XXIII SEMEAD
Seminários em Administração

novembro de 2020
ISSN 2177-3866

From Maths To Myths: How Technology-Driven Experimentation Can Promote Strategic Reorientations

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Agradecimento à orgão de fomento:
This work was supported in part by Coordination for the Improvement of Higher Education Personnel (CAPES) Foundation (a Brazilian research agency) under scholarship grants.

FROM MATHS TO MYTHS: HOW TECHNOLOGY-DRIVEN EXPERIMENTATION CAN PROMOTE STRATEGIC REORIENTATIONS

Introduction

Far from being easy-going, the new venture creation journey may be chaotic, unpredictable and often the original plans experience fundamental reorientations before the finding of a promising value proposition (Grimes, 2018; McDonald & Gao, 2019). These reorientations may affect not only the further actions but also can modify strategical guidelines enabling a whole reconfiguration of the business (Dottore, 2009). Several authors such as McDonald and Gao (2019) and Bajwa et al. (2017) point out that customer feedback causes reorientations and may alter the value proposition or the array of customers and products. However, there are situations in which the experiments with the technology trigger the changes. For instance, the FinTech Capital One, is increasingly moving towards an AI company (Castellanos, 2017) after establishing "a machine-learning Center of Excellence (COE) for studying how the technology can be used to reimagine the customer experience" (Daugherty & Wilson, 2018, p.149).

In spite of the existence of cases like FinTech Capital One, researches fall short by overlooking the strategic reorientations in young firms (Hampel, Tracey, & Weber, 2019; Parastuty, Schwarz, Breitenecker, & Harms, 2015) and especially those reorientations derived from technology experimentation (Earle, Merenda, & Davis, 2019). To shed light on this topic, we conduct a case study of *Abacko*, an EdTech spin-off developed by researchers at the National University of Colombia in Palmira, to deeply examine how technology-driven experimentation can promote strategic reorientations. The spin-off experienced three major strategic adjustments in which the experimentation with technology was imperative. Our underlying assumption is that technology-driven experimentation not only lead to strategic reorientations but also it can both broaden and enrich the business's value proposition.

The contribution of this study is twofold. First, we contribute to the literature in business strategy by proposing a process model outlining the iterative strategy development cycle boosted by technology-driven experimentations and actualizations. Second, by complementing entrepreneurial action literature giving an alternative approach about how entrepreneurs redirect their course of action to continue with the business opportunity recognition process. Managerially, our study contributes by enabling entrepreneurs and enthusiasts to expand their repertoire of alternatives to redirect their business strategies.

The remainder of this paper is divided into five sections. In the next section, we review the theoretical background related to strategic reorientations, ways for strategy formulation, and technology-driven experimentation. In the third section, we describe the design research including methods, data collecting, and analysis. The fourth section presents the research context and findings. Next, we present the discussion, including our theoretical framework; new procedures; the relationship between education, new technologies, and territory; and the opportunities and challenges. Finally, we present the conclusions, limitations, and suggestions for further research agenda.

Theoretical Background

Strategic Reorientations

During the strategy formation process, very often, entrepreneurs need to reorient their business ideas and strategies several times before finding out a promising value proposition (Bajwa et al., 2017; Korber & McNaughton, 2018; McMullen, 2015). According to Ott,

Eisenhardt, and Bingham, (2017, p. 306) the strategy formation process involves the creation of "a unique set of interdependent activities to create and capture value", and despite its intrinsic importance, there are several issues of the process unclear such as why and how an entrepreneur decides to implement any particular strategy, or the tradeoffs associated with being flexible and learn or being efficiency-seeker through a holistic understanding.

