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Agile Innovation Methodologies Applied to Teaching and Research. The Experience in Silicon Valley and Costa Rica

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Abstract

This conference takes a journey through the experience developed in Silicon Valley (California, USA) with the aim of exploring agile innovation methodologies within learning and research processes. By recognizing the trends and best practices generated in higher education institutions (e.g., Stanford University) and in prestigious international business environments (e.g., Google, NASA), it seeks to contribute to the improvement of academic training and the professional profiles of university students, especially in the field of Business Administration, to contribute to the various areas of academic projection.

During this immersion in the world's leading innovation ecosystem, semi- structured interviews with experts, academic visits, and observation of best practices, among other activities, were conducted. The findings were processed in the Atlas.ti Program (Version 23.08.0), and the main results support a didactic work to be applied with university students and in teacher training processes. This work includes the approach to seven agile innovation methodologies (e.g., Triz, Storytelling, Design Thinking, SCRUM, among others) and develops a playful strategy called "Agile Stellar Mission," which integrates a series of challenges to motivate and appropriate the topic. These resources become a roadmap to guide and energize the insertion of agile innovation methodologies in teaching and research, as well as facilitate the design and development of projects and initiatives that integrate these learnings into university education, as contextualized in a pilot experience at the University of Costa Rica, within the School of Business Administration.

Keywords: Agile Innovation Methodologies, Silicon Valley, Lean Six Sigma, Google, NASA, Project Management, VUCA (Volatility, Uncertainty, Complexity, Ambiguity), BANI (Brittle, Anxious, Non-linear, Incomprehensible)

Descriptors

Agile Innovation Methodologies - University Teaching - Research Projects - Silicon Valley - University of Costa Rica

Introduction

In the era of digital transformation, collaborative association, and open innovation , agile methodologies to foster innovation in the management of teaching and research are becoming increasingly relevant and significant [1]. On one hand, project management and continuous innovation are showing growing interest within the field of Business Administration to seek creative solutions to the various problems faced by organizations and society in general. On the other hand, agile methods have proven to be highly efficient in changing and highly uncertain environments, such as those we face today, in various scenarios [2-4].

Therefore, universities and organizations in general increasingly require flexible, autonomous, and efficient management of processes and projects, as well as the continuous improvement of their services, increased productivity, cost reduction, and resource optimization [5, 6]. Thus, keeping up with these innovative methodologies is key to success in a VUCA (Volatility, Uncertainty, Complexity, Ambiguity) environment and challenging a BANI (Brittle, Anxious, Non-linear, and Incomprehensible) context [7, 8].

But what strategy contributes to this task [9, 10] ? As Robert Noyce, an American scientist, co-founder of Intel, and inventor of the integrated circuit or microchip (along with Jack Kilby, Nobel Prize in Physics), stated, “innovation is everything...” [1]. Since innovation is the lifeblood that nurtures the change and improvements Humanity expects, it is worth approaching the question: what are the main agile innovation methodologies that can be applied to teaching and research to improve professional profiles in the field of Business Administration?

The term "innovation" was used by Greek philosophers such as Plato and Aristotle to reference its meaning in their writings on politics. They understood innovation as “introducing a change in the established order” [11]. Initially, it had a pejorative and even negative connotation, being associated with the interest in shocking the status quo, and thus, it was identified with revolutionaries or system critics. It was not until the Renaissance that a qualitative leap was made by linking this term with what is new, what arouses curiosity, using words such as "reform," "renewal," "improvement of imperfect things," among others. However, the concept of innovation itself appeared in the scientific and technological context at the end of the 19th century and the beginning of the 20th century, in such a way that “…the term ‘innovation’ began to be used to link scientific and technological novelties with the idea of ‘introducing’ something ‘useful’ into the world” (ibid, p.15).

By the end of the 20th century, innovation became a focus in the economic studies and policies of developed countries, being the subject of study (especially since the 1980s) by scientists from various disciplines interested in understanding the types of innovation, the processes for its management, the characteristics of people and organizations committed to innovation, the environmental conditions that influence its development, among other focal points [12].

Thus, today, innovation is understood as a polysemic and multifaceted concept as it is simultaneously a process and its result [11]. It is gradual and evolutionary; it can even be accidental, meaning generated by an accidental discovery [13]. For example, neither the founders of Google nor Yahoo intended to develop search engines, yet they discovered them. Therefore, innovation is a process of continuous renewal that includes both invention and commercialization or implementation [5].

But what is meant by agile innovation methodology? These are methods, strategies, mechanisms, or procedures that facilitate individuals and teams to generate innovations more quickly and effectively. Initially, they were applied to the software industry but have since expanded and adapted to different sectors and areas. In the face of complex problems and unknown solutions, there are some principles and values declared in the Agile Manifesto, which emphasize the importance of continuous work (Work in Progress, or WIP), meeting client needs and expectations, collaborative work, individual responsibility during development, and a positive attitude towards change. This implies that those involved feel motivated and have a conducive environment and basic resources to carry out their tasks [14].

From a modern perspective, agile development aims for requirements and solutions to evolve over time according to project needs, where team collaboration is essential for achieving objectives [4]. It is about teams achieving high work standards and ensuring that iterations add value to the product or service. In this sense, “what is always sought is for the iteration to be very short, very fast, with very clear measurement criteria, where you can quickly learn what needs to be modified or improved and enter that cycle of building and launching as quickly as possible” (M. Palacios, personal communication, March 13, 2023).

Agile methodologies respond to the needs of this new global business environment and allow teams to structure their work by exploring problems, designing solutions, and testing and improving these solutions. Although these frameworks are generally used to structure work in software, product development, or IT organizations, it is crucial to understand these methodologies and how they apply within any organization or field [15]. Thus, within agile innovation methodologies, iteration is an essential phase or moment for adjusting ideas, evolving, and testing them until the product or service improves and generates the expected value.

Therefore, the purpose of this work is, on one hand, to present the main findings derived from the research conducted in Silicon Valley (San Francisco, California, USA) regarding which agile innovation methodologies can be contextualized within the academic processes of teaching and research in the field of Business Administration. On the other hand, it is to share the results obtained from a pilot plan developed with students of Business Management and Public Accounting at the University of Costa Rica, as a first approach to the feasibility of implementing this strategy in this university environment.

The goal is for students to experience a series of learnings mediated by agile innovation methodologies in their educational process, allowing them to acquire knowledge and practices that enhance the skills they have built throughout their careers [9]. They can integrate these into the design of research proposals and entrepreneurial projects, as well as in the academic process of Final Graduation Projects (TFG).

