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DIRECTORATE FOR SCIENCE, TECHNOLOGY AND INDUSTRY
COMMITTEE FOR INFORMATION, COMPUTER AND COMMUNICATIONS POLICY

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Working Party on Indicators for the Information Society

IN-DEPTH REVIEW: MEASURING THE INFORMATION SOCIETY AND STATISTICS ON SCIENCE, TECHNOLOGY AND INNOVATION

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This document, prepared by the Australian Bureau of Statistics, summarises international work on measuring the information society and statistics on science, technology and innovation, identifies challenges and proposes a way forward. The document was originally submitted to the Conference of European Statisticians, 58 plenary session, 8–10 June 2010, Paris (ECE/CES/2010/4).

The Working Party is invited to note and comment on this document and to discuss next steps under item 2.1 of the Draft Agenda.

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IN-DEPTH REVIEW: MEASURING THE INFORMATION SOCIETY AND STATISTICS ON SCIENCE, TECHNOLOGY AND INNOVATION

1. Introduction

1. The Bureau of the Conference of European Statisticians selected at its October 2009 meeting the topic of measuring the information society and statistics on science, technology and innovation for an in-depth review by the Bureau in 2010. The purpose of these reviews is to summarise international statistical work in the area, identify challenges and to propose a way forward.

2. The aim of this paper is to promote discussion as input into the in-depth review on measuring the information society and statistics on science, technology and innovation.

2. A short chronology

3. The concept of the information society does not benefit from a single definition, but rather revolves around the role information and knowledge play in society. For example, one definition[1] refers to a society "that responds to the expansion and ubiquity of information ... The information society is one in which information is the defining feature ...". The importance of knowledge and information can be observed in a number of different ways (*e.g.* the use of information communication technologies (ICTs) and their contribution to economic activity).

4. The field of official science and technology statistics is almost sixty years old[2], with military and science policy focusing early research and development (R&D) statistics on manpower inputs (*e.g.* technical competence, qualifications, and occupations). Work in this field of statistics increased following World War II, as research was acknowledged as a necessary factor in strategic and economic planning. Science and technology measurement was influenced further through a desire to document technology gaps between countries in the 1960's and 1970's. Four categories of science and technology statistics emerged which measured: scientific and technical manpower; R&D; technology outputs; and science and technology indicators. The *Frascati Manual* was released in 1963 which standardized survey collection methodology for R&D statistics.

5. Most countries began actively measuring the outputs of science and technology in the 1980's, following the publication of *Science Indicators* by the United States National Science Foundation in 1973. The Organisation for Economic Co-operation and Development (OECD) has since produced an ongoing series of *Science and Technology Indicators* which attempt to measure not only the direct results or products of research but also the more indirect impacts upon society and the economy. The *Oslo Manual* was released in 1992 which specified guidelines for collecting and interpreting innovation data.

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1. *A Dictionary of Sociology*. John Scott and Gordon Marshall, Oxford University Press 2009. Oxford Reference Online, Oxford University Press.
2. *The Numbers Game: Fifty Years of Science and Technology Official Statistics*, 2002, Benoit Godin.

6. The challenge for statistical organizations is to develop and disseminate a range of tailored statistics that assist in understanding the impact of science, technology and innovation on the economy, society, and the environment.

7. While there will always be the challenge of ensuring that these statistics are relevant and accurate, many of the information requirements should be generally accessible through existing statistical infrastructure provided by the various National Statistical Offices (NSOs). For example, the information society can be considered part of the economy like any other industry, with the principles for its measurement largely consistent with those principles used for measuring other parts of the economy. Statistics should be unbiased and measurable in both a theoretical and practical sense, evidenced in the System of National Accounts, which provides an important basis for producing integrated economic statistics.

8. More specifically, the desire is to produce statistics that make a difference that are relevant, accurate, timely, accessible, interpretable and coherent[3]. This review shall touch on these quality dimensions to varying extents, particularly in relation to relevance and coherence.

3. The importance of the information society

9. There is little doubt that the information knowledge and its transmission via new information and communication technologies play a significant role in day-to-day life, permeating across the economy, society and environment. For example, it has been long understood that the generation, exploitation and diffusion of knowledge is fundamental to economic growth and the well-being of nations. Innovation, science and technology are important enablers of productivity, with innovation producing improvements in goods or services, operational processes, organisational processes and marketing methods[4]. More specifically, productivity is realised through innovation leading to a reduced demand on inputs (*e.g.* capital and labour) to support given outputs or greater outputs for given inputs.

