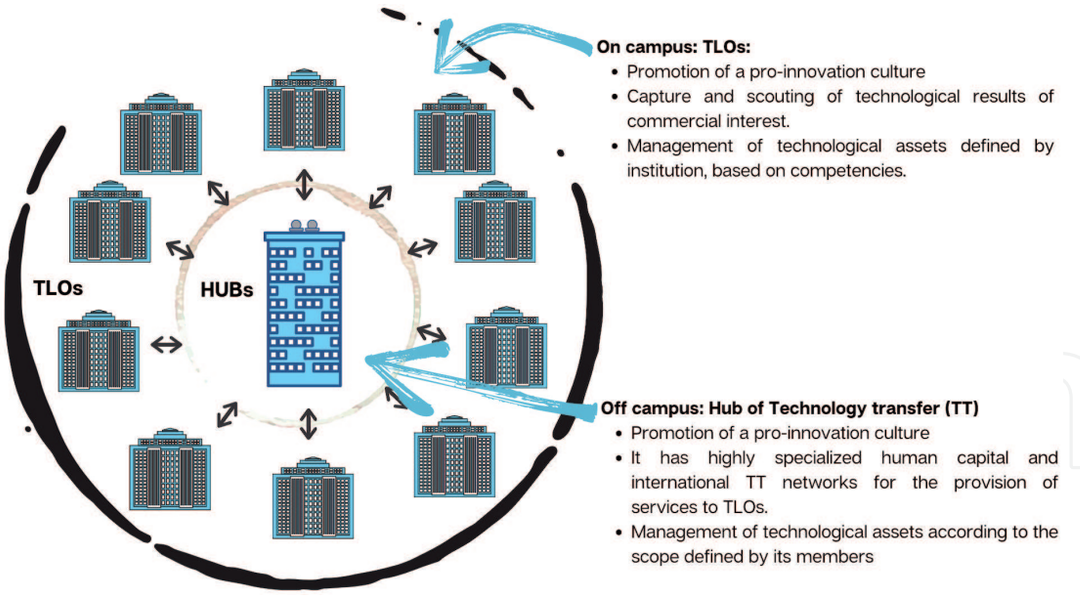

Figure 2.
On–off campus model.

centers and their transference to the market, using the "on campus - off campus" model described above. Hubs are associative organizations comprised by several universities and research centers, which are linked to companies, trade associations, investment and venture capital funds, among others. According to Corfo, "the Hubs should perform functions of technological surveillance and competitive intelligence, intellectual property management, commercialization of licenses, and creation and assistance to spin-offs. It also involves closing capability gaps required by the TLOs, through their own work, or by intermediating external capabilities." [14].

The specific objectives are: [14].

- Implement an associative model with specialization of functions on campus-off campus that achieves the necessary scale for the sustainability of the technology transfer HUBs in the medium and short term.

- Attract and generate human capital specialized in intellectual property management, technology transfer and industry linkage models, such as technology contracts, open innovation, among others.

- Improve the market potential of the technological assets generated by R&D&I projects, adopting international best practices in technology management.

- Increase the creation of technology-based ventures based on R&D results, increasing the amount of private resources invested and boosting access to early-stage venture capital, both nationally and internationally.

- Strengthen the positioning of on campus - off campus technology transfer entities in the national innovation and national entrepreneurship ecosystem."

"The expected outcomes of this new program are: [14].

- Development of a HUB's 10-year strategic plan that considers a governance and business model that allows the achievement of its objectives and sustainability.

- Implementation of an associative model with specialization of functions on campus and off campus.

- Increasing the quantity and quality of the actors' competencies in the innovation system related to management of intellectual and industrial property, technology transfer, links with industry and open innovation.

- Increasing the value of the portfolio of technological assets and innovations, improving the management of disclosures, intellectual and industrial property, and new technological businesses with a global focus.

- Increasing the number and amounts of applied R&D contracts entered into by universities with companies, licenses and university-company collaboration projects in high-impact strategic sectors.

- Increasing the commercialization of Chilean technologies abroad.

- Increasing the number of spin-offs and technology-based companies.