Authors such as McDonald and Gao (2019) and Bajwa et al. (2017) point out that customer feedback triggers strategic reorientations. Likewise, techniques for the creation of startups like the business model canvas, lean startup, or design thinking, encourage the market interactions prematurely in order to get customer feedback and thus, validate and adjust the business' ideas (Ries, 2011). However, these techniques have received several criticisms particularly because these approaches are explicitly designed for incremental innovations, rather than radical (Felin, Gambardella, Stern, & Zenger, 2019). Developing prototypes and tests with customers rapidly are desirable when technology and other critical resources are available, and when the proposed solution is similar to the products available in the market, and therefore, it is crucial to receive customer feedback. Differently, when technology is not ready to market, and when the solution is quite far from the products available in the market, conventional market interactions would be unappropriated and mislead the project development (Lynn, Morone, & Paulson, 1996). That is the reason why Apple relies on the interactions and opinions of key experts instead of conventional customers; recalling Henry Ford's famous sentence: "if I'd asked customers what they wanted, they would have told me, 'a faster horse'!"

Strategic reorientations are very challenging situations due to the fact that entrepreneurs should consider several conflicting interests and judgments stemming from investors, clients, collaborators, suppliers, co-founders, and other key stakeholders on which the venture depends on resources (Hampel et al., 2019). Additionally, entrepreneurs need to take into account their self-concepts and beliefs, appraise and reappraise the circumstances and the overall goal, identify what is at stake, and try to minimize the biases involved in order to make the necessary strategic reorientations (Grimes, 2018).

Ways for Strategy Formulation

There is a dichotomy in the entrepreneurship literature suggesting that entrepreneurs should strategize, on one hand, by thinking (i.e. by planning), or strategize by doing (i.e. in an experimental fashion) on the other (Ott et al., 2017). The former advocates that having a holistic understanding of the environment employing cognition over action is the most effective way to determine strategies (Kiss & Barr, 2015). In this line, individuals strategize using "blueprints" (e.g. mental models, plans, visions, analogies, and identities) to conceptualize how to integrate the interdependent activities and actors in order to realize a sustainable business model (Ott et al., 2017).

On the other hand, a substantial body of literature assumes that experimentation (also noun as effectuation) is more suitable for entrepreneurship and radical innovation projects because individuals cannot effectively reduce the possible future alternatives (Dew, Read, Sarasvathy, & Wiltbank, 2009; Mahmoud-Jouini & Charue-Duboc, 2017; Ott et al., 2017; Sarasvathy, 2001). Sarasvathy and Dew (2005) argue that new firms should embrace more experimental approaches to conduct the strategy process, largely due to the extremely uncertain conditions in which startups are embedded (Paternoster et al., 2014). Moreover, Thomke (2008) suggests that learning by experimentation not only reduces the total time spent and costs for new product development, but also enables to rapidly discard dysfunctional ideas while focusing on the promising ones. The adoption of flexible and experimental approaches allows faster learning about the external world and respond more quickly to potential threats and seizing potential opportunities.

Technology-driven Experimentation

Technology-driven experimentation is an unstructured approach wherein individuals explore and test the technology in an iterative fashion in order to analyze and refine the business potential of the ideas (Curran, 2016). This approach is characterized by internal creative processes, where designing and developing the product precedes market opportunity analysis (Habtay, 2012; Nag, Corley, Gioia, Corley, & Gioia, 2007).

Berman and Hagan (2006) argue that technology-driven approaches may lead to three achievements: To change the basis of competition, broke the rules of scale, and introduce totally new business models. The authors also highlight several differences between technology-driven and traditional approaches; for instance, technology-driven is discovery-based, iterative and future oriented, recognize and incorporate uncertainty to the process, and focuses on "exploration of new, uncharted areas (…), emerging market segments (…), and new operational capabilities that change the nature of competition"(Berman & Hagan, 2006, p. 32).

