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Science, technology and innovation indicators

Anthony Arundel – January 2021

This report provides a general overview of science, technology and innovation (STI) indicators and recommendations for the collection of STI indicators for Viet Nam.

STI indicators measure, where relevant, the inputs, activities, outputs and outcomes of science, technology and innovation. The focus of science indicators is on the creation of new knowledge, as measured by R&D, bibliometrics, patent statistics, or the supply of scientists and engineers, while indicators for innovation focus on the commercialization of technologies (broadly defined).

STI indicators need to clearly distinguish between science and technology, on the one hand, and innovation on the other hand. While science and technology differ, there is a continuum between them, in the sense that technology often depends on science and applied research can lead directly to new technology. Conversely, there is an important conceptual difference with innovation, which requires the implementation of new or improved products or processes. With a few exceptions, such as technology licensing that can produce income for the licensee, the economic and social benefits of science and technology require their use in practical applications (ie. innovation).

STI policy needs

The majority of economic activity is in low and medium technology manufacturing and service sectors that can benefit substantially from innovation activities. Consequently, STI policy needs to address STI activities of relevance to high, medium and low technology sectors.

Policy needs to differentiate between 'ST' indicators and 'I' indicators. Science and technology policy concerns the creation of new knowledge, while innovation policy focuses on improving the innovation capabilities of businesses, while ensuring that they are still competitive and profitable. Innovation is required to turn new knowledge into economic and social benefits.

High quality STI indicators can be used for benchmarking, such as progress towards a policy target, and to inform the development of new policy and changes to existing policy. Indicators at the micro level of the business or institution can also be used in academic research on the factors that support or hinder outputs or outcomes. Many indicators that are collected on a regular basis over time can be used to track developments in targeted technologies or industries, as long as data are available for specific sectors of interest. Indicators derived from surveys need to be representative of the population of interest, which requires either a census or random sampling and low error rates. Best practice requires survey questions to ask respondents about events for which they have direct knowledge (for instance their business's experience with government policies on technical change).

Most STI indicators are constructed from administrative or survey data. An alternative is the use of 'big data' sources, such as the internet or data collected by devices such as smartphones. The main methodology is data mining by web-scraping bots that use textual analysis to identify innovation activities that are posted on websites. However, web-scraping methods substantially underestimate innovation activities.

International expertise and experience with STI indicators

Indicators have been developed for 13 categories: human resources, R&D, bibliometrics and patents / design registration, entrepreneurship, knowledge transfer, demand, capital expenditures, trade, digitalization, innovation, environmental innovation, and public sector innovation.

With respect to STI indicators and policy, economies can be divided into two main sectors: 1) the research and training sector (primarily universities, research institutes, and other tertiary training institutions) that produces new knowledge and skilled people who can develop and apply knowledge to the creation of new goods and services; and 2) sectors that use existing and new knowledge and technology to produce goods and services (SOEs, private businesses, and governments). A third requirement is for indicators for knowledge exchange, both within and between the two main sectors.

STI indicators need to capture inputs, activities, outputs and outcomes within each sector and knowledge exchange between the two sectors and with organisations abroad. Of crucial importance, indicators are required for both quantity and quality. For instance, indicators of research outcomes must cover not only the number of publications, but also the quality of publications.

STI indicator requirements and recommendations

The production of STI indicators requires the following types of data or surveys:

1. R&D survey of businesses and public research organisations
2. Data for student graduation rates, plus supplementary data on post-graduation employment. This may be available from administrative records kept by universities and other tertiary education institutions.
3. Surveys of the knowledge transfer activities of public research organisations. These can usually be addressed to the knowledge transfer office (KTO) affiliated to each university or research institute.
4. Innovation survey of businesses, SOEs and possibly public sector organizations.
5. Labour force survey.

The collection of indicators over time can be used to assess progress towards pre-defined targets. Baseline and other types of data are required to set targets. When no data are available, it is sometimes possible to set an approximate target based on experience in other countries.

Almost all types of indicators can be disaggregated to collect data for priority sectors or research fields, but this requires collecting the necessary data at a granular level. Collecting data for the business sector on the use of and research into generic technologies that span multiple sectors, such as biotechnology or artificial intelligence (AI), requires customized surveys (technology use surveys) that focus on specific fields of science.

Recommended indicators for Viet Nam are provided in the full report; for the research and training sector, the goods and services producing sectors, and the knowledge exchange sector. These include indicators of relevance to: the start-up ecosystem; the share of enterprises with innovation activities; foreign investment in R&D and innovation; technology acquisition from international sources; links between businesses and research institutes / universities; S&T based enterprises; capabilities in priority technologies; capabilities of the public research and training infrastructure; capabilities of public research to respond to market demand; capabilities of the organizations producing goods and services; management of S&T and innovation; digital transformation; network of intermediary and knowledge transfer organisations; restructuring of service industries and adoption of high technology in manufacturing and other sectors.

For further information

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