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Research Article

Pandemic and Innovation in Healthcare: The End-To-End Innovation Adoption Model

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ABSTRACT

The pandemic has been a challenge for many public health systems worldwide. Several health measures and innovations have been implemented to help in reducing COVID-19 spread and to avoid healthcare system overwhelming. During the pandemic emergency, the need for social protection and social distancing scenario has provided the push for healthcare stakeholders to innovate, and telemedicine has emerged as an efficient and effective way to provide care while reducing hospital overload and COVID-19 spread. The pandemic is having a direct impact on innovation and servitization by accelerating innovation processes, creating new interactions among ecosystem actors, promoting new ways to provide value and care, as well as time to market, and social acceptance for innovative solutions. Taking the widespread adoption of telemedicine as an example of innovation processes with the scope to identify which key innovation determinants are participating in the innovation adoption process and what type of contextual conditions are relevant for its development, we propose a seven-stage model with the aim to provide an end-to-end innovation adoption process to map and identify how society, technology, and environment act during the innovation adoption, including economic, social, and political impacts along with its regulation and time to market.

Keywords: COVID-19; innovation adoption; innovation model; telemedicine; time to market

JEL Code: O3

INTRODUCTION

The COVID-19 pandemic has suddenly changed people's everyday lives worldwide not only due to the increasing number of victims and hospitalized patients, but also due to social distancing, complete or partial lockdown strategies, economic crisis, and much more, bringing society into an environmental paradigm shift. Within a few weeks, the virus pushed the health systems of major industrialized countries to the limit, and current developments show that there is still no end to this worldwide (Anthony, 2021; Boettler et al., 2020).

The COVID-19 pandemic made it necessary to open and embrace innovative paths, especially when it comes to personnel and overall health, infection protection, access to care, patient care, and safety (Pierce, Schroeder, & Suchecki, 2021; Sageena, Sharma, & Kapur, 2021).

Across the globe, healthcare systems were not ready or designed to deal with a large scale and unpredictable pandemic demand. This challenge called for an urgent mobilization of resources, system architecture remodeling, and a new way to provide care. The COVID-19 pandemic has forced health care ecosystems, including government leaders, to act immediately, co-create, identify, and spread best practices in order to delivery care and reduce contamination (Anthony, 2021; Pierce, Schroeder, & Suchecki, 2021; Shur et al., 2021). A new and more active ecosystem arose to respond to the critical healthcare status quo, and to boost and drive needed innovation (Vargo, Wieland, & Akaka, 2015, p. 67).

As stated by Lusch and Vargo, service ecosystems are "relatively self-contained, self-adjusting systems of resource-integrating actors connected by shared institutional logics and mutual value creation through service exchange" (Lusch & Vargo, 2014, p. 161).
Furthermore, inside an ecosystem, value co-creation together with the dynamic integration of resources and the active participation of institutions is fundamental to integrate emerging views on market needs and systemic processes to access additional resources and finally to create new resources through integration (Vargo & Lusch, 2011).

The COVID-19 pandemic has been a catalyst for the growth of innovative solutions, especially digital technologies focused on telehealth (Anthony, 2021; Boettler et al., 2020; Oborn, Pilosof, Hinings, Zimlichman, 2021). Many countries have promoted remote care via telemedicine, have invested in its development, and have sought integration and communication across national borders (Pierce, Schroeder, & Suchecki, 2021; Ridruejo & Soza, 2020).

With the rapid spread of infection and social distancing, telemedicine has emerged worldwide as one of the leading innovations to improve patient care management, contain pandemic spread, speed up early identification, reduce health professional contamination, and promote continued care for vulnerable patients with multiple chronic conditions (Anthony, 2021; Barbosa, Zhou, Waddell, Myers, & Dorsey, 2021; Oborn et al., 2021).

Digital technologies used for telemedicine have existed for decades, but due to heavy regulation, low market acceptance (Anthony, 2021; Flannery & Jarrin, 2018), and no supportive payment structures, they have had poor market penetration (Schulman & Richman, 2019), but during the pandemic we have seen a fast and successful innovation adoption by both private and public systems. In this scenario we have seen different actors coming together to create a new and more active ecosystem to identify, design, regulate, implement, and promote innovative solutions to overcome market pressure and healthcare crises (Pierce et al., 2021; Shur et al., 2021). Taking telemedicine implementation as an example of a fast and successful innovation adoption, we can identify an integrated collaboration among several different actors in an unknown lead-time, leading to innovation design and adoption with lessons for future solution developments (Barbosa et al., 2021; Knierim et al., 2021; Weiner et al., 2021). Based on that, our research questions are: What are the main key determinant factors that had a part in this successful innovation adoption? And what type of contextual conditions is supporting the innovation adoption process from an end-to-end perspective?