Furthermore, Khanagha and colleagues (2017) pointed out that there are several managerial initiatives that companies should fulfill in order to foster technology-driven experimentation; for instance, increase the autonomy of the innovation teams and key employees, enable the formation of cross-functional collaborations, and "developing routines and processes that nurture experimentation and allow for trial-and-error learning" (Khanagha et al., 2017, p. 5). Furthermore, as suggested by McGrath (2001), these experimental approaches require open attitudes towards failure, in other words, it is important that the team members adequate their mindset with respect to failure as means for learning in uncertain conditions.

Methods

Considering the still limited empirical evidence for how technology-driven experimentation encourages strategic reorientations, it is appropriate to perform an exploratory case study (Yin, 2009). The case was conducted with a digital-learning spin-off based in Palmira – Valle del Cauca (Colombia). We apply semi-structured interviews and we also benefit from having an observer and participant of the project on our author team. Direct observation, interviews with the key actors of the project, and access to internal documents enable us to understand in depth the particularities of the evolution of the project, how the experimentation phases were addressed, the achievements and the challenges as well.

For data analysis, we follow the narrative strategy described by Langley (1999). The aim of this strategy is to "achieve understanding of organizational phenomena, not through formal propositions but by providing *vicarious experience* of a real setting in all its richness and complexity" (Langley, 1999, p. 695). Our objective is, thus, to provide a thick description of the case, as conducted by Bartunek (1984), in order to allow the readers to dive into the project.

Research Context

In Colombia, there is a growing interest in the development of digital products, in both the private and public sector. The Ministry of Culture and the Ministry of Information and Communications Technologies of Colombia (*MinTIC)* have developed some initiatives focus on digital production and research by funding projects in public universities.

One of these initiatives was coordinated by the National Innovation Direction (known in Spanish as DNIA), an internal department of the National University of Colombia (UNAL). The objective was the creation of digital content aiming to solve some learning difficulties

among the students at UNAL; and one of the proposals approved gave birth to Abacko, the case study presented in this research.

Abacko is an EdTech spin-off created in 2017 at the National University of Colombia in Palmira, which develops educational applications based on gamification, local narrative, and discovery learning. The spin-off works with its own methodology that emphasizes the collaborative work among different disciplines such as Physics, Pedagogy, Graphic, and Industrial Design.

Research Findings

Strategic Reorientations Process Model

We set out to examine how technology-driven experimentation can promote strategic reorientations in recently created innovative ventures. To do so, we conducted a qualitative process study of Abacko an EdTech spin-off specialized in the development of 3D experiential learning platforms. The firm experienced four major strategic reorientations represented in figure 1. For each reorientation, we identified the relationship between the incorporation of technology (i.e. equipment and software) and the changes in the strategy and purpose, Table 1 shows this finding.

