

Postgraduate Schools in Developing Countries

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Abstract— The increasing gap between developed and developing countries can be effectively addressed by coordinated north-south cooperation only. The development pace is slow in countries with low budgets for science and technology investment. To tackle a lack of government support, human talent (critical mass), infrastructure, internationalization, financial resources and low designated time for research activities, a research ecosystem needs to be built using the better practices of the developed world in a participative environment, both in science/technology as well as in a partnership with the world markets. While developed countries introduce new science/technology products, the developing countries are the consumers of it and a larger leakage of low GDP resources is incurred, increasing the gap. In this work we introduce a cooperation model that sets up what is to be intended a new postgraduate school, which is based on intensive research using what we call the extended *Sábato’s approach*. This model looks for the creation of a new development framework that, nowadays, is successfully used by developed countries. We look to create new development based on global market niches, bringing local technology companies to existence. We expect this approach to be instantiated at the Bolivian Universities with international cooperation, trying to solve our NP-Completeness issue.

Keywords—*Sabato’s triangle, Research, Postgraduate Schools, Research Ecosystem, development gap, peace engineering*

I. INTRODUCTION

The gross domestic products (GDP) in developing countries are low when compared to the GDPs of developed ones [1], [17]. Economists agree that the main factor in this worldwide economic performance divergence is significantly due to lagging labor productivity and managerial efficiency, related in part to the failure to adopt the latest technologies or to update the labor force [2]. This gap needs to be closed by creating new education paradigms as peace engineering proposes. Approaches that can diminish the international knowledge-gap between developed and developing countries

through reinforced universities and their relationship in a globalized world.

Nowadays, despite the ongoing efforts and impulses given by the national governments of countries in development with the aim to close the gap in the development of science and technology (S&T), when their development is compared with the developed countries, we can perceive that a long walk still must be done [3]. The enormous gap between the research groups of countries in development and the ones of developed countries is remarkable. On one hand, the first ones are trying to address problems relating to emerging industries in their countries, industries that are not necessarily the most competitive ones and perhaps are not leaders in productivity worldwide [4]. On the other hand, researchers in developed countries are focusing in answering fundamental questions that relate to advancing scientific knowledge and developing new technologies [5]. Those scientists look towards a complete understanding of a natural phenomenon; one that will enable to create new solution that will flood the world with new products and will increase the gap between developed and the developing countries [6] [7].

The scenario becomes difficult to solve. Our aim of raising our research processes in S&T to levels like those of internationally recognized universities seems to be unattainable due to an existing gap in: training, research, budgets and clear development policy and plans. Our universities in development countries require solving these issues to compete with developed countries’ universities [18].

Through peace engineering, each developing country should make an effort to burn through development stages and advance towards more productive development environments. Researchers in the developing world must go from being simple users of S&T, trying to fulfill a particular need (user role), to full-fledged actors of the world development in S&T diminishing the existing gap (adopting a developer role). We believe that this could be achieved by creating new

postgraduate schools, which operate in a true research ecosystem and with an active participation of the developed world.

The paper is outlined as follows: Section II presents a background and describes a proposed general approach. Section III describes Sabato's approach and extends the paradigm, introducing internationalization with the extended Sabato's approach based in an international Research Ecosystem. Section IV discusses the Postgraduate School and the importance of internationalization in order to create the difference. Finally, in Section V the article is concluded.

II. BACKGROUND

In this section, we present a general background, introducing first the general issues faced by developing countries' universities. Furthermore, to conclude this section the Research Ecosystem of our postgraduate schools is delineated.

A. Basic or applied research

Due to budget constraints, the question of which type of research approach to be done, basic or applied, arises. On one hand, basic research has as the ultimate objective to obtain and collect information to build knowledge bases, which are added to previous information. In other words, it extends and broadens the base knowledge, nevertheless is costly compared with a applied research [8] [9]. On the other hand, applied research aims to solve a specific problem or approach. Those problems that are often related to the industry and are usually funded for their development [10].

In developing countries, this difficult to answer question arises, and it emerges prominently in our universities: what type of research should our universities carry out? The consensus in our institutions is that we cannot stop basic scientific research despite its prohibitive costs. Basically, it is difficult to lead applied research with innovative solutions for our growing industries without trying to fulfill worldwide needs.

