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Knowing what research organizations actually do, with whom, where, how and for what purpose: Monitoring research portfolios and collaborations

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1. Introduction

Managers and policy makers have struggled to develop effective monitoring systems to track the evolution of research organizations. This paper presents the first components of a novel monitoring system for monitoring such organizations. These components can be used to generate detailed static pictures of the actual activities and partnerships of a large research program or organization, in other words, what the organization is actually doing, with whom, where, how and for what purpose. It can also identify whether new incentives or organizational structures have an immediate effect on the researchers' activities. Once developed, the full system will be able to monitor the evolution of the organization's activities and assess mid- and long-term effects of specific incentives. Essentially, the system asks individual researchers to list *all the important* collaborations they engaged in during the preceding 12 months and to provide some information about these collaborations. The data are then aggregated to describe the organization's portfolio of activities and engagement with other actors in the innovation system.

The system presented here can show how an organization actually allocates its efforts which can be different from budgetary allocations. This information is important for planning and management of research. As Argyris and Schön (1974) have shown, often there is a gap between what an organization plans and what it actually does. The divergence is particularly acute in not-for-profit research organizations because researchers are expected to raise an important share of their funds, meaning that managers have limited control over the researchers' activities.

Also, the system maps research activities as they are being conducted, which is important for resource allocation. Research organizations have struggled to generate information for this purpose, reverting often to ex-ante and ex-post impact assessments. While ex-ante assessments can provide some guidance for decision making, they have to be revised as the research progresses because the reality is usually different from what was predicted. The methodology presented in this paper can help in these revisions. On the other hand, ex-post impact assessments cannot be used for resource allocation because they can only be conducted after enough time has passed for the impacts to be measurable, in other words, many years after the decisions have been made. Since our system can be used at relatively short intervals (ideally every two or three years) and is based on current activities, its results can be used while the projects are still being implemented.

Three reasons justify analyzing the links established by researchers. Firstly, research is increasingly implemented by inter-disciplinary, multi-institutional teams that network formally and informally both locally and globally (vom Brocke & Lippe, 2015; Adams 2012; Lieff Benderly 2014; Stephan 2012; Bennett, Gadlin, & Levine-Finley, 2010). Secondly, programs to foster interdisciplinary, inter-institutional collaborations between researchers and other actors in innovation systems have been implemented in several countries and policy-makers are asking about their impacts (Trochim et al., 2011). Thirdly, collaborations with researchers and non-researchers are important influences that help researchers to better contribute to innovation processes

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and to become more productive and creative (Li, Liao, & Yen, 2013; Klenk, Hickey, & MacLellan, 2010; Wagner, 2008).

Finally, there is a strong pressure on research organizations to demonstrate the social and economic impacts of their activities (Kraemer 2006; Rusike et al., 2014). Traditionally, these impacts have been measured through rates of return estimated with econometric models (see, for instance, Alston, Norton, & Pardey, 1995). However, in recent years these methods have been criticized because they depend on very strong assumptions that impose simple, constant causalities on the data and do not take into account the complexity of research, where many causes interact in ways that change over time (Patton 2010). Thus, the focus has progressively shifted to the analysis of the roles research plays in innovation and social processes, which requires both the definition of the organization's theories of change and how its actual activities agree with or deviate from the theories of change (Mayne & Stern 2013). While there are many publications on how to build theories of change for research activities (Davies, 2004; ISPC, 2012), few works have been published on how to map the actual research activities of large programs or organizations. This paper contributes to fill this gap.

The system was developed in a pilot project that involved the Roots, Tubers and Bananas CGIAR Research Program (RTB), a large agricultural "research for development" program (RTB is described in Section 4).[1] The information for this project was collected only nine months after RTB started operating; therefore, its networks reflect mostly pre-existing activities. However, in its short life RTB induced important changes in the way research activities were conducted, fostering greater interaction among CGIAR centers, and refocusing partnerships according to the partners' capabilities and RTB's research priorities. The fact that the system could identify these changes despite their incipient nature attests to its effectiveness.