- Increasing the number of technology-based spin-offs by obtaining funds for scaling them and in the amounts of private investment (Venture Capital) for spin-offs and technology-based companies."

To finance the hubs, Corfo launched in 2015 a competitive award to subsidy 80% of the total cost of the project, with a maximum of USD 8,000,000 for 5 years, and a potential extension of a second 5-year period.

"The projects were selected after an international evaluation. Subsequently, an internal Corfo committee reviewed the proposals and decided to fund the three proposed projects: HubTec, Know Hub Chile (KH) and Andes Pacific Technology Access (APTA), each focused primarily on agriculture; health; industrial production, technology and energy and comprised by a group of Chilean universities, companies, research centers and technology centers." [15].

4. Know hub Chile

4.1 History of know hub Chile

Know Hub Chile was born as a non-profit corporation on January 23, 2018 and as part of a public policy discussed previously. Its main objective is collaborating to transformer scientific research results of its partners into products and services available to the market and society, with emphasis on their global impact. In other words, Know Hub Chile collaborates to transform science into innovation.

Know Hub Chile was initially founded by seven universities -Universidad de Chile, Universidad de Talca, Universidad Católica del Maule, Universidad del Bío-Bío, Universidad Católica de Temuco, Universidad Austral de Chile and Universidad de Los Lagos- and three scientific institutions -Instituto de Neurociencia Biomédica, Instituto de Investigaciones Agropecuarias and Centro de Estudios en Alimentos Procesados- mainly from central-southern Chile. At the beginning of 2019, the eleventh member joined: the Universidad Tecnológica Metropolitana.

4.2 Programs of know hub Chile

Initially, Know Hub Chile implemented a working model based on the identification and commercialization of technologies that were in an advanced stage of development and high market potential developed by its associates. Under this model, Know Hub Chile created the first technology portfolio, comprised by more than a hundred research results and technologies that were evaluated by different entities (KIM Global Spain, Genesis Partners and University of California Riverside). The conclusions obtained from this process were the following:

1. Low state of development of the technologies evaluated, since most of them were at Technology Readiness Level (TRL) 3 or 4;

2. Most of the technologies did not have a commercial partner, the customer was not identified and they did not even respond to a specific industry need;

3. Research teams barely committed to the later stages of technology development, and/or lack of funding for further development.

Considering the conclusions, the commercialization potential of Know Hub Chile's first technology portfolio was quite low. For this reason, during the first half of 2019 the foundation decided to modify its strategy.

Firstly, Know Hub Chile's current strategy is based on the design and implementation of programs that respond to gaps in the innovation ecosystem, aiming to bring research results to the market and society. Secondly, the foundation seeks to provide strategic support to its partners, beyond technology commercialization activities, with the objective of improving institutional capabilities in technology transfer. In this way, and thirdly, Know Hub Chile major goal is to contribute to the maturation of the Chilean innovation ecosystem.

Based on this strategy, and in terms of technology transfer, Know Hub Chile designed five programs to improve commercialization opportunities and to accelerate transfer processes focused on international markets. These programs are:

- Know Hub Ignition: strengthening and promoting technologically based entrepreneurship.

- Know Hub Portfolio: identifying, assessing, selecting and managing technologies developed by its associates in order to bring them to market directly or through Know Hub's strategic alliances.

- Know Hub Bridge: reducing technology risk to improve technology of opportunities to international market.

- Know Hub Connect: strengthening the bonds with industry through technology contracts.

- Know Hub Dual-Tech: supporting the creation and acceleration of science- and technology-based companies with civil-military applications.

While three programs were designed for positioning and validating the foundation:

- Know Hub Building: To develop and strengthen the professional and institutional competencies of our partners in issues related to technology-based innovation.

- Know Hub Partnership: Generate national and international public-private alliances to collaborate in initiatives that broaden the scope of technology-based innovation. To expand the scope of their partners' and national ecosystem technology transfer in order to bring technologies closer to society.

- Communications: Strengthen the dissemination and positioning of Know Hub Chile, through its success stories in technology transfer and its value proposition.

5. Know hub bridge program

As previously mentioned, Know Hub Chile is deploying its efforts to transfer Chilean technologies through various mechanisms, such as the creation of programs to reduce the gaps that prevent technologies from reaching the national and international markets effectively.