10. Science, technology and innovation impact on the ways in which people live, learn and work, such as through new modes of personal interaction (*e.g.* Short Message Service or SMS) and social networking. Greater personal access to information and social interaction via electronic means is reflected in increased use of the Internet from home. For example, 71% of people in Australia reported that their main reason for accessing the Internet was for personal or private purposes[5].

11. Science, technology and innovation also have a significant impact on the environment with the strategic use of ICT able to contribute significantly to energy efficiency. It can reduce the need for travel and transportation of goods by bridging distance problems and increase efficiency and innovation by allowing people to work in more flexible ways. Most importantly, innovation and ICT can play key roles in the reduction, management and monitoring of energy consumption and the carbon footprint of buildings and infrastructure. This reduction in energy consumption also leads to an improvement in the efficiency of the economy.

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3. *Managing Data Quality in a Statistical Agency*, Brackstone G., (1999) Survey Methodology, Vol. 25, no. 2, Statistics Canada.
4. *NESTI Roadmap: Contributions to the Innovation Strategy and Longer-term Directions*, June 2008, Working Party of National Experts on Science and Technology Indicators.
5. *Household Use of Information Technology, Australia*, 2008-09, ABS Catalogue number 8146.0.

12. It is for these reasons that the relationship of the information society, science, technology and innovation with the economy is of key interest.

4. Building on current approaches

13. This document considers challenges relating to progressing the measurement of the information society and related statistics within three broad areas: conceptual frameworks; statistical infrastructure and coordination. Findings in these areas provide important pointers to producing statistics that make a difference.

A. Conceptual frameworks

14. Concepts around the information society, science, technology and innovation are broad in nature. In order to provide relevant and coherent statistics on these concepts, it is essential that they are properly mapped against appropriate conceptual frameworks which consider the related research and policy data needs. In doing so, the focus should not be on defining the perfect framework, but rather on having conceptual frameworks that support appropriate discussion on the impact of the information society on the economy, society and the environment. In facilitating this discussion, the challenge therefore is to identify where these frameworks fall short, and to address these limitations.

15. Currently, there exist a range of relevant frameworks to draw upon, including (but not limited to): the economy (the System of National Accounts); innovation statistics (the Oslo Manual); and R&D statistics (the Frascati Manual). These frameworks need to collectively provide a more integrated and more comprehensive coverage of the field of statistics that measure the information society.

16. The OECD *Guide to Measuring the Information Society, 2009* notes that there is no agreed comprehensive statistical framework for the information society, but in moving forward, careful consideration should be given as to whether the collective scope of conceptual frameworks needs to be expanded to meet emerging information requirements across the 'triple bottom line' concept of the economy, society and the environment. One good example relates to emerging international interest in the measurement of public sector innovation, which is an area that can have economic and fiscal dimensions, social benefits and improvements in the timeliness and quality of products and services - so it is important that this not be considered in isolation, but as part of the overall development of agreed conceptual frameworks.

17. 1These frameworks need to be integrated appropriately, such as with the System of National Accounts, and have international agreement and support. This will require close and coordinated international cooperation.

B. Statistical infrastructure

18. Statistics for the information society cut across a broad range of subjects crossing many aspects of official statistics. A traditional response to this is to map these specific data requirements across the various existing and potential collection vehicles. For an NSO, this sometimes translates into a hybrid of dedicated individual surveys relating to specific data requirements (*e.g.* use of ICT by businesses) and the inclusion of individual questions on existing surveys (*e.g.* questions on environmental innovation on environmental surveys).

19. While this approach offers important data to inform government and the community, it can under-deliver upon those policy and research questions which are interested in the inter-relationship between factors that are measured across different data sources (*e.g.* the relationship between propensity for a business to innovate and the ICT capability of the business; or the relationship between innovation and productivity). These questions require an integrated approach to data collection to bring together the data required for the necessary analysis.

20. A common analytical challenge is to better understand the relationship between innovation, the use of ICT and business productivity. This cannot be readily addressed through the standard approach of a one-off survey given the expected time lags in these relationships. The Australian Bureau of Statistics (ABS) has attempted to address this by developing a survey vehicle in which the same businesses are included over successive years. This business longitudinal database provides a rich source of firm level data to facilitate the analysis of individual business performance over time. Administrative data (*e.g.* taxation and customs data) are also matched to these businesses to provide information on the performance of those businesses (*e.g.* turnover, wages, capital expenditure and export characteristics).