Section 2 presents the conceptual framework on which the system is based. Section 3 reviews recent publications that use Social Network Analysis techniques (SNA) to analyze research networks. Section 4 presents RTB, while Section 5 discusses the methodology used in the study. Section 6 discusses the type of information that the system generates and Section 7 concludes.

2. Conceptual framework

The system is strongly anchored to complexity theories (Axelrod & Cohen 1999) and evaluation frameworks based on them (Mayne & Stern 2013; Patton 2010), the innovation systems framework (Edquist 2005) and the recent literature on research systems (Stephan 2012; Wagner 2008). While several methods have been developed for monitoring programs (see, for example, Brandon et al., 2013), there is a dearth of research on monitoring complex programs and organizations such as large research institutions.

The system presented in this paper is based on the observation that interactions among researchers and non-research actors in an innovation system can be represented as networks (Kratzer, Gemuneden, & Lettl, 2008) that form a complex system. These systems are characterized by the interactions among different types of actors constrained by the socioeconomic and physical environment in which they operate (Axelrod & Cohen, 1999). Due to the large number of interacting forces, complex systems are essentially unpredictable. Planning can reduce the uncertainty but cannot eliminate it. Therefore, rigid strategic planning driven by ex-ante impact assessment is of little use and actors need to adapt their strategies as they collect new information about the evolving state of the system (Patton, 2010). However, this is no easy task. Due to their limited resources, decision makers need guidance on what information should be collected and how it should be interpreted (Mayne & Stern, 2013). This guidance is provided by what the decision makers know about the process and how they expect their interventions to influence it, in other words, by their theories of change. Also, in order to be adaptive, actors need process indicators that inform them about the current state of the system.

In the case of not-for-profit research organizations the theory of change and the process indicators can be built from the innovation systems framework, recent studies of the organization of research and a thorough knowledge of the organization that is being analyzed. In these organizations, the theory of change plays a critical role because they lack a clear indicator of success such as profit.

According to the innovation systems framework, research has positive social and economic impacts when researchers interact with different types of research and non-research partners in knowledge processes that feature several feedback loops (Edquist, 2005). Therefore, the theory of change posits that an agricultural research organization that interacts only with advanced research institutions and a few extension agents is likely to have a smaller impact than an organization that also interacts with private firms, farmer organizations and innovative farmers. The literature on research has also found that the quality of research depends critically on the researchers having active international connections (Wagner, 2008), which indicates that a researcher in a developing country that interacts only with colleagues in her organization should be less productive and creative than a researcher that has many international links. Therefore, the process indicators can be constructed from the links the organization establishes with other actors in the innovation system, and can be analyzed with simple tables and statistical methods, and SNA techniques as is explained below. It should be noted, though, that there are very few detailed studies that link research activities, the structure of networks and innovations. For example, it is not known how biotechnology networks should differ from animal health networks. Therefore, the information generated with this system can also be used to answer important theoretical and empirical questions about the relationship between research collaborations and innovation processes.

Other process indicators can be constructed by analyzing the organization's portfolio of activities. For example, the CGIAR has defined that it needs to strengthen its research on nutrition and health, with special focus on Africa and the least developed Asian and Latin American countries. With the system presented in this paper it is possible to calculate the share of collaborations established for research on a particular topic, the geographical focus, the type of research that is being conducted and other features. These results can then be compared with the organizational priorities and studied over time to understand the evolution of the networks. The information can be used as an input in management decisions.

Finally, since the researchers can identify whether a particular collaboration was established as a result of a specific incentive, such as a new line of financing, it is possible to identify the immediate impact of the incentive on the patterns of research activities and collaborations. The mid- and long-term effects can be identified by repeating the exercise periodically.

[1] Research for development is defined as scientific activities that are expected to have positive impacts on economic and social wellbeing and the sustainable management of natural resources.