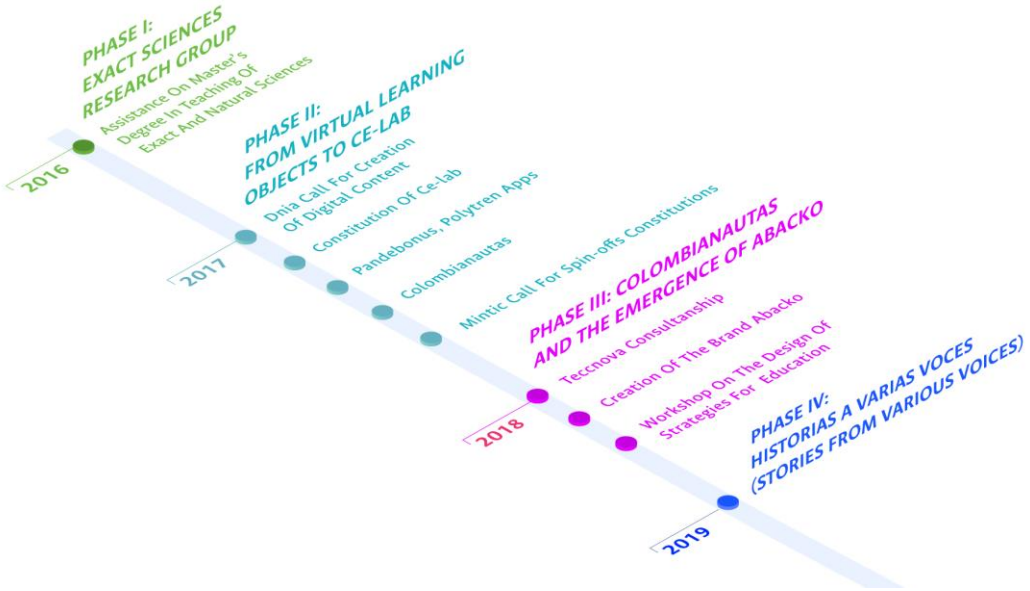

Figure 1. Phases of Abacko

Table 1. Technology and Strategic Reorientations

Phase	Technology	Strategic (Re) Orientation	Purpose
I	○ Physical learning objects (PLO)	Improvement of Mathematics instruction	Mathematics
II	○ Virtual Learning Objects (VLO) ○ Virtual Reality (VR) headset ○ AR/Mix Reality HoloLens ○ Unity	○ Improvement of students' learning experience in Mathematics ○ Integrative playful applications for Mathematics instruction	Mathematics

III	○ Integrated digital platform for playful games ○ 3D Scan context-capture	3D experiential learning platform that allows the interaction with the Colombian territory	Mathematics
IV	○ Integrated digital platform for apps and narrative experience ○ Sound recording equipment	3D experiential learning platform that promotes cultural and oral traditions of Colombian indigenous communities	Cultural and oral traditions (Myths)

Based on prior literature and the findings of this case, we propose a strategic reorientation process model (Figure 2) of how the business strategy may be reformulated after cycles of technology-driven experimentation.

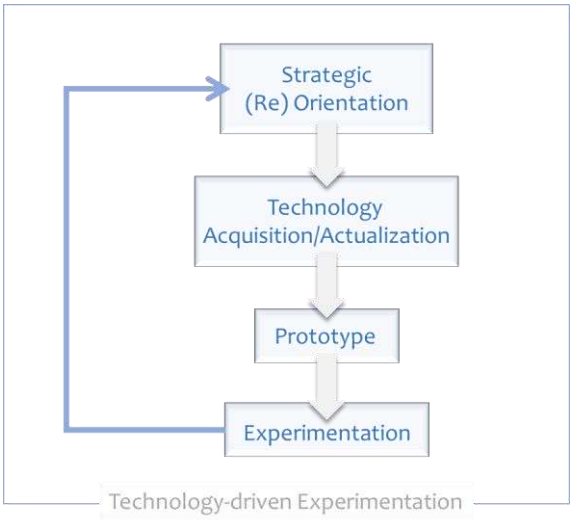

Figure 2. Strategic reorientations process model

In the first phase, the new venture defined the strategic orientation, it includes a unique set of resources and activities that allows to create and capture value (Ott et al., 2017), the team also set the guidelines for product development and the requirements for technology. Once the team acquires or renews the technology, they develop a prototype aiming to validate specific product features such as concept, function, and usability (Tanev, Rasmussen, Zijdemans, Lemminger, & Svendsen, 2015; Ulrich & Eppinger, 2012). Afterward, they proceed with the technology experimentation cycles wherein designers and developers interact with technology exploring the potential alternatives in order to enrich the business's value proposition (Berman & Hagan, 2006). All these alternatives are evaluated and a 'strategic re-orientation' is defined. Consequently, each of the strategic re-orientations redefines the guidelines for product development and the requirements for technology acquisition or renewal. The technology-driven experimentation cycle continues until the finding of a promising value proposition. In our study case, the venture performed four cycles, for each cycle we show the actions taken by the firm.