In this sense, and as part of KH's mapping of the national innovation and entrepreneurship ecosystem, it was observed that there is a lack of integration and cohesion between the different funding sources for R&D and innovation, both public and private. This means that a significant number of technologies in which resources and time have been invested do not manage to overcome the "valley of death" and fail to reach the market.

The "valley of death" concept was initially applied in the field of entrepreneurship by Sthepan Markham (2002), describing the inability of a company to maintain a sustainable business model [16]. This is also a metaphorical concept used to describe the gap between academic-based innovations and their commercial applications in the market. More specifically, the "valley of death" refers directly to the difficulty of maturing TRL 6 to 8 technologies through their demonstration and validation stage due to a series of barriers that prevent them from reaching the market. Among the barriers are high costs associated to carry out demonstration and validation tests, low capital investment, difficulties to obtain certifications, among others. Overcoming the "valley of death" is one of the most expensive stages in the development of an innovation [17]. In the specific case of Chile, an additional barrier is the industry's reticence to technological risk, avoiding innovations to reach the value chain of industries as mining, salmon farming, forestry.

In the specific case of Know Hub Chile's partners, out of more than 120 technologies evaluated by the foundation, 52% have a TRL 4 or lower and more than 65% do not have a commercial partner to support their transfer to the market. These figures are a true reflection of what has been seen in the national innovation and entrepreneurship ecosystem.

In order to improve the transfer chances of the portfolio by increasing their value and mitigating technological risks for the industry, Know Hub Chile has designed Know Hub Bridge. This program promotes the creation of favorable conditions for the maturation and introduction of new technological products or services in the market. Also, the initiative contributes to the development of scientific and technological based companies (STBCs) or technology-based companies (TBCs), by the investment of third parties in them or by licensing the technologies directly to the industry.

To this end, Know Hub conducts a review of other existing programs to formulate its own program.

In this regard, the "Horizon 2020" program of the European Union (EU) - specifically of the European Commission- stands out for implementing the "Innovation Union" strategy. This initiative seeks to create an open environment for innovation that facilitates the conversion of great ideas into products and services that boost EU economy and create jobs. Horizon 2020/Innovation Union has a strong focus on the market [18].

One of the instruments within "Horizon 2020" focuses on small and medium-size enterprises (SMEs) by supporting the technology development, helping to leverage capital for technology development and commercialization, mitigating technological risk and accelerating technology arrival to the market. Since its implementation in 2014, this instrument has managed to raise around USD 3.6 billion of private investment, investing a total of USD 1.5 billion, which means that for every dollar of public money invested, is generated USD 2.83 of private investment. This amount has been increasing over time. They have also supported more than 4,500 SMEs and are expected to reach 6,000 by 2021 [19].

Another initiative is The Research Council of Norways's programme on Commercializing R&D results (FORNY2020), which is a Proof-of-Concept Funding that supports testing, scaling-up and the continuation of research projects to facilitate the commercialization of research results carried out in public research institutions [20].

Finally, the U.S. Department of Defense (DOD) Science and Technology (S&T) program, has two initiatives, "Advanced Technology Development" (ATD) and the "Advance Component Development and Prototypes" (ACD&P), that support the generation of prototype models and their testing in controlled or real operating conditions, allowing the transition from the laboratory to operational use or even being part of the DOD acquisition processes [21].

All these programs -and many others of the Proof of Concept type- have in common that they finance technologies with a high potential to be transferred (TRL 5–6) or commercialized in short or medium term. These technologies come from different areas and need financing to achieve validation under real conditions, scaling up and market launch. In general, funding ranges from USD 25 K to USD 100 K. Finally, these programs not only focus on technologies coming from universities or research centers, but also from STBCs.

All these elements gave rise to the Know Hub Bridge program, whose general objective is to improve the transfer opportunities and terms of negotiation of the research results of KH's partners, by reducing the technological risk for potential licensees and/or investors, through the financing of market viability tests. The specific objectives of the program are as follows:

- To generate an increase the commercial value of the technologies generated by Know Hub Chile's partners.