Different models, processes, and frameworks have been developed over time to explain and predict innovation adoption of new products, services, and technologies. These models are focused on factors that affect the innovation design and adoption in various knowledge areas such as business development, management, and even psychology.

This paper is organized into four main sections besides the introduction. The first section is a literature review focused on examining the existing and most used innovation models, as well as their application, type of innovation, focus area, and gaps. After analyzing the most recent literature and scenario evidences, we introduce in the second section the end-to-end (E2E) innovation adoption model. In this section, we analyze each segment, the key innovation determinants, and the contextual conditions within them. We then look at the innovation adoption process during the COVID-19 pandemic from an E2E perspective, taking telemedicine implementation as a background. The third section brings final considerations, while in the fourth and last section we propose a case study as future research to test the E2E innovation adoption model, to verify its applicability for other innovation scenarios, and to refine its steps.

AN OVERVIEW ON INNOVATION MODELS

A model's scope is to simplify reality representation and there is a huge variety of models about innovation management, with the type of innovation analyzed differing from one model to another. Most innovation models are focused on analyzing radical and incremental innovation, as well as product and process development in both the public and private sectors (Cooper & Kleinschmidt, 1986; Verloop & Wissema, 2004).

As mentioned before, in modern economies, service innovation is increasingly receiving attention, promoting the creation and use of new types of innovation models that are focused on incremental and/or radical innovation (Tidd & Bessant, 2020, Jacobs & Snijders, 2008).

Innovation frameworks are also getting more attention every day from both governmental and public sectors (Mulgan & Albury, 2003).

Models in general are settled in order of stages, phases, components, as well as main activities or building blocks. As for some authors, the upcoming phase can only start if all prior phase requirements have been fulfilled, which is necessary to determine if the project should proceed or not, but also to track possible changes or unexpected occurrences along the process.

Indeed, some authors argue that this linear view of the process is simplifying the innovation adoption too much and that along the process there are many feedback loops and cycles that take place before proceeding to the next step, as well as during the next step (Brown, 2008; Ries, 2011; Tidd & Bessant, 2020). Another relevant frame is the Agile one, based on 12 principles and focused on deploying solutions from a backlog via an iterative and project management approach, driving teams to deliver value to their customer faster while also providing the chance to evaluate and, when necessary, quickly adapt the solution at each development phase (Manifesto, 2001).

Tidd and Bessant (2020), as well as Jacobs and Snijder (2008), adopted Cooper's stage-gate model (Cooper & Sommer, 2016) during the implementation phase of their model. During the first phases of idea generation and selection, the phases are not linear, with many feedback loops, while a more linear approach is used when the process gets to the final steps.

All models begin with the idea generation/searching phase. The following step for most authors is to narrow down the best identified options to then decide and select which projects are going ahead and which ones are not (Rogers, 1962; Jacobs & Snijders, 2008; Sila, 2015). This selection is generally based on both an organizational strategy and an existing project portfolio in order to reduce risks. This is the point where it must be defined and decided if the innovation is potentially lucrative and/or if it is going to increase the public perceived value (Moore, 1995).

Once the decision is made, the next step is to turn the ideas selected into a tangible product, process, or service. This phase is described differently by almost all authors, sometimes described as the development phase (Cooper & Kleinschmidt, 1986; Van de Ven & Poole, 1990), as prototyping (Mulgan & Albury, 2003), or even manufacturing (Rothwell, 1994) and realization (Ries, 2011; Brown, 2008). The innovation is generally tested during this phase.

The fourth general step is the one related to implementation and/or launch. In this step, the newly developed product, process, or service will be implemented in the real world. This is also the step in which most of the models stop their innovation process. Some authors (Mulgan & Albury, 2003; Rogers, 1962; Tidd & Bessant, 2020; Jacobs & Snijders, 2008) include a post-launch phase to sustain, support, or reinvent the innovation. Others also include a post-implementation learning phase to improve the process, avoid mistakes in the future, and deploy the innovation itself (Jacobs & Snijders, 2008; Mulgan & Albury, 2003; Tidd & Bessant, 2020).

Besides these innovation models, there are several authors who see the innovation process not as an isolated process, but also influenced by contextual factors (Cooper & Sommer, 2016; Jacobs

& Snijders, 2008; Mulgan & Albury, 2003; Rothwell, 1994; Tidd & Bessant, 2020; Van de Ven & Poole, 1990; Xie, Li, & Xie, 2016).

