Development of Evaluation Tools for Assessing Capabilities in Health Technology

Report to

Korea Institute of Science and Technology Evaluation and Planning

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I. Introduction

In this report we present the fundamentals of a strategy for capacity assessment of applicants for public R&D funding in health technology (HT). It is important to have a way to assess capacity because proposals for new projects often contain good ideas for projects but do not offer a direct way to gauge if the team or organization of the proponent is able to sustain the right sort of effort to bring the ideas to fruition.

The report contains a model of health technology projects review and evaluation, a set of proposed indicators of health technology development capacity that emerges from the model and an outline of data needs for designing the data base to continuously monitor capacity as the experience of funding projects continues.

II. Health Technology Project Review and Evaluation Model

Evaluations are most often focused on the realization of the explicit goals of programs and policies. The evaluation of HT projects would then mostly involve the congruence between the technical features of the proposed technology and the goals of the program to which the application for funding is submitted. In addition, the technical merit of the project would be assessed to decide an award.

There are alternative implicit objectives of R&D policies that are not always stated as goals of the specific programs and policies in question. Given that R&D is involved with knowledge and learning, it is generally expected that the results of R&D funding will not only be the completion of the content goals of the proposed projects but that the researchers, teams and organizations that receive funding will be in a position to do future similar projects or take the next steps toward the logical challenges that follow with the capacity developed to address the present project. Ordinary R&D performance indicators do not capture capacity building very well. The assessment of capacity will also provide a more firm basis for setting expectations for future programs because information about the population of candidate performance will accumulate if followed in time. If capacity assessment is tracked with the technical content of the projects, then a diversified set of candidates will be identified with knowledge of the technical focus of their specific strengths. In order to make effective use of capacity assessment in the award of projects to develop the HT field, the agency should take an active role monitoring the field of potential project performers. This activity will serve as input to the design of future programs and potentially give the agency the ability to guide and stimulate the evolution of the field.

The strategy we propose in this report has two theoretical components. First, it adopts the Scientific and Technical Human Capital (STHC) framework for analysis of researchers, teams and organizations involved in R&D (Dietz & Bozeman 2005). Second, it proposes a model of HT development that an agency such as KISTEP might use to frame the proposals. The STHC is a general framework of scientific and technical work that combines information on the technical content of R&D workers from publications, grant proposals, contracts, patents, and other such materials with information on the networks of interaction used to pursue scientific goals including collaborators and contacts in other organizations. The sources of this information are publication databases, grant databases, CVs, and possibly direct calls to members of the teams for specific items.

The model of HT project review and evaluation reflects the position of KISTEP and its potential strategy in technology development within which HT projects would fit. This model addresses the institutional and technical context within which KISTEP supports HT projects and allows the inference of some background priorities that must be taken into consideration when assessing project proposals. It also considers the audiences for which the measures of capacity are intended and assumes they are mainly internal to the organization for program management and improvement.

The model of HT development highlighting the role of KISTEP consists in the following components:

- HT development R&D contexts

- Markets for HT
- KISTEP strategic plan as it relates to HT
- HT project selection processes
- HT project monitoring processes
- KISTEP HT program evaluation
- HT Technology Opportunities Analysis (TOA)
- HT Capacity Asessment
- Data Requirements and Resources

The links between these components are shown in figure 1.

A KISTEP HT program operates in the context of the overall innovation system for these technologies. For the purposes of this analysis we only represent two of the components of that system that directly interface with the issue at hand, namely, first, the set of firms with R&D capabilities in HT and other R&D facilities that may apply for project grants in these programs and, second, the markets in which demand for HT is projected.

KISTEP will have a strategic plan for HT that is grounded in the priorities given by policy but articulated for the case of this field of technology by an empirical analysis of technology opportunities in HT (TOA). This analysis will allow for setting specific HT targets that will be made explicit in grant competition instructions or whatever instrument is used to generate the interest of potential candidates for HT projects.