Phase I: Exact Sciences Research Group

The proposal which gave birth to Abacko, was led by the director of the Master's course of Exact and Natural Sciences and was aimed at developing tools to improve the students'

learning experience in mathematics. The first results were released in 2016 and consisted on digital and physical learning objects created jointly with the candidates for Master's Degree in Teaching of Exact and Natural Sciences at UNAL Palmira and with the support of the Industrial Design Department. The learning objects were tested in certain remote rural areas, where teachers from schools and colleges created the first generation of digital educational resources that captured students' attention. In parallel with this, in the design department, some industrial design students and teachers formed an informal research group based on experimentation in new technologies and media.

Phase II: From Virtual Learning Objects to Celab

After the relative success of the first generation of digital educational resources, the director of the Master with the support of the DNIA, opened the call to consolidate an interdisciplinary team integrating illustrators, pedagogues, and engineers. At that time, in 2017, the main objective was to upgrade the design and aesthetics of the Virtual Learning Objects (VLO*)*, but promptly, the concept artist realized that traditional VLOs consisting on presentations and basic iterative PDFs and PPTs "were not enough to improve the students' learning experience, the team had to go further." To that end, the concept artist suggested incorporating the informal research group in new technologies and media to the team project. As a result of the merge, was formed the Science, Education, and Innovation Research Laboratory, CeLab.

During 2017 and 2018, CeLab developed five playful apps (*PandeBonus, Polytren, ColombiaNautas, Numeralitos Salvajes,* and *Numeria*) that integrate playful and narrative in multiplatform and augmented reality apps for the teaching of mathematics.

As new outcomes emerged, new technologies like VR and AR equipment, free software, and opensource technology were incorporated; a situation that has proved decisive for the conception and development of digital products. *Unity,* a cross-platform game engine allowed the group to project several applications, and following an effectual logic (Sarasvathy, 2001), driven by several iterative experimental cycles, the team developed interactive formats and multiplatform games, expanding its reach and impact. Thus, the team decided to focus on two pillars for product development: territory and context-based learning.

The products connect the territory and the learning experience in several ways. For instance, in the app *Numeria*, using a combination of VR and AR*,* users are challenged to recognize the university campus through activities and dynamics framed in mathematics. The game *Numeralitos Salvajes* set in Arauca -on the west border of Colombia, uses institutional colors of regional schools, and employs illustrations and characters representing local fauna and flora, all within one 3D interactive interface aiming to introduce students to the basic concepts of the fractional numbers. Additionally, the game *Polytren*, get users into a virtual tour on the Pacific Train -which in the past connected cities such as Buenaventura, Yumbo, Palmira, and Cali, while they learn about polynomials.

At the same time, CeLab created a workshop in the design and development of objects and strategies for education in the municipality of Corinto, offered for teachers from the rural areas of Cauca and Valle del Cauca.

Phase III: Colombianautas and the Emergence of Abacko

Once again, the iterative experimental cycles lead the team to the creation of a platform that integrates all the playful apps. In the words of one of the collaborators:

> "The idea of Colombianautas arise by chance: a professor had created a map of Colombia, and during one of the tests for product development, we put 'Panela' [a game's character] inside that map and let her walk, climb mountains, cross rivers, and so on; and I wondered what would happen if we put all our applications and games in this map, (…), and we saw that this could be the connecting thread of all our work: a platform which allows the free exploration and interaction within the Colombian digital geography"

This launched *Colombianautas*, a platform that presents an open world video game enabling the 3D exploration experience through the Colombian geography, where the character discovers in valleys, rivers, and mountains, the gates containing the minigames which are created based on the local identity of the wide diversity of Colombian regions. For instance, on the route from the southern region to the extreme north of the country, the player will find natural and sonorous landscapes, animals, plants, characters, and representative places of the country.

