Applying FTA methods in less developed countries

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Future-Oriented Technology Analysis (FTA) methods have been used in highly developed countries for decades to improve competitive strategies, evaluate social responses to technological development paths, and foresee critical situations in sensitive areas, such as energy, the environment, natural resources and demographic trends, as well as to explore the implications of advanced technologies in areas like ICT technologies and basic research on molecular biology.

FTA methods have been increasingly considered as essential inputs for decision-making at different levels, whether by national and regional policy makers or by businesses and other actors. FTA methods now play an important role in decision-making in the fields of R&D, risk evaluation, environmental studies, S&T policies and strategies design, support for innovation, and evaluation of the social impact of innovations.

As the nature of these decisions become more complex, so FTA methods are becoming increasingly sophisticated and diverse. Methods for analyzing future technologies now include prospective studies based upon the Delphi method, technological intelligence, mining of bibliometric and patents databases, mathematical simulation models and scenarios, among others. The common feature of all these methods is that they are tools for ordering information, discovering behavior patterns, and understanding relationships between different phenomena, thus making the social impact of developments in the field of science and technology more foreseeable.

The value of FTA methods for formulating accurate predictions of future events is now widely accepted by decision makers in both the public and the private sectors. This point is worth stressing because the effectiveness of FTA methods in decision making processes not only depends on the quality of the studies produced but also, to a large extent, on the willingness of decision makers to implement the proposals of these studies. Here, as in other fields of social activity, demand plays an important role and this demand should be stimulated.

FTA instruments could also be very useful for less developed countries (LDC). As they face major challenges from **global competition** and **current paths of technological development**, FTA could play a key role in both areas in designing strategies for social and economic development aimed at taking advantage of opportunities and reducing risks. Nevertheless, experience in this field is limited and there are still difficulties in applying FTA instruments in the economic, social and political context of LDC.

According to their FTA experience, no one LDC, as yet, belongs to the “leaders’ group”. Only Brazil might be included in a “followers’ group” while an LDC like India would be a part of a “recent followers’ group”. Most Latin American countries, however, like most other LDC, belong to an “incipient group”.

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Sadly, this classification ignores the fact that, in the '70s, Latin American countries performed some very important prospective studies, such as the Bariloche Foundation's Latin American World Model created in response to the "Limits to Growth" report. However, there has been little follow-up since then on those pioneering exercises.

This paper focuses on experiences with FTA methods in Latin America. It remains to be seen whether the findings presented here are applicable to LDC outside the region.

Latin American experience of prospective and future-oriented studies

Latin American countries were forerunners in the use of prospective methods for improving policies in the area of S&T. These policies were implemented from the Fifties onwards within a framework of broader development strategies. Indeed, most countries in Latin America began to develop institutional structures for science and technology during this period along the guidelines proposed by UNESCO and taking France's CNRS (Centre National de la Recherche Scientifique) as a source of inspiration. All these initiatives were guided by the linear diffusion model of scientific knowledge and technological transfer, whose influence on science policy was at its height.

The first prospective studies were intended to understand and predict the structure of the word, as well as to support an alternative vision of the international distribution of power and wealth which in turn, in order to materialize, would have required the capacity to introduce major changes on the real facts. This affected the predictive power of the models by depriving them of an objective point of view. As the development model began to fail and the world economy entered a period of transformation during the Seventies, the wishful thinking that had inspired those models became more obvious. The two pioneering studies were the Latin American World Model and the Technological Outlook for Latin America project (known in Spanish as PTAL). Apart from defining the ethical and political principles to be pursued, neither achieved very much owing to their normative approach. Also, their holistic aspirations contrasted with the insufficiency of the information available.

Latin American World Model

From the outset, Latin American approaches have been directed at understanding and predicting the structure of the world. The most famous of these was the "Latin American World Model" designed by the Bariloche Foundation of Argentina, under the direction of Amílcar Herrera. The Latin American World Model was first proposed in Rio de Janeiro in the early '70s with the purpose of refuting the Club of Rome's report entitled "The Limits to Growth" and creating a model based on alternative assumptions. This task was entrusted to the Bariloche Foundation.[1]

The "Limits to Growth" model was an analysis that set out to show the limits imposed on growth by the physical environment. Based on various assumptions about the behavior of the humanity and the availability of natural resources, its central hypothesis was that exponential population growth and consumption would necessarily lead to a "catastrophe" midway through the 21st century. Unless these trends were corrected, the exhaustion of nonrenewable natural resources and environmental pollution would eventually lead to the collapse of the ecosystem. The key to averting the catastrophe

[1] Marí and Callejo (2000).

envisaged in the Club of Rome's report was to control population growth, reduce pollution and use resources in a rational way.

