3 History of the Community Innovation Survey

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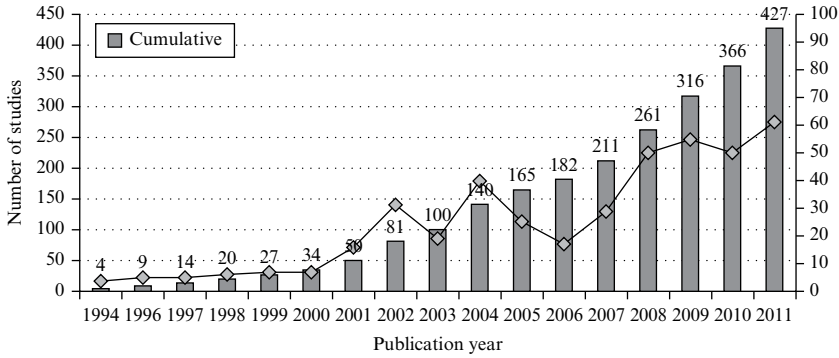
1. INTRODUCTION

The Community Innovation Survey (CIS) was first developed in the early 1990s. It arose from a shared view by researchers and policy makers that understanding the extent and distribution of innovation activity required direct and economy-wide indicators of innovation inputs and outputs at the firm level.[1] These included tangible and intangible investments in innovation, outputs in terms of sales of new or changed products, plus data on such topics as collaboration, and knowledge flows.

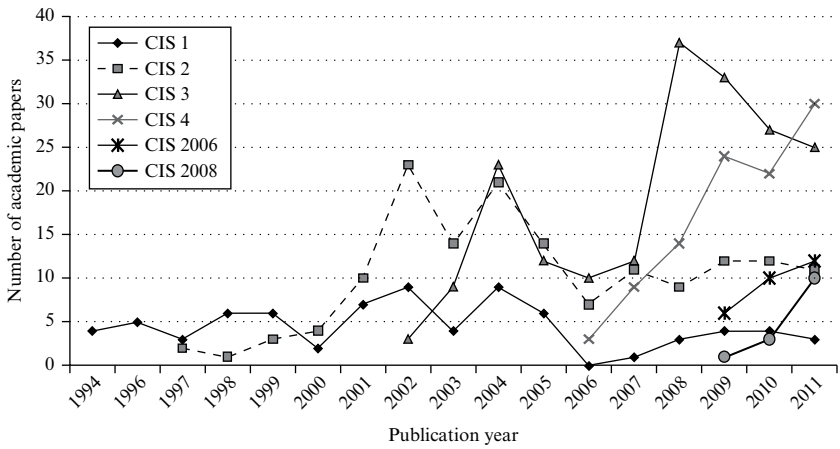
The first CIS has evolved into the largest innovation survey in the world based on the number of participating countries and the number of responding enterprises. It is conducted in the 27 member states of the European Union (EU) plus Norway and Iceland, and is used in many of the candidate states to the EU, such as Croatia and Turkey. The 2008 CIS, the most recent survey for which data are available, obtained responses from 196 000 enterprises in the EU-27 countries. The CIS has influenced the design of innovation survey questions in other countries, including Australia, Canada, China, Japan, New Zealand, Russia, South Africa, Switzerland and the USA. The frequency of the CIS was increased after 2004 from every four years to every two years. The last completed survey at the time of writing, CIS 2010, was implemented in 2011 and a proposed version of the questionnaire for the next survey, CIS 2012, was produced in July 2012.

The CIS survey produces policy-relevant indicators that are used in Europe's Innovation Union Scoreboard (IUS) and by the OECD. Six out of 25 indicators in the 2011 IUS are obtained from the CIS, including indicators for innovation expenditures as a share of turnover, the percentage of SMEs that develop innovations in house, and the percentage of turnover from new-to-market and new-to-firm innovations. In addition, the survey provides a rich data source for academic research. As shown in Figure 3.1, the number of academic papers, in English, that use CIS data has increased from fewer than ten per year before 2000 to over 50 per year after 2008. Academics also continue to be interested in each version of the



Source: N. Es-Sadki and A. Arundel, UNU-MERIT.

Figure 3.1 Academic papers (in English) using CIS data (1994–2011)



Source: N. Es-Sadki and A. Arundel, UNU-MERIT.

Figure 3.2 Use of each CIS version over time

CIS, due to different questions included in each survey and variations in data access. For example, in 2011, three academic papers were published using CIS 1 data and 11 were published using CIS 2 data (see Figure 3.2).

The CIS has its origins in the OECD's *Frascati Manual* on how to measure R&D, where it was recognized that R&D covered only a part of all innovation expenditures and innovation activities. This provided the motivation for a series of studies, dating back to the late 1950s, that

sought to measure non-R&D innovation activities as well as innovation outputs. The types of questions included in the CIS were initially driven by academics involved in the design of innovation surveys, but over time the greatest influence on the CIS has gradually shifted from academics to the interest of policy analysts in innovation indicators and the interest of national statistical offices in obtaining comparable and reliable data while at the same time reducing the time required for respondents to answer the survey. The use of the CIS to produce indicators has been established in European law, with Commission Regulation 1450/2004 requiring all EU member states to provide Eurostat with a number of innovation indicators derived from the survey.

The CIS questionnaire is not static, with both minor and substantive changes to the questions made for every CIS. Some of the changes are driven by efforts to improve data quality or to solve problems with the interpretation of the data. Many of these issues date back to the period of experimentation with innovation measurement, from the 1950s to the first CIS survey (CIS 1) in 1993. For example, researchers active before and after the first CIS have grappled with how to improve the accuracy of data on innovation expenditures and how to improve the comparability of data derived from questions that use subjective definitions of innovation. Other changes to the CIS have been made to ensure that the questionnaire remains relevant for its main users, policy analysts and academics. This includes the 2008 decision to alternate questions between each consecutive CIS in order to create space for a module of one-off questions of interest to policy. Other changes have been made to improve the usefulness of the questionnaire for academic research. For example, the 2012 questionnaire includes a number of changes to support econometric research on the linkages between innovation and growth.

In this chapter we examine the history of the CIS, starting with its origins in the period of experimentation before the first CIS, followed by an evaluation of the changes to the survey questionnaire since CIS 1. Our focus is on the CIS questionnaire instead of the survey methodology, since the questionnaire determines the research questions that can be addressed using CIS data and the types of indicator that can be constructed from the data. The concluding section discusses some of the challenges for the future.