A paradigm of Complementarity could help to achieve both research approaches. A university institution in a developing country should respond to both research types. To achieve this, it is fundamental to enhance our Postgraduate Schools. Our Universities require a real insertion in the developed world, and this depends on the coordination and creation of new development lines with the participation of the developed world in a subsidiarity way. The enhanced postgraduate schools require an active collaboration of Universities of the developed world.

B. Basic Research Ecosystem

One of the key factors for developing S&T, as well as to achieve basic or applied research programs, is closely related to the establishment of a research ecosystem [11] [12]. The research ecosystem establishes a complete environment capable of bringing all the necessary mechanisms to catalyze innovative activities in S&T. To become a major university worldwide and become the engine for progress, creating new

knowledge and exploring the found niches that are catalyzing new productive opportunities, we require the establishment of a real research ecosystem.

Establish the dynamic relations of a research ecosystem (see Fig. 1) is still a task in course in universities of the developing countries. We still need to work carefully to establish the main components of the research ecosystem. Such components are enounced as follows:

- **Administrative factor:** Regulations, norms, policies, databases.
- **Research stakeholders:** Faculties, Research Units, plant researchers, outstanding undergraduate and graduate students.
- **Infrastructure:** Campus dimension, facilities, equipment.
- **Intellectual:** Knowledge, expertise, information, ideas.
- **Financial stakeholders:** Scholarships for research, funding, angel investors, projects co-financed in research and postgraduate programs.
- **Internationalization:** Internal knowledge networks in the institution, national and international networks, attendance at conferences, short international courses and sabbaticals.

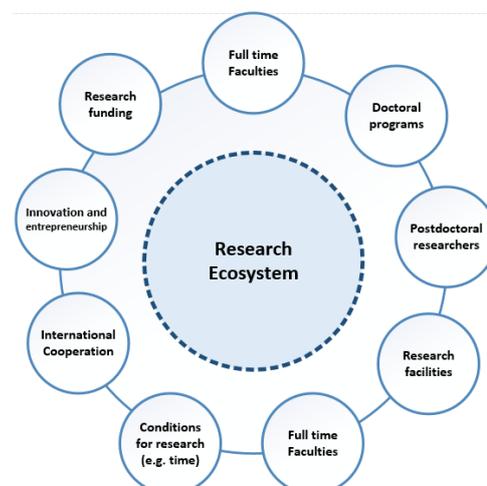


Fig. 1 Components of a Research Ecosystem

The aforementioned components are crucial to enable a proper research activity in any postgraduate school and to be considered as a development motor element. Therefore, research units within the research ecosystems such as research labs, should be in charge to create successful postgraduate programs in which the research component is crucial for their activities and doing S&T within academic degree programs. Meanwhile avoiding the creation of professional certificates only (see fig 4). Furthermore, the new postgraduate schools should promote not only training and research they should guide the university extension widening their tasks, creating a real research culture.

When the research culture is rooted within an institution, research and innovation are breathed naturally, in the way of being and acting of researchers, based on the functioning of a research ecosystem that provides the basic elements for S&T development.

The success of the research ecosystem lies in the total interaction of the different stakeholders [11]. Tasks such as training, research and university extension, require that its community of researchers reach a high level of interaction with each other (internally in the university), as well as with its environment, and especially between the interested parties in the development of knowledge or products. A close interaction between internal and external stakeholders when the research processes are being developed (e.g. researchers and clients, both denominated as stakeholders) is needed. The interaction requires a constant transfer of knowledge between the parties, thus processes and agreements at the system level that encourage and achieve the realization of research are to be created. For this, it is necessary that universities have an Liaison Office with the Industry and, to fulfill country policies, with the participation of the government.

III. FROM SÁBATO'S TRIANGLE TO AN EXTENDED SÁBATO'S APPROACH AND THE RESEARCH ECOSYSTEM

In this section, we revisit Sábato's approach, relating it with outsourcing and extending the idea of outsourcing with Sábato's proposal.