This undoubtedly generates a series of benefits at both personal and professional levels, but above all, it enriches their innovative potential, motivation, and the impact they can make in the organizational and business environments where they operate. Additionally, it facilitates the innovative development of TFGs and future research, responding assertively and proactively to the complexity of changes they face. This academic work dynamic promotes greater motivation in future job performance, enhances leadership and teamwork skills, and fosters commitment to finding new services, products, and solutions to the problems or opportunities identified in their research processes [13, 16]. All this helps business administration professionals to have a visionary impact on the transformation and improvement of society, where mastering agile innovation methodology becomes an added value in their training process, strengthening their innovative spirit, critical capacity, and commitment to excellence.

Methodology

Exploratory research was conducted with a qualitative approach, based on the Delphi Method. Initially, fourteen experts from various higher education institutions and internationally renowned companies, mostly located in Silicon Valley (USA), were con-

tacted [17]. Subsequently, six of these specialists were selected for in- depth, face-to-face interviews. In the case of the expert from TEC de Monterrey, the questionnaire was answered asynchronously after the initial online session that took place at the end of February 2023.

Chart 1 shows the name, position, institution or company they belong to, and the date of instrument application, as well as the code with which they are identified.

Chart 1. Experts participating in the research

Code	Expert	Position held	Institution or company	date
Ex1	Ph.D. Nayra Mendoza Enríquez	Associate Professor, researcher, Manager of the Executive Training Program	TEC Monterrey Institute for the future	22 feb-2023
Ex2	Ph.D. Andrés Mora	Robotics Engineer at NASA AMES Research Center	NASA	16 mar-2023
Ex3	Eng. Manuel Palacios	Global Hardware Quality & Reliability Engineering Manager Google Cloud	Google	13 mar-2023 14 mar-2023 17 mar-2023
Ex4	Ph.D Austin Li	System-on-a-Chip (SoC) Software & Mobile Devic	Google	16 mar-2023
Ex5	Eng. Harold Sequeira	Director of Manufacturing	Viant	17 mar-2023
Ex6	Ph.D. Govind Ramu	Quality Management Professional, ASQ Fellow, Professional Engineer, ASQ Crosby Medal Recipient Professor at Stanford University	Google Stanford University	14 mar-2023

To this end, a question guide was used, which included some general instructions for the interviewee, as well as considerations to be taken into account by the researcher. The questionnaire included three parts: the first focused on knowledge of agile innovation methodologies; the second addressed the application of agile innovation methodologies in teaching and research with Business Administration students; and the third included the experience in applying such methodologies, particularly in this disciplinary area. A total of eleven open-ended questions were asked, the answers to which were audio recorded, and Google's transcription tool was used as additional support.

Subsequently, with the help of Atlas.Ti Software (Version 23.08.0), thirteen categories of analysis were coded and processed. From these, 302 codes, 176 citations, and 12 networks were derived, capturing the main arguments given by the experts regarding the chosen qualitative variables. A brief summary of the observation of best practices collected from visits to some companies or organizations, mostly where the experts worked, is also presented. Finally, a sample of the pilot plan records conducted with Business students within the Zoom Platform is added.

Development

The research was conducted from January to June 2023 through an immersion in Silicon Valley, the world's leading innovation ecosystem. This process involved several phases, which are briefly described below.

Planning the immersion process in Silicon Valley. This involved designing the roadmap to follow for the research work.

Literature review on the topic. An exhaustive search was carried out in different specialized databases (e.g., EBSCO, Digitalia, e-Libro, Emerald, JSTOR, ProQuest, SAGE, Science Direct, Springer eBooks, among others). Additionally, subscriptions to journals and various online resources such as Harvard Business Review, MIT Technology Review, MIT Sloan Executive Education, Agile Alliance, EFQM Insight Newsletter, IDEO Newsletter, among others, were secured.

Initial negotiation with Silicon Valley experts. Fourteen experts from different Higher Education institutions and prestigious international companies, mostly located in Silicon Valley (e.g., Google, NASA, IDEO, Stanford University), were contacted. These initial meetings allowed for an explanation of the research purpose, the proposed activities, recommendations of other experts, as well as suggestions of best practices and specialized literature on the topic.

In-depth interviews with experts on Agile Innovation Methodologies. Following the initial contact with the 14 experts on the topic, six of them were selected for an in-depth face-to-face interview. These were conducted from March 12 to 18, 2023, during the visit to Silicon Valley. The following table shows the expert, the assigned code, the institution they belong to, and the date of the consultation (see Table 1).

Processing and analysis of in-depth interviews with experts. The main findings from this phase are summarized below, considering the main analysis categories of this work

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Knowledge of agile innovation methodologies. According to the experts, in the modern business world, improvement methodologies were the protagonists before directing innovation toward customers. These tools were used to identify new ideas and opportunities for product or service improvement or any daily operational efficiency. Thus, the emphasis on fostering an innovative culture within the corporate environment generated interest in the development of agile innovation methodologies, among which the following stood out: a) Scrum (Ex2-Ex3), b) Design

Thinking (Ex1-Ex2), c) Design, d) Kanban (Ex2), e) Six Sigma (Ex3-Exp 6), f) Lean Six Sigma (Ex6), g) Quality Function Deployment (Ex6), h) Triz (Ex3), and also, i) Critical Path (Ex5).

One expert mention that innovation management is based on principles rather than methodologies. In this regard, they mention, "...what is applied more than methodologies are certain principles, their application may vary depending on the work being done... the principles are constant" (Ex3, Cod.1, pp.18-23). They emphasize that it is about iterating as quickly as possible based on requirements, without waiting for all expectations or specifications to be met. From their perspective, iteration is "building a test product to examine it, and then launching it for potential users to use and verify whether it meets expectations or not" (Ex3, C1, pp.25-27). They also warn that iterations should be short to avoid generating an inefficient process; long iterations lead to wasted resources and time.

In this sense, the concept of "pretotyping vs. prototyping" (Ex3, C1, p.111) is extremely interesting. The former simulates the functions a future product will perform, even if the capacity or resources for its construction are not yet available. It is more about launching a product that is still quite incomplete to test some of the characteristics it should meet and, as progress is made, adding more elements, even if it is not yet fully mature or defined. Therefore, according to one expert's criterion, it is necessary to put oneself in the user's shoes (empathy) and think about their needs and expectations (Ex3). They explain the example of how the Palm Pilot was developed, where its precursor used a piece of paper and a piece of wood to ideate the product.

Another expert consulted states that "Lean reduces waste, Six Sigma reduces variation, Scrum deals with iteration and efficient execution" (Ex4, C1, pp.59- 61). Therefore, in this process, agile innovation methodologies are often linked with quality. In their argument, another interviewee explains that Six Sigma is a methodology to reduce the variability of the products and services provided. In daily operations, errors occur due to human intervention and product imperfection, and products cannot function as designed; therefore, this type of tool is necessary (Ex6). Additionally, another expert highlights that: ...the key to project management are the Three P's, People (who have to be very good, we hire the most qualified people possible), and that facilitates the next P; Processes (if you have very good people, the processes will be consistent), and in the end, solid processes give you a good Product, which is the third P (Ex5, C1, pp.100-104).