These priorities and technological focus will guide the substance of the project selection process which then leads to the monitoring of awarded projects which in turn leads to the ex-post performance evaluation of both executed projects and the program. The latter evaluation stage will have an inevitable economic component given that technologies are expected to be taken to market, even when the benefits in the case of health are not only private rent for commercial firms but also economic effects on the healthcare system in terms of changes of cost and menus of offered health services.

The details of these economic models of HT performance are the province of ex post health technology assessment (HTA) and they exceed the purview of this project (Giovagnoni et al. 2009).

In this model, the HT Capacity Assessment (HTCA), which is the focus of this report, is a process that is based on the articulation of priorities set in the strategic plan for HT and takes information from the subset of eligible HT performing entities to inform the project selection process. The TOA will also inform the HTCA in order to fine tune capacity indicator design. A data base of information on HT will draw on three sources, the results of TOA, HTCA and ongoing evaluation processes.

In this report we develop the HTCA component using the rest of the model as the background assumptions for its design. The details of strategic planning, HT project selection and performance evaluation are not necessary and may exist in a variety of forms at KISTEP. Two modules of this model may already exist, but if they are not, they are recommended for implementation by this report. These are, first, a HT Technology Opportunities Analysis (TOA) and, second, a HT Project Monitoring process.

There is a general and a particular reason for recommending the implementation of these processes. The general reason is the international experience of technology focused publicly supported programs. Technology development programs are subject to stringent evaluation by policy makers given the expectations that they make a difference in the overall competitiveness of countries' or regions' innovation systems. Without an empirically based analysis of technological opportunities it is very difficult to set reasonable priorities for these projects. Furthermore, in the area of health technology assessment, which would be a necessary dimension of the performance evaluation of an HT program, there is a growing trend toward health technology "horizon scanning" of emerging health technologies to set criteria in HTA (O'Malley & Jordan 2009).

In the case of project monitoring, the complexities of technology development programs often require interventions during execution to address circumstances that were not anticipated during the proposal review stage. In the United States, both DARPA technology projects and those in the now defunct Advanced Technology Projects, owed their success to careful monitoring of projects as well as learning from multiple stage follow up of the project performers after the project was concluded (Ruegg 1998). As a matter of fact, the ATP experience is probably a very relevant one for learning from one of the most intensive efforts in publicly funded technology development program evaluation (Ruegg & Feller 2003).

The special reason for recommending TOA and HT project monitoring is that they are intimately connected to capacity assessment. The indicators of capacity need a clear reference to context in order to gain some precision. As we will see below, the very nature of a priori capacity assessment makes precision and specificity difficult. This can be compensated for by using additional information from the technological horizon as determined by the TOA and the demonstrated capacity during the progress of project execution.

There is one caveat that must be mentioned. Drug development is possibly completely different from other sorts of HT. The generic model described here may not be adequate given that drugs are treated as special technologies by regulatory regimes. This is highlighted by the fact that there is a separate track of HTA in Korea for drug development (Kim 09). There is no attempt in this report to cover the potential differences that might make drug development a special case.

III. Indicators of Health Technology Development Capacity

a. Some background observations

The determination of capacity or ability to deliver R&D results at a certain level of performance has inherent uncertainties. Capacity assessment is a prediction of future performance based on past experiences and performance. The measurement of both components is difficult and their predictive value is not always clear. There is also an inherent conservatism in the notion that having done similar things before is the best qualification for future projects. It is by design discriminatory against new entrants and changes in technological trajectory for which past similarities don't really exist. Forcing the appearance of continuity stifles the proposal of new approaches. Therefore, these indicators of capacity must be used with care and in the context of a historical record so these weaknesses can be compensated for.