A. Sábato's approach

Sábato's triangle [13] [14] is a model that establishes a close interrelation between science, industry and government. This scientific-technological system requires three sectors which are strongly linked together over the long term to function: The state (which formulates and implements policy); the scientific and technological infrastructure (which provides technology, e.g. university); and the productive sector (which uses technology, e.g. industry). This interrelationship is portrayed in the form of a triangle as is depicted in Fig 2.

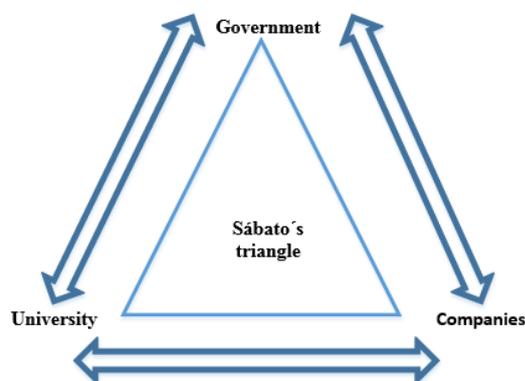


Fig. 2 Sábato's triangle

This model has been partially successful in some Latin-American countries. The main problem arises when research budgets are considered. The weak performance of the private enterprises that hardly invest resources in research and development has limited its spread-out. Therefore, a new extended mechanism should be introduced to avoid the budget constraints and allow the universities to fulfill their role.

B. The outsourcing and offshoring wave

The world's dynamic has evolved and several tasks in the field of S&T have been outsourced by the developed countries [15] [16]. Business dynamics are guided by the paradigm of business without barriers and a borderless world.

The global citizenship concept must be extended so that the concept of global researcher can be created. The participation in the S&T development has to be established worldwide and the global researcher must have the rights and responsibilities to be a member of the world and coauthor of its development. Researchers should not have a particular citizenship, they should be considered as global researchers without any prejudice of the particular nation in which they live, and this should be considered an essential part of peace engineering.

C. The extended Sabato Approach

Universities must define new collaborations with external and international institutions, the industry and central or departmental government, aiming towards improving Sábato's approach.

We are revisiting Sábato's approach due its important impact in Latin-American countries since its introduction in the 60s. The three main triangle components that relate to scientific-technological policy require being redefined and extended. Nowadays, considering that we inhabit a globalized world, we define them as follows:

1. The State: Acts as a co-designer of and executor of the innovation policy. Nowadays, the worldwide development factor should be considered within a global multinational policy, in which developed countries' governments consider complementarity in S&T development. Complementarity refers to allowing developing countries to participate in S&T programs augmenting and complementing the research that is being achieved in developed countries.
2. The scientific-technological component: Which oversees fulfilling of the S&T needs, e.g. university, research centers, etc. In this approach, it should be guided by the industry and worldwide government policies, producing both regional solutions as well as global solutions considering the complementary approach.
3. Productive sector: Which is the client or technology seeker that benefits from the innovation process. The new approach needs an industry that contemplates a

global view, considering complementarity and new emerging development niches in the world.

To enable the aforementioned approach, it is necessary to make new policies regionally (e.g. South America) and globally, between worldwide governments (e.g. OAS, UN, etc.) . The new polices should contemplate development sharing in a peace engineering approach. The fundamental topics that they must discuss, and address are:

1. Assurance of Markets for everyone
2. Participation in Science and Technology development
3. Planning of development in a complementary way

The following figure states the extended Sábato's approach to sustain a world that believes in peace engineering.

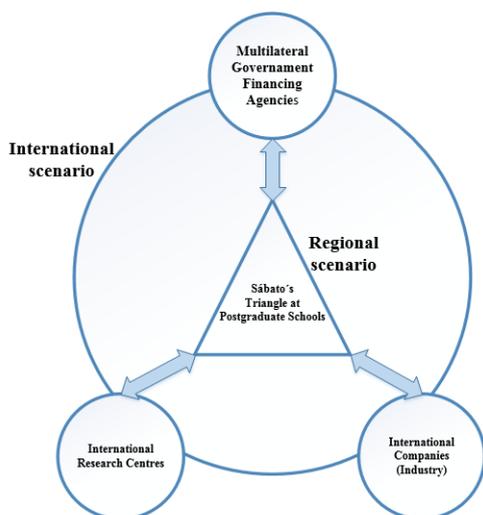


Fig. 3 Extended Sábato's approach

D. Planning the S&T activities in a complementary perspective: Postgraduate schools escences

We have stated that peace engineering requires creating a worldwide commerce model in which the S&T creation and production is shared between the developed and in developing countries. This sustainable model requires redefining prices and values, especially in markets that have historical market definitions. The new policies have to surpass the political boundaries that were traditionally adopted in those definitions. In the development of S&T as well as in a worldwide market shared between developed and in development countries complementarity will introduce new balance in our economies and will diminish the development gap between them.