In this way, this approach is complemented by the Silicon Valley philosophy, regarding the premise "Fail fast and fix" (Ex3). This generally contrasts with agile philosophies in that "...to generate a small change, you need all projects to be restructured, and decisions made in a very rigid structure, of hierarchies, and that's why we don't force... we encourage knowing all the tools, using the one that works for you" (Ex5, C1; pp. 116-120). Thus, failing quickly and learning reaffirms the importance of not being afraid to iterate and measure clearly whether what is being done has the desired effect or not. This implies a continuous improvement cycle involving quick iteration.

Knowledge of successful experiences in applying agile innovation methodologies in teaching and research. In response to this query, the consulted experts highlight some successful experiences in applying agile innovation methodologies both in teaching and research, such as:
Six Sigma (SS). This methodology was popularized by Bill Smith of Motorola and was applied in the design of PAGER (beeper) to prevent errors in hardware and services by sending signals to users. Until the 1990s, people produced quality products based on their normal distribution +/- 3 of deviation [18]. However, this measure cannot be applied to all circumstances. In processes to improve operational efficiency, reducing its variability within the process and product is required. SS reduces variability by half and centers the process right in the middle, where variability can be acceptable within this range (Ex6).

Design Thinking. Made known by IDEO Company and Stanford School of Business. The innovation approach of design thinking is human- centered, which involves generating empathy for the user or consumer, discovering what people want and need, and in this process, observation is fundamental (Exp6). Design Sprints. Sprints are an effective way to implement agile development methodologies or design thinking. They require a challenge, the right team, a clear definition of time and space (preferably without interruptions). It is one of the methodologies applied at Tecnológico de Monterrey. It is used for the development of new products and services with entrepreneurs (Ex1).

Kanban. This methodology provides updated information on the status of the ongoing project, allowing knowledge of who is working on what. This facilitates the organization and distribution of the tasks being carried out. At the NASA Ames Research Center, there are a series of products and services supporting space missions, where this type of agile methodology is applied (Exp 2). Critical Path Method. This is used to manage projects in a systematic and strategic manner that allows for continuous corporate innovation [1]. There is fluid communication, with daily or weekly meetings to monitor the various tasks, where the team's work dynamics are evaluated in real-time (Ex5).

Application of Agile Innovation Methodologies in University Teaching. The experts unanimously agree that it is feasible to implement agile methodologies in learning processes (Ex1, Ex2, Ex3, Ex4, Ex5, Ex6). They emphasize that meeting the user's needs aligned with the mission of organizations is fundamental. In the case of Google, its mission to "organize the world's information and make it universally accessible and useful" (Ex3, C1, p.568) takes priority over business. From this perspective, success is achieved more assertively with a user-focused approach, where the highest hierarchical level is the user, followed by the client, or if they coincide, decision-making considers both above the company's needs (Ex3), as "the money comes later".

(Ex3, C1, p.545). Traditional companies think of the process entirely in reverse, prioritizing return on investment (Exp3). Another perspective emphasizes that if you want to innovate, it is important to know the different methodologies, although the important thing is knowing how to apply them (Ex5). It stresses, "I know them, I respect them, and I respect all the people who dedicated their lives to this and got certified... for me, if you want to innovate, this is what I recommend, take the good" (Ex5, C3, pp.176- 178). Teaching should focus on the fact that the original creation process is not the same as development;

they operate with different rules, where the genesis is user oriented. Thus, "great innovation comes simply from people having space, time, not worrying about their survival [focusing] on how to create that culture or how to maintain that culture" (Ex3, C9, pp.945-949).

In this way, in addition to the agile innovation methodologies collected in the previous section, they explain other roadmaps such as the following:

- **Design Six Sigma.** This involves focusing on creating a new product or process, clearly understanding the customer's need we are meeting before spending resources and time. This methodology is recommended in multidisciplinary courses, such as "design and business."
- **Agile Development.** This allows the development of the product in smaller modules and fragments, periodically tested with the user group, and characteristics are continuously added to the product. This way, it is built faster in design portions, and the supply chain is created for the user, and so on, for each fragment (Exp2). It is a new approach different from the past where the entire product was designed and built, tested, and then delivered to the user. This way, actions can be taken quickly, the product can be launched in small increments, the market can be tested continuously, and time and costs can be saved.
- **Triz.** This is used in creating new products by viewing a problem as a black box. Thus, it involves understanding what the inputs and outputs are (causes and consequences in a logical process), what characteristics a product must have to meet the constraints, and what the product can generate [19]. In this sense, generating ideas to find creative solutions to problems is one of its fundamental purposes (Exp3).

Application of Agile Innovation Methodologies in Research. Among the consulted experts, it is highlighted that working in Silicon Valley provides access to the world's best development talent. One of them notes, ...it is a privilege to be here, a blessing, and it makes one very humble, to be alongside incredible people, gurus, doctors, company owners, entrepreneurs who have built their companies and sold them for ten times their value, multimillionaires with very low profiles but with the real motivation to help humanity (Exp.5, C5, pp.243-247).

They emphasize that empathy tools, such as ethnographic design methods employing interviews, web searches, surveys, and narratives for data collection, are valuable for building creative solutions and prototyping (Ex1). They point out that Waterfall, Agile, and Kanban have great potential for application in Business Administration, Engineering, and Exact Sciences research (Ex2). The study by Gaete et al. also reaffirms this approach. Another expert highlights the importance of interdisciplinary dialogue to apply these methodologies in business research. One of them illustrates this idea by explaining a dialogue between a mathematician and a molecular biologist to address the topic of Knot Theory and how to solve the problem of protein folding (e.g., how many knots, how they link, how they intersect, and how this problem can be solved by combining theoretical and empirical approaches) (Ex4).

They also mention that every business has the opportunity to improve, though most people don't know how to do it, what isn't working well. In this sense, students can evaluate how business owners manage an organization in terms of performance and finances, what opportunity has the greatest advantage to improve the company (Ex6). Regarding this, "if an organization has hundreds of opportunities to improve, it should observe which of those opportunities make the most sense, assigning them a percentage value in their impact level, 30%, 20%, 10%, and the remaining 40%. This is a reference assessment" (Ex6, C4, pp.360-365). The integration of these ideas and others mentioned by the experts significantly contributes to investigative processes for creative problem-solving and taking advantage of the opportunities derived from these efforts.