- To increase the level of technological development of the research results or TRL in a period of 12 to 18 months, at the most.

- To facilitate and accelerate the commercialization of research results and/or technologies developed by Know Hub Chile partners, by mitigating part of their technological risks.

- To increase the number of technological products or services belonging to Know Hub Chile's partners that are ready to be commercialized in national and international markets.

- To increase the number of technological products or services belonging to Know Hub Chile's partners that achieve private leverage in co-investment format.

The Know Hub Bridge program is composed by 3 stages (**Figure 3**):

1. *Identification of research results or technologies with potential to be transferred to the market*. KH Bridge focuses on the maturation of technologies that have a level of development equivalent to a TRL 4 status. Its first element of value is the identification of research results or technologies or inventions with commercial potential developed by professional teams from KH's partners, as well as technologies developed by technology-based companies derived from KH partners. This identification process is carried out through an open call for a determined period of time. The proposals are submitted through an application form, which are submitted to a formal evaluation based on evaluation criteria: amount of investment and increase in value, time to commercialization, team capacity and project design. Then, the selected proposals present their plan of activities and key milestones to be developed during the program.

2. *Execution of activity plan/key milestones.* Proposals supported by the KH Bridge program are challenged to develop a plan of activities and key milestones that will have a duration of 12 months, which may be extended up to 6 additional months (as in the case of projects involving biological cycles). This plan should state activities, milestones with their respective detailed descriptions, budget, time and the people responsible for the team to carry out each of the activities.

3. *Support in the business model and commercialization of research results or technologies*. During the program, Know Hub Chile will actively support the definition of the business model and the raising of private investment for market entry, customer search and/or productive scaling of research results from technology-based companies, as well as in the prospecting of potential licensees and/or companies interested in the development of final stages of research results or technologies, both nationally and internationally.

In general terms, the program consists of supporting the selected teams for a maximum period of 12 months, moving from a TRL 4 to a TRL6.

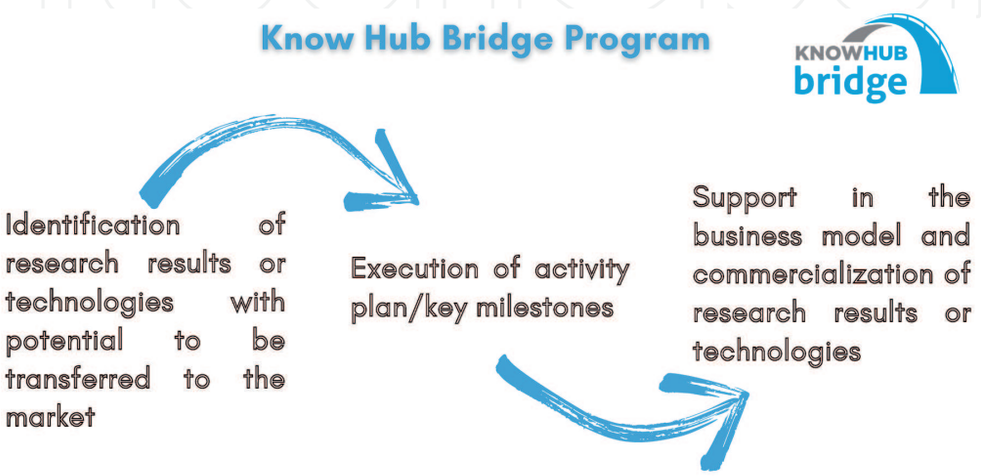

Figure 3.
Stages of know hub bridge program.

5.1 Piloting the program: COVID-19 open bridge experience and results

When the Covid-19 pandemic began in Chile and Latin America, initiatives focused on validating technologies that would help to fight against coronavirus have arisen. At Latin America level, the "Covid-19 Challenge" (TransferenciAP) [22], and Chilean level "SiEmpre initiative" carried out by SOFOFA hub [23] and the "Innovation Challenges for diagnostic kits and personal protection elements", promoted by the Chilean Economic Development Agency (Corfo) and the Ministry of Science, Technology, Knowledge and Innovation (MinCTCi) [24, 25].