From this new platform perspective, CeLab decides to participate in the call launched in 2017, organized by *MinTIC and Teccnova* for the *Creation of Spin-Off Companies*. CeLab won and was favored by receiving support and training in order to consolidate the business project. In this process was identified that the core of the products created was the way in which the learning experience was connected to the territory, moreover, the whole experience represented a discovery learning process, because while the user interacts with the virtual map and apps, he or she is learning about the Colombian geography and territorial diversity. To consolidate this original and valuable insight, *Teccnova* suggested the conformation of a spin-off, so it was created the trademark *Abacko*, as a more commercial brand open to both public and private investors.

Phase IV: Historias a Varias Voces (Stories from Various Voices)

Along with the new integrated platform, the team realized that it could open the spectrum for teaching other subjects besides mathematics, according to the project director: "students can learn something more than math with this platform, students might learn something special from each region."

This triggered the creation of the project *Historias a Varias Voces* (Stories from Various Voices), an application based on narrative aiming the teaching and promotion of cultural and oral traditions of Colombian indigenous communities. The underlying idea is to promote the preservation of cultural heritage, territory, stories, and languages. This project is currently under construction and seeks to participate in various national calls.

Discussion

Based on the case of Abacko, we found that ventures can reorient their strategies by performing cycles of technology-driven experimentation. However, the case also provides other interesting considerations which will be discussed below.

New orientations, New Procedures

For the development of each stage, new procedures and approaches were established. One of the most remarkable approaches was the creation of a new production methodology or 'pipeline' for the accomplishment of the projects. The pipeline, exhibits in Figure 3, has four phases, creation, development, product, and scalability. During the creation phase, researchers and designers identify potential opportunities matching particular teaching and learning trends, necessities, or unsatisfactory situations with technological and design resources. Once the

problem and the requirements have been defined, the development team engages in the conceptualization that consists of the experimental iterations with technology and art concepts. In this process, the technology-driven experimentation is particularly intensive.