We will assume that the performers of HT projects may be private firms, government labs, academic labs or joint ventures of any of the latter with private firms or of more than one private firm. Rather than focus on the details of the combinations of actors, what we are really aiming for is to avoid limiting the set of performers to the academic or public sector and to introduce the possibility of collaborative ventures. The latter have special characteristics from the point of view of capacity and also from the expected outcomes of projects. Collaboration across sectors or of more than one private firm on these projects often leads to a change in the culture of the participating organizations that may be a desirable outcome in its own right.

b. Indicator categories and definitions

We propose indicators of capacity in two main category families: the technical competence of the technology development team and the organizational context of the lab, firm or joint venture. The first set of categories reflects the human and social capital embodied in the performers of the technical work in the form of explicit and tacit knowledge from formal education and past experience, their past work experience, collaborative projects and accomplishments reflected in publications, patents, awards and other evidence of past performance.

The second set of categories addresses both the material and organizational infrastructure and some of the social capital embedded in some specific organizational capabilities such as the participation in prior joint ventures, their commercial and market networks and their participation in health regulated processes, which are important for many health technologies.

Table: Health Technology Capacity Assessment Indicators

Evaluation area	Dimensions	Indicators	Data
Technical competence of the team	Formal training	Education/Degrees Certifications Professional development	CV
	Informal training	Work experience Prior projects	CV Publications Patents
	Past achievements	Awards Product success Entrepreneurial activities	CV Patents Trade journal pubs
	Relationship of proven competence to current project	Technical similarity (or difference) of subject categories of papers, patents and products	Papers Patents Product specifications
	Collaboration history	Co-authorship of articles Co-ownership of patents Co-PIs on grants	CV Papers Patents Public grant information
Organizational context	Collaborative structure	Technical collaboration Health related collaboration Joint ventures Co-authorship (by affiliation)	Firm website Firm disclosures Product info Prior proposals Firm surveys
	Competencies	Past and existing products Market share Intellectual property IP dedicated office or personnel	Firm website Firm disclosures Product info Patents Firm surveys
	Facilities	Laboratories Instruments Prior use of available	Firm website Firm disclosures Firm surveys

		facilities	
	Testing capabilities	Testing arrangements Prior use of available facilities Work with patients	Firm website Firm disclosures Firm surveys
	Regulatory competency	Participation in regulated HT processes Specialized office or personnel	Firm website Firm disclosures Firm surveys Regulatory agency information

c. Indicator Interpretation

The interpretation of these indicators in order to draw conclusions about capacity must be done with careful attention to some basic principles. First, the assessed level of capacity is not a one dimensional ranking since the activities in technological development are multifarious, so are the capacities to do things. Therefore, the simplistic interpretations of one time, single indicator hierarchies must be avoided at all costs.

In the same vein, second, the procedure should aim for building profiles of firms, labs and collaborative organizations at the organizational level and of members of technical teams at the individual level. Both of these should be tracked in time. The basis for these profiles will function as working hypotheses that are continuously tested and updated as data and experience accumulate. As experience with the data and the set of performers in the field grows, the critical combinations and values of the indicators should converge toward relatively stable configurations that will allow informed judgment of capacity for program management.

The profiles would combine various possibilities for the indicators in the two areas. For example, teams of industry-university collaborators with more technological development experience and patent holding on the industry side and higher credentials and experience with sophisticated testing equipment on the university side and a pattern of use of each others' facilities might be a typical joint venture profile. More interestingly, profiles that defy stereotypes such as these may certainly emerge from the data making the role of KISTEP all the more constructive in facilitating the evolution of the HT field.

Various tools and modeling approaches in data analysis can be used for this purpose. For example, using network models of collaboration based on publications, joint venture information, patents with multiple assignees, and other such indicators and observing their dynamic evolution can provide valuable insights on the positioning of these actors in the HT field. Similar approaches can be used to track career trajectories of team members and their location when participating in relevant past projects. The evolution of their career in the aftermath of such projects may reveal rewards or less than favorable response to their results that are not directly reported in CVs and other information sources.

The limited scope of this project has not allowed the gathering of test data to illustrate these points. However, it should not be too difficult to envision.