The Latin American World Model started from a different assumption: the most important problems confronting the modern world are not physical but social and political, and arise from the unequal distribution of power in the world at both national and international levels. Consequently, it did not try to predict trends by examining present realities, but to propose a final goal, a wished-for scenario or the image of an ideal society.

At the preliminary stage, discussion was centered on the theoretical assumptions in the "Limits to Growth" report about the availability and use of natural resources and increasing pollution. The concept of "reserves" was also discussed – a concept that did not reflect the earth's richness, but only the resources that were known about at the time. The authors of the model indicated that although there were no scientific reasons to anticipate an ecological catastrophe or an acute shortage of resources as "Limits to Growth" has done, this did not mean that such danger could not exist if the social model changed. On the contrary, they argued that the social model they proposed guaranteed that there would be no danger of a catastrophe. They also argued that it was necessary to reduce the rate of technological development since advances in technology had already outstripped existing consumer needs.

An attempt was made to show with a mathematical simulation model that the expenditure of natural resources was not the real problem and that, as things stood, the different countries or regions of the world, especially the poorest, could achieve the proposed goal in a reasonable period of time. Various applications of the mathematical model demonstrated that by applying the proposed policies, mankind could reach acceptable levels of well-being in just over a generation, with practically no physical limitations.

With regard to the assumptions mentioned earlier and the idea that there are no absolute physical limits to human development, the model tried "to demonstrate" the viability of the proposed society starting from the existing natural resources, but assuming that the necessary social and political changes required by the model would actually happen. The model also showed that population growth would descend as general living conditions improved, especially those related to basic necessities.

The Latin American World Model did not try to diminish the problem of the exhaustion of resources. Simply, it wanted to focus the model on social and political structures. The development of the model was a valuable experience because, in addition to its intrinsic value, a new school of technicians was created that spread across Latin America. In particular, their model served as an inspiration for a long term economic simulation model adopted by the United Nations. This model was used for the development of long term planning models and for the formation of technicians.[2]

Technological Outlook for Latin America (PTAL) project

One of the spin-offs from the Latin American World Model was Technological Outlook for Latin America project (PTAL) that started up in 1983. Again, Amílcar Herrera led the project but this time it was located at the Center for Scientific and Technological Policy of the Institute of Geosciences at the University of Campinas and a network of Latin American centers took part.[3]

[2] Ibidem.
[3] Ibidem.

The project came at a moment when the impact of the new technologies spreading across the globe was threatening to change existing patterns of production and theories of technical change. The project analyzed these trends and existing future-oriented studies. Like the Bariloche Model before it and unlike the trend extrapolation studies that dominated in the developed world, the project took an ideological and normative approach. As in the Bariloche Model, an ideal society was defined: egalitarian, participative, independent (non--autarkic), with free time for creative activities, sober, intrinsically compatible with the physical environment.

The Outlook for Latin America (PTAL) project was methodologically different, from the Latin American World Model. While the latter had been based on simulations, PTAL worked with scenarios. In order to construct the scenarios, key variables, both internal and external, were defined. Attempts were made to integrate some external variables into bipolar constructs, such as the tension between dependency and autonomy in Latin American countries, or alternative scenarios of world-wide economic crisis in contrast with a new phase of global economic growth. The internal variables included the predominant type of social agreement, the level of Latin American cooperation that could be achieved and the style of development. Also transformation factors were considered, such as currently existing “heavy" trends and the germs of the future (fundamentally the new technologies and the emerging social movements). The project assigned great importance to social movements as a fundamental element of change.

The project devoted much of its efforts to the analysis of impacts and possibilities arising from developments in new technologies, mainly computer science, biotechnology and new materials. To this end, guidelines for scientific and technological policies were suggested in each of these areas.

Unlike what had happened with the Latin American World-wide Model, the PTAL not only tried to design an ideal scenario, but also a strategy to achieve it.