The diffusion of innovation (DOI) theory model (Kaminski, 2011) examines a diversity of innovations by introducing innovation, social systems, time, and communication channels as four main factors that influence the spread of innovation. DOI has been used at both organizational and individual levels, but it also offers a theoretical foundation when talking about adoption at a global level. The DOI model integrates three major components: adopter characteristics, characteristics of an innovation, and the innovation decision process. Five categories are defined in the adopter characteristics: innovators, early adopters, early majority, late majority, and laggards (Sila, 2015).

Xie, Li, and Xie found that the five categories mentioned above interact with each other to establish a style of modern innovation management based on which their innovation management model is designed (Xie et al., 2016).

Presently, the main current approaches to innovation frames are focused on developing the solution itself. We identified five main approach areas (strategy, problem/opportunity, idea, solution, and scale-up) and six main components (culture, leadership, organizational structure, resources, skills, and market alignment).

Table 1

Overview of innovation adoption models

	Empirical vs. Theoretical	Application	Innovation Type	Process hase	Organization Features	Institution Type	Environment
Rogers (1962)	Theoretical	Product, Process	Incremental	Design	Large	Private	Psychology
Cooper and Kleinschmidt (1986)	Empirical and Theoretical	Product	Incremental	Adoption, Implementation	Large	Private	Retail
Van de Ven and Poole (1990)	Theoretical	Product, Process, Services	Radical	Design, Adoption, Implementation	Large	Private	Academy
Rothwell (1994)	Theoretical	Product	Radical	Design, Adoption, Implementation	Large, Medium	Private	Technology
Moore (1995)	Theoretical	Policies	Incremental	Context, Reform	Government	Public	Public Management
Manifesto (2001)	Empirical	Product, Process, Services	Incremental	Adoption, Implementation	Large, Medium, and Small	Private, Public	Software Engineering
Mulgan and Albury (2003)	Empirical and Theoretical	Services	Radical, Incremental	Context, Reform	Government	Public	Public Management
Verloop and Wissema (2004)	Empirical	Product, Process, Services	Radical, Incremental	Design, Adoption, Implementation	Large	Private	Oil and Gas
Tidd and Bessant (2020)	Empirical and Theoretical	Product, Process, Services	Radical, Incremental	Design, Adoption, Implementation	Large, Small	Private, Public	Management

Continues

Table 1 (continued)

	Empirical vs. Theoretical	Application	Innovation Type	Process hase	Organization Features	Institution Type	Environment
Brown (2008)	Empirical and Theoretical	Product, Process, Services	Radical, Incremental	Design	Large, Medium, and Small	Private, Public	Design
Jacobs and Snijders (2008)	Empirical and Theoretical	Product, Process, Services	Incremental	Design, Adoption, Implementation	Large, Medium, and Small	Private, Public	Management
Ries (2011)	Empirical	Product, Process, Services	Incremental	Design, Adoption, Implementation	Small	Private	Start-up
Kaminski (2011)	Theoretical	Product, Process, Services	Radical, Incremental	Design, Adoption, Implementation	Large, Medium, and Small	Private, Public	Technology, Management
Sila (2015)	Empirical	Product, Process, Services	Incremental	Design, Adoption, Implementation	Large, Medium, and Small	Private	Business
Xie et al. (2016)	Empirical	Product, Process, Services	Incremental	Design, Adoption, Implementation	Large	Private	Technology, China

As we can see in Table 1, the existent innovation models are looking at the innovation adoption starting from the idea generation and from the perspective of either an enterprise or an entrepreneur looking to a specific need, problem to solve, or opportunity. Two major perspectives can be identified: the contextual one focused on policies and public management regarding creating a positive environment for innovation, and the organizational one focused on the design, adoption, and implementation of the innovation in all kinds of companies.

The innovation adoption theme is pulverized in different knowledge areas and business environments, adding even more complexity to creating a unified end-to-end view.

As discussed previously, none of the frames analyzed is focused on a broader view of the political, social, and economic environment, neither on the impact and learning after innovations are adopted. Policymakers, governments, and other relevant ecosystem agents could and should be part of the entire innovation adoption process.

THE END-TO-END (E2E) INNOVATION ADOPTION MODEL: A FRAMEWORK PROPOSAL

Based on the telemedicine adoption case during the pandemic scenario and considering both how society, technology, and environment have been acting during its development and all the main innovation adoption models analyzed before, we are proposing a model that looks to the entire innovation adoption process and brings an end-to-end view of the process itself including economic, social, and political impacts, as well as its regulation and market adoption.