In parallel, Know Hub contacted to the National Institute of Geriatrics (Instituto Nacional de Geriatría, INGER) and the Padre Hurtado Hospital. Both health institutions requested to support the generation of spaces for innovators to propose solutions for problems triggered by the pandemic. Know Hub Chile took up this request, allocating resources from the Know Hub Bridge Program to generate a pilot experience to seek innovative solutions related to the health emergency.

In this sense, KH collected, organized and prioritized the requirements of the health centers in three thematic axes: Personal Protective Equipment (PPE); Cleaning, Asepsis and Disinfection Technologies, and Information and Communication Technologies (ICTs). Due to the urgency of the pandemic, the developed technologies must be transferred within three to four months. Know Hub Bridge would finance the feasibility tests in clinical fields.

In order to accomplish the tight deadlines, collaboration was essential. Thus, the Innovation and Entrepreneurship Center of the Faculty of Physical and Mathematical Sciences of the Universidad de Chile, OpenBeauchef joined to the initiative, contributing with its experience in evaluation and incubation, contacts, and links with the Universidad de Chile Clinical Hospital (HCUCH). Thus, the name of the call was OpenBridge Covid-19 and its objective public were groups of researchers, entrepreneurs or graduate students linked to KH's partner institutions.

The international entrepreneurship project Santander X, from the bank of the same name, also joined to the initiative proving resources for another award. The Santander X Award acknowledged ideas from undergraduate and graduate students from KH institutions that were also linked to the three strategic axes of the call.

The Open Bridge COVID-19 call is characterized by the rapid implementation of technologies and/or research results to solve the particular needs of institutions such as INGER, HCUCH and other health institutions, in order to mitigate the effects generated by the pandemic caused by SARS-CoV-2 in these institutions and in the Chilean health system.

To achieve its objective, OpenBridge Covid-19 worked in two parallel fronts.

Firstly, supporting the maturation of technologies that have a level of development equivalent to a TRL 4 status, through the implementation and development of a work plan to be developed in 3–4 months that allows a validation process together with the INGER, HCUCH and/or other health institutions;

Secondly, working with the developers of the technologies in all the elements related to protection strategy, business model and legal aspects related to the creation of companies that are able to perform adequately as potential suppliers of the mentioned health institutions and/or prepared to raise investment.

OpenBridge Covid-19 opened its call for applications on May 6, 2020. After an intense communication and scouting campaign with KH partners, on May 29, 2020 the process close successfully with 43 applications.

After a selection process, where 13 teams passed to the pitch stage, three initiatives were selected to be financed:

- Safe Vision (SV), is a video analytical system for health facilities which is connected directly to the standard cameras of these centers. Its purpose is to process images for metadata analysis in real time. The current system counts capacity and flow of people (patients, companions and health staff), checks masks and other PPE usage, and verifies compliance with social distancing. Safe Vision generates indicators likely to configure alerts to health center personnel. Created by the startup Dual Vision

- Medical Shield Staffing (MSS), is a system which manages health staff time availability, in order to work in different shift settings. This information feeds a dynamic optimization model, which uses stochastic dynamic simulation tools and mathematical programming. The system provides a shift scheme proposal, through a user-friendly interface, which minimizes contagion probability. The principle used by the model is concentrating work shifts on the virus incubation period, assigning medical staff free days to cover up contagion period, in case of infection. Developed by a research team from the Universidad de Chile

- Active Protection (ActPro), is a Personal Protective Equipment (PPE) for health workers. Given the fact that it has copper nanoparticles incorporated – with antimicrobial and antiviral activity– and due to its ergonomic design, it would prevent SARS-CoV-2 contagion, whether in direct contact with infected patients, or during disposal or replacement PPE process. Developed by a research team from the Universidad Católica de Temuco.

These three solutions were piloted for 4 months in public hospitals with a budget of USD 20 K each.

After slightly over more 4 months of design and implementation of pilot experiences with the selected teams, the results obtained within the framework of OpenBridge Covid-19 are the following:

5.1.1 Safe vision

5.1.1.1 Diagnosis

The health centers do not have systems in place to comply the measures established by the health authority related to physical distance, mask use, number of people allowed in facilities and temperature measurement. All control procedures are carried out manually by facility personnel.