Study of opportunities and strategies for the MERCOSUR

In 1999 the O.A.S. financed a project bringing together experts from six different countries: Argentina, Bolivia, Brazil, Chile, Paraguay and Uruguay. The project, known as "Opportunities and Strategies for the MERCOSUR", involved the use of the Delphi method on regional scale. The study included definition of strategic targets, identification of opportunities, analysis of trends and construction of future-oriented hypotheses about the extended MERCOSUR (Chile and Bolivia were then in the process of joining the four existing member countries). The time horizon of the study was limited to five years into the future because of the volatile nature of economic, social and political situations in the region.

The project was developed by an international team of specialists in scientific and technological policy from each of the member countries of the extended MERCOSUR. A schedule was adopted that included opinion surveys, national reports and a final regional report. The study also included a SWOT analysis of the process of economic and social development within the MERCOSUR. More exactly the steps were as follows:

a) an opinion survey aiming at identifying the scientific capabilities needed to achieve MERCOSUR strategic targets;
b) elaboration of national reports;
c) consultation, discussions and interviews with specialists; and
d) the publication of a regional MERCOSUR document.

A modified Delphi method was used for the opinion survey. The first round included 120 significant actors involved in regional decision making processes (politicians responsible for coordinating the activities of the MERCOSUR, opinion leaders, as well as spokesmen and spokeswomen in important positions for the process of regional integration). The second round, significant actors in the field of science, technology and innovation were questioned.

The first Delphi exercise aimed to identify strategic elements for the development of the MERCOSUR taking the views of important social actors involved in the process of regional integration as its starting point. Participants responded to questionnaires designed to elicit their views about the future of regional integration. The data obtained made it possible to define strategic areas and opportunities for MERCOSUR development, as well as giving an overview of the current level of integration of scientific activities within the process of regional development.

Once high-priority areas and opportunities had been identified in the first round of consultations, a second round of consultations was carried out to determine the extent to which the national and regional scientific capabilities needed to achieve the previously identified strategic targets were, in fact, available. In particular, questions focused on the availability of these capabilities, the need to develop new capabilities, the extent to which different national systems of science and technology in the region complimented one another, the potential for initiatives in intra-regional scientific cooperation, and the number and effectiveness of existing policy instruments.

Not only scientists and technologists participated in this second round of consultations, but also other actors playing a significant role in the definition of science, technology and innovation policies: innovative entrepreneurs, science and technology policy analysts, and technology consultants. Around 60 specialists from the different member countries were consulted.

Once both Delphi exercises had been completed – that is, once the necessary strategic elements for the development of the MERCOSUR had been identified and the national and regional scientific capabilities needed to meet the strategic targets of the MERCOSUR had been determined – the next step was to draw up national reports on strategic targets, opportunities and the scientific capabilities of each member country.

In order to improve the quality of the reports, additional consultations and interviews were held with specialists in the previously determined strategic areas. Members of the scientific and technological communities and the economic-industrial sectors were asked to define how the different national systems of science, technology and innovation might contribute to the strategic goals of the MERCOSUR. However, the general guidelines were not used as these had proved not to be accurate enough and had, in fact, been replaced during the second Delphi.

Finally, the results of these consultations were analyzed together with the different national reports and a set of recommendations for improving science, technology and innovation policies in the MERCOSUR was drawn up. The recommendations of the study were adopted by the MERCOSUR's Special Meeting on Science and Technology (known in Spanish as RECyT), the body responsible for promoting regional integration in science and technology and defining the guidelines for integration in this area. A regional "Framework Program" for science, technology and innovation is currently being drafted based on recommendations of the study.

Other experiences

The Latin America and Caribbean Technology Foresight Initiative supported by the United Nations Industrial Development Organization (UNIDO) was created to as network of Latin American and Caribbean countries for the exchange of knowledge about technology forecasting between these and other countries. The program, which was only partly implemented, set out to construct a database of experiences and methodology in this field and to provide opportunities for distance training. Although Brazil was a pioneer in this area, UNIDO sponsorship made it possible to promote this initiative in other Latin American countries.[4]

The Ibero-American Network of Technological Prospective, belonging to the Ibero-American Program of Science and Technology for Development - CYTED, which began operating in 2003 and is currently still active, was created to promote regional capabilities in technology forecasting and to serve as an instrument for formulating government, institutional and company policies and strategies. It is made up of experts from Argentina, Bolivia, Brazil, Colombia, Cuba, Spain, Uruguay and Venezuela. One of the objectives of the network is to promote forecasting in areas of interest to the CYTED Program and members countries.