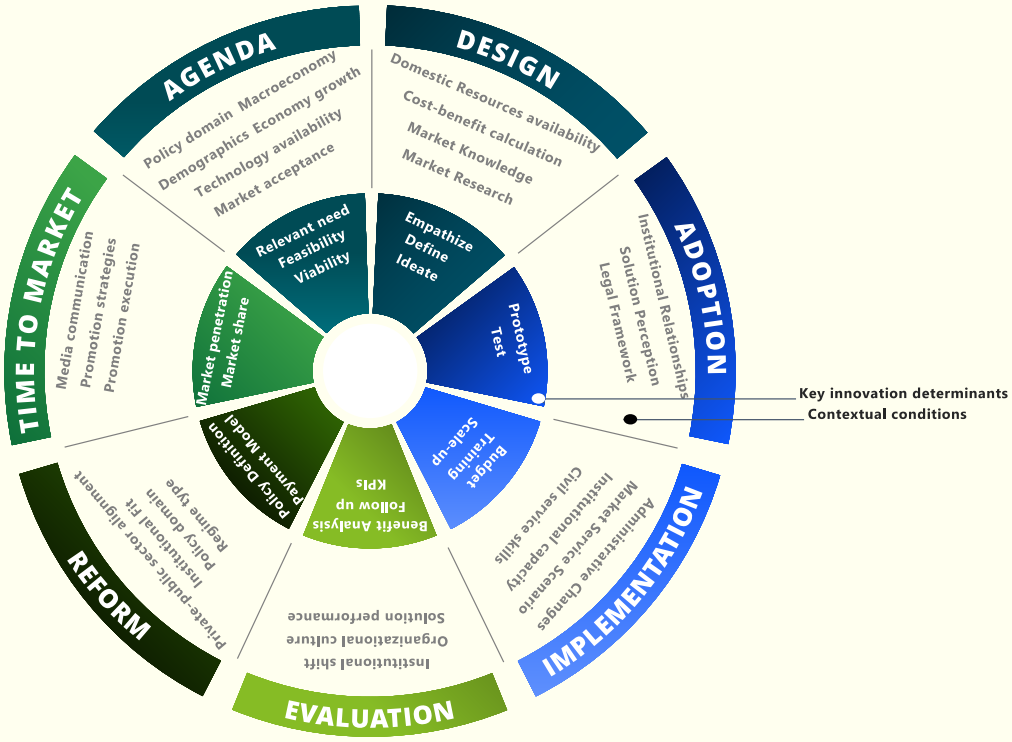

Figure 1. End-to-end innovation adoption model.

The end-to-end (E2E) innovation adoption model (Figure 1) focuses on organizing and understanding the innovation adoption process. The E2E model has been constructed in a synthetic analytic approach (Cairney, 2013) combining existing academic findings with empirical case studies. As discussed in the previous section, we analyzed different innovation theories and combined their frameworks as well as their applications, environments, concepts, and insights. We then combined all findings in order to identify gaps and synergies to produce a new single theory. Once the gaps and synergies were identified, we analytically categorized relations and intersections between each theory segment and created the E2E innovation adoption model.

The E2E innovation adoption model is composed of 18 variables divided into seven different stages and proposed in a circular, step-by-step model through the innovation adoption process. Each stage of the model highlights the main drivers for adopting the innovation. The circular model in Figure 1 highlights these variables, which are represented and organized in seven stages, as follows: context, design, adoption, implementation, evaluation, reform, and time to market. Each stage gives attention to both the contextual conditions that are actively participating to the success of that stage and to the key innovation determinants that are defining the core outcome for each of the seven stages.

Segments of the E2E model

Context

Why do certain issues emerge on the innovation adoption agenda while others do not? Four main needs are highlighted in the literature. First, the technology has to address a relevant and recognized need for the key population segments (Kingdon & Stano, 1984). Under this circumstance, contextual conditions such as a country's macroeconomic status quo, demographics, technology availability, market acceptance, and economic growth shape the resonance of potential market implementation and the type of innovation strategy that fits the best. As said by Katz, Preez, and Schutte (2010), an innovation strategy is an incremental, functional, predetermined plan governing the allocation of resources to different types of innovations with the aim to achieve a company's overall corporate strategic objectives. Furthermore, it is also a decision framework guiding a company to when and how it should, or not, selectively abandon the past and, in that case, change both its corporate strategy and objectives to focus on a new business of the future (Katz, Du Preez, & Schutte, 2010).

A second key innovation determinant is related to feasibility. How can a solution be built to make the healthcare system healthier and stronger? When a solution requires the complete construction of new capabilities, the investment can be at risk because of the amount of resources required and because it may have an impact on the company's market perception, which may not be for the better.

Finally, under viability, which considers profitability as well as technology availability and sustainability, we are ready to answer the following question: Does the solution proposed fit customer expectations and the way they expect to use and pay for the service?