2. EXPERIMENTATION WITH INNOVATION MEASUREMENT: THE 1950S TO 1993

Early survey research on innovation was initially limited to R&D, with R&D surveys conducted in Canada, the UK and the USA from the 1920s.

These developed into larger-scale surveys in the 1950s, with the NSF (National Science Foundation) conducting a survey of industrial R&D in 1953. The next major step in the development of R&D surveys was the work by the OECD in the early 1960s to develop standard definitions of R&D for use in surveys by OECD countries (Godin 2001a, 2001b). The definitions were published as the *Frascati Manual* (OECD 1963) and were used in the first attempt to conduct an internationally comparable R&D survey in 1963, with 16 participating countries.

The *Frascati Manual* has gone through six editions, with the most recent version from 2002 (OECD 2002). From the start, the contributors to the different editions of the *Frascati Manual* recognized that R&D was one of many inputs to innovation and that there was a need both to measure other inputs for innovation and to obtain output measures for innovation itself. This recognition increased with successive versions of the *Frascati Manual*, with the fourth edition from 1981 noting that R&D did not include many activities and steps to bring a product to market. Instead, the fourth edition states that innovation 'consists of all those scientific, technical, commercial and financial steps necessary for the successful development and marketing of new or improved manufactured products, the commercial use of new or improved processes or equipment or the introduction of a new approach to social service' (OECD 1981: 15–16).

The limitations of R&D as a measure of innovation created an interest in measuring innovation outputs, which began with measuring the innovation itself. Until the 1980s, the most common methodology for collecting innovation data was an object-based approach that gathered data on specific innovations, which constitute the 'object' of the study. Innovations were identified by technology experts or from advertisements or announcements in trade publications. Additional information on the innovation was obtained from follow-up questionnaires sent to the firm that developed each innovation. This information included the date of introduction, whether or not the innovation was a world-first development, the sources of ideas behind the innovation and the amount of investment in money or time to develop it (Hansen 1987).

According to Godin (2009), the earliest reported object-based innovation survey pre-dates the first *Frascati Manual* and was conducted in the late 1950s by Carter and Williams (1957). The study evaluated 201 innovations developed by 116 firms in the UK. Godin (2009: 9) also cites several object-based studies from the 1960s, including studies by Arthur D. Little (1963), the IIT Research Institute (1968) and a study by Myers and Marquis (1969) that was supported by the National Science Foundation. Hansen (1987) refers to an object-based study in the 1970s by Gellman

Research Associates and several other object-based studies funded by the NSF in the USA.

One of the largest object-based studies was conducted by academics from the Science Policy Research Unit (SPRU) in England. The survey was first conducted in the 1960s and later repeated in the 1970s and 1980s, with the final data set including information on 4378 innovations introduced between 1945 and 1983 (Townsend 1981; Pavitt et al. 1987). The relevance of this study to the CIS was due to its influence on the design of a research project in the early 1980s by de Bresson and Murray (1984) on innovations in Canada, which also covered innovations since 1945 and was funded by the Science Council of Canada. Instead of relying only on experts or trade journals to identify innovations, as in previous object-based research, de Bresson and Murray introduced several novel methods that influenced future research on innovation. First, they conducted a stratified random sample of all firms, including firms that were not previously identified as innovative, and asked the respondents to briefly describe their three most important innovations. Second, they provided a definition of innovation to guide the respondents' answers. The definition was as follows:

> By innovation we mean any new or improved product which has withstood the trial of the market and generated a return on investment, or a new or improved process for commercial production. By new we intend new to Canada.

This definition contains several features that were used in innovation surveys during the 1980s and consequently influenced the definition of innovation used by the CIS. First, it defined innovation as either a 'new or improved' product or process. Second, the innovation had to be implemented (it generated a return on investment), and third, there was a novelty requirement, although in this case the innovation did not need to be new to the world, but only 'new to Canada'. A follow-up telephone survey to respondents that reported at least one innovation requested additional information, including on the users of the innovation and on who developed the innovation. Response options for the latter included the firm itself, an affiliated firm, or a different firm. This question introduced the concept that a firm could innovate without having developed the innovation itself.

A few object-based innovation surveys were conducted after 1984, but the focus of innovation survey research shifted to a subject-based methodology where the unit of analysis was the firm (or product division) instead of the innovation. An early pioneer of this methodology was Humphrey Stead of Statistics Canada, who conducted surveys in the early 1970s in order to examine the R&D share of total innovation expenditures by

firms (Stead 2001). Stead's work influenced Lothar Scholz of the German Institut für Wirtschaftsforschung (Ifo), who used the subject-based method in a 1979 survey. The questionnaire was sent to the product divisions of German industrial firms, rather than to the head office (Hansen 1987). The Ifo questionnaire defined innovation as 'new products or significant improvements of products as well as production and strategic technologies including the information techniques in administration'. The Ifo survey continues to be conducted on an annual basis.

The subject-based methodology has a major advantage over the object-based approach for measuring innovation: it can obtain information on all types of innovations from all firms, regardless of whether or not the firm innovated or if a particular innovation was successful. In contrast, the object-based approach, when based on experts or trade journals to identify innovations, is biased towards successful product innovations (Smith 1992). By contrast, subject surveys can also collect information on 'innovation outputs that are "routine", incremental, part of the normal competitive activity of firms, yet not strikingly new enough to be reported in trade journals' (ibid.: 385). This can include innovations that are new to the firm only, rather than being new to a market or even to the world. Subject-based surveys, at least for national statistical offices with access to a business register, are also less costly to implement because they do not require a lot of work to identify innovations in advance.

In addition to the Ifo survey, six other subject-based innovation surveys in Germany, the USA, the Netherlands, France, Italy and the Nordic countries were conducted in the 1980s and had a significant influence on the first CIS. These surveys tested a range of questions on innovation and often conducted pre-testing, either pilot surveys or interviews with respondents, to determine if respondents were able to answer the questions. Testing often resulted in extensive changes to questions, with researchers from the Fraunhofer Institute changing almost half of their proposed questions, but it is not known how many of the interviews in the different studies were conducted using best-practice standards for cognitive interviewing.[2] According to Smith (1992), the interviews found that respondents understood the questions, were able to answer them with reasonable precision, but rarely read detailed definitions – instead they worked with intuitive understandings derived from their readings of the question itself. The implications of this finding were not fully implemented until the fourth CIS was developed in 2004.