Trends in Agile Innovation Methodologies Applied in Teaching and Research. In the conducted consultation, it is highlighted that to foster innovation in Silicon Valley, beyond an academic title or recognition (e.g., Nobel), emphasis is placed on how knowledge is applied, especially in a corporate context. In other words, what you know is less important than what you can do with what you know (Exp5). This means that demonstrating skill in one's work is more valuable than having a degree or certificate to do it. Thus, the key is integrating people, practical experience, and intellectual knowledge to solve problems. In this sense, students should not be limited to their area of specialization but rather open to new knowledge that broadens and enriches their perspective and performance.

Experts emphasize that the motivator for innovation should be based on the company's principles, the reason for the company's existence, and its culture. This means designing effective and economically viable models (Ex3). However, the relationship between people and companies goes beyond the transaction, giving them a purpose, helping a business with an impact on their careers and, above all, their lives. Therefore, it becomes increasingly important to answer the personal "why." Employees are no longer tied to a company; they choose where they want to be, under what modality, and for how long (Ex5).

The specialist's comment on the importance of clearly establishing the company's objective, its mission, and the organizational culture parameters that foster innovation [7]. This involves creating mechanisms and spaces for people to do their innovative work freely, without tensions or fear of reprisals that might jeopardize their jobs (Ex3). Therefore, the most important thing is to attract and retain the best talent. It is about thinking at the individual level, as everyone wants to grow in their career, increase their skills, and see how their knowledge and experience can impact the work they are doing for the company or the community; although this does not mean that everyone wants to become a CEO (Ex3-Ex4-Ex5).

Individual aspirations and goals are important in the current business climate, recession or not, if people feel valued and satisfied, they will want to continue doing their work in one company or another. Thus, one of the experts asserts, "the right industries will retain talent" (Ex4, C5, p.314). (Ex4). Interdisciplinary connections and perspectives are fundamental in an innovative process today. It is necessary to be flexible and know how to contextualize. Not to obsess too much over agile methodologies. One expert state, "if you only have a hammer, everything looks like a nail... when you have tools and only one nail, the way

to fix it is by hammering" (Ex5, C5, pp.227-228). Tools can be applied according to the research field, context, organization, teams, among other variables. One of the expert opinions highlights that companies like Google, Apple, and Amazon create trends (Ex3). Therefore, in the field of innovation, these companies are undoubtedly global references, as can be seen in their work dynamics, detailed in subsequent sections.

Observing and Recording Best Practices on the Application of Agile Innovation Methodologies in Higher Education Institutions and Business Environments. Most observations of these best practices were conducted in person, while others were compiled from various websites, videos, and bibliographic sources provided by the companies or institutions themselves. The main findings during these visits include:

GOOGLE. This world-leading technology company emphasizes principles that underpin its organizational culture more than specific agile methodologies. For example:

- Focus on the user. More than product profitability, the potential to satisfy a user's need or expectation is recognized.
- Think big. Most people tend to think incrementally rather than seeking radical transformation.
- 70/20/10 rule for resource allocation. "70% is dedicated to the core business, 20% to emerging businesses, and 10% to new businesses" [20].
- 20% time. A program allowing employees to spend 20% of their time working on what they choose, promoting freedom to create and innovate. This has resulted in numerous high-quality products like Google News, Google Maps, and Google Search.
- Ideas come from anywhere. Employees are encouraged to suggest improvements for the company. Ideas can emerge during informal meetings, in the free food restaurants, or at the gym.
- Fail fast and learn. Any failed project should generate knowledge that informs future efforts.
-

Additionally, Google encourages people to pursue their dreams (Ex3). Therefore, the company provides exceptional working conditions and specialized teams that constantly think about reducing employee stress factors. NASA AMES Research Center. A tour of the entire campus was conducted, with an expert explaining: a) History of the AMES CENTER, b) Area of robotic lunar exploration, c) Wind tunnel, d) Hangar that housed Zeppelin-style aircraft (USS Macon) and e) Robotics Laboratory. The expert works here and participated in the team that designed and developed "Astrobee" (an autonomous flying robot) that serves as an assistant to astronauts during space missions (e.g., taking inventory, recording tasks).

Agile methodologies such as Kanban and Scrum are applied in the planning and development of space missions [21]. Google and NASA have established a close partnership for several years. In 2013, Google announced the launch of the Quantum Artificial Intelligence Laboratory, which will be housed at the AMES Research Center. Hasso Plattner Institute of Design (Stanford University). The creative potential and vision of this distinguished academic space were evident. As pioneers in the Design Thinking methodology, all classes are taught by teams of faculty from various specializations (e.g., business, entrepreneurship, arts). The classrooms are fully flexible, with modular furniture (e.g., chairs, tables, walls, partitions) and varied resources to facilitate the adaptation and versatility of the learning dynamic (Personal communication, Britos, L. March 16, 2023).

Classrooms are assigned to the class being taught, not to specific professors. For example, tables with wheels allow the classroom space to be easily organized according to the lesson's interest or purpose. Most materials are designed by the institute's faculty, students, or collaborators. These resources help students stay motivated and persevere in their creative development despite ambiguity and obstacles. They learn how the thinking behind design can enrich their work and unlock their creative potential. Viant Medical. This business specializes in designing and developing medical devices, committed to innovation to improve people's quality of life worldwide. Their focus on the customer and operational excellence was evident during the company visit. They support entrepreneurship in the medical field by providing resources offered by large companies.

Founded in Silicon Valley in 1999 by serial entrepreneurs Tim and Christopher Vanderhook, Viant's motto is "We're in it for life." The company specializes in creating complex medical and surgical devices in orthopedics, cardiology, bioelectronics, among other areas. Their solutions are comprehensive, from design and development to manufacturing, assembly, and packaging. They rely on Lean principles throughout the product lifecycle and lead in quickly providing high-quality complex medical devices. Additionally, as highlighted by the expert interviewed, the Critical Path Methodology is another approach they use. When designing a product, scientists, technicians, the project director, and investors collaborate to find the best solution.

Designing a Didactic Proposal on Agile Innovation Methodologies. As part of the outcomes of this investigative process, a didactic guide was developed to guide the application of agile innovation methodologies in teaching and research with university students. It includes an approach to the theoretical foundations of the main agile innovation methodologies, their pioneers, and basic guidelines for their application. It is divided into three parts: a) Introduction to agile innovation methodologies (concept, importance, and types); b) The playful strategy with three challenges to understand and apply these tools; c) Guidance for professors with reflective and experiential activities.

Pilot Experience in Costa Rica at the School of Business Administration. In an initial experience of applying agile innovation methodologies in university teaching and research project design, an introduction to the topic was conducted within Group 01 and Group 04 of the DN-0115 Research Workshop course at the School of Business Administration, University of Costa Rica. This first application of the didactic guide demonstrated its feasibility and the positive reception by the students.