5.1.1.2 Proposal

Image analysis system based on artificial intelligence and computer vision, and using the existing camera system to count people, identify mask use and determine physical distancing. The images are processed, obtaining data that are presented on a platform, allowing to visualize data in real time, configure issue alerts, track historical metrics and make decisions to improve compliance with the measures, and resource optimization of health facilities.

5.1.1.3 Results

The Dual Vision's team developed its own recognition algorithms for people counting and for identifying mask use and physical distancing. To do this, they took

images from the existing cameras in the healthcare facility and began to train the artificial intelligence system in real conditions. Once the recognition algorithms were developed, system assembly optimizations were made to obtain a packaged product at a lower cost. In parallel, the team worked on the development of an intuitive visualization platform to present the information in real time. In terms of visualization, it was decided to sectorize the metrics to aid decision making, and to include an option to access to historical record.

To implement the solution at INGER, additional cameras were required for installing in strategic spots to check areas of interest. Once the cameras were calibrated, the analytical phase began. To verify the correct functioning of the system, stress tests were performed. The piloting process began with a white run to show the hospital management area the system operating under real conditions. After this experience, the hospital staff provided feedback and requirements, which resulted in improvements to the service. It is expected that the hospital will acquire the technology.

In commercial aspects, the startup team proposed a Software As A Service (SaaS) business model with a one-year contract monthly charged, amortizing the software components and product development,

It should be noted that INGER has expressed interest in continuing to expand the range of analytics beyond the needs of the pandemic. The hospital objective is to obtain relevant information to improve the quality of patient care.

Dual Vision currently has business in the retail area as well. Know Hub Chile team is supporting them to achieve the venture consolidation in a short term.

5.1.2 Medical shield staffing (MSS)

5.1.2.1 Diagnosis

Public health centers in Chile do not have automated systems for staff shifts planning for different medical areas -such as Intensive Care Units or ICUs- in order to obtain the best shift patterns that allow personnel to rest and reduce the probability of getting Covid-19.

5.1.2.2 Proposal

MSS is a system that manages the availability of health personnel to work in different shifts configurations through a dynamic optimization model, which uses stochastic dynamic simulation tools and mathematical programming. The system delivers, through a friendly user interface, a shift planning proposal that minimizes the probability of contagion among personnel.

5.1.2.3 Results

MSS technology was designed, implemented and successfully put into operation at the Hospital Clínico de la Universidad de Chile (HCUCH) and the Hospital Clínico Herminda Martín de Chillán (South of Chile), two facilities that have been the front line fighting against the coronavirus. In the case of HCUCH, a facility that expanded its Critical Patient Unit as a result of the pandemic, MSS contemplated the design of shifts with a lower risk of infection, which at the same time would be adjusted to the available medical staffing: the 2 × 10 and 4 × 4 shift schedules maintain the same number of hours worked for each department and their implementation reduced the risk of infection among hospital workers by 25%. In the case of the Critical Patient Unit of the Hospital Clínico Herminda Martín, MSS was

able to reduce the risk of contagion by 9%. Currently, the MSS team is finishing the validation process in another Chilean health institution.

In the commercial aspects, the team expects a business model based on licensing the technology to companies that have the operational capabilities to carry out the MSS service. In addition, the technology can be used in other areas where shift systems are used, such as retail and mining.

5.1.3 Active protection

5.1.3.1 Diagnosis

Personal protective equipment has become unusually important in the current pandemic, so any improvement in its design and materiality is necessary to prevent the infection of medical staff.

5.1.3.2 Proposal

ActPro is a personal protective equipment, specifically a plastic apron, for health staff use. Given the fact that it has copper nanoparticles incorporated –with antimicrobial and antiviral activity– and due to its ergonomic design, it would prevent SARS-CoV-2 contagion, whether in direct contact with infected patients, or during disposal or replacement PPE process.