21. This highlights both the importance and challenge of building a statistical infrastructure which is best suited to delivering upon the key research and policy objectives in a cost-effective manner. This is discussed in greater detail in terms of enabling suitable analysis later in this paper under *Producing statistics that make a difference.*

C. Coordination

22. The international comparability and coherence of statistics relies on consistent frameworks and international cooperation. Fortunately, the information society, science, technology and innovation benefit from considerable (and growing) international interest. However, given the wide range of subject matter covered, the international community contains a large number of international working parties and committees which have been set up to address many issues in this field. For example, the OECD alone includes the following (non-exhaustive) groups and committees which could be considered relevant:

- Advisory Expert Group on Innovation in the Software Sector;
- Committee for Information, Computer and Communications Policy (ICCP);
- Committee for Scientific and Technological Policy (CSTP);
- Committee on Consumer Policy (CCP);
- Committee on Energy Research and Technology (CERT);
- Committee on Industry, Innovation and Entrepreneurship (CIIE);
- Network of Senior E-Government Officials (EGOV);
- Steering Group for the Meeting at Ministerial Level on the Internet Economy;
- Steering Group on the Complementary Areas of E-Government Work;
- Task Force on Industrial Biotechnology (TFIB);
- Task Force on Spam;
- Working Party of National Experts on Science and Technology Indicators (NESTI);
- Working Party on Biotechnology (WPB);
- Working Party on Communication Infrastructures and Services Policy (CISP);
- Working Party on Indicators for the Information Society (WPIIS);
- Working Party on Industry Analysis (WPIA);
- Working Party on the Information Economy (WPIE);
- Working Party on Information Security and Privacy (WPISP);

- Working Party on Innovation and Technology Policy (TIP);
- Working Party on Nanotechnology (WPN).

23. While having such a large number of international groups directing their attentions towards such relevant issues offers significant opportunities for tackling difficult measurement issues, it also creates a number of challenges in coordinating these efforts and sharing the outputs of such collaborations. Many of these groups work together closely, but these are all areas that are competing for attention amongst NSOs and researchers. Put simply, it is difficult to gain an understanding of the sum of these parts and what it means for the future directions of statistics in these fields.

24. In order to obtain coherence both internationally and across related fields, mechanisms need to be put in place for the appropriate sharing of both the outcomes and existing work programs of these groups. Without such coordination, there is significantly increased potential for rework (with the possibility of diverging outcomes) and incoherent frameworks and related statistics. Greater sharing of information should become easier to achieve with ongoing clarity of responsibilities.

25. In order to achieve these goals, it will be important to develop and agree on suitable governance arrangements covering the relationship of groups with each other and the processes for promoting and coordinating the sharing of information. These arrangements, along with the respective roles and responsibilities for each of the groups, will need to be well documented, readily available and understood for the benefit or all stake holders – this can start with refreshing the organisational map for these activities.

D. Producing statistics that make a difference

26. Ultimately, the goal is to develop, produce and disseminate statistics that make a difference. That is, to inform decision-making, research and discussion within government and the community - to contribute to positive outcomes for the economy, society and the environment. The first step in achieving this is collecting appropriate statistics, by producing measures which are of sufficient quality to support the required research and analysis.

27. In terms of ensuring statistics are relevant, it is important to understand how the subject matter relates to the broader economy, society and the environment. For example, first order impacts of the information society include the speed of transmission of information and the accessibility of information. Higher speeds of transmission increase the rate of information sharing between people or from information sources, while information is becoming more easily available in terms of both affordability (with innovations leading to cost reductions) and accessibility (such as Wireless networks and greater geographic coverage in general). This raises questions on what ICT products and services are available and at what cost, leading in turn to questions about the impacts of improved services on the economy, society and the environment.

28. The impact of these products and services on the economy, and more specifically productivity, is of particular interest as these products and services often rely on developing and maintaining an appropriate technical infrastructure. This infrastructure can come at a significant cost (*e.g.* to improve wireless coverage, or to lay optic fibre networks) and needs to be justified in terms of providing a sufficient return on investment either directly (*e.g.* through increased efficiencies) or indirectly (such as through increased social capital and social cohesiveness). In addition, not all technologies are applied in a manner that raises productivity (think of the proliferation of email communications and the time devoted to managing email).

29. In considering the return on investment and the impact of innovation and information technologies on the economy, one must return to 'first principles' and consider the production function which describes the relationship between the outputs of a firm and its inputs. Innovations can change this relationship to generate a greater return on investment through outcomes such as a reduction in the inputs required (*e.g*. cheaper production processes or increased throughput rates). A relevant and integrated statistical system is therefore required to provide the data necessary for assessing whether the investment in the technical infrastructure is warranted.

