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Designing a national science and technology evaluation system based on a new typology of international practices

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ABSTRACT

This paper aims to provide a new classification of national science and technology (S & T) evaluation systems. This evaluation system will consider five analytical dimensions extracted from international practices consisting of the following: evaluation system function, evaluation interactions framework, evaluation organization, evaluation model of funding, and process of result evaluation. The classification proposed in the present paper is intended for application in detecting the current position of and expanding suitable evaluation systems based on the countries' native context as a national analysis tool (especially for late-comer countries). Therefore, in the case of Iran, we reviewed both the existing and optimized modes of national science and technology evaluation systems. The results show that the existing evaluation system in Iran is not optimized, so evolutionary changes are required for obtaining the desired system goals. Policy results of the mentioned classification as well as national science and technology evaluation systems are considered. In general, it appears that such a descriptive analytical typology can be applicable for all countries. However, the classification is specifically applied for designing an optimized S & T evaluation system in Iran.

1. Introduction

The evolving S & T evaluation systems in several countries show that many of these countries have moved to consider all factors involved in the development of S & T in their economies (Vartiainen, 2002; Mrinalini and Nath, 2006; Georghiou and Laredo, 2006). Most of these evaluation systems have been formed gradually and developed through trial and error, and are not necessarily optimal. In Iran, for example, after three decades of dramatic S & T development, policy-makers have begun to evaluate the outcomes of the S & T evaluation system, and have discovered serious shortcomings including:

- The parallel evaluations by different institutions,
- Scattered and case-based evaluations,
- Overly controlling evaluations,
- Lack of the STI evaluation system integration,
- Lack of evaluated institutions' cooperation within the government agency in charge,
- Lack of attention to the interests of all key stakeholders in the evaluation system design,
- Lack of attention to social benefit of STI projects,
- Evaluation only based on output indicators (not impact indicators) (Farazkish, 2017).

It seems that there is no unique solution for dealing with such challenges in different countries, although the comparative studies show that the policy makers face similar key issues in various countries (Coryn et al., 2007). Identification of the main issues, as well as the approaches taken to cope with them in different countries, can be used as a starting point for the conceptual design of an optimal S & T evaluation system, particularly for latecomer countries. To achieve such an explanatory classification by considering extension and dispersion of the S & T evaluation system studies we offer a sound typology below (Marradi, 1990). Because of the different dimensions of the main issues and their solutions, the proposed classification is also multi-dimensional.

The advantage of such a typology is the possibility it gives to partitioning the national S & T evaluation solutions. In fact, this is a new descriptive (not prescriptive) analytical tool that can be used in two situations. At the first situation, a country's S & T evaluation system has been formed during the time. By applying the proposed typology in order to design the desired S & T evaluation system, the existing system

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can be optimized. But at the second situation, a late comer country needs to develop an S & T evaluation system from the beginning. The proposed classification enables the country to choose the specifications of its own S & T evaluation system based on similar experience contexts.

To clarify this advantage, and how to use it, we selected Iran as a case study, and the specifications of its optimized S & T evaluation system have been chosen based on its history and features of the existing system.

Section 2 of this paper describes the typology dimensions. In this regard, the national S & T evaluation systems are classified based on the evaluation system function, evaluation interactions framework, evaluation organization, evaluation model of funding, and process of result evaluation. The historical development of S & T in Iran concerning four different periods from 1980 to 2014 is explored in Section 3. Regarding the descriptive typology given in Section 2, the state of the art S & T evaluation system of Iran is described and also a general picture of the current situation is offered in Section 4. In Section 5, the evaluation system of Iran is dealt with the mentioned typology in order to make a gap analysis between current and desired conditions in Section 6. Finally, a policy conclusion is drawn in the last section. The proposed typology may be applicable in other countries.

2. Typology of national S & T evaluation systems

Comparative studies on S & T evaluation systems have a tendency towards reviewing the differences of evaluation approaches, strengths and weaknesses of each approach, and how they are developed (Coryn et al., 2007). In addition, some studies have analyzed the reasons for the variability in the evaluation systems. Gibbons and Georghiou (1987) suggest that this variety is a reflection of different political and managerial cultures.