It is noteworthy that this course is offered in the final year of the Bachelor's and Licentiate programs in Business Administration and Public Accounting. In this academic space, students receive conceptual and methodological academic support, contributing to strengthening their professional performance in research. Through the "Learning by Doing" methodology, students are facilitated in designing potential project proposals for their Final

Graduation Project (TFG) with criteria of quality, innovation, relevance, and pertinence in current topics, research problems, or improvement opportunities related to business and organizational management.

Given the course profile, the first challenge of the Playful Strategy from the didactic guide was carried out and complemented with some activities from the second challenge. The scenario begins with humanity in danger of extinction and Earth facing a series of severe problems. Thus, students must identify these problems and find a viable solution as quickly as possible with accessible resources, demonstrating creative development with maximum efficiency. In this process, they must follow instructions to apply one of the agile innovation methodologies: a) Design Thinking, b) Design Sprint, c) Scrum, d) Lean Six Sigma, e) Triz, f) Storytelling, and g) Critical Path Method. It is noteworthy that they had a maximum of one hour within the Zoom platform, as this course was taught in a high virtual modality (75% online, 25% in-person).

Once the activities were completed, each team had to present their work to the "Circle of Kosmos" (in this case, the rest of the class) for evaluation.

Below are two examples of this pilot experience worked on with each student group. (Figure 1).

Figure 1: Students from Group 01 and Group 04 of the DN-115 Research Workshop course at the School of Business Administration. University of Costa Rica.

Source. Research project video library, 2023.

Example 1. Pilot Experience with Group 01 of the DN-0115 Research Workshop Course. In this group of students, seven teams were formed, each assigned a mission on a specific planet and its corresponding vital energy (or agile innovation methodology). Here, we share the work done by Team 5 of Group 01 of the DN-0115 Research Workshop course (EAN-UCR), consisting of students María Paula Calderón Elizondo, Francisco Echeverría Cárdenas, Escarleth Méndez Torres, and José Daniel Vargas Rodríguez. Their Stellar Mission was directed to the planet MirusGo, where they tackled the challenge to find the vital energy "Triz" (as an agile innovation methodology) and its corresponding activities. After investigating and reading materials in the Stellar Library (repository of the guide) and other sources, they defined this agile methodology, explained its purpose, and how it is applied. They also explored and selected a success case related to General Motors Brazil, involving the production of car prototypes. Finally, they chose a problem facing humanity and proposed a corresponding solution. The issue was "Education," and their proposed solution was called "For Quality and Accessible Education".

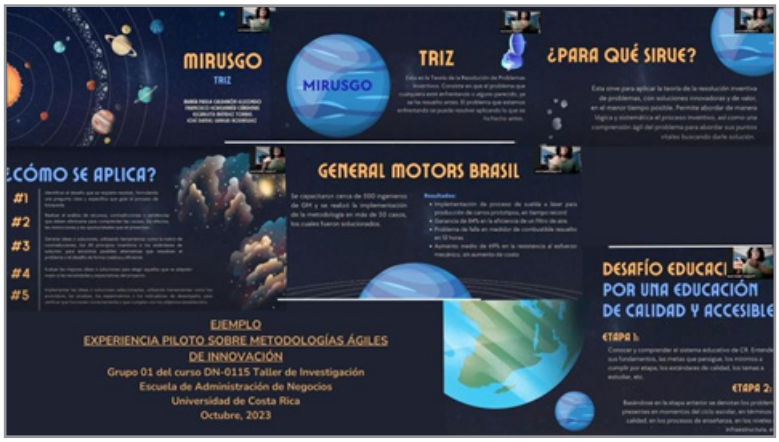

Figure 2: Scenes from the presentation by Team 5 (Group 01) of the DN-0115 Research Workshop course (EAN-UCR).
Source: Research projectvideo library, 2023.

Example 2. Pilot Experience with Group 04 of the DN-0115 Research Workshop Course

Similarly, among the seven teams formed, this example showcases the work done by Team 2 of Group 04 of this course. The members of this crew were Johanna Emilce Delgado Ordóñez, Yubran Alí Sandoval Ticay, Francisco José Solís Mc Clair, and Eduardo Montoya Sedó. They formed the Crew for the Stellar Mission to the planet NousGo, to find the vital energy "Storytelling" (as an agile innovation methodology) and carry out the corresponding challenge [22].

In this regard, they followed the same steps described in the previous example, using the Stellar Library as their resource. They defined the conceptual framework of this methodology, indicated its usefulness, and established the application process.

Additionally, they investigated a success case and chose the work of Swedish environmental activist Greta Thunberg, who challenges world leaders to take actions for a more sustainable future. Thus, in response to the chosen problem of "Climate Change" facing humanity, they created a story titled "The Mission of the Green Astronauts" to teach young children from an early age about the importance of conservation and respect for the environment. The story aims to demonstrate how the example set by adults can inspire new generations to take steps to protect the planet. Figures 3 and 4 show some of the materials prepared by Crew 2 to present their proposal to the Circle of Kosmos. Let's take a look.

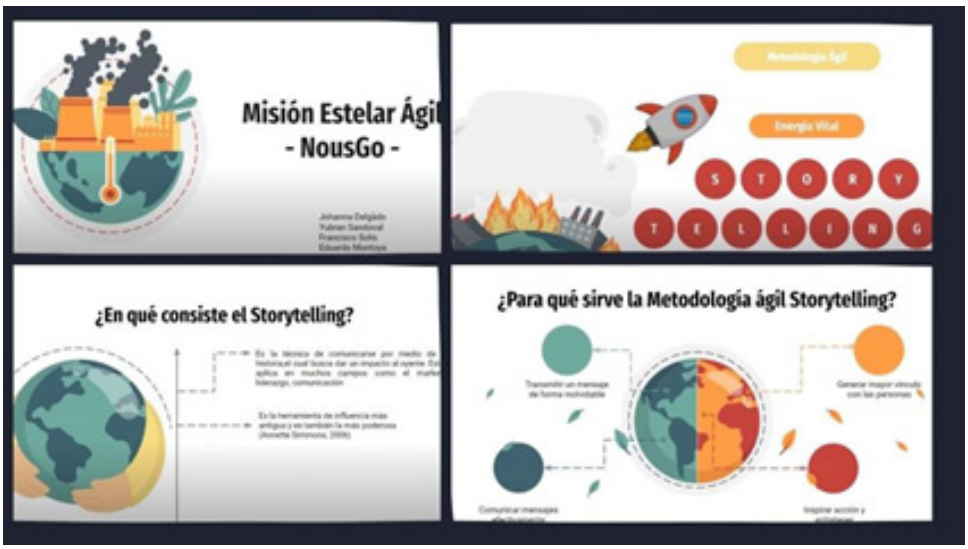

Figure 3: Scenes from the presentation by Team 2 (Group 04) of the DN-0115 Research Workshop course (EAN-UCR). Source: Research projectvideo library, 2023