5.1.3.3 Results

To date, it has been designed a model of protective plastic apron according to the needs of medical staff. The team has had a close interaction with personnel from an specific area of the Hospital Dr. Hernán Henríquez Aravena, in Temuco (South of Chile) and concluded that the health staff requires a PPE easy to put on and to take off for disposal. In addition, the team has carried out several evaluations of the polymer used to manufacture the PPE, occupying different concentrations of copper nanoparticles to generate the antimicrobial property. Currently, an external laboratory is certificating the PPE. It is hoped to scale this pilot project to other areas of the same hospital and validate the design and technology of the material containing copper nanoparticles.

Regarding commercial aspects, the team wants to manufacture and sell the plastic apron directly. They also decided to development other PPEs, such as boots, shoe covers, and full body suits, not only for use in the medical field, but also in the food industry and other areas where personnel need to be protected.

Know Hub Chile has been supporting the teams to carry out their respective pilots, and guiding their commercial aspects, such as defining the value proposition, business model, and strengthening the team in commercial issues. Another important point for Know Hub Chile is that the technologies can be scalable and the scientific-technological based ventures can be sustainable over time, continuing beyond the Covid-19 pandemic. For that reason, the corporation has helped the teams to explore other customer segments where the technology can be applied.

6. Conclusions

In the context of the Covid-19 pandemic, the economic situation has been strongly impacted, especially in Latin American countries that were already in severe recessions and political instability. In Chile, strong public spending has been made to

remedy the consequences of the economic activities that have come to a halt, as well as to support the most vulnerable families. In this context of crisis, the generation of scientific knowledge and its transfer become relevant in society by demonstrating the ability to solve concrete problems, such as the generation of new PCR identification kits, treatment of convalescent plasma, and the development of vaccines, among others. In budgetary terms, it is expected that there will be a sharp cut in public spending in the coming years, and one of the budgets that will be impacted is science, technology and innovation. However, with the consolidation of the Ministry of Science, Technology and Innovation, it is hoped that the budgets allocated will increase, and that regardless of the prevailing political climate, a greater contribution of GDP will be allocated to scientific and technological development, and continuity will be given to public policies on technology transfer. In this sense, the ministry has created a new entrepreneurship program called "Startup ciencia", to promote the development of technologies with potential, and the budget for the extension of the Hub project is currently being discussed by the National Agency for Research and Development (ANID), in order to achieve sustainability. It is hoped that this change in the valuation of the contribution of science to society in a transversal way will result in establishing technological development as an engine for sustainable economic growth, using as a basis the scientific and technological knowledge generated by the country's universities and research centers, with Know Hub Chile being a key element in facilitating the arrival of technologies to the market.

The entities that articulate the technology transfer process -as technology transfer hubs and specifically Know Hub Chile- are able to adapt to extraordinary complex circumstances like the Covid-19 pandemic. In this sense, collaboration and flexibility have marked initiatives such as OpenBridge Covid-19, where technologies developed by universities and STBCs were able to assist health centers in their fight against the current pandemic, accelerating and supporting them to "cross" the "valley of death". So, even though the pandemic has been one of the worst issues that humankind has faced last times, there has also been an opportunity for innovator. In fact, the circumstances have pushed to validate technologies in a real environment and in short periods of time, making a concrete contribution to national public health through technologies coming from academia.

The three initiatives supported by OpenBridge Covid-19 achieved the objective of being piloted in a real environment. It should be noted that within the technological risks assumed by KH supporting these technologies, it was expected that despite the successful piloting, some of them would not raise market interest due to very high entry barriers, low scalable technologies, lack of commercial/operational capabilities of the team, among others. In this sense, Safe Vision technology is the one that has made the most progress towards an early market launch, not only in the medical field but also in other areas, such as retail and mining, industries that would need this kind of technologies and beyond the pandemic. This process is supported by the KH team.

There is still a lot of work ahead for these initiatives to achieve sustainability considering that the pandemic will remain an unresolved issue in the coming months or even years. Also, the teams should be able to look beyond and ensure their continuity supporting health institutions in other needs unrelated to the pandemic, such as improving patient care quality.

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Conflict of interest

"The authors declare no conflict of interest."

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Author details

Alonso Ureta Dumont* and Jovanka Trebotich Zúñiga
Know Hub Chile, Santiago, Chile

*Address all correspondence to: alonso.ureta@knowhub.cl

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