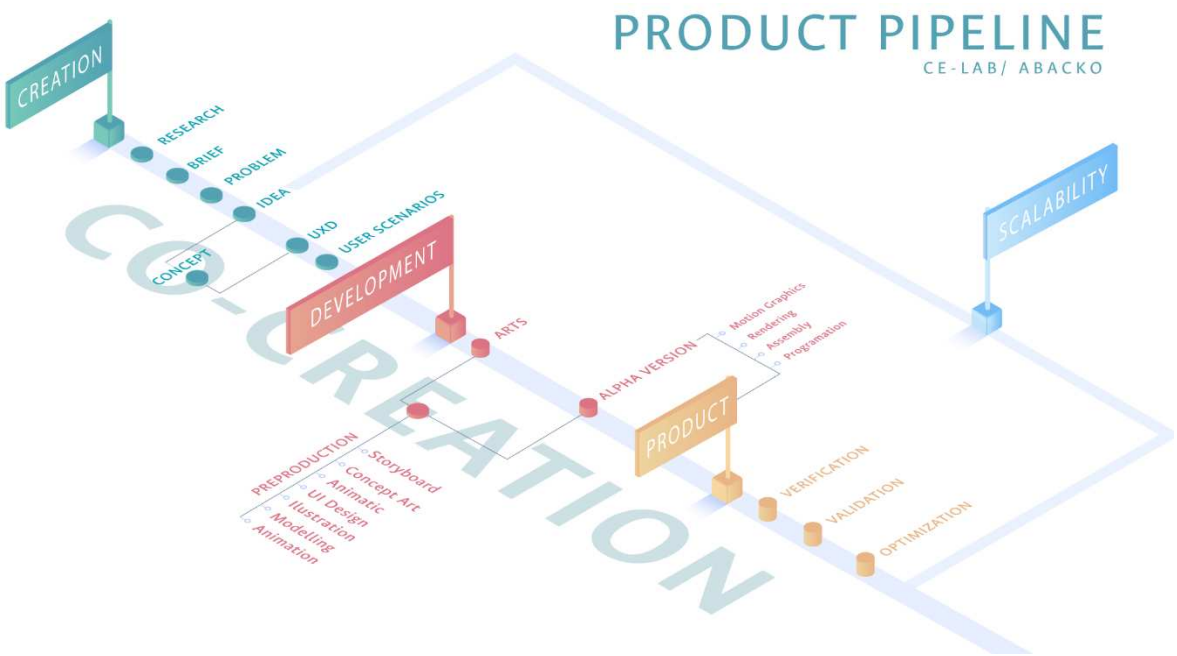

Figure 3. Product pipeline Abacko

Following, in the development phase, characters, objects, and scenarios are designed - this involves both 2D and 3D techniques. Then, software programmers and designers develop user interfaces (UI) and the backend language. Finally, all these elements are assembled and the tests with alpha versions start. After the adjustments are completed, the third phase, product, is conducted. In this phase, the main goal is the verification and validation of the product (i.e. platform or game) in order to optimize the interactivity and the experience. The last phase is scalability, and consists on the improvement of the resources of the system in order to handle a growing number of users.

In addition, it was created a controlling system named ‘la bitácora’, a digital document that contains the actualizations made at each process step by each team member. The objective of this mechanism was to reduce the number of meetings and to encourage self-regulation. These new procedures are consistent with Khanagha et al. (2017) that mentioned that new managerial approaches and initiatives are required in order to enable the exploration of technologies.

In the same way, we identify several attitudes related to the effectuation logic (Dew et al., 2009; Sarasvathy, 2001). For instance, we identify that the team members drew upon their actual means (i.e. who I am, What I know, Whom I know see Sarasvathy and Dew (2005)) several times: first, by incorporating the informal research group in new technologies and media to the team project, second by the inclusion of a programming student and relative of a member of the team, who presented the software Unity to the team, which was decisive for the development of the platforms. Finally, were identified moments of serendipity or unintended rewards of enabling exploration of various resources (Carayannis, Provance, & Givens, 2011), as in the case of the Colombianautas platform that, according to the conceptual artist, was ideated “by chance”.

Education, New Technologies, and the Territory

Digitalization and new technologies enable the creation of new relationships between students and learning processes (Crittenden, Biel, & Lovely, 2019). Nowadays, there are several products and services which offer revolutionary experiences in education (Elmqaddem, 2019). For instance, the systems of VR and AR such as iGlass or ARCore, educational games like 'My Word Coach', or the gamification education tools like 'Kahoot!'. However, there is a concern regarding the potential loose of local identity against a standard identity that offers a homogenized vision of the world through the aesthetics of the apps and games, and even through music and sounds (Revilla Gutiérrez, 2011).

Therefore, the strengthening of local identities is also part of the overall mission of Abacko. As informed by the project's director:

> "Right now, we can find in the market a bunch of video games and platforms which teach maths and sciences, but they use a foreign language; we have always learned things with outside stuff, like Disney things, and so on (…). They [the books] come from different countries with stories and narratives different from ours, and we just don't fit into that, and we are not learning from things that make us feel identified"

Yet, the team members also found out that through their products, they can contribute to the projection of the Colombian territory as well. According to Tung et al. (2019), video games have an enormous potential for destination marketing, different from films and series, video games enable the users to interact directly and freely with the environment. This, coupled with the permanent government's interest in promoting tourism (EFE, 2019), represents an important opportunity that could be explored. In the words of one of the designers:

> "Initiatives like this [Colombianautas] also contributes to the image of Colombia abroad. We have received excellent comments when we have had the opportunity to present our project in other countries like Mexico, Portugal, or Argentina. The platform, besides enhancing the learning in science, also serves as a means to communicate the Colombian culture. Once, somebody told us that we have to show this [the project] outside of the country (…), and help the other countries to develop their own platforms using their own regional characteristics, and thus, to spread out all our Latin-American identities"

Opportunities and Challenges

The product portfolio developed by Abacko represents an innovative proposal for educational purposes that integrates technological platforms, pedagogical techniques, and the design of visual interfaces and aesthetics which evoke historical, cultural, and geographical aspects of the country. This integration has allowed the improvement of the learning experience by promoting the discovery and the exploration of the Colombian territory. The spin-off, firmly believes that the merge between the design, digital platforms, and narratives, enables the construction of local imaginaries and regional identities. Likewise, one important goal of the firm is to function as a bridge-builder for connecting the new generations to the rurality and the cultural heritage.