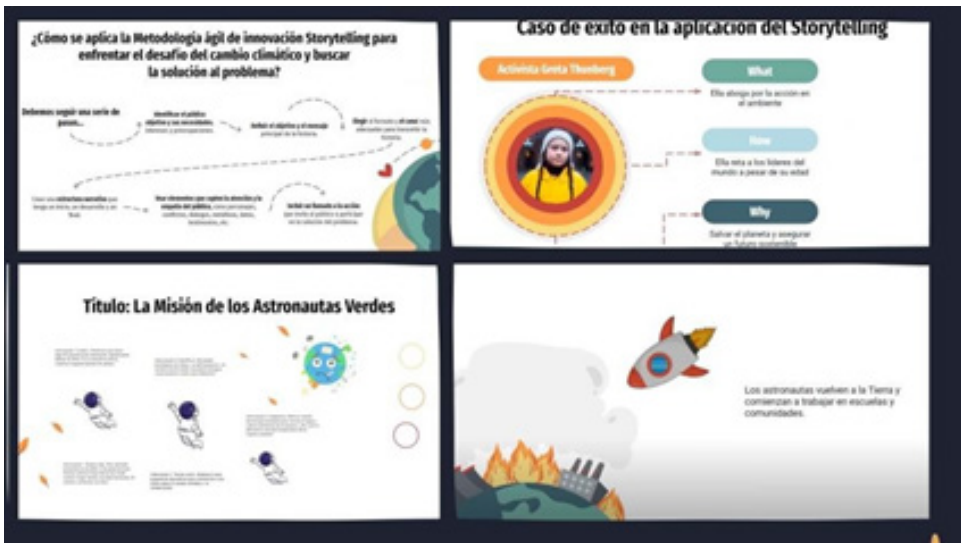

Figure 4: Continuation of the Scenes from the presentation by Team 2 (Group 04) of the DN-0115 Research Workshop course (EAN-UCR). Source: Research project video library, 2023

This approach to the pilot experiences described in the previous paragraphs illustrates the impact that such playful strategies can have in promoting learning about agile innovation methodologies. The awareness and motivation they generate among students serve as an incentive for educators to integrate this topic into their teaching processes. This dynamic, reflective, and collaborative approach helps achieve the goals guiding a quality education.

Discussion

The experts consulted agree that it is crucial to have clear objectives when applying agile innovation methodologies. These objectives should align with or address the intended goals. It is essential to have clear criteria, including success or performance indicators, as this evaluation helps determine whether expectations are met, how they will be measured, the sources of these guidelines, and what will be done with the collected data. Thus, objectives help make better decisions not only about which tool to select but also about whether it is necessary to modify the product or process to correct or adjust what needs improvement (Ex3).

Knowledge of the tools is timely and relevant, but it should be noted that they do not always apply to all contexts, organizations, groups, or situations. The strengths of various tools can be utilized (Ex5) to achieve their complementarity, as one expert highlighted the benefits of Lean, Six Sigma, and Scrum (Exp.4). Additionally, another specialist explained how Design Thinking and Six Sigma "are powerful tools for improving processes and achieving goals" (Ex6, C2, pp. 171-172). He elaborated, "Six Sigma is a methodology for reducing the variability of the products and services we provide when daily operations have errors due to human intervention and product imperfections, as products sometimes do not function as designed" (Ex6, C1, pp. 48- 49). If an organization can reduce process variability by half and stay within the process objectives, it may achieve Six Sigma quality levels. On the other hand, Design Thinking focuses on understanding user needs and developing creative solutions.

Different methodologies can be employed for each context. Another expert mentioned that within their company, "we embrace uncertainty... nothing is unexpected..." (Ex5, C1, pp. 131-132). Thus, problems are approached proactively as opportunities for improvement, which implies a paradigm shift. The interdisciplinary work in developing new products and the importance of the project leader in guiding the process are emphasized. New projects are carried out with people who have or are seeking for the required project component, as "with capable people, everything starts to flow" (Ex5, C1, pp. 106-107). The environment is very dynamic, working closely with the design team and undergoing many iterations. They have a range of "tools" (Ex5, C1, p. 114) (as they referred to the very sophisticated tools that allow for rapid changes) to make such adjustments, so they maintain a number of highly relevant active projects (e.g., 45 projects related to the medical device industry).

As users of tools, it is important that these tools serve the users and not the other way around. This means having teams trained in all agile philosophies but not a rigid procedure that offers a step-by-step guide. Instead, they should be encouraged to use the methodology that best responds to solving the problem. In this sense, methodology is the "how" to achieve final business objectives. But how are these skills learned and practical experience gained? One interviewee highlighted that improvement projects are assigned, and different methodologies are developed. However, "the way people are treated and supported is really the critical part of the equation" (Ex4, C2, pp. 156-157). From this perspective, managers and leaders set the vision, direction, and infrastructure, but the best creates an environment where the workforce can succeed. This adds a lot of value and avoids micromanagement, which can fragment the company. The pillars are multifunctional; for example, a single pillar might include a manager, a factory worker, technicians, or other collaborators.

Furthermore, another expert emphasized that "the creative process fuels the innovation process" (Exp3, C3, pp. 357-358); without creating the space and time for it, the company or any organization will have a short lifespan. Many methodologies exist to manage the creative process, but they should not be too prescriptive. Instead, people should be educated about other methods. This can be done in person (preferably) or virtually (e.g., with the support of various collaborative work tools. Therefore, especially in the field of Business Administration, while traditional processes related to management and product development, project planning, resource management, budgeting, and scheduling should be taught, there is a need to prepare professionals for the existence of a preliminary phase, an original creation phase that is truly innovative (Exp3).

Some of the interviewed specialists also noted that organizations (e.g., ASQ) should facilitate exposure to other areas where there is some connection and that methodologies like Lean Six Sigma enable "application to a new problem in a new context" (Exp4, C5, pp. 302-303). This same expert highlighted, "...there is a lot of value in innovation, a lot of growth and discovery, significant impact on products, quality of life, and careers; entirely new industries can be created, which generates stronger economies" (Ex4, C5, pp. 304-305).

Thus, from Higher Education, there is a germ of possibilities in various fields of knowledge that, when interconnected, transcend boundaries. As this specialist aptly notes, this encourages "more people to look beyond the limits of a diploma" (Ex4, C5, p. 306). They also emphasize that, although Artificial Intelligence and robotics will become advanced, it is necessary to teach innovation.…there will always be a need for humans for innovation and creative problem-solving, so this area will be in demand and competitive in the coming years. Therefore, it is important to teach these areas… if starting a business, selling a product, or providing a service, it must be done with innovation, as innovation can be incremental improvement (Ex6, C5, pp. 407-411).