Experience in the use of the Delphi method

Recent Latin American initiatives have been mainly limited to a small number of Delphi studies oriented to improve centralized planning, mostly at a national level. Indeed, the majority of recent future-oriented studies in Latin America in the field of science and the technology have been based either on the Delphi method and or in some cases, on scenario writing.

One of the reasons why Delphi has become the method of choice for FTA in Latin America is its flexibility since it only requires experience in carrying out surveys. Unfortunately, it is not always possible to balance a Delphi study with more "objective" methods as this type of information is frequently not available.

Nevertheless, there have been several other national initiatives besides the regional Delphi study of opportunities and strategies for the MERCOSUR mentioned earlier. In Brazil there have been some Delphi surveys aimed at enhancing competitiveness and technology training in industry, improving the quality of life of the population and promoting strategic lines of R&D. Delphi forecasting has also been used in human resources training and to develop the scientific and Brazil's technological infrastructure. The Brazilian Technology Foresight Program, created by Brazil's Ministry of Development, Industry and Foreign Trade, has focused on future-oriented analysis of chains of production in the plastics industry, civil construction, textiles and clothing, wood and furniture, among others.

In Chile a Delphi study was made of the country's positioning strategy, priorities for product development, training and education needs, technology development needs and other strategic areas. In 2001, Uruguay implemented the Uruguay 2015 Technology Foresight Program within the framework of a wider national foresight Initiative. This program focused on areas such as logistics and transport and used Delphi and scenario methods. In 2002 a study was made on Biotechnology in the Agro-alimentary System, using the technique of panels of experts. Argentina also carried out a Delphi study as the basis for its Strategic Plan in Science, Technology and Innovation 2005-2015.

[4] Mojica (2004).

Experience in predictive mathematical models

The design of mathematical models to represent complex systems is a technique that has been used in Latin-American countries to represent complex global, regional and local systems and to predict how they would evolve. The most outstanding example of these was the above mentioned Latin American World Model, which aspired to trace a broad path of development for LDC to follow. But it was not the only one. In 1995, a regional project known as “The ecological future of a continent. A prospective vision of Latin America" used simulation models to study land use within alternative socioeconomic scenarios.

The development of mathematical models for studying social processes in LDC can be traced back to Oscar Varsavsky (1971), whose approach was relatively well-known in Latin America some years ago, particularly in Buenos Aires, Caracas and Santiago de Chile. The method, known as "numerical experimentation" applied mathematical models to the social sciences. However, its usefulness was limited by the fact that the models only can detect clearly understandable and quantifiable elements and relationships, which can prove to be problematic in Latin America. In the field of science and technology, Latin American countries have many difficulties in developing long series of indicators. A basic shortage of information affects the validity and reliability of the models and accentuates the subjective biases of the people who design them. In addition, a minimum number of experts in mathematical modeling of complex systems are required, as well as a suitable institutional context. Few centers in the region have the necessary capability at present to develop models of this type and there is very little consensus about the need for them.

Experience in scenarios

Scenarios, as a method for extrapolating existing information into alternative versions of the future and for understanding the logic of events, are frequently used in LA countries particularly to analyze regional development and ecological problems. It is a relatively easy technique to apply since all it requires is experts in the field to be studied and the ability to organize the different dimensions in a logical manner. Their strengths and weaknesses of this method are intimately bound up with the logical structure of the scenarios: if the logical choices are well formulated, then it is a powerful tool; otherwise, it simply goes round in circles. Scenario writing is generally used to complement Delphi surveys.

Scenarios also incorporate, explicitly or implicitly, the perspective of their creators. For this reason, they are never totally neutral. Scenarios are based on scientific knowledge – an understanding of historical patterns, present conditions, physical and social processes – but they also require imagination to conceive, articulate and evaluate a whole range of social trends. The balance between knowledge and imagination may vary according to the purpose of the scenarios. This means that scenarios may be analytical (concentrating on the unfolding of the basic processes) or impressionistic (dramatizing with illustrations of specific events).[5]

In Colombia, COLCIENCIAS gave fresh impulse to future-oriented studies by financing the foresight agendas of regions like San Andrés, the Guajira, Amazonas, Casanare and Antioquia, among others. The agendas set out to analyze scenarios for regional technological scientific development with time horizons of ten and twenty years.