Most of these surveys asked similar questions on whether or not the firm innovated over a defined time period (usually five years), the number of innovations, the type of innovation, the source of ideas or other knowledge for innovation, collaboration, innovation objectives or

effects, innovation barriers, and the sources of finance for innovation. Of particular interest are the treatment of key questions for expenditures on innovation and innovation outputs in terms of the percentage of sales from innovation (the innovation sales share), and questions on innovation novelty, non-technological innovation and the source of innovations. These key questions have been central to ongoing discussions on how to improve the CIS questionnaire and experimentation with these questions in the 1980s continues to be relevant.

The methodologies and key questions used in six of these surveys are summarized in Table 3.1, using the information gathered by Hansen (1987). Hansen interviewed the leading researchers for each of the surveys and consequently was able to obtain information on the survey methodology and pre-testing that was not available in published reports.

All six studies covered industrial or manufacturing firms or product divisions, with two studies limited to firms or divisions that performed R&D. Several studies that included non-R&D performers also found that considerably more firms than in the official R&D surveys reported R&D (Sirilli 1998). All of the survey questionnaires contained extensive questions on R&D activities, although many of the questions on innovation processes (information sources, barriers, objectives etc.) could apply to either R&D or non-R&D innovative activities.

All but one of the surveys included questions on innovation expenditures, including investments on activities other than R&D, and three surveys included a question on the innovation sales share. Most of the questions on expenditures requested the percentage of total innovation expenditures for each category, while the questions on innovation sales shares provided categorical response categories.

Several reviews have linked the definition of an innovation that is used in innovation surveys to Schumpeter's five types of innovation: new products, production methods, exploiting new markets, new methods for organizing business activities, and new sources of supply (Godin 2009; Smith 1992). Schumpeter also noted that innovations could be incremental or involve radical, disruptive new technologies (Schumpeter 1934). The innovation surveys of the 1980s consistently appeared to follow Schumpeter by including new products and production methods (processes) in their definitions of innovation, but only the surveys by Ifo and the 1984 survey by the National Institute of Statistics in Italy (Istat) included a reference to organizational innovation (although only in the 1984 scoping survey) and none of the surveys examined new markets and sources of supply or attempted to collect data on radical innovations.

The roots of innovation surveys in the *Frascati Manual* created an important ambiguity over the definition of innovation and consequently

Table 3.1 Subject-based innovation surveys in the 1980s

Country & year	Question pre-testing	Sampling unit and Definition of innovation	Number of respondents	Questions
Germany (Ifo), 1979	Interviews with firms, but no details provided	Unit: product divisions within firms Definition: 'new products or significant improvements of products as well as production and strategic technologies including information techniques in administration' Reference period one year	400 in 1979, up to 1500 units in mid-1980s	*Expenditures*: percentage of total innovation expenditures in 8 categories, including 'preparation for selling new products' *Innovation sales share*: not asked *Innovation novelty*: questions on the underlying technologies behind product and process innovations *Non-technological innovation*: process innovations related to administration *Who developed*: not asked
Germany (Fraunhofer), 1980 and 1983	10 interviews with firms using cognitive testing principles; half of questions changed as a result	Unit: R&D-performing SMEs (fewer than 1000 employees) participating in government R&D subsidy programmes Definition: None provided, but survey limited to R&D-performing SMEs. Some of the questions refer to R&D projects. Reference period of five years	700 in 1980 and 780 in 1983	*Expenditures*: distribution of total innovation expenditures over past 5 years for R&D up to prototype stage, gearing up production, and market introduction costs *Innovation sales share*: categories for share from products introduced in the last 5 years that were new to the enterprise and those that were 'entirely new technological applications' *Innovation novelty*: 'entirely new technological applications' *Non-technological innovation*: not asked *Who developed*: not asked as focus on in-house R&D projects

Table 3.1 (continued)

Country & year	Question pre-testing	Sampling unit and Definition of innovation	Number of respondents	Questions
MIT, USA, 1984	Discussion of questions with potential respondents and pre-testing with 9 firms followed by 60 firms; 12 in-person follow-up interviews with respondents to 1984 survey	Unit: *Business Week* list of firms that performed R&D and with more than US$30 million in sales Definition: none provided, but survey limited to R&D performing firms	300 to 1984 survey	*Expenditures*: 5 categories of non-R&D expenditures, including equipment purchases and marketing *Innovation sales share*: percentage categories for products introduced in previous 5 years *Innovation novelty*: limited to R&D-performing firms *Non-technological innovation*: not asked *Who developed*: not asked
France, 1984	Tested with experts, but not with potential respondents	Interviews with stratified sample of firms with 50 to 2000 employees in 10 industrial sectors Definition: none; firms asked to provide their own definition Reference period of possibly 5 years, but not always specified	302, of which 146 did not report R&D	*Expenditures*: total cost of innovation activities plus expenditures by 7 categories, including investment in new production equipment and on marketing *Innovation sales share*: not asked *Innovation novelty*: level of change from previous products, three-point scale for level of technology, and questions on first to world, first to France, first to firm; main novel features of their recent innovations; time to develop three principal innovations from beginning of

				R&D to commercialization (less than a year, 1 to 2 years, over 2 years) *Non-technological innovation*: not asked *Who developed*: in-house or external development of process innovations
Netherlands, 1983 and 1984	10 firms sent a sample questionnaire to determine if respondents could answer the questions; interviews with respondents to 1983 survey, resulting in some questions being dropped	Unit: 1984 survey sent to a sample of 2900 manufacturing firms drawn from the Dutch Chamber of Commerce Definition: a product innovation is 'the market introduction of products that in your opinion are entirely new for your enterprise, or which show considerable technical improvements with regard to former products'. A process innovation is 'the introduction of production techniques which in your opinion are entirely new for your enterprise or which are considered technically improved with regard to former production techniques' Reference period: not given	130 in 1983, 1842 in 1984	*Expenditures*: not asked *Innovation sales share*: not asked *Innovation novelty*: number of new-to-firm and new-to-the-Netherlands product innovations; categories for average time required to develop product, process and combined product–process innovations *Non-technological innovation*: not asked *Who developed*: not asked

Table 3.1 (continued)