Additionally, including risk management and its approach within innovation in the curriculum to avoid introducing unwanted risks to society. The way people approach business, sell products, or provide services is changing, with a competitive focus that compels continuous improvement of products and services. Future students will be responsible, whether they work for the government or the private sector, and need to do so more efficiently (Ex5, Ex6). Therefore, the tool is used for rapid devel-

opment, which is very useful and essential. However, "the true foundation lies in having a clear goal, a culture that supports it, and creating spaces for people to work on innovation" (Ex3). Innovation is about solving problems creatively; this is the most essential skill among the top ten skills for the next 30 years, as the world adopts more artificial intelligence and robotics (Ex6, C5, pp. 398-400).

In the application of agile innovation methodologies within teaching and research, the consulted experts claim to have had very positive experiences. Among these, the following stand out:

- The strategy to involve people in the purpose and mission. These essential components must result from deep reflection to facilitate understanding, requiring clear and concise articulation of these principles. People must believe in them to commit to being with the leader and be part of the organizational culture (Ex3).
- The team for working agilely. One expert note, "I go back to people, and I believe that choosing the right people and ensuring they have the technical knowledge is crucial, as many projects fail due to very subtle issues" (Ex5, C7, pp. 301-303). From this perspective, having expertise to organize work effectively, collaboratively seek solutions to problems, and consequently make the best decisions is important. Another interviewee agrees, emphasizing the importance of hiring suitable individuals with a sense of belonging, clearly involved in processes, and with strong commitment, where they feel recognized and rewarded, especially emotionally. "This will keep the organization very successful" (Ex6, C10, pp. 544-545).
- Identifying requirements for project design. This involves understanding the steps, the project's needs, the personnel required to develop the process, having a sequence: "You can't skip any steps, but there are many ways to navigate that process. You can run it, skip it, or crawl through it…" (Ex5, C7, pp. 318-320). It's about forecasting how long the operation will take, but discrepancies may arise, which are seen as "things we discover… that we fix, which made the product and the process better" (Ex5, C7, pp. 330-331).
- The development of new products and services (Ex1). Agile innovation methodologies can enhance ideas, prototype manufacturing (Exp1), and a wide and diverse range of projects with their various iterations.
- The use of empathy tools. These facilitate understanding of the potential market, support the evolution of the idea before launching it to the target audience, or allow for "making necessary modifications before advancing with the business" (Ex1, C8, pp. 140-141). It is crucial to focus on people, as their needs and expectations should be the central focus of an innovative process. User experience fosters loyalty, competitive advantages for companies, increased sales, and a sustainable environment for businesses or organizations. The tools, techniques, and methodologies are already available, but "what's difficult is understanding the mind of people" (Ex6, C10, p. 520). You need people around you to listen to ideas and collaborate; "if those people are not with you mentally and emotionally, you cannot succeed" (Ex6, C10, pp. 516-517).
- Viewing non-conformities as opportunities. Difficulties and setbacks are not hidden or avoided; they are not limited to a specific number. Non-conformities are prioritized, and the necessary understanding is sought to resolve them to adjust and optimize the outcome. Thus, the statement "kick the stones, kick them, you will find many things underneath and solve them" (Exp5, C7, pp. 339-340) shows that within non-conformity there is space for continuous improvement.
- Access to experts in different areas. In this dynamic, access to all the "gurus" (e.g., from the medical industry) is invaluable (Ex5). Knowledge, experiences, and new approaches for training, development, and updating of collaborators are shared. One expert mention that broadcasting systems and Facetime are quite efficient tools, as the way knowledge is exchanged internally between clients and experts is crucial. Therefore, involving stakeholders to keep them connected and committed to innovation is essential, as "a Stanford professor says innovation without adoption is just an invention" (Exp6, C10, pp. 512-513).
- Knowing how to apply primary research methods. Identifying opportunities using qualitative tools is fundamental. Often, business students have skills in justifying an idea with numerical analysis and market perception based on quantitative secondary reports, but they have little experience in collecting qualitative information (Ex1). Additionally, they struggle to prototype ideas when they don't consider it necessary, assuming that numerical justification of the proposal is sufficient. They have strong skills in cost, promotion, and advertising of a product or service (Ex1). In this sense, "the cherry on top is the practical part, the experience with the product, which varies by industry, whether it's a bank, a chemical company, a pharmaceutical company, etc." (Ex5, C7, p. 290).

Regarding the benefits of applying agile innovation methodologies within teaching or research, the consulted experts highlight the following: a) Identification of needs latent in a potential market, using more qualitative empathy tools to focus the proposed solutions (Ex1); b) interest and motivation in seeking solutions to problems (Ex1-Ex3-Ex6); c) discussion and analysis of problems and their implications (Ex3-Ex6). One expert comments, "Every day we have a goal, and when we think about the critical path, it has to happen today, it's very visual, if you have good communication and the systems are correct" (Ex5, C8, pp. 360-361); d) rapid and easy prototyping of ideas to demonstrate that the proposed idea truly satisfies a specific market or to make necessary modifications before advancing with the business (E1-Ex5); e) making the relationship between teacher and student more horizontal (Ex1); e) enabling a connection mindset, as diverse professional groups meet to learn about the latest research and innovations (Ex4); thus, spaces created in conferences or seminars, for example, can change a career and are not quantifiable (Ex4).

These scenarios are "magical, presenting a young professional or student with an idea of what else is out there, something they don't even know, and discovering that it will be very satisfying for them as a career" (Ex4, C11, pp. 393-396). People find ways to collaborate in person or not; however, in in-person settings, there is a greater opportunity to discover, see, or hear something that captures attention and interest.

Also, from an academic point of view, knowledge is increased, and from a commercial perspective, it can enhance the creation

of businesses, as well as new industries, jobs, and training processes (Ex4).

Additionally, other positive effects generated by applying agile innovation methodologies include collaboration among colleagues from different industries and exposure to new or emerging ideas. For example, at the ASQ conference last fall, one expert explains that "in the discussion about AI, chemical engineers present the role of quantum computing and solving problems in chemical engineering" (Ex4, C11, pp. 380- 381). Also, when applying the Six Sigma methodology, the problem and opportunity are defined, measured, projected for improvement, such as reducing incident rates, interest rates, costs, improving cash flow, user experience, satisfaction, among others. This involves communicating to all stakeholders how to be more efficient and achieve success (Ex6).

This entails the survival of the company and avoiding obsolescence of the business and the product, as the cost or risk is disappearance, not merely improving efficiency. The best products, the new generation, reducing costs of poor quality, and improving results are immediate benefits. A company or organization that lacks the capacity to innovate becomes obsolete, e.g., Blackberry (Ex3). Another expert summarizes that one of the main benefits of involving students with these methodologies is helping them change the perspective of what seems almost unattainable.