[5] Gallopín (1995).

The European Union's FAST Program commissioned and financed a study of Scenarios in Latin America which was carried out in 1989 and coordinated from the Center for Advanced Studies of the University of Buenos Aires. Academics from Argentina, Brazil, Chile and Uruguay participated in the program. From the methodological point of view, alternative scenarios were constructed on the axes" of "growth" and "equity". The project established a typology of scenarios on dimensions of political structure, economic policy model, directions in higher education and science and technology policy. The scenes were evaluated using a face-to-face Delphi type survey with leaders from several Latin American countries.

Monitoring and technological intelligence

Technological intelligence (TI), consisting of methods gathering reliable information and converting it into an intelligent product for decision making[6] is no so much applied in Latin-American countries, due to the difficulties for accessing international bibliographic and patents data bases. TI programs cover four basic areas: a) monitoring of technologies; b) evaluation and prognosis of technologies; c) evaluation of competitors, suppliers and associates; d) monitoring and analysis of social trends that impact on scientific and technological activities.

In methodological terms, TI attempts to explore future trends by extrapolating from data bases of patents, R&D, technological trade and similar information in order to infer how certain technologies will develop, whether offshoots will appear or whether these technologies will eventually divide and go separate ways. The tools of TI are those used in bibliometry: text mining or data mining and the creation of conceptual "maps" of patents or lines of research and development by means of suitable software. The basic requirements for this type of research are, of course, access to international data bases and technical expertise in using the software. This reminds us of the need for a minimum of institutional infrastructure, such as centers for competitive strategy. These exist in very few countries in Latin America.

In 2002 Colombia created the National Program for Technological and Industrial Foresight (PNP). The purpose of the program was to increase national capabilities and encourage dialogue between the government, industrialists, scientists and engineers and other social actors in order to construct a shared vision of the future and design long-term policies and strategies for scientific, technological and industrial development. The main organizations taking part in the program are COLCIENCIAS, the Andean Development Corporation and the Ministry of Industry, Commerce and Tourism. There is a permanent manager and a national committee made up of representatives from different institutions.[7]

Chile has a Technological Foresight Program (PPT) belonging to the "Program for Development and Technological Innovation" run by the Ministry of the Economy together with the Corporation for the Promotion of Production (CORFO), the National Commission for Scientific Research and Technology (CONICYT), the Foundation for Agricultural Innovation (FIA), the National Standards Institute (INN) and the Corporation for Technological Investigation (INTEC-Chile). The well known study "Imagining Chile's Economic Future" examined four fields: wines, aquiculture, biotechnology, and education. The National Institute for Scientific and Technological information (CAICYT) in Argentina has recently organized an area for TI studies and services.

[6] Escorsa, Maspons y Cruz (2006).
[7] Medina Vásquez y Rincón Bergman (2006).

FTA methods, requirements and conditions in LDC

FTA	Requirements		Conditions in the LDC
	Material resources	**Human and institutional resources**	
Mathematical simulation models	Technical equipment adequate for elaborating models	Academic groups devoted to elaborate mathematical simulation models, with the capacity of constructing symbolical representations of reality, giving relevance to its logical structure	Not every LDC have groups with the necessary scientific and technological skills
Analysis and projections of trends	Availability of long series of multianual indicators	- Existence of statistical information institutions - Technical capacities in the institutions devoted to statistics	Lack of information and abilities in the statistical institutions for elaborating long-term series
Delphi	Normal resources for conducting surveys	- Experts in applying Delphi methods - Abundance of thematic experts	Difficulties for achieving critical mass of experts on some subjects
Scenarios	General information to support the drawing of alternatives	Experts in elaborating scenarios	Not every LDC have experts to elaborate scenarios in strategic areas
Monitoring and technological intelligence	Access to bibliographic and patents databases	- Groups and institutions with adequate technical skills and the necessary linkage with stakeholders - Thematic scientific and technological advisers	Difficulty for accessing to databases

Difficulties for FTA in less developed countries

Which could be the explanation for the phenomenon of LA countries having been forerunners in the past and being "followers" or "incipient" users of FTA methods in the present time?

Some explanations are related to the context**:** the world has changed. Latin American initiatives were infuse with notions of endogenous development, which called into question the emerging political and economic order of the postwar period. Globalization and the increased path of technological change were some of the elements that caused a deep crisis of that development model. So far, Latin American countries cannot find successful strategies to face the new challenges. As somebody in Latin America once said: "in the good old times, the future was better". At least, it seemed to be more predictable.