Country & year	Question pre-testing	Sampling unit and Definition of innovation	Number of respondents	Questions
ISTAT, Italy, 1984 and 1987	Interviews with 25 firms for preparation of 1987 survey	Unit: for 1984 survey manufacturing firms with 20 or more employees; for 1987 survey limited to 16 000 innovative firms that replied to the 1984 survey Definition for 1987 survey: 'a product that allows the firm to enter a new market, a product substantially new from a technological point of view when compared to products previously produced'; 'a process designed to produce new or improved products otherwise not producible using existing systems. Also the application of new techniques' Reference period: 3 years	24 500 in 1984, 8220 in 1987	*Expenditures*: total investment in new processes; average share of total innovation expenditures by development stage (R&D, engineering, pilot projects, and marketing) *Innovation sales share*: categorical percentage response options for share of sales in 1985 from innovations introduced over 3 years *Innovation novelty*: average time between the start of an innovation project and the beginning of production; novelty of research; number of new-to-firm, new-to-region, and new-to-Italy product innovations *Non-technological innovation*: asked about organizational innovation in 1984, but not included in 1987 survey *Who developed*: not asked

Note: The leading researchers in each of the above studies include Lothar Scholz (Ifo), Frieder Meyer-Krahmer (Fraunhofer), John Hansen and Christopher Hill (USA), Andre Piatier (France), Alfred Kleinknecht (Netherlands) and Giorgio Sirilli (Italy).

Source: Hansen (1987).

what innovation surveys were designed to measure. The perspective of the *Frascati Manual* is that innovation is a supplementary activity to R&D, in that R&D-performing firms must make other investments to develop an R&D project into a commercially useful product or process. Pavitt supported this perspective in a 1976 paper for the OECD (Godin 2009: 6). The MIT and Fraunhofer studies took this approach by limiting the surveyed population to R&D-performing firms. The alternative perspective is that innovation is a unique activity that may or may not be combined with R&D. This perspective was partly supported by Kline and Rosenberg's (1986) chain link model of innovation, where the inspiration and source of information for an innovation can come from many sources other than the R&D department. However, Kline and Rosenberg's model can also be interpreted as largely applying to R&D-performing firms, with management choosing between several strategies for developing an innovation.

De Bresson and Murray (1984), by defining 'new to Canada' products and processes as an innovation, had widened the definition of innovation to include technologies that the firm may not have developed. In effect, this combined the concept of technology production with the concept of technology diffusion, as a firm that implemented a pre-existing technology obtained from another firm was the recipient of a diffusion process. Most previous research on innovation tended to separate the production of innovations from their diffusion and study them as two distinct processes (David 2011).

Only the French survey directly asked if the firm had introduced innovations that were developed by other firms, although this option was only provided for process innovations. Otherwise, many of the six surveys summarized in Table 3.1 were ambiguous on this issue. The Dutch, French and Italian surveys asked if the firm had introduced an innovation that was only new to the firm or its local region, implying that these innovations could have been obtained from external sources, but this possibility was not explicitly recognized in the definition of an innovation. This ambiguity in most of the surveys from the 1980s over who developed the innovation could have been due to the importance given by academics to in-house R&D, with the assumption that R&D-performing firms developed at least some of their innovations through their own in-house activities. This ambiguity also continued with the first *Oslo Manual* and the first CIS.

Three of the six surveys provided definitions of a product and a process innovation. Two surveys that were limited to R&D-performing firms did not include a definition of innovation, presumably because responding firms were assumed to innovate, and the French survey allowed firms to

provide their own definitions of an innovation. The three surveys that defined innovation included both entirely new products or processes and improved products or processes.

Including in the definition innovations that are only new to the firm creates substantial problems of comparability across firms because it includes as innovative both firms that only buy in new technology and firms that invest considerable financial resources to develop an innovation. Several of the questionnaires provided an opportunity to address the subjective element of these definitions by including other questions to establish the novelty of the firm's innovations. As shown in Table 3.1, two methods were commonly used to do so. The first was to ask if the firm had introduced innovations that were new to its country, while the second asked for the average amount of time required to develop an innovation from the initial stages to commercialization.

Other surveys in the late 1980s also contributed to innovation measurement and influenced the CIS. The Nordic Innovation Indicators Group conducted a survey of innovation in manufacturing firms located in Finland, Norway, Sweden and Denmark. Its main contribution was to implement a coordinated survey of innovation in four countries. The survey included questions that were similar to those used in the earlier studies in Germany, France, the Netherlands, Italy and the USA (Smith 1992). In respect to 'who developed' the innovation, the Nordic survey provided conflicting definitions of an innovation. A wide definition of product innovation was offered early on in the questionnaire as 'new products and substantial improvements of old products', but a later definition stressed in-house R&D, with product innovations defined as deriving from 'R&D projects that have resulted in marketable new products or essential improvements in existing products' (Smith 1992: 388). Finally, an American survey in the mid-1980s of R&D-performing firms examined appropriation strategies, technological opportunities and technological advance (Levin et al. 1987). The survey influenced the design of a question in CIS 1 on the importance of several appropriation strategies.

3. THE SYNTHESIS: THE FIRST *OSLO MANUAL* AND CIS 1

The OECD actively encouraged research on the measurement of innovation from the early 1980s, holding a conference in September 1980 on S&T indicators (OECD 1992). One of the goals was to 'reach a consensus on R&D output indicators', which essentially required indicators of innovation. A paper on 'New innovation indicators: conceptual basis and practi-

cal problems' was prepared by Keith Smith and presented to an OECD meeting of the National Experts on Science and Technology Indicators (NESTI) in November 1989. It drew on the results of the six surveys summarized in Table 3.1 plus the experience of the Nordic Indicators Group.

The need for better innovation indicators was translated into action by the efforts of the OECD's Technology Economy Programme (TEP), which ran between 1992 and 1994. The TEP was an extraordinarily wide-ranging networking initiative led by Robert Chabbal of the Directorate for Science, Technology and Industry (DSTI) in the OECD, bringing in researchers from around the world to discuss innovation and growth, the innovation research agenda, indicator needs (to do with human resources as well as innovation) and policy implications. On the indicators issue, a small working group met on a number of occasions, especially in Oslo, to discuss the definitional and collection issues and eventually to draft a set of guidelines for data collection. This group included Lothar Scholz, Giorgio Sirilli, Alfred Kleinknecht, John Hansen, Chris de Bresson and Keith Smith. The group provided the impetus for the draft *Oslo Manual*, or *Proposed Guidelines for Collecting and Interpreting Technological Innovation Data*, which was written by Keith Smith and Mikael Akerblom of the Finnish Statistical Office, and approved by the OECD's NESTI Working Party in 1992.