Design

The type of mix between relevant need, feasibility, and viability identified in the context stage can play a strong role in this section. There are many frameworks describing the design process, designing it either from literature or from practice. These frameworks typically have three to seven steps with their names varying depending on the framework we are looking at, but they all share the same mindset (Stickdorn, Schneider, Andrews, & Lawrence, 2011). The common focus is to understand the main problem, guiding you into a market research in order to understand the domestic resources availability, building a cost-benefit calculation, and investigating market knowledge (Bćkkelie, 2016; Stickdorn, Schneider, Andrews, & Lawrence).

Three factors appear during the design stage that play an important role as key innovation determinants: empathize, define, and ideate. During the empathize stage, the focus is to get a better understanding of the problem to conquer, which includes consulting experts on the matter, diving deeper into the problem, and having a wider comprehension of everything that is involved in the problem. The empathy stage allows us to gain insight into the needs regarding the issue. A good amount of information is gathered during the empathize stage that is brought

to the next few stages to support and define the problem in order to understand how to better deal with it. A second key factor is the define stage. During this stage, all the information reached in the empathize stage is put together and analyzed in order to better describe the problems that will be solved (Martínez-Alcalá, Muñoz, & Monguet-Fierro, 2013). The define stage helps gather great ideas and understand how to use them effectively. Define is fundamental to ideate, the third and last key innovation determinant of the design stage.

Adoption

The adoption of innovation can be an opportunity of change for organizations in response to market or environmental demands with the aim to exploit new opportunities. Innovation scholars have often postulate that the primary stimulus for innovation and organizational change comes from the external environment, and for this reason the characteristics of an organization's environment may be critical to its ability to innovate (Camisón-Zornoza, Lapiedra-Alcamí, Segarra-Ciprés, & Boronat-Navarro, 2004). In the adoption stage, we are evaluating the ideas proposed from three main perspective: strategic, financial, and technical (Meyer & Goes, 1988). In this phase, top organizational echelons (managers, committees, and boards) decide to adopt the innovation and allocate resources to it. A first critical determinant of adoption is the relative power of opponents and proponents. Both opponents and proponents may not appear in the context segment, but rather after the design is solidified. Cooper, in his publication "From experience: The invisible success factors in product innovation" (Cooper, 1999, pp. 115–116), identifies two main key critical success factors for product innovation projects. The first one deals with 'doing the right projects' and the second one with 'doing projects right.' Bruns and Stalker (1961), in their publication *The management of innovation*, distinguished mechanistic from organic structures and advanced that these organizational ways were influencing innovation and change (Bruns & Stalker, 1961); (Damanpour & Schneider, 2006). Consequently, innovation scholars investigated effects of a wide range of structural antecedents of innovation adoption such as centralization, formalization, specialization, professionalism, and functional differentiation. Meta-analyses of empirical research findings have generally provided positive support for the Burns and Stalker's thesis by finding that centralization and formalization are influencing negatively the adoption of innovation and that specialization, professionalism, and differentiation are indeed affecting innovation adoption positively (Camisón-Zornoza, Lapiedra-Alcamí, Segarra-Ciprés, & Boronat-Navarro, 2004). Under this statement, we identify prototype and testing as key innovation determinants.

This stage focuses on experimentation. Here the focus is to produce numerous scaled-down versions of the project based on the shortlist defined during the design phase. Having the users' experience as the baseline, in this stage the main focus is on improving, re-examining, or rejecting the ideas created in the previous stages. Finally, the testing stage focuses on running tests on the prototypes created in the previous stage to check how well they address the main problem. At the end of this stage, it will be possible to make adjustments and changes.

Implementation

In this stage, the focus is on actions that pertain to either adapting and modifying the innovation, preparing the organization for its use, organizing the trial use, or driving the acceptance of the innovation by the users, and focused on the continued use of the innovation until it becomes a routine feature in the organization (Duncan, 1976). Once a backlog of solutions has been defined, we can implement them with agility, reinforcing the value added by any increment of work.

In this phase, the innovation is put into use within the organization, clients, and/or customers. In this contextual condition, we find market service scenarios, institutional capacities, and administrative changes.

The key requirements for the implementation stage are access to the requisite budget and training, and a certain degree of institutional capacity is required among the agents responsible for the rollout and technology scale-up (Ohannessian, Duong, & Odone, 2020).

Delays in resource expenditure may fall into implementation delays. Training represents one of the most important key requirements in the implementation phase, being fundamental for the entire implementation use (Doshi, Platt, Dressen, Mathews, & Siy, 2020; Li & Ray, 2010). Training is required for all members of the care team in order to optimize the virtual telepresence and create a great patient experience (Mann, Chen, Chunara, Testa, & Nov, 2020). Provider training and technical education are very important to create a virtual telepresence and are essential in building a strong relationship between the care provider and the caregiver (Doshi et al., 2020).