Plausible explanations for the paradox are mostly related to the structural conditions of LDC. As Daniel Bell (1994) pointed out, the basic conditions for "prognosis" are:

a) an abundance of available information, and
b) stakeholders with foreseeable behaviors.

These factors, in turn, depend on the existence of:

c) appropriate social structures and adequate management resources, which are often lacking in LDC.

a) Availability of information

Bell claimed that prognosis requires stable situations and recurring phenomena or trends whose general direction, at least, can be described in terms of statistical time series or persistent historical tendencies.[8] In many LDC these statistical temporal series are not simply available.

In some countries, specific FTA methods cannot be applied because of poor surveys and lack of systematic information in basic areas, as well as difficulties in accessing international databases. The cost of accessing bibliometric databases, for instance, is an almost insurmountable difficulty for S&T institutions in LDC.

Many countries have severe difficulties in collecting and processing basic indicators of science, technology and innovation in a reliable and continuous way owing to a lack of expertise in the institutions responsible for producing that kind of information.

b) Foreseeable behavior of the stakeholders

According to Bell, prognosis is only possible when it can be assumed that the people who influence events behave rationally, recognize the limitations on their actions and the costs attached to different courses of actions, are prepared to play by the rules as these are generally understood and are prepared to be consistent. He also points out that when privileges and prejudices are involved, behavior tends to be far less rational.[9]

[8] Bell (1994).
[9] Ibidem.

The fact that the behaviour of the stakeholders is difficult to predict is partly due to lack of social, economic and political stability in LDC, and partly to the fact that multinational corporations with factories in LDC, are based abroad and their decisions are influenced by global, rather than local, concerns.

c) Structural conditions

However, the biggest difficulty is structural in nature and derives from the fact that LDC are not leaders but followers of technologies developed in other contexts. Thus, FTA methodologies developed in countries working on the S&T frontier are not always appropriate for LDC. This explains some of the criticisms that have been made about the validity of FTA methods and suggests there is a need to create new methods or adapt existing ones to the needs and operative possibilities of LDC. Some inspired thinking is needed in order to make FTA tools available to LDC.

There is a fundamental difference between the forecasting done in developed and developing countries: in industrialized countries, forecasting is linked to the pushing back of existing frontiers, the potential offered by knowledge and the future demands of society. In LDC forecasting takes on a different meaning. Faced with an international scenario of fierce scientific and technological development and increasingly limited resources, it is necessary to carefully evaluate the opportunities and the threats.

Another characteristic of developing countries is that they do not make the decisions; they receive them passively. Consequently, except in certain niche markets, forecasting is limited to the monitoring those area that show the greatest potential. Nevertheless, this subject is more complex than it might seem at first sight since it is not just a problem of information. Underdevelopment implies structural conditions that are very vulnerable to global events, which are difficult to anticipate and even more difficult to correct.

Universities, for example, are preparing many of their best graduates to cover the demand for professionals in industrialized countries. How they can make long term decisions in a context like that? In short, uncertainty is greater in LDC, there is less information available and fewer variables can be anticipated and controlled.

Nevertheless, these structural limitations do not imply determinism, and there are always opportunities that LDC can explore and strategies they can adopt to integrate more successfully into the global economy. This gives FTA an additional task, namely, to identify such opportunities. The ability to do this would offer LDC a powerful instrument to plan their development.

The challenges

Following the previous statements, it is necessary to build basic capabilities on at least three levels:

a) information systems and access to databases;
b) links among heterogeneous actors;
c) human and institutional resources.

The main challenge is, however, to promote changes in decision-making processes in order that decisions could be based upon high quality information about their future consequences and impacts.

Such a task is naturally beyond the scope of experts in FTA since it would require changes in behavior from other high-ranking actors in public and private institutions. Nevertheless, even within the field of FTA studies it is possible to demonstrate the need for this sort of information to define the available options more clearly and understand the consequences of present decisions.

a) Information systems
Information systems are a major area for improvement in Latin America and in most LDC. Basic indicators in the fields of science, technology, innovation and even higher education lack the necessary continuity and standardization. It is also necessary to facilitate access to bibliometry and patents databases for smaller countries with fewer available resources.

b) Linking heterogeneous actors
The second area for improvement –probably the most essential one for LDC- is networking. Systemic links should be developed among heterogeneous actors, such as academic groups and stakeholders, both at government and businesses levels to streamline FTA studies to decision-making.

c) Human and institutional resources
A certain number of trained people are needed so that FTA tools could be efficiently used. This means providing training and support for groups carrying out foresight studies. This process could be enhanced by networking between experienced and beginners groups, which would help to spread know-how and allow groups to learn from each other's experiences.