The first *Oslo Manual* identified six core issues for innovation survey research that included both the production of output indicators and the collection of process-oriented data on corporate strategies such as diffusion, the sources of innovative ideas and obstacles to innovation, the role of public policy and innovation inputs. The manual set out several basic concepts that continue to influence the design of the CIS and ongoing innovation research. For example, the manual, although focused on technological product and process innovation, noted that innovation can occur anywhere, including the public sector and the services sector (OECD 1992: para. 84). Research on service sector innovation expanded in the 1990s and in the first decade of the 2000s several exploratory surveys of innovation in the public sector were conducted that replicated the history of innovation surveys of private sector firms. The early surveys used the object-based method (Borins 2001; NAO 2006), while the later surveys, inspired by the *Oslo Manual*, adopted the subject-based method (Arundel and Hollanders 2011; Bugge et al. 2011; Hughes et al. 2011; APSC 2011).

Unfortunately, the manual was not completely clear on the relationship between R&D and innovation. The first *Oslo Manual* notes that 'the core task is to integrate an understanding of the R&D contribution with an account of the non-R&D inputs to the innovation process' and that we

need an 'overview of the balance which firms strike between R&D and non-R&D activities' (OECD 1992: para. 71). The paragraph suggests that innovation is a supplementary activity to R&D, although the definition of a technological innovation in paragraph 90 describes a process that does not necessarily require R&D. The ambiguity over the relationship between R&D and innovation continued through the first three CIS surveys.

In respect of the subjective nature of the definition of innovation, the first *Oslo Manual* suggests that the distinguishing factors that differentiate an innovation from a change that is not an innovation are 'elements of novelty and significance', but gives little further assistance other than to note that these elements are 'difficult to specify'. The reliance on 'elements of novelty' is similar to the definition of R&D in the *Frascati Manual*, which defines the difference between R&D and other problem-solving activities as based on an 'appreciable element of novelty and the resolution of scientific and/or technological uncertainty, i.e. when the solution to a problem is not readily apparent to someone familiar with the basic stock of common knowledge and techniques for the area concerned' (OECD 2002: 34). In paragraphs 146 and 147 the *Oslo Manual* suggests several questions to identify novelty, such as on the use of new materials or new production techniques.

The *Olso Manual* would have remained nothing more than a set of guidelines had it not been for the intervention of the European Commission. The Commission had at that time a programme in DG-XIII (later DG Enterprise) known as the European Innovation Monitoring System (EIMS), which undertook a wide range of analytical projects on innovation policy. EIMS was led by a visionary official, Gerhard Bräunling, who decided to implement the *Oslo Manual* as a Europe-wide survey, funded by the EIMS and organized and coordinated by Eurostat. The relevant Eurostat official, Werner Grünewald, saw the opportunity to create a much-needed set of policy indicators, and gave the project strong support. This led directly to the Community Innovation Survey (the title was Bräunling's contribution).[3]

The development of the first CIS, according to Smith (1997: 20), 'required a long process of discussions to seek a consensus on what types of firms should be included and what types of questions should be asked'. Many of the first *Oslo Manual's* recommendations for questions on innovation were not included in CIS 1. These include questions on the number of product and process innovations, the number of new-to-the-world innovations in order to give an 'impression of the originality of innovations' (para. 149) and an open question asking for a description of an innovation (para. 176). Similarly, not all recommendations in the second and third *Oslo Manual* were implemented in later versions of the CIS.

In several respects, CIS 1 was a large-scale pilot survey for innovation measurement, with 14 participating countries using different survey methods, survey units (establishment or enterprise) and follow-up protocols (Archibugi et al. 1997). The lack of a standard survey methodology and the absence of consistent participation by official statistical agencies led to large differences in response rates and the complete failure of the survey in the UK, where the survey was implemented by the Confederation of British Industry and the response rate was lower than 5 per cent. The standard questionnaire was based on the experience of the surveys of the 1980s, many of which had undergone some testing, but CIS 1 included many new questions and changes that had not been fully tested. But it laid the groundwork for what was to come.

The EIMS did not confine itself to coordinating the first CIS. It also funded over a dozen academic analyses of the CIS 1 data, with the results presented to a major 1996 conference in Luxembourg titled 'Innovation Measurement and Policies' (Arundel and Garrelfs 1997).

Godin (2009) argues that the main goal of the OECD and Eurostat for innovation surveys was to produce output indicators, a goal that arguably was not satisfactorily met because the surveys only produced two output indicators, the innovation sales share and the percentage of firms that innovated. The comparability of the latter indicator across sectors and countries was reduced by the highly subjective definition of product and process innovation that was used in the CIS. An examination of the history of innovation surveys, however, shows that the primary driver of innovation research was not statistical agencies but academics, although often with the support of government agencies interested in indicators, such as the NSF, Statistics Canada or the European Commission. Academic involvement ensured that innovation surveys collected microdata of value for research into four areas of economic theory: interactive models of innovation; evolutionary economics; the role of learning in innovation; and national systems of innovation (Smith 1997). The use of innovation surveys to produce indicators was not compulsory for the CIS until the implementation in 2004 of European Commission Regulation 1450/2004.

4. CIS 2 TO CIS 4

Each CIS questionnaire since CIS 1 has been altered, either to improve respondent understanding and consequently the quality of responses, or to obtain new information on innovation. Eurostat has coordinated changes to the standard CIS questionnaire, for use by all member states of the EU, with the assistance of an expert responsible for collecting proposals and

drawing up different draft versions of the questionnaire. Countries may add questions to the standard CIS and several countries have also altered the wording or response categories of some of the standard questions. Of note, this history is limited to changes to the standard questionnaire.

Up to and including CIS 2006, changes to the questionnaire were suggested and discussed by a committee that included all participating national statistical offices (NSOs). Due to the increasing number of participating NSOs, Veijo-Ismo Ritola of Eurostat replaced the full committee with a smaller CIS task force, consisting of approximately ten volunteer NSOs. Since CIS 2008, the Task Force has been responsible for developing a draft questionnaire that is presented to a meeting of all participating NSOs for discussion. As before, the final decision on which changes to accept or reject is made by consensus.