IV. Data Structures for Health Technology Development Capacity

The data requirements for the capacity assessment function proposed in this project have several dimensions. Capacity assessment of potential candidates for the execution of technology projects requires the development of in-house capacity to understand the fields of technology in which the agency has strategic interest. The foundation of this capacity is a continuous effort in data development about those fields of technology activity. The data components recommended below are meant to be monitored continuously to build what essentially amounts to an observatory of the field of interest. The adjudication of capacity assessment in a one-time snapshot is essentially impossible. The ability to make these judgments will essentially be based on the capacity of the agency to learn from continuous observation of the field of interest and commit to organizational memory the trajectory of the main actors in the technology field.

CVs
Publications
    Research journals
    Trade journals
Patents
Firm information
Product information

CV analysis presents some challenges (Dietz et al. 2000). There is no uniform format for CVs so there is no guarantee that they will contain all the information that is needed for the indicators. There is a marked difference between CVs in the academic sector and those usually used in the private sector. The former are more detailed and generally contain a fairly complete record of former academic appointments and publications. The latter are generally much shorter and contain the most recent information relevant to the current position. Therefore, the construction of a database of CVs is quite laborious and no useful automatic harvesting of CVs is available to date.

From the indicator definitions in the previous section it is clear that at least the following fields from CVs must be included:

Full Name
Demographic information (Gender, Date of birth, Nationality)
Education information (Degrees, Dates, Institutions, Fields)
Employment information (past and present)
Publication information (full reference)
Patent information (title, granted status, dates of application and grant, field codes, awardees' affiliation data)
Grants and Awards information

The publication and patent information can be triangulated for data cleaning purposes with data from the data infrastructure sources such as Web of Science and Scopus for publications and the patent offices' data for patents.

The publication and patents database components must rest on a search strategy that identifies the field of HT clearly. The boundaries of the field of interest will be determined by the search strategy that is used to gather all the publications and patents in a relevant period. At the beginning of the effort to apply these recommendations, the deliberation based on the strategic focus of KISTEP must be conducted to arrive at the definition of the HT field and its corresponding set of search terms for use in the general databases. An example of such a strategy for the field of nanotechnology is shown in Porter and Youtie (2008). A stable definition of the field based on a search strategy will enable orderly continuous updating of the databases in order to maintain the capacity to build the latest profiles of the organizations and personnel of interest.

The information on firms can be developed from public or proprietary databases of firms, which must be verified for availability in Korea, and from firm websites. For a focus field such as the HT area, it is advisable to conduct periodic surveys of firms (every 3-4 years). The information on firms would include at least the following fields:

Name of the firm
Date of foundation
Ownership information
Size (employees and sales)
Product line
Intellectual property (from patent databases and disclosure)
R&D activity (budget, facilities, number of R&D personnel)

This information will be an important resource for many decisions in the process of interpreting data contained in the CVs and the claims made in HT project proposals in terms of the relevance, technical quality and innovativeness of its substance. Therefore we recommend that for any serious effort of capacity assessment in a field of interest, especially in technology projects, the development of general data resources such as these that give the agency critical expertise on the shape of the fields in which the projects will be carried out. This will enable true evidence-based program management.

V. Summary of Recommendations

To conclude, we present a summary list of the recommendations explained in the body of this report:

1. For the HT Capacity Assessment:
    a. Develop a data base that is regularly updated in time
    b. Main items in the data base are
        i. Qualified personnel in the country
        ii. Candidate organizations to perform HT projects
    c. Develop an indicator structure as shown in Table 1
    d. Develop profiles of HT performers in the country and update annually
    e. Data sources are:
        i. CV
        ii. Publication data bases
        iii. Patent data bases
        iv. Firm and product databases
        v. Firm and R&D organization websites
        vi. Surveys of HT organizations
2. HT review and evaluation process:
    a. Implement Technology Opportunities Analysis in HT
    b. Implement HT project monitoring and ex-post follow up (using ATP model)

The full set of recommendations amounts to an HT observatory operation for facilitation of field development.

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Figure 1: Model of Health Technology Capacity Assessment Framework