Complementary to these insights, the results presented from the two pilot experiences conducted with Business Administration students (Group 01 and 04) in the Research Workshop Chair show that the motivation evoked by this topic is significant. The discovery of agile innovation methodologies (for most participating students) opens new avenues for understanding the approach to various societal issues and, especially, the roadmaps that can be outlined for seeking creative solutions in companies and organizations. The level of attention, involvement, and criticality with which each of the proposed agile methodologies (e.g., Design Thinking, Storytelling, Triz, SCRUM, among others) was analyzed, through a playful strategy, facilitated a magical moment of exchanging knowledge, experiences, and searches, leading to the emergence of innovative proposals.

This initial exercise confirms the creative talent of the students, as well as their degree of commitment and motivation when educational scenarios are organized where analysis, critical reflection, creative play, imagination, and collaborative work are combined.

Exemplifying the educational experience carried out was not easy; only one team from each group was selected to showcase this initial exploration, but every contribution was inspiring. The final comments from each of the five teams across the different groups revealed not only their satisfaction with the development of the strategy but also the learnings derived from these agile innovation methodologies and their future motivations.

Conclusions

The exploration of "Agile Innovation Methodologies Applied to Teaching and Research" opened a range of possibilities to energize learning processes by recognizing trends and best practices emerging in higher education institutions and in business contexts with notable international leadership such as Silicon Valley (USA). This Innovation Ecosystem brought us closer to experts who, with a humanistic and innovative vision, exemplify in their daily work the scope of implementing such methodologies, highlighting the versatility and complementarity they offer for their implementation, depending on the environment in which they are developed. In this regard, one of the experts noted, "each project is unique, each project has unique needs, and I think this is like the key to innovation and continuous development" (Ex5, C1, pp. 63-65).

In this sense, Peng asserts, "all approaches are effective if applied to the right projects in the right circumstances" (p.38). The research conducted confirms this statement by showing the importance of having a clear purpose and objectives for each project in an organizational environment so that the roadmap outlined is guided and enriched by the agile innovation methodologies that enable the team to achieve the desired results more efficiently [23]. The knowledge and mastery of these strategies show that they do not always apply to all contexts, organizations, groups, or situations. Therefore, it is advisable to have a theoretical and practical mastery of several tools so that their strengths can be utilized and adjusted according to the uniqueness of the problem and environment faced.

The goal is for these methodologies and tools to serve the users and not the other way around; that is, those who use them should not serve the tools. This means having teams trained in all agile philosophies, but not having a rigid procedure that offers a step-by-step guide, rather encouraging them to use the one that best responds to the problem's solution. Therefore, it is encouraged to "know all the tools, use the one that suits you" (Ex5, C1, pp. 120-121).

In-depth interviews with experts and the exploration of best practices allowed for outlining a series of recommendations on applying agile innovation methodologies within teaching and research, particularly with Business Administration students. Let's see.

On Agile Innovation Methodologies:

- Identify the potential of each methodology and tool. This means adapting them according to the company and the industry [15, 24, 25].
- A good tool facilitates an environment where ideas emerge. Many classic tools make rapid decision-making difficult (Ex5).
- Avoid using tools with more than three rules. People should not have to study, certify, and spend more time maintaining the system, so that the system works for the person, rather than the person working for the system (Ex5).
- Keep an open mind to combine methodologies and address the problem optimally. One can be an expert in SCRUM or Lean Six Sigma, but companies may contextualize the methodologies, meaning they have their own versions (Ex3-Ex4-Ex6).
- The correct methodology is the one that can solve the problem in the most responsible way for the involved parties. It should be used as an enabler, not as a limited (Ex5).
- Avoid fanaticism towards any particular agile methodology; this means "Learn all the tools you can, but never become a fanatic of any" (Ex5, C8, pp. 362-363). This attitude prevents finding and accepting other ideas that can help better understand the problem and its solution.

On Innovation:

Consider, among other elements:

- Focus on the organizational culture, which is the foundation of the innovation process (Ex3).
- Great innovation comes from people having the space, time, and not being concerned about their survival. This means having mechanisms for stress reduction (Ex3). Tense and worried people have their focus on other personal, family, or work situations that hinder productivity and innovation in any aspect of human life. This is why Google strives to help its employees focus on their tasks and projects by ensuring their personal needs are met through various benefits.
- Avoid environments where very rigid processes are assumed. These environments do not foster development or continuous improvement. Having an environment where all ideas are valued and there is freedom to implement them quickly is crucial because "there are no bad ideas" (Ex5, C8, p. 367).
- Prototype ideas to support their evolution (Ex1-Ex3), where the iteration process is essential.

On Teaching:

Consider that:

- Courses should address the topic of organizational culture, how it is created or maintained, with an emphasis on fostering innovation (Ex3).
- It is not enough to focus only on the tool itself; a structural foundation linked to culture and mission is necessary (Ex3-Ex5).
- Students should be aware of the applications of the methodologies and tools they learn, as well as their practical implications in real-world scenarios. Knowledge in the real business world, it is possible to work simultaneously with the company, learn and apply the methodology in small modules (Ex6); and
- Keep students interested and engaged with the topic, making them feel useful, discussing the scope and implications to foster their commitment to innovation and continuous improvement (Ex1-Ex3-Ex4-Ex5-Ex6).

On Research:

Pay attention to:

- Ensure that students always focus their project on a specific potential market, i.e., a particular market niche, verifying hypotheses about a new product or service (Ex1-Ex3- Ex6).
- When working with students, consider proposing an initial module on discovery, where opportunities in a business are identified. Work with the company or organization to apply the learnings, and then have students return and advance with the process. This way, the learning cycle is repeated, where students work with the company as they learn. This type of knowledge is maintained and enriched because it is applied, validated, and adjusted simultaneously or immediately.
- Once students have developed their body of knowledge, encourage them to continue updating with support from various bibliographic sources and resources (both print and online).
- Also, it is useful to master some concepts related to statistical thinking, design thinking, and materials that are accessible and simple, but that help deepen the approach to the methodology.

If there is difficulty accessing a real business or organizational environment initially, simulation exercises or activities can be used, where students face challenges in a playful and participatory manner. This allows them to grasp agile innovation methodologies, recognizing their benefits and the advantages they bring from successful cases identified through exploring various sources. All this can take place in face-to-face, hybrid, or online learning environments, as illustrated by the pilot experience described in previous sections with students from the DN-0115 Research Workshop (Group 01 and Group 04) at the School of Business Administration at the University of Costa Rica.

Therefore, there are no limits for those who wish to learn, innovate, and improve their practice. Opening new avenues and routes to serve Higher Education and the different contexts we impact is a driving force of our Being and Presence in the world.

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This exploratory space enriched both personal and academic life with new knowledge and best practices that have transcended into pilot experiences with faculty and students at the School of Business Administration at the University of Costa Rica, as well as in the dissemination of these results, which we hope will inspire new initiatives [27].

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