From CIS 4, Eurostat has required the external expert responsible for coordinating the changes to the CIS to produce a comprehensive final report that documents the reasons for all changes to the CIS questionnaire and the results of any pilot or cognitive testing. The reports also include other material of interest, such as the results of surveys of NSOs, academics and policy analysts on their use of CIS data.

Using the Eurostat reports and other documents, the history of the CIS after CIS 1 can be divided into two periods. Up until the fourth CIS (implemented in 2005 and referring to innovation activities between 2002 and 2004), the CIS underwent several substantial changes to some of the main concepts and definitions in order to address the ambiguity over who developed the innovation and the role of R&D. In addition, the coverage of innovation was expanded to include non-technological organizational and marketing innovation. By CIS 4, the main questions and questionnaire structure had crystallized. The need for consensus resulted in resistance to further substantial changes, with several NSOs preferring to maintain continuity over time in the indicators. For instance, a proposed CIS 4 questionnaire that gave equal treatment to product, process, organizational and marketing innovation was rejected in a meeting of representatives from all NSOs because it would destroy comparability with earlier CIS results for product and process innovation (Arundel and Bordoy 2005). Later attempts to develop a questionnaire that did not give preferential treatment to product and process innovation were also unsuccessful. Consequently, changes to the questionnaire after CIS 4 have been minor, with some exceptions discussed below. Table 3.2 provides an overview of the main changes to the CIS questionnaire, from CIS 2 to CIS 2012.

The largest changes to the CIS questionnaire were made for CIS 2. Mikael Åkerblom (1996), as the coordinating expert, proposed several substantive changes in a paper circulated to the participating NSOs and

Table 3.2 Overview of the CIS questionnaires

Survey	Observation period	Main changes or additions compared to the previous survey
CIS 1	1990–1992	–
CIS 2	1994–1996	Added questions on who developed product and process innovations Cooperation question extended from R&D only to include 'joint R&D and other innovation projects' Deleted questions on sources of new technology, technology transfer outside the enterprise, appropriation methods and product life cycles Separate questionnaire developed for service sector firms
CIS 3	1998–2000	Only one questionnaire for service and manufacturing firms, with improved relevance for service innovations by no longer referring to 'technological' product and process innovations Changed question on the innovation sales share from the share of sales from new products, improved products and unchanged products to the share of sales from unchanged, new-to-firm and new-to-market products
CIS 4	2002–2004	Added questions on three types of organizational innovation and two types of marketing innovation, plus questions on the effects of organizational innovation Under product innovation included separate questions for goods and services. Asked about three types of process innovations Cooperation question removes reference to 'active participation in joint R&D'
CIS 2006	2004–2006	Frequency increased to every 2 years Implemented cognitive testing for all question changes and additions
CIS 2008	2006–2008	Increased coverage of organizational and marketing innovation Introduced a rotating one-page module for questions of high policy interest, with the first module on environmental innovation
CIS 2010	2008–2010	Separate question on expenditures for design Module on creativity and skills
CIS 2012	2010–2012	Module on strategies and obstacles to growth, plus minor changes throughout the questionnaire to support econometric research on the link between innovation and growth Reintroduced a modified version of the CIS 1 appropriation question Added questions on the effect of the public sector and public procurement on innovation

Source: Authors.

to several external experts. One of the changes was to develop a modified questionnaire to be sent to service sector firms in order to meet the second *Oslo Manual's* (OECD/Eurostat 1997) recommendation to extend innovation surveys to cover selected service sectors. Other suggestions included reducing the lower bound for firm size from 20 to 10 employees, considerably reducing the length of the questionnaire to improve response rates and including an open question on the firm's most important innovation.

Åkerblom proposed deleting several questions in CIS 1 to reduce the questionnaire length: two questions on technology acquisition and technology transfer on the grounds that it was difficult to interpret the results to these questions; a question on appropriation; a question on product life cycles that accordingly produced unusable results due to very low response rates (Young 1997); and a question on exports from new or changed products that was very similar to the innovation sales share question and consequently added little additional information. The questionnaire length was also shortened by reducing the number of sub-questions on information sources, objectives and hampering factors, with the latter reduced from 18 to nine.

In addition to the question on the firm's most important innovation, Åkerblom proposed several new questions that were not included in the final version of CIS 2, for example questions on the factors that caused an increase in productivity, the frequency of introduction of new products or processes, the firm's main supplier of information and main customer, the time required to develop innovations, the expected pay-off period and the total budget. Conversely, several of Åkerblom's suggestions for new questions were accepted, including a question on incomplete or abandoned innovations, the use of government support, and if the firm had applied for at least one patent.

In addition to the major deletions and simplifications made to the CIS 2 questionnaire, significant changes were made up to and including CIS 4 to: (1) build all definitions into the question; (2) reduce the CIS emphasis on R&D; (3) improve the output questions on innovation expenditures and the innovation sales share; and (4) add questions on organizational and marketing innovations.

Definitions

CIS 1 and CIS 2 included lengthy definitions in preambles before questions, for instance to define product and process innovations and different types of innovation activities. The length of the definitions was reduced for CIS 3, but from CIS 4 all definitions were built into the question itself, wherever possible, to force respondents to read the question and to take

advantage of the opportunity to collect additional data. For instance, CIS 4 used separate questions to determine if the firm introduced each of three types of process innovations, whereas CIS 3 used one question that referred to a lengthy definition of process innovation in a preamble.

Resolving the R&D Question

The CIS questionnaire's bias towards R&D was reduced by resolving the ambiguity over the status of innovative activities that did not require R&D. As a first step, CIS 2 added a question, proposed by Niels de Lanoy of the Dutch Central Bureau of Statistics, on 'who developed' product and process innovations. The options included 'mainly other enterprises or institutes', 'your enterprise and other enterprises or institutes' and 'mainly other enterprises or institutes'.[4] Respondents could tick one or more of these options, as relevant. The last option was designed to capture product and process innovations that firms primarily acquired from external sources. However, the definition of a product and process innovation in CIS 2 did not specify that an innovation only needed to be 'new to the enterprise', which was included as the minimum threshold for an innovation in the second edition of the *Oslo Manual* (OECD/Eurostat 1997). This change was made in the third CIS, which noted that a product or process innovation only needed to be 'new to your enterprise' and therefore could have been developed by 'your enterprise or by another enterprise'.