But the main questions are: “How can these various experiences be applied by other countries?” and “How can the countries' current S & T evaluation systems be improved by learning from similar situations?” It seems that effective use of the other international cases is dependent on the ability of integrating and framing them as an explanatory typology (Elman, 2005). To achieve such an integrated analytical framework, the systemic and problem-oriented approach has been applied. After identifying the five key dimensions of an evaluation system (Phaal et al., 2004), the species of confronting countries with each dimension's issues also have been extracted. Explanations are provided in the following subsections.

2.1. Evaluation system function

The system level studies survey the effects of the governing structures of S & T on its evaluation system. According to this point of view, Molas-Gallart (2012) has introduced three main functions of national S & T evaluation systems:

- Distributing function, which seeks to distribute resources among the potential actors and stakeholders of a special policy or program;
- Improving function, which seeks to learn from the past experiences in order to find the best practices and replicate them;
- Controlling function, which surveys precisely the way of using public resources, individuals and institutions for the necessary activities in order to reach policy goals.

The differences identified in choosing the S & T evaluation function of countries are appropriate with the structure of their national S & T governance.

2.2. Evaluation interaction framework

As mentioned before, “Governing structure” in this paper specifically refers to the processes in which public policies are defined and implemented, how actors play their roles in these processes, and interactions are formed between them (Jordan, 2008). According to the initial function of a national evaluation system, the framework of actors' interactions should be designed (Cetindamar et al., 2009). Additionally, different applications of such a framework lead to two distinct approaches on S & T evaluation systems: a) a static approach concerned with the structure and position of actors within a S & T evaluation system, and b) a dynamic approach concerned with causality and interaction between the actors of a S & T evaluation system. In such a framework, different stakeholders involved in the evaluation system and their interactions in different levels are considered (Shehabuddeen, 2000).

2.3. Evaluation organization map

An evaluation map supports understanding of the static relationship between actors of a system (Phaal et al., 2004). Therefore, the map analysis shows how to organize the system actors. According to the S & T evaluation system literature, two main approaches have been recognized as funding organizations: the centralized versus decentralized organization (OECD, 2003).

2.4. Evaluation model of funding

The reasoning here is that the mechanisms for evaluating publicly financed S & T must determine the choice of the evaluation model. There are three major types of mechanisms (Coryn, 2007). In the first type, financing practices are based on performance (Georghiou and Laredo, 2006). The second type of S & T-funding models is those that allocate large sums of money granted by the national government to a regional government (or another body) with only general provisions on how to spend the sum (Motohashi, 2003). Indicator-oriented budget models, as the third type, have been developed based on the algorithms derived from student research, institutional programs, or bibliometric indicators.

These three types of models are designed with the aim of a) clarifying the results of public investment in S & T for both government and taxpayers, b) ensuring the agencies and S & T financiers' focus on quality and their communication, and c) avoiding high costs for S & T.

2.5. Process of result evaluation

The fifth dimension is rooted in the understanding of how evaluation processes can be overarched. The literature on process level evaluation (e.g. Campbell, 2003) recommends a systematic and consistent evaluation if it is marked by its thoroughness, regularity, consistency (e.g., of measurement, quality criteria, and performance standards), and being methodical in its procedure. Correspondingly, pluralized evaluation is recommended if the evaluation process is characterized by a high degree of situation-specific variability in terms of their conceptions, methods, and applications.

2.6. Presenting the typology

Therefore, five different dimensions of categorizing related to the choice of evaluation systems are available. Different countries' S & T evaluation systems can be detected by using different analysis dimensions. Combining five dimensions of evaluation ultimately leads to 72 system types, shown in Fig. 1.

Each country based on its national context can be placed in one of the 72 routes in the tree diagram of Fig. 1, and no country is able to have all of them. Comparative studies shows that different types of national S & T evaluation systems based on the context of countries has been created. Some of the experiences are presented in Table 1. For instance, England's S & T evaluation system consists of the improving, dynamic, centralized, performance-based, and systematic categories, so