Evaluation

The evaluation phase is based on analyzing the solution performance and taking action on the main gaps identified. In order to provide enough information for making better decisions and adjustments, it is crucial to define the correct key performance indicators (KPIs). The E2E model suggests the construction of an objective dashboard of KPIs before the implementation with continuous monitoring. If a solution is not performing as expected, the internal process needs to highlight this and demand some adjustments or even the redesigning of the solution itself, returning it to previous phases on the E2E model.

An institutional shift is important for a sustainable result, while making sure that the organizational culture and behaviors are aligned with the implementation and are able to adjust with agility when gaps are identified. The solution performance provides organizational learning and future scale, while communicating the benefits reached and next steps is helpful with change management. The organizational insights and learnings also provide inputs for reform and time to market definitions, being crucial to the future of policies and requirements.

Reform

Changes in service delivery and performance are the outcomes of best value, and it is perhaps this part of the reform process that is more keenly affected rather than the process of utilizing an innovative reform management program itself (Collier & Collier, 2002; Wright & Caudill, 2020). During this phase, the alignment between private and public sectors, as well as the entire political environment, can play a fundamental role and act as either blockers or enablers of innovation adoption.

Public and private policies regarding payment for telemedicine services are pointed out by many advocates of telemedicine as a major obstacle (Hollander & Carr, 2020). If and how such policy concerns are solved may have a direct effect on both telemedicine cost and benefits and thus impact the sustainability of telemedicine programs (Bashshur, Doarn, Frenk, Kvedar, & Woolliscroft, 2020). While some governmental policies have generated problems for telemedicine, others have been formulated specifically to encourage telemedicine adoption. Such policies include project funding, technical assistance, research, telecommunications infrastructure development, and giving support for applications, especially for distance learning (Field & Institute of Medicine, 1996).

Time to market

Finally, we get to the time to market stage. This stage focuses on innovation communication and promotion strategies. Media and promotion execution play a fundamental role as the channels with higher penetration, especially during lockdown and social distancing.

In recent times, as stated by Guarcello, "the growing interaction between all actors in the healthcare service ecosystem contributes to the improvement and promotion of innovation and value co-creation through coordinated mechanisms active at operational, social, economic, political, and ethical levels. In this new healthcare service ecosystem, where patients are always more acknowledged and owners of their own journey, providers should focus more on value rather than volume" (Guarcello & de Vargas, 2020, p. 12). In this light, more markets have always jumped into the network ecosystem characteristics partly thanks to both the ever-improving communication technologies, the spread of the internet, and also partly because of business' increased reliance on global markets for products and services. Markets with a strong network allow the rapid diffusion of news, ideas, and innovations, but they also raise barriers to the adoption of innovations because of the interdependencies between players (Guarcello & de Vargas, 2020, p. 12).

The successful adoption of an innovation will generate profit increases or cost reductions, which attract or force other players to try to adopt the same innovation. Therefore, the innovation will mostly spread out among the potential adopters. The diffusion process speed for a specific innovation will depend on the characteristics of the communication networks to which the players and adopters are connected.

TELEMEDICINE ADOPTION: A CASE ANALYSIS BASED ON THE E2E INNOVATION ADOPTION MODEL PERSPECTIVE

During the coronavirus outbreak, the demand for telehealth services and digital solutions to prevent further infections and increase healthcare delivery, as well as access to care, has risen immediately (Barbosa et al., 2021; Shur et al., 2021). As said, before the COVID-19 pandemic, the use of telehealth solutions such as telemedicine has been limited by federal and state regulations around reimbursement and license demand (Knierim et al., 2021; Weiner et al., 2021). Private and public insurance programs have historically excluded telemedicine from their coverage and have made it difficult to promote the platform's adoption.

The COVID-19 pandemic made it necessary for healthcare systems and healthcare providers to quickly and efficiently embrace innovation and find innovative ways to provide care while keeping social distancing in order to reduce the virus spread. This need for fast innovation solutions driven by the COVID-19 pandemic brought together in a short period the actors and factors along with the contextual conditions and innovation determinants necessary to accelerate the innovation adoption (Anthony, 2021; Shur et al., 2021).

The pandemic scenario helped in overcoming some adoption barriers, speeding up innovation, and promoting a rapid growth of telehealth initiatives including using artificial intelligence and telemedicine, providing new solutions for both healthcare providers and care demanders, as well as promoting new strategies to manage costs, scale up access to care, and improve communication between patients and doctors (Pierce et al., 2021; Weiner et al., 2021). Whether through real-time patient monitoring or remote clinical health management, telemedicine is increasingly becoming a necessity in health care, especially in increasing access to care and reducing hospital emergency waiting lists (Caetano et al., 2020; Ohannessian, Duong, & Odone, 2020). Using information and communication technology (ICT) in the field of medicine is increasing the ecosystem actors' interaction, creating new values and new ways to provide care (Guarcello & Vargas, 2020).