The question on cooperation for innovation was also changed over time to reduce the emphasis on R&D. In CIS 1 the question asked 'did your enterprise have any cooperation arrangements on R&D activities with other enterprises or institutions?' The requirement for R&D was reduced in CIS 2 and CIS 3, with innovation cooperation defined as 'joint R&D and other innovations projects' in CIS 2 and as 'active participation in joint R&D and other innovation projects' in CIS 3. In CIS 4 the reference to 'R&D projects' was finally removed, due to concerns that the inclusion of 'R&D' would still give a priority to R&D-based collaboration activities (Arundel and Bordoy 2005: 79).

Innovation Output Questions

The results for the CIS 1 survey showed that approximately 45 per cent of respondents by country did not answer the questions on the percentage of product sales by innovative novelty (unchanged, incrementally changed and significantly changed or new) and 37.5 per cent did not answer the questions on the percentage of total innovation expenditures for R&D

and other innovation activities (Arundel et al. 2007: Table B2). As these are the two main output questions for CIS, they have undergone extensive changes over time to improve response rates and data quality.

The structure of the innovation sales share question was changed for CIS 2 and changed again for CIS 3, with a shift in focus to the share of sales for products that were only new to the firm and the share from products that were new to the firm's market. Yet both CIS 2 and CIS 3 had made the question more complex than in CIS 1 by also attempting to obtain data on the innovation sales shares by level of novelty. CIS 4 reduced the complexity of the question by only asking for the percentage of sales in terms of the firm's market and by providing a definition of the firm's market (Arundel and Bordoy 2005: 74). Since then, the innovation sales share question has remained unchanged, except for a few minor changes in wording. Non-response rates to this question dropped to less than 3 per cent for CIS 4 (Arundel et al. 2007: Table B2).

The innovation expenditure question has undergone several changes in order to increase the reliability of the responses. One option that was considered for CIS 3 was to only ask for qualitative data on innovation activities (Foyn 2006). This option was rejected because of strong policy interest in expenditure data.

The basic format of the innovation expenditure question was reached for CIS 4, which made two substantive changes to the expenditure question compared to earlier versions of the CIS. First, the definitions of innovation activities were included in the question (instead of in a lengthy preamble as in CIS 2) and second, the question was split into two parts. The first part asked, on a yes-or-no basis, if the firm engaged in different types of innovation activities. The second part asked for expenditure data for four main activities: in-house R&D; external R&D; acquisitions of machinery, equipment and software; and acquisition of other external knowledge. These changes increased the response rate for the innovation expenditure question from an average of approximately 64 per cent for CIS 1 to 85 per cent for CIS 4 (Arundel et al. 2007: Table B2).

There are ongoing concerns over the comparability of the responses to the question on innovation expenditures across countries, although less so within countries. Only 3.2 per cent of 28 NSOs, surveyed in October 2010, gave a rating of 'poor' or 'moderate' for within-country comparability for the expenditure question on the acquisition of machinery, equipment and software (Arundel et al. 2010: 28). Some of the concerns over the expenditure question have been addressed by NSOs by adopting best-practice survey methods, such as contacting firms to verify unusually high or low expenditure data. In addition, alternative versions of the expenditure data question underwent cognitive testing as part of the preparatory work for

CIS 2012. One version asked for total expenditures by activity and then for the share of the total that was for innovation. For example, respondents were asked to give their firm's total expenditures for new machinery, equipment and software and then asked for the share of these expenditures that were related to innovation. None of the alternative versions of the question performed better in the cognitive tests than the version that has been in use since CIS 4.[5]

Organizational and Marketing Innovation

Annex 2 of the second *Oslo Manual* (OECD/Eurostat 1997) discussed the measurement of non-technological innovations, consisting of organizational and managerial innovations. The first questions on non-technological innovations were included in CIS 3 (developed in 2000). The question asked if the firm had introduced a new strategy, management technique, organizational structure, marketing concept or significant change to the aesthetic appearance or design of products. CIS 4 included questions on three types of organizational innovations and two types of marketing innovations, along with a question on the effects of organizational innovations. The questions on non-technological innovations were expanded for CIS 2008 to meet the requirements of the third *Oslo Manual* (OECD/Eurostat 2005), but the basic framework of these questions has remained the same, with questions on different types of organizational and marketing innovations followed by a question on their effects. A series of more ambitious questions on both organizational and marketing innovation and on knowledge management had been proposed for pilot surveys and cognitive testing as part of the work to develop CIS 2006, with Denmark testing these questions in pilot surveys. The questions on organizational and marketing innovation asked who developed the innovation, if the innovation was linked to product or process innovations, the effects of the innovation, and the reasons for not introducing an organizational or marketing innovation (Arundel et al. 2007: 54–8). Yet, for space reasons, the CIS has never included a full set of questions on non-technological innovation.

5. CIS 2006 TO CIS 2012

The preparatory work for CIS 4 by UNU-MERIT included an evaluation of the use of CIS questions by academics (based on analysis of academic studies using CIS data) and a survey of the use of the CIS by policy analysts. The results found that academics rarely used CIS questions on

innovation objectives and hampering factors, indicating that these questions did not need to be included in every CIS, and that policy analysts continued to rely on R&D and patent statistics. The main impact of the CIS on policy analysts had not been via indicators, but through academic research that showed that R&D and innovation were not the same. These CIS results 'had a diffuse effect on the innovation strategies of national governments and the European Commission, but rarely had a direct and identifiable impact on specific policy initiatives' (Arundel and Bordoy 2005: 109).

The CIS 4 report made 11 recommendations on how to improve the reliability and quality of CIS data and the value of the CIS to policy and academic users. Five recommendations were implemented by Eurostat: (1) improved data access for academics by means of a safe centre that provided secure data access; (2) the preparation of a quality report after each survey to collect data from all EU countries on question non-response rates and other information of value to the design of each CIS; (3) the implementation of field or cognitive face-to-face testing of all new questions or changes to existing questions; (4) basing all question changes on empirical evidence on data quality and the relevance of the question to users; and (5) the inclusion of policy users in the decision process for each CIS.