However, there are conflicting aspects that challenge the growth of the spin-off. For instance, on the one hand, working under the UNAL's umbrella have helped the firm in many different ways (e.g. to set up the team, financing the first stages, and sharing prestige), but on the other hand, it is an entity with a huge bureaucratic burden that slows down the dynamism that a spin-off like Abacko should have. Unfortunately, even though the favorable laws to the

creation of spin-offs at the public universities, the measures necessary to ensure the practical operation have not yet been taken. This situation might be analogous to the concept of 'Agility trap' that "occurs when businesses seeking rapid digital transformation run fast and get stuck due to organizational or technological complexity." (Bizagi, 2016, p.3)

Another important barrier faced by institutions like Abacko is access to financing. This constraint is also reported in the literature, for example, Cunningham et al. (2008) suggest that the lack of financial resources is by far the biggest challenge for new enterprises. In order to avoid the over-reliance on public funding, Abacko has attempted to raise funds from private entities. But it has not been an easy task; according to Abacko's director

> "the private firms are looking for market-ready products, or close to be commercialized. Additionally, these private entities provide only limited resources, and for projects like Abacko, are insufficient. So, we are looking for entities which understand that we are still in the developing phases, and we are proposing a co-creation approach because we probably need another two or three years to get the intended results."

On this respect, authors such as Breznitz and Noonan (2018) argue that public initiatives have a crucial role in funding creative firms. Coupled to the lack of resources and bargaining power, new entities such as Abacko usually have technologies and products in previous phases of marketing stages, therefore, commercial negotiations with profit-oriented firms are significantly difficult. Hence, and in accordance with the literature, public initiatives had contributed positively to the development of Abacko. However, the team considers that "the financial support is very limited (…) especially for technological and long-term projects like ours", as explained by the director

In this regard, the spin-off is focusing on finding different financing mechanisms, both public and private, taking advantage of the public initiatives to develop digital projects and also generating new product proposals to extend the scope of application.

Conclusion, Limitations, and Future Research Opportunities

This study examined how technology-driven experimentation encourages strategic reorientations in new ventures. Although the majority of the literature set out that interactions with the market are responsible for strategic reorientations (Bajwa et al., 2017; McDonald & Gao, 2019) we provide empirical evidence that those reorientations can also be caused by technology-driven experimentations. Drawing on the case-study of Abacko, we develop a theoretical process model indicating how the business strategy is affected by the technology experimentation cycles wherein designers and developers interact with technology exploring the potential alternatives in order to enrich the business's value proposition.

Our study has limitations which offer possibilities for future research. First, we investigated how experimentation with technology triggers reorientations but we did not investigate internal dynamics neither decision-making process within the team. We encourage scholars to explore how these internal dynamics work, how the relationships between members can affect the reorientation decisions. Further, it is likely that the growth stage (i.e. early-stage and later-stage) of the new firm influences directly or indirectly the strategic reorientations. Considering the recent interest in explaining the lifecycle of new firms (Paternoster et al., 2014), it would be intriguing to explore how new ventures undertake strategic reorientations through a temporal perspective.

Moreover, insights from this study are grounded in particular founders who operate in particular institutions and context; certainly, to conduct further research analyzing different

firms would enable to identify how contextual differences may affect the reorientations or not, and also identify different patterns of strategy formation.

Our study and framework advance research at the nexus of strategy formulation in entrepreneurship by incorporating technological-interactions as important motives for adaptation and learning in new ventures. We hope that our study will motivate additional research in this vein.

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