The World Health Organization (WHO) defined the term telemedicine as follows: "The delivery of health care services, where distance is a critical factor, by all health care professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of health care providers, all in the interests of advancing the health of individuals and their communities" (World Health Organization [WHO], 1998, p. 9). The goal of telemedicine is to promote global health, control disease, and provide health care, as well as education, management, and research for the health system (Zhang, Gao, & Ye, 2020).

Initially used marginally and without a regulatory structure, telemedicine is today driving the digital revolution in telehealth (Knierim et al., 2021; Shur et al., 2021). Telemedicine has answered to the medical challenges of our time, which is characterized by aging of society, increase of chronic diseases (Kubzansky et al., 2018), and now social distancing. According to doctors and

public authorities, telemedicine solved many problems in the health system (Knierim et al., 2021; Sageena et al., 2021). From the point of view of care delivery, the use of telemedicine has also greatly mitigated the harmful effects of medical desertification (Moseson et al., 2020; Shur et al., 2021).

During the pandemic scenario, together with the introduction of national implementation strategies and thanks to the support of all healthcare ecosystem stakeholders, telemedicine has been rapidly implemented and considered almost unanimously as a miraculous innovation, making it possible to answer to the public health pandemic crisis (Barbosa et al., 2021; Knierim et al., 2021).

Thus, depending on the local ecosystem and technology maturity level, different segments of the E2E innovation adoption model have been identified in the telemedicine adoption during the pandemic, sometimes as a starter in the context or the reform phase, the design one, or in areas with a more integrated ecosystem or technological maturity level, even the implementation phase itself.

Segments of the E2E innovation adoption model during the telemedicine pandemic implementation

The fast implementation of the telemedicine process during the pandemic provides us with several examples of the applications of segments of the E2E innovation adoption model of key innovation determinants and contextual conditions.

Looking at the 'context' segment, we see that during the first pandemic, policy domain, macroeconomy, together with demographics and local feasibility, were a crucial part for telemedicine implementation in different countries. Under these circumstances, we have seen a really close cooperation among public and private ecosystem actors to define the program viability and settle the basis to quickly introduce telemedicine adoption into the innovation adoption agenda (Pierce et al., 2021). To ensure that the business models are contributing to the future of both community and society, viability has looked to profitability and to technology availability and sustainability (Sageena et al., 2021).

The 'design' segment appears in almost all telemedicine adoption cases during the pandemic. Focused on the domestic resource availability and aiming to provide cost-benefit advantages, telemedicine has quickly reduced the burden of care for patients whether they were chronic, in quarantine, or in remote areas, reducing ambulatory contacts by up to 18% and increasing telemedicine contacts from 0.3% in 2019 to 23% in 2020 (Weiner et al., 2021). Based on the data collected after the implementation, it has been possible to refine the model and look at the problem's possible solutions from different points of view and to continue designing new possible solutions to provide better access to care (Shur et al., 2021).

The fast 'adoption' of telemedicine and its successful 'implementation' are the most discussed and analyzed segments during the pandemic. Political commitment has been fundamental for

the implementation of telemedicine and we have seen a successful healthcare ecosystem interaction in both private and public institutions toward budget relocation. In the beginning of 2021, the Colombian congress legally authorized the creation of an interoperable electronic medical records system that allows healthcare professional to get online access to clinical data and medical outcomes (Pierce et al., 2021). As shown in the literature, during the pandemic, personnel training together with administrative and budget relocation changes have been crucial steps to test the solution and provide virtual care (Sageena et al., 2021). Telemedicine use has seen health professionals familiarizing themselves with their state policies about telematic visits, licensure requirements, documentation needed to conduct a telematic visit, and prescription regulations (Wright & Caudill, 2020).

Once telemedicine has been implemented, it has been possible to better centralize data in a safe and digitalized way (Alvandi, 2017; Shur et al., 2021). The 'evaluation' of skill set development, together with organizational shifts, continuing medical education via accredited virtual courses, definition of KPIs, and data collection, has played an important role in the implementation process, providing to all ecosystem actors a better understanding of the status quo and pandemic spread (Weiner et al., 2021).

Looking at the 'reform' segment of the E2E innovation adoption model, we can see that private and public insurance programs have historically excluded telemedicine from their coverage and made it difficult to promote the platform's adoption (Knierim et al., 2021). Thus, telemedicine has been underutilized in the last decade generally due to administrative (licensing, credentialing) and reimbursement barriers (Gadzinski, Gore, Ellimoottil, Odisho, & Watts, 2020). During the pandemic, we have seen how institutional relationships together with legal frameworks have been able to improve success factors for adopting telemedicine especially over time. As pointed out by W. Pierce, there have been calls internationally to legislators to facilitate telehealth services between nations to combat the COVID-19 pandemic. Countries such as the United States, Chile, Colombia, Costa Rica, Peru, and Uruguay have redefined medical jurisdictions as well as liability, reimbursement, and social benefits to promote and regulate telemedicine (Pierce et al., 2021).

Global media communications and promotion strategies have rapidly helped in transitioning a pilot telemedicine program into a telemedicine first model (Barbosa et al., 2021; Shur et al., 2021), speeding up the 'time to market' and allowing countries to interchange data, care program efficiency results, and daily info on pandemic progression.

FINAL CONSIDERATIONS

To overcome the fast contamination spread and to improve patient care while keeping lockdown and social distancing during the pandemic, we have seen that health ecosystem actors and factors came together to promote a fast development and implementation of innovative solutions, especially related to telehealth, such as telemedicine.

The analysis of these factors and actors in the COVID-19 case provides an end-to-end view of the innovation adoption process at a speed and efficiency never seen before. This phenomenon represents a unique opportunity to explore all the phases, stages, and environmental factors that contributed to it.

The complications of an unsuccessful innovation adoption on the pandemic scenario are directly related to the increase of deaths and the telemedicine example is helping reduce health system overload and lead times on access to care (Oborn et al., 2021; Knierim et al., 2021). This need for success provided by the crises has made innovation actors, factors, and environment to collaborate better and faster.

As proven by the quick adoption of telemedicine during the COVID-19 pandemic, the innovation adoption process benefits itself and finds its best efficiency under a more holistic approach in which all ecosystem actors, both public and private, are included and actively participate to promote a clear and efficient end-to-end process (Sageena et al., 2021; Weiner et al., 2021).

Due to its broad implementation and worldwide adoption, taking telemedicine as the background, it is clear that the entire ecosystem came together to reach a common outcome, bringing more efficiency, better interaction among actors, factors, and decision-makers, and reducing the time to market and the innovation adoption itself (Anthony, 2021; Pierce et al., 2021).

In this scenario, we have been able to see and map an end-to-end process of innovation adoption including contextual conditions and key innovation determinants. Because of urgency and impacts of the pandemic, the entire innovation adoption process that would take some years found its development in only a few months, including authorization, integration, reimbursement, and regulation (Ohannessian et al., 2020; Shur et al., 2021).

As mentioned before, analyzing how the adoption process of telemedicine innovation and its implementation took place quickly, we noticed that the active interaction among all actors brought to a faster and more efficient outcome and, consequently, an optimization of the adoption process of telemedicine innovation. Together with the ecosystem actors' interaction, we identified that there are some key innovation determinants, as well as contextual conditions, that directly affect the end-to-end innovation adoption success.

As shown, the innovation development and adoption models used the most look at the innovation adoption starting from the idea generation or looking to a specific need, problem to solve, or opportunity to find, but none look at the innovation adoption as a whole from an end-to-end perspective including all internal and external ecosystem actors along the entire innovation adoption process. The innovation development and adoption models used the most lack an analysis of the external environment, especially when referring to authorization, integration, reimbursement, and regulation. They are more focused on the intra-business perspective with no interaction from the outside world, lacking in a clear end-to-end ecosystem interaction.

As the pandemic provided a scenario where all actors and factors had to collaborate in a timely matter, we propose a new model (E2E) that in seven stages analyzes the contextual conditions as well as the key innovation determinants and brings an end-to-end view, starting with a deep context analysis including the participation of all internal and external actors, the scaling up of implications, and promotes continuous learning and improvement through the innovation adoptions. Our model provides a view that is strategic in an external and internal business perspective, being able to connect these actors in a cyclic process.

The model design was based on innovation adoptions provided during the COVID-19 pandemic solutions, especially on telemedicine. The test of this model is necessary to conclude its applicability for other innovation scenarios and to refine its steps. If applicable, this model represents a unified view of the innovation adoption process including public and private, internal and external actors, as needed by literature.

The research result shows literature knowledge and theoretical gaps regarding innovation adoption models. These gaps are restricted to literature knowledge about strategic management on innovation adoptions.

Based on the evidences discussed throughout the paper, we created a core set of 18 variables divided into seven different stages proposed in a circular model as a step-by-step innovation adoption process. Each stage of the E2E innovation adoption model highlights the main drivers for the innovation adoption including internal and external, public and private actors, as well as key innovation determinants and contextual conditions.

In order to test de E2E innovation adoption model and to verify its applicability for other innovation scenarios and refine its steps, we propose a case study research that will overcome research gaps related to the model's stages and generate knowledge that will contribute essentially to a better understanding of innovation adoption.

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