The third recommendation, for cognitive testing of all changes, had been strongly supported by Mark Pollard of the UK Office of National Statistics for several years. Since extensive testing for CIS 1, cognitive testing of changes to the CIS had been haphazard. France had conducted 34 cognitive interviews for CIS 2 and the Dutch Central Bureau of Statistics had tested several layouts for the CIS questionnaire (Foyn 1999), but there had been no organized method of conducting comparable testing in more than one country or sharing cognitive testing results between countries. In response to the recommendations of the CIS 4 report, pilot testing was implemented for CIS 2006 and since CIS 2008 all new and altered questions have undergone two rounds of cognitive testing in several countries.

Many proposed CIS questions that were cognitively tested failed, for instance if the question was interpreted differently by various interviewees or if several interviewees could not understand the question. Other questions passed testing, but were not used in the CIS due to space constraints. The UNU-MERIT reports for CIS 2006, CIS 2008 (Arundel et al. 2009) and CIS 2010 provide full details for the cognitive testing results. Annex A of the report for CIS 2010 provides a summary of tested questions that have not been used in the CIS (Arundel et al. 2010). This information can assist future research on innovation surveys by identifying the problems

with tested questions and by providing a library of successful although unused questions on a range of topics.

As noted above, the main CIS questions have changed little since CIS 4, other than minor additions, deletions or wording changes. Nevertheless, several significant changes were included for CIS 2008 to ensure that the questionnaire remained flexible and relevant to changing policy interests. The CIS 2008 Task Force recommended including a one-page module of questions that could change every year in response to policy interest. To keep the questionnaire short, space for the module has been created by rotating questions that ask about factors that change slowly over time. These consist of the questions on hampering factors, intellectual property, information sources and innovation objectives. The first module for CIS 2008 covered environmental innovation, the second module for CIS 2010 asked about creativity and skills, and the module for CIS 2012 asks about the effects of strategies and obstacles for growth.

Flexibility can also be created by making minor changes throughout the CIS questionnaire. CIS 2010 improved coverage of the service sector by asking separate questions on goods and service innovations in the question group on product innovations. The proposed CIS 2012 questionnaire made several minor changes throughout the questionnaire to gather better data on the role of the public sector in private sector innovation. This included the addition of a question on the importance of 'clients or customers from the public sector' to the questions on information sources and cooperation and a new question on public procurement. These questions will complement ongoing work to measure innovation in the public sector.

Concern over the comparability of an innovation across sectors and countries has led to several additional changes after CIS 4 to identify the novelty of innovations. At the Blue Sky Forum in Ottawa in 2006, Svein Olaf Nas recommended adding a question on modifications and minor changes to existing processes and products obtained from other firms. This idea was picked up and included in a 'who developed' question in the 2007 Innobarometer Survey, designed to explore how non-R&D-performing firms innovate. The question was later added to the 2010 CIS. Extensive cognitive testing of questions on 'world-first' product innovations and new-to-market process innovations were conducted for CIS 2010 and CIS 2012, with a question on world-first product innovations and new-to-market process innovations added to CIS 2010. Cognitive testing for 2012 confirmed that respondents could answer an additional question on the share of total turnover from world-first product innovations.

Several perennial issues have been evaluated for almost every CIS survey since CIS 4 without reaching agreement. These include whether or not to provide equal coverage for organizational and marketing innovations, the

length of the observation period (two or three years), and if the questionnaire should be redesigned to avoid filter questions that currently send non-innovators to the end of the questionnaire.

6. CONCLUSION: FUTURE CHALLENGES FOR THE CIS

The future of the CIS depends on improving data quality and keeping the survey relevant for policy and academic users. The addition of a question module since CIS 2008 helps to maintain the interest of both sets of users, as will questions on the role of the public sector, which can complement current research on public sector innovation.

Other steps could also help to improve the relevance of the CIS. Eurostat (2012) currently publishes over 90 types of innovation indicators drawn from the CIS. However, all these indicators are based on one question, for instance the percentage of small firms that collaborate with clients or customers. This does not solve the novelty problem for innovative firms as the results combine highly innovative firms with weakly innovative firms. The more recent versions of the CIS include data that could be used to classify firms by innovative capability. For instance, indicators could be provided for firms that are world-first product innovators or for firms that are both world-first product innovators and active on global markets (Arundel 2007). These types of compound indicators could considerably improve comparability across countries.

Another limitation is that the main CIS output indicator, the innovation sales share, is limited to product innovations. There are no output indicators for process innovations or for organizational and marketing innovations. An option is to collect data on the effects of these innovations on costs. Questions to collect output measures of process innovation have undergone preliminary cognitive testing (Arundel et al. 2010: 58), but 25 per cent of the interviewees could not answer the question. Additional question development and testing would be required to reduce this percentage.

An option for the CIS that has been supported by some countries, including the USA, is to combine the innovation survey and the R&D survey. This would create cost savings and possibly reduce respondent burden. A concern expressed by many CIS Task Force members is that combining the two surveys would give respondents the impression that R&D is the dominant form of innovation, which if true would be a retrograde step, given the changes to the CIS over time to separate R&D from innovation. So far, there is a lack of good empirical evidence on the effect

of combining the innovation and R&D surveys. An exception is a study by the Norwegian Statistical Office (Wilhelmsen 2012), which randomly assigned firms to two groups, one of which received the innovation survey by itself while the other received a combined R&D and innovation survey. The results are equivocal. The percentage of firms reporting product or process innovation was significantly lower in the combined survey compared to the separate innovation survey, but the differences were not statistically significant for the percentage of firms that introduced a marketing or organizational innovation (although for both the percentage was notably lower in the combined survey). Aggregated total innovation expenditures did not differ between the two surveys. Some of these results are a cause for concern, but similar studies would need to be conducted in other countries before concluding that a combined survey would be able to provide innovation data that are unbiased by proximity to a considerable number of questions on R&D.

NOTES

1. Most innovation surveys cover enterprises (the smallest legally defined business unit), but for simplicity this chapter uses the term 'firm'.
2. See Collins (2003), Noel and Prizeman (2005) and Qureschi and Rowlands (2004) for a discussion of cognitive testing methods and examples of applications.
3. Bräunling was also responsible for the creation of TrendChart, another major Commission innovation policy initiative.
4. The next four CIS asked respondents to select the most appropriate option of the 'who developed' question (CIS 3, CIS 4, CIS 2006 and CIS 2008), but from CIS 2010 the question reverted to asking respondents to select all relevant options. This was done to be able to calculate the percentage of firms that only innovated through acquiring product and process innovations (Arundel and Bordoy 2005).
5. The final report for CIS 2012 should be available from Eurostat in late 2012 or early 2013.

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