The Foresight Network of the Ibero-American Program of Science and Technology for Development - CYTED, is a good example of this. Very few future-oriented studies are carried out at postgraduate level in Latin American universities To make up for this scarcity, regional postgraduate programs are needed to pool the existing capabilities of different countries and thus contribute to the training of professionals in this area. A network of postgraduate students might compensate for the current shortage of professors with necessary skills. Networks in LDC could take advantage of international cooperation agreements to get professors from industrialized countries to come and teach at regional level.

The RICYT, a "good practice" to be taken into account

Some regional experiences, such as the Ibero-American Network of Science and Technology Indicators (RICYT), could be considered as examples of "good practices" that could be taken into account as a model for designing a strategy aimed at consolidating FTA capabilities.

RICYT was created in the Nineties, when it had become apparent that the scientific and technological information available in Latin America was highly unsatisfactory. Most countries lacked reliable and comparable information although some of them had made attempts in the Seventies to gather information on scientific and technological activities. Nevertheless, these attempts faded away in the following decade.

RICYT was set up by the CYTED Program in April 1995 as a collective undertaking to encourage and to facilitate the production of indicators for the diagnosis and management of science and the technology in the region. At the moment it involves

national S&T institutions from all American countries, Spain and Portugal. It also involves in it activities academic groups devoted to science, technology and society studies.

An initial characteristic of the network, that contained features of the CYTED Program, was that it brought together two diverse sets of actors: on the one hand, national organizations of science and technology, that are simultaneously producers and users of information; and, on the other hand, researchers devoted to studying the relationship between science, technology and society, as well as experts in indicators. This dual participation conditioned both the approach and the agenda. Thus, some concentrated more on designing indicators for policies while others preferred to explore new dimensions. This dual approach is still present and reflects the type of the actors who participate in the network.

The RICYT organized its activities in four areas:

a) Production and dissemination of information
This was the RICYT's main task, and it was intended to compensate for the existing dearth of information in most countries of the region.

b) Methodological agreements
This line of work aimed to reach agreements so that international norms on indicators could be adapted to the conditions of the region without abandoning the possibility of making international comparisons.

c) Consolidation of capabilities
This line of work aimed to produce technical capabilities for the development of the remaining tasks. The network set itself the goal of implementing training programs based on regional criteria.

d) Development of new indicators
This line of work was directed at developing new indicators for decision making in various areas of science, technology and innovation policy.

For just over ten years now, the RICYT has been collecting and publishing data regularly from all the countries of Latin America, as well as Spain and Portugal, using around fifty comparative indicators. Although the information is still discontinuous, for the first time there are also many complete series. These date from 1990 onwards and are updated annually.

By addressing multiple dimensions, the network proved to be a suitable organizational form for managing a triple heterogeneity:

a) Diversity of involved disciplines
b) Diversity among actors
c) Diversity of capabilities.

Diversity makes management more complex, and may prevent the emergence of a culture common and get in the way of efficiency. Nevertheless, it constitutes more of a challenge than a threat to the network and can be seen as an asset offering a whole range of opportunities.

The structural conditions referred to previously involve not only "internal conditions" (training human resources, availability of information and systemic links), but also

“external” conditions, such as a new culture in decision-making processes, both at public and private levels. RICYT was able to manage both dimensions of the process, producing better information and promoting its use in the decision-making process in S&T policies.

It will also have to take into account the problem of getting people to cooperate, especially key decision makers in science and technology. It will be necessary to reconcile institutional diversities and to answer the specific needs of the countries of the region. In short, it will be necessary to manage diversity. But seen in the right way, diversity constitutes a challenge and strength. By bringing together different capabilities, successful initiatives can emerge.

Last but not least: learning from the previous Latin American experience, FTA exercises should not be aimed at achieving holistic certainties. Rather, FTA could be useful for illuminating concrete scenarios in a general framework of uncertainty, allowing to identify opportunities and to solve problems.

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