30. Relevant statistics also require a firm understanding of what information will assist decision-makers. For example, one key policy interest is the relationship between technology and the productivity of businesses. To understand this, a range of information is required: are businesses aware of the technology and its benefits; is the technology accessible; do they use the technology; and, if so, how are they using this technology? Each of these pieces of information go towards our understanding of how a business uses technology to maximise its productivity. What sort of businesses are failing to realise the productivity benefits technology offers and why does this occur?

31. The real value is not in merely providing more indicators, more frameworks and greater integration, but in drawing out research that addresses the questions of importance. This requires that data sources are developed with these questions in mind, as well as the types of analyses required to answer these questions.

32. Data need to be of sufficient accuracy to support the research and analysis. One such challenge has been the difficulty in measuring the impact of ICT diffusion and its use on productivity, particularly as many of the impacts occur over a longer time scale as new ICT infiltrates its way throughout the economy. Any statistical measures need to consider this and be supportable through information that can be readily provided by respondents. For example, while data on business expenditure on innovation are highly desirable from an analytical viewpoint, the Australian experience is that these data are not able to be estimated accurately by respondents.

33. Many of these measurement challenges require careful consideration to ensure that research is supported by data of sufficient quality. In this context, it is essential that statistical priorities are properly assessed and agreed to enable targeted efforts in addressing these challenges.

34. Even after addressing these challenges to provide relevant, accurate and coherent statistics, accessibility to the data to undertake the necessary research and analysis can be problematic (*e.g*. where there is a demand for confidential firm level data). In such instances, it is important that avenues are explored to allow more sophisticated unit level analysis to be undertaken. Possible options will vary by NSO, depending on the nature of the legislation by which they are bound. For the ABS, for example, analytical units have been set up within the ABS with the analytical capacity to undertake such analyses across the breadth of the ABS statistics and with access to the unit-level data.

4. Conclusion

35. Ultimately, the goal is to develop, produce and disseminate statistics that make a difference. That is, through access to these data, government and the community are able to make more informed decisions resulting in positive impacts to the economy, society and the environment. As previously discussed, this is achieved through producing statistics on the information society, science, technology and innovation which are of sufficient quality to support research and policy.

36. It is important to continue to develop and integrate the conceptual frameworks underpinning these statistics to better assist in understanding the impact on the economy, society and the environment. For example, the impact on the economy from innovation can now be better understood through the treatment of R&D expenditure as Gross Fixed Capital Formation within the System of National Accounts. Future work should continue to consider the integration of such issues into existing bodies of statistics.

37. A relevant and integrated data collection strategy, developed with end uses in mind, is required to provide the data necessary for understanding how the subject matter impacts on the economy, society and the environment.

38. Another challenge in producing and disseminating statistics is to ensure that the statistics remain relevant. In the case of the information society, science, technology and innovation, this is particularly challenging due to the need to be responsive to a rapidly evolving technical environment. While the rate of take-up of new innovations and technology by individual businesses or people can be relatively slow, the introduction of these innovations and technologies into society can be comparatively quick. Without the ability to respond quickly to these changes in the environment, it can be difficult to collect relevant and timely data. However, this must be weighed up against the time required to properly research these new concepts and integrate them into existing statistical collections (or to develop new collections), as well as the need to provide stability in collections to facilitate analysis of data between different time periods.

39. Despite all these challenges, the need remains to reliably measure the information society, science, technology and innovation. In order to achieve this, efforts must be focused on those initiatives which will best address these challenges: the development of internationally agreed conceptual frameworks; improved international cooperation, particularly in terms of improved coordination and clear responsibilities and governance; a strong sense of priority in the key areas for future development in these areas of statistics; and the development and maintenance of a statistical infrastructure which will meet the needs of research and analysis.

5. A proposed way forward

40. To guide the input of WPIIS delegates into the detailed review on measuring the information society and statistics on science, technology and innovation, the following points are provided as a means to inform discussion:

a) WPIIS delegates may wish to comment on the coordination of the many activities being carried out across the relevant areas measuring the information society;

b) WPIIS delegates may wish to comment on the current gaps in measuring the information society and related priorities for statistical development - and why those statistics would make a difference;

c) In addition, the WPIIS could provide an organisational map of the current international groups and their activities, as a basis for the discussion;

d) Once input to the review has been consolidated, a final report should document the recommended way forward in relation to measuring the information society and statistics on science, technology and innovation.

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