A shared market economy in which developed countries establish a shared responsibility is necessary and it should be led by universities. A peace-engineering model should lead us to create both social justice and environmental sustainability. In practice, a complementary economy is introduced through a

continuous process of redistribution of the markets and shared development in the S&T niches for a worldwide equity development scenario.

IV. THE POSTGRADUATE SHOOLS AND INTERNATIONALIZATION MODEL

Traditionally postgraduate schools offer professional master's degrees that are similar to a Master of Science program but without a strict thesis work (research component). The new postgraduate schools should be required to continue offering professional master's degrees, because the industry requires improved and updated professionals. Nevertheless, those schools should be required to increase the number and quality of the Master of Sciences programs such that we are allowed to improve new Doctorate Courses that we have to implement. Therefore, new postgraduate schools should combine professional certificates, with improved Academic Graduate Education (MSc and PhD), as is depicted in Fig. 4. Furthermore, to develop their research ecosystem, new schools require following international models. For this, each university in the developing countries should have a partner university in the developed world to help the establishment of the research ecosystem following international models. In this section, we present some tasks for helping the creation of research ecosystems with international cooperation.

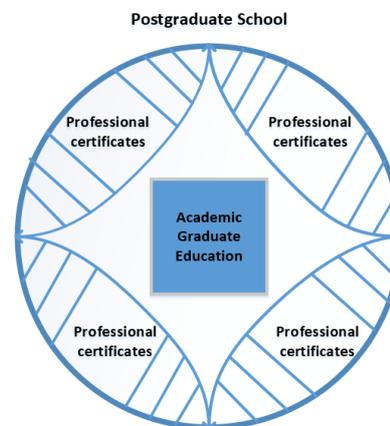


Fig 4. Professional certificates Academic components of a Postgraduate School.

A. University-industry cooperation program

The new approach requires that our universities consider that an important component for a research ecosystem is a collaborative liaison office between the university and the industry/government as seen in Fig. 5. This office is responsible for managing the interaction between those stakeholders, governing issues of intellectual property (IP) and maximizing the income from these intangibles. This office acts as a source of information about the formation of companies on the university campus and/or the institutional relationship offered by the university to carry out research work on demand in both the local and global field. The following figure depicts the described university and industry relationship.

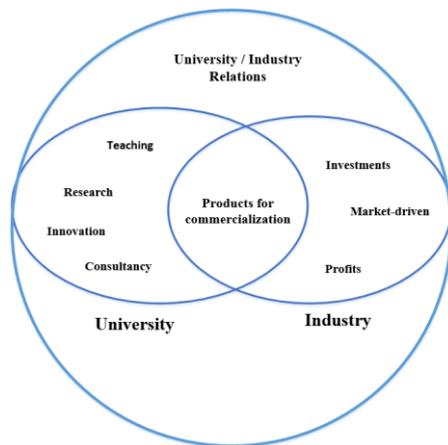


Fig 5. University and industry relationship

A strong relationship culture between the university and the industry requires working carefully in the following points:

- Defining the strategic context of research projects and selecting them for execution after that evaluation.
- Internalizing along to the university research team, the vision of the industrial company, seeking to help them to achieve their goals.
- Investing in long-term relationships with the industry, in a win - win approach.
- Establishing strong communication links within the team of university researchers, considering all the development support areas.
- Creating a broad awareness of the project within the company, rationalizing the innovation task that University is achieving, showing that this is a joint task.

B. Administration

Administration improvement is another pillar of a research ecosystem. The new administration should avoid having a vertical structure. Instead, the new governance should tend to decentralize processes and decision making in a subsidiary fashion, replacing its vertical administration with a horizontal one that facilitates innovation processes. Furthermore, administration bottlenecks usually are related to budget constraints; therefore, the new administration should look to promote operation under the paradigm of "Research on demand", adopting the extended Sábato's approach.

Postgraduate school research units must have a clear development plan; a plan that states its research topics, considering both local and global needs (co-participation of the S&T development). For that, the following tasks are considered:

- Creation of university and regional-wide databases to allow us to categorize the Leading Researchers in different knowledge domains.

- Refinement of both Short-term and Medium-term development plans, considering complementarity and both local and global market's needs.
- Establishment of strategic research lines that support both local and global needs.
- To create a Regulation of the Researcher entity that operates in both nationwide and regional fashion (e.g., Bolivia, South America), to facilitate the internationalization (e.g. mobility, jointly research, etc.).
- Create governance bases for Graduate Schools with the participation of partner universities of the developed world. This should allow us to get immersed in a complementary and participative development.

C. Critical mass (Research Stakeholders)

It is well known that knowledge and expertise are basic for any country's development and for any university research ecosystem. It is also well known that our universities need qualified researchers to produce a broad base of knowledge relevant to diminishing the knowledge gap and improving our economies. To achieve this, it is necessary to establish an agreement between in-development countries and developed ones, creating the necessary mechanisms to augment and maintain our critical mass of researchers (without brain drain) then they undertake postgraduate studies abroad. The classic approach suggests building our research capacity by adopting the research training schemes of developed countries and this is quite good. Nevertheless, the approach this be completed with the our model, which suggests a close and complementary cooperation of both worlds in order to create, maintain and develop our critical mass and S&T development. To achieve this, it is necessary to consider the following tasks:

- Redefine and update undergraduate curricula with standards of the developed world.
- Creation of Master programs and Doctorates with international cooperation and with international standards.
- High mobility worldwide under the global researcher paradigm.

D. Infrastructure

A fundamental component of a research ecosystem is its infrastructure. The design and implementation of a new postgraduate school with strong laboratories complex should be achieved with international collaboration. This infrastructure should be the seed to start our S&T development, using it not only for teaching activities, but also for Research activities.

An appropriate research ecosystem needs to produce immediate outcomes. As in the case of large universities, in which the researchers have available university facilities twenty-four hours a day and seven days a week (24/7), our universities need to adopt the continuous work paradigm in

order to increase our productivity, power up our economy and start diminishing the development gap.

E. Financial Stakeholders

The financial issues are important to the operation of any enterprise and require to be approached carefully in the research ecosystem. We still believe in international cooperation as a potential financial seed option in several knowledge domains, and in the operation of worldwide banks and other entities to finance clear development plans. Nevertheless, no financial efforts will be enough if the complementarity in S&T is not assumed by the developed world.

In order to have a fluid relationship with the financial stakeholder (e.g. industry, government, worldwide industries, etc.), postgraduate schools need to create a special unit that is continually evaluating the possibilities of funding and opportunities to obtain scholarships, investors, etc. To allow the aforementioned ideas, it is suggested:

- To create international courses in financial entrepreneurship and a school dedicated to teaching how to deal with all those financial initiative issues.
- To create a database of funding entities and a mechanism to access the resources in an easy way to from the point of view of the researchers.
- Rethink the mechanisms so that, with the Industry and International Cooperation, it becomes possible to create and / or reactivate a set of incubators of technology-based companies.

F. Internationalization

Government and universities should promote the participation of researchers in internal knowledge networks (regional), as well as international networks. These participations should also be encouraged by the University and the postgraduate school. We encourage the internationalization of postgraduate schools, promoting the realization of the following tasks:

- To participate with international cooperation in the elaboration of a mechanism to enable our S&T development considering the complementary paradigm.
- Creation of a strategy to approach the national and international industry.

V. CONCLUSION

We have stated our point of view with the aim of reducing both the S&T and economic gap between in-development countries and the developed ones. To achieve this, we must implement coordinated north-south cooperation based on complementarity. A postgraduate school should be the seed to enable research ecosystems, complete systems capable of enhance the S&T development of our universities and our

countries. All these aims can be possible only with a real collaboration of the developed world in a world capable of doing peace engineering for a more harmonious development sharing the world markets using the extended